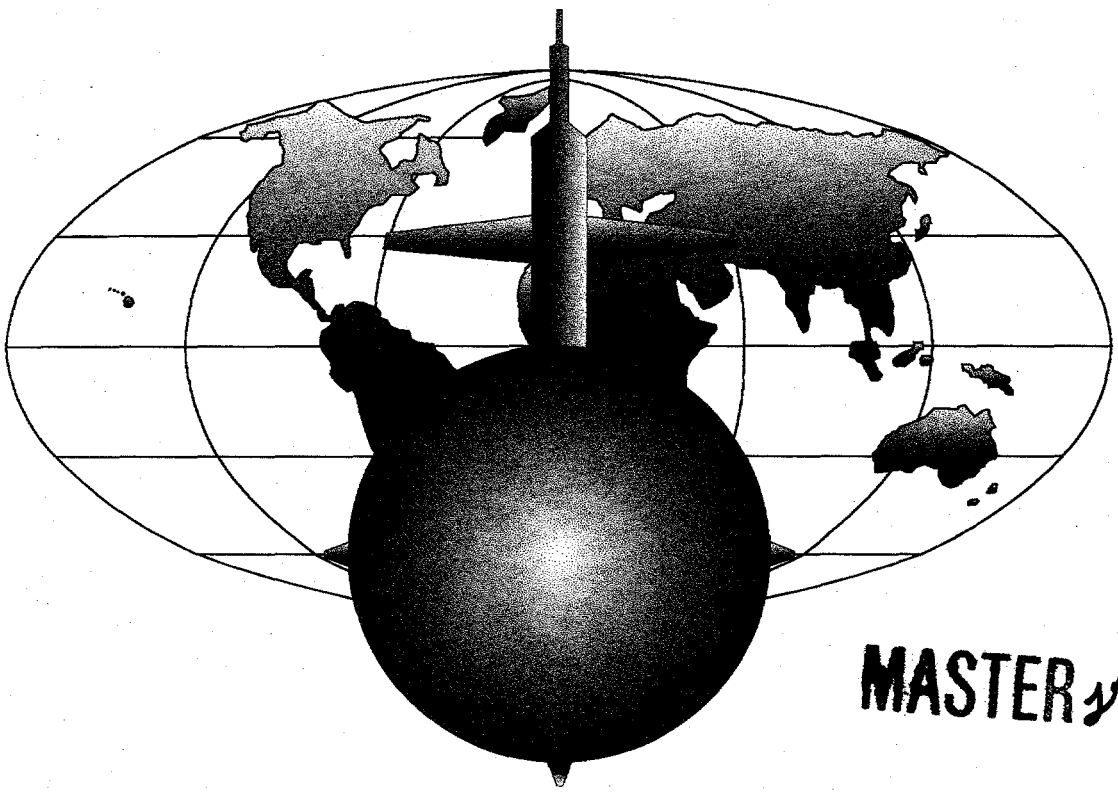
KAPL-4835

Knolls Atomic Power Laboratory

Environmental Monitoring Report

Calendar Year 1997



Operated for the U.S. Department of Energy
by KAPL, Inc., a Lockheed Martin company

DISCLAIMER

KAPL-4835
UC-41, Health and Safety

KNOLLS ATOMIC POWER LABORATORY

ANNUAL ENVIRONMENTAL MONITORING REPORT

CALENDAR YEAR 1997

This report contains data and information for the three government owned sites comprising the Knolls Atomic Power Laboratory operated for the Department of Energy by KAPL, Inc., a Lockheed Martin company, Schenectady, New York

KAPL, Inc.
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York
Operated for the United States Department of Energy,
Contract DE-AC 12-76SN00052

CONTENTS

CONTENTS (Con't)

CONTENTS (Con't)

TABLES

TABLES (Con't)

TABLES (Con't)

FIGURES

SUMMARY

The results of the effluent and environmental monitoring programs at the three Knolls Atomic Power Laboratory (KAPL) sites are summarized and assessed in this report. Operations at the three KAPL sites resulted in no significant release of hazardous substances or radioactivity to the environment.

The effluent and environmental monitoring programs conducted by KAPL are designed to determine the effectiveness of treatment and control methods, to provide measurement of the concentrations in effluents for comparison with applicable standards, and to assess resultant concentrations in the environment. The monitoring programs include analyses of samples of liquid and gaseous effluents for chemical constituents and radioactivity as well as monitoring of environmental air, water, sediment, and fish. Radiation measurements are also made around the perimeter of each site and at off-site background locations.

KAPL environmental controls are subject to applicable local, state and federal regulations governing use, emission, treatment, storage and/or disposal of solid, liquid and gaseous materials. Some non-radiological water and air emissions are generated and treated on-site prior to discharge to the environment.

Liquid effluents are controlled and monitored in accordance with permits issued by the Connecticut Department of Environmental Protection (CTDEP) for the S1C Site (also known as the KAPL Windsor Site) and by the New York State Department of Environmental Conservation (NYSDEC) for the Knolls and Kesselring Sites. Liquid effluent monitoring data show that KAPL has maintained a high degree of compliance with permit requirements. At the Knolls Site, sewage discharge limitations are imposed locally by the Town of Niskayuna in accordance with an Outside User's Agreement.

Air emissions are controlled and monitored in accordance with permits issued by NYSDEC for the Knolls and Kesselring Sites. The S1C Site has permanently secured all registered air emission sources and potential future air emissions are below levels that would require permitting. Where required, radionuclide air emission sources are authorized by the U.S. Environmental Protection Agency (EPA). Non-radiological air emissions are not required to be monitored. The use and maintenance of air emissions control equipment are sufficient for permit compliance. All air emissions conformed to applicable state and federal standards.

KAPL no longer operates landfills at the Knolls and Kesselring Sites. Knolls and Kesselring Site landfill operations were terminated in 1993 and 1994, respectively. Non-hazardous solid wastes are disposed of through local permitted facilities.

Chemicals are not manufactured at KAPL but are used incidental to site operations. Those substances characterized as hazardous by federal and state regulations are controlled through administrative procedures and personnel training. Small amounts of wastes are generated and disposed of off-site by waste vendors operating under permits issued by the cognizant state and federal regulatory agencies. Handling and storage incidental to shipment of wastes are controlled and monitored by trained personnel in compliance with applicable regulations. KAPL strives to minimize the quantity of hazardous and solid waste which it produces. Waste avoidance, beneficial reuse and recycling are practiced whenever practicable.

Accountability and radiation survey procedures are used at each KAPL site for the handling, packaging, and transportation of all radioactive materials. Shipments of radioactive materials are performed in accordance with detailed written procedures to ensure compliance with all applicable regulations of the Department of Transportation (DOT), the U.S. Department of Energy (DOE), and the U.S. Nuclear Regulatory Commission (NRC). All KAPL generated wastes that contain radioactive constituents are regulated under the Atomic Energy Act of 1954 and applicable DOE requirements. The volume of solid radioactive waste that requires disposal is minimized through the use of procedures that limit the amount of materials that become contaminated, by compaction of compressible wastes, and by recycling. Radioactive wastes are not disposed of at any of the three KAPL sites, but are shipped to government owned disposal sites. During 1997, approximately 324 cubic meters (424 cubic yards) of low level radioactive waste were shipped from the KAPL sites for disposal. This is less than one percent of the amount of radioactive solid waste

disposed annually at government owned disposal sites.

KAPL is in full compliance with DOE and EPA standards governing the release of radioactivity to the environment. The annual average concentration of radioactivity in liquid and gaseous effluents from each site corresponded to less than one percent of the permissible DOE radioactivity concentration guides at the boundary of each site. Radionuclide air emissions were also less than one percent of the EPA air emission standard. The total quantity of radioactivity released in airborne and liquid effluents from the three sites in 1997 was approximately 2.7 curies. No radioactivity attributable to 1997 operations at the three KAPL sites was detected in any of the environmental samples. Radiation dose to the general public as a result of KAPL operations was too small to be measured and therefore must be estimated using conservative calculational techniques that provide an upper bound on the potential dose. The maximum potential annual dose to an individual off-site was less than 0.1 millirem per year. This is less than one percent of the numerical guide established by the NRC for commercial reactor sites to demonstrate that radioactive materials in effluents released to unrestricted areas are "as low as is reasonably achievable". The maximum potential annual dose is also less than five percent of the total radiation a person aboard a commercial airplane would receive from cosmic sources during one coast-to-coast flight. The estimated annual collective dose to the entire population within 80 kilometers (50 miles) of any site was less than 0.1 person-rem, which corresponds to less than one thousandth of one percent of the dose received by the population from normal background radiation.

INTRODUCTION

The Knolls Atomic Power Laboratory (KAPL) is operated by KAPL, Inc., a Lockheed Martin company, under contract with the U.S. Department of Energy (DOE). KAPL consists of three separate sites: the Knolls Site, the Kesselring Site and the S1C Site, all of which are United States Government owned facilities. The principal function at KAPL is research and development in the design and operation of Naval nuclear propulsion plants. The Kesselring Site is also used for the training of personnel in the operation of these plants. The Naval nuclear propulsion plant at the Windsor Site shutdown in 1993 and is currently being dismantled.

The Knolls Site is located in the Town of Niskayuna, New York, approximately 3.2 kilometers (two miles) east of the City of Schenectady (Figure 11). The Site is situated on 170 acres of land on the south bank of the Mohawk River. Facilities at the Knolls Site include administrative offices, machine shops, a sewage pumping station, wastewater treatment facilities, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and chemistry, physics, and metallurgical laboratories. The surrounding area is a mixture of open land, other light industry, small farms, a closed municipal landfill, and suburban residential areas.

The Kesselring Site consists of 3900 acres on which are located four pressurized-water Naval nuclear propulsion plants and support facilities, including administrative offices, machine shops, training facilities, equipment service buildings, chemistry laboratories, a boiler house, oil storage facilities, cooling towers, waste storage facilities and wastewater treatment facilities. Two of the four nuclear propulsion plants have been permanently shut down, the S3G plant during 1991 and the D1G plant during 1996. These plants have been defueled and dismantlement work has commenced, starting with the S3G Prototype reactor plant. Dismantlement work began after completion of the National Environmental Policy Act process in January 1998. This process included public input in the evaluation of environmental impacts which could result from the dismantlement of the plants and is discussed later on in this report. The Site is located near West Milton, New York, approximately 27.4 kilometers (17 miles) north of the City of Schenectady, 14.5 kilometers (9 miles) southwest of Saratoga Springs and 21 kilometers (13 miles) northeast of Amsterdam (Figure 11). The surrounding area is a rural, sparsely populated region of wooded lands through which flow the Glowegee Creek and several small streams that empty into the Kayaderosseras Creek.

The S1C Site is situated on 10.8 acres of land in the Town of Windsor, Connecticut, approximately eight kilometers (five miles) north of the City of Hartford (Figure 12). Beginning in early 1997, dismantlement operations began on the defueled pressurized water Naval nuclear propulsion plant located at the S1C Site. This plant had been shut down since 1993. Dismantlement work began after completion of the National Environmental Policy Act process in December 1996. This process included public input in the evaluation of environmental impacts which could result from the dismantlement of the plant and is discussed later in this report. Support facilities at the site include administrative offices, a sanitary waste septic system, craft shops, waste storage facilities, and an equipment service building. The area surrounding the S1C Site is a mixture of open land, industrial regions, tobacco farms and suburban residential areas, through which the Farmington River flows in a generally southeasterly direction to its confluence with the Connecticut River.

Liquid effluents are monitored at the Knolls and Kesselring sites for radioactivity and for the chemical parameters listed in the applicable state pollutant discharge elimination system permits. Analyses are also performed on effluent and receiving stream water samples for select chemical parameters, some of which have state water quality standards. The S1C Site surface water effluent discharges, other than storm water, were terminated in 1995. Fish, water, and bottom sediment samples from the receiving streams are collected and analyzed for radioactivity. Non-radiological industrial air emission sources do not require monitoring under the terms of current state air permits due to the very low levels of emissions and the air emission control equipment specified in some of the permits. Airborne effluents from the main radiological emission points

are continuously sampled for radioactivity. Other minor radiological emission points are evaluated for the potential for release and monitored on a periodic basis, as necessary, to confirm the low emissions. In addition, radiation levels around the perimeter of each site and at several off-site background locations are monitored with sensitive dosimeters.

The quantities of radioactivity contained in liquid and gaseous effluents during operations in 1997 at the three KAPL sites were too small to have a measurable effect on normal background radioactivity. Solid radioactive wastes are packaged and shipped from the sites in accordance with all applicable U.S. Department of Transportation (DOT), DOE and U.S. Nuclear Regulatory Commission (NRC) regulations.

The use of chemically hazardous substances at the KAPL sites is strictly limited to the types and quantities essential for operation. Handling, transportation and disposal of hazardous waste are limited to vendors operating under permits issued by the cognizant state and federal regulatory agencies. Additionally, all KAPL personnel participate in a training program on the hazards of chemical substances. Other types of solid waste produced on-site, such as cafeteria waste, are disposed of at permitted facilities. Paper, cardboard, glass, wood, and plastic are also segregated for recycling whenever possible. Scrap metals are recycled through local vendors.

Effluent and environmental surveillance programs are conducted at each KAPL site in accordance with applicable DOE Orders to monitor con formance with applicable state and federal standards and to confirm that operations have had nosignificant impact on the environment or the public. The KAPL policy is to minimize releases tolevels that are as low as reasonably achievable. A summary of the 1997 monitoring data for each KAPL site is presented and assessed in this report.

During 1997, the three KAPL sites were inspected 19 times by state and/or federal environmental inspectors. These inspections have not identified any instances of non-compliance in operations. Seventy-seven periodic environmental related reports were filed with local, state and federal agencies. One report identified minor deviations from permit conditions.

Areas where historical petroleum or chemical spills have been identified were reported to appropriate regulatory authorities. The areas have been remediated or will be in the near future to meet state requirements.

Numerous programs to reduce the potential for environmental effects from KAPL operations were conducted. The Knolls and Kesselring Sites reported on detailed hazardous waste reduction plans for specific waste streams. Additionally during 1997, a program, started in 1991, was completed which resulted in the removal of all forty-one PCB transformers at KAPL sites. The PCB transformers were replaced with non-PCB transformers.

The Appendix provides general information on radiation and radioactivity for those who may not be familiar with radiological terms and concepts.

STANDARDS

Federal and state effluent and environmental air and water quality standards are used to interpret monitoring data and to assess the environmental impact from operations at the KAPL sites. In instances where standards are not provided for a specially monitored medium, e.g., river bottom sediment, assessments are based on a comparison of monitoring results to relevant parameters such as normal background radioactivity levels.

Specific effluent and environmental radioactivity standards applicable to KAPL operations are taken from U.S. DOE Orders 5400.1 and 5400.5, References (1) and (2), respectively, and the radiation dose limits established by the EPA for air emissions from DOE facilities, Reference (3). In addition, the potential radiation doses from KAPL operations to individuals off-site are compared to the numerical guides given in Appendix I of Title 10 - Code of Federal Regulations - Part 50 (10CFR50), Reference (4), and the radiation dose limit established by the EPA for public drinking water, Reference (5). Conformance with all the above guides as verified through sampling is considered to be conclusive evidence that radioactivity in effluents is kept as low as is reasonably achievable.

For chemical constituents in wastewater, the specific effluent and environmental standards applicable to KAPL operations are taken from the applicable state and federal standards given in References (1), (6), and (7). New York State water quality standards applicable to the Mohawk River and Glowegee Creek are given in Reference (8). The biological and chemical constituents of the Knolls Site sewage are regulated by an Outside User's Agreement with the Town of Niskayuna as defined in Reference (38). Applicable state air quality standards for chemical constituents are listed in References (9) and (10) for New York. Surface water effluent discharges, other than storm water, from the S1C Site in Connecticut were terminated in October 1995.

All environmental permits issued to the three KAPL Sites are listed in Table 44.

Any substance used at the three KAPL sites that is considered hazardous by the EPA or the state is procured, controlled, used, transported and disposed of off-site in accordance with the applicable state and federal standards given in References (11), (12), (13), (14), and (15).

To ensure that accuracy and precision are maintained in the analyses of effluent and environmental samples, KAPL maintains a quality assurance program that includes participation in the EPA Environmental Sciences Division Performance Evaluation Studies Program, the Quality Assessment Program of the DOE Environmental Measurements Laboratory, and an internal quality assurance program.

The internal quality assurance program involves routine analyses of calibration standards and background samples, as well as distribution of control samples to laboratory components and subcontractors that normally analyze effluent and environmental samples. Results of the analyses are evaluated by comparing the reported values with the known values. All calibration standards and control samples used in the quality assurance program are prepared and verified according to proven methods. Whenever possible, the calibration standards are based on the EPA or National Institute of Standards and Technology (NIST) standards.

Average values determined from the analyses of effluent and environmental samples are reported with their associated error limits. In some instances, the error limits might imply a negative value. The lowest possible value for any parameter is zero. A result that is below the minimum detectable level for a particular measurement is expressed as less than (<) the minimum detectable value. In calculating average values, sample results that are less than the minimum detectable levels are assigned the detection limit value, and the resultant average value is expressed as less than (<) the computed average value. This method of recording data is conservative.

KNOLLS SITE EFFLUENT AND ENVIRONMENTAL MONITORING

SITE DESCRIPTION

The Knolls Site (Figure 11) is located in the Town of Niskayuna, New York, approximately two miles (3.2 kilometers) east of the City of Schenectady. The Site is situated on 170 acres of land on the south bank of the Mohawk River. Facilities at the Knolls Site include administrative offices, machine shops, a sewage pumping station, wastewater treatment facilities, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and chemistry, physics, and metallurgical laboratories. The surrounding area is a mixture of open land, other light industry, small farms, a closed municipal landfill, and suburban residential areas.

The climate in the region of the Knolls Site is primarily continental in character, but is subjected to some modification from the maritime climate which prevails in the extreme southeastern portion of New York State. Winters are usually cold and occasionally fairly severe. Maximum temperatures during the colder winter months often are below freezing, and nighttime low temperatures frequently drop to 10°F or lower. Sub-zero temperatures occur rather infrequently, about a dozen times a year. Snowfall in the area is quite variable, averaging approximately 65 inches per year. The mean annual precipitation for the region is approximately 36 inches/year. Westerly winds (W to NW) predominate, and a secondary maximum occurs about the SSE.

The Knolls Site is located in the Mohawk River Valley at an elevation of approximately 330 ft. above sea level. Monitoring wells and test borings in the vicinity of the Knolls Site show that unconsolidated materials, consisting of mainly glacial deposits, overlie bedrock. The depth of bedrock beneath the land surface generally ranges between 10 and 70 feet. Rock outcrops are visible on both banks of the Mohawk River between Rexford and a point about three quarters of a mile downstream from the Knolls Site. The outcrops are flat-lying shales and sandstones of the Schenectady formation of Ordovician age. These rocks are characteristically non-porous and impermeable, and form poor aquifers. The structure of most of the consolidated rocks in Schenectady County is relatively simple. Over 90 percent of the entire County is underlain by the Schenectady formation, a series of alternating beds of shale, sandstone and grit about 2,000 feet thick, which dip gently west and southwest. The Snake Hill formation is exposed along both sides of the Mohawk River near the dam at Lock 7, downstream from the Knolls Site. This formation consists of a considerable thickness of dark gray to black, bluish, and greenish-gray shale. It is the only formation in Schenectady County that is strongly folded, having been thrust westward against and over the Schenectady formation.

The glacial deposits consist almost entirely of glacial till. Basal till at the Knolls Site is a clay rich glacial drift. It is dense, compact, and is known locally as hardpan. The depth under the site ranges from 0 to 70 feet. The till appears a grayish-blue color but in the upper twelve feet portion it has been weathered to a yellowish brown color. Within the till occasional lenses of graded material, usually fine sand, exist. The till is almost entirely impermeable except for a few lenses of sand which are capable of transmitting water. It is believed that these lenses are small in size and isolated from one another based upon drilling records. Overlying the till are thin glacial lake sequences (silts and clays) and discontinuous ice-contact deposits (sand and gravel). The ice-contact deposits are capable of transmitting water but their limited extent diminishes the potential for yielding useable water volumes.

The Knolls Site is located adjacent to the Mohawk River which serves as the main water course for the Mohawk River Drainage Basin, covering an area of 3456 square miles. The river flows eastward to where it joins the Hudson River in Cohoes, N.Y. The average flow rate of the Mohawk River is 5,662 cubic feet per second (cfs) and the lowest recorded seven-day average flow is 458 cfs (296 million gallons per day) during August 1995. Three streams drain directly to the Mohawk River from the Knolls Site. The East Boundary Stream is located on the Knolls Site between the Knolls and the Niskayuna Landfills. The Midline Stream drains the central area of the site and basically receives only runoff from the site property. The West Boundary Stream is located adjacent to the Knolls Site on GE Research and Development (R&D) Center property and receives some surface water runoff from the Knolls Site, and the surrounding land. A fourth

stream, which is actually a drainage ditch on the west side of the Knolls landfill, is known as the West Landfill Stream. This stream does not directly discharge to the Mohawk River. The flow in all of these streams becomes extremely low during the dry summer weather. These streams are not accessible to the public except at the point where they each meet the Mohawk River.

The groundwater under the Knolls Site is very limited due to the low permeability of the soil which prohibits the development of this area as a potable water supply. There are no underlying principal or primary bedrock or overburden aquifers. Water for site operations involving potable and limited cooling use is obtained from the Schenectady and Niskayuna Municipal Water System. The majority of water for non-contact cooling at the Knolls Site is obtained from the Mohawk River. There are no production wells for service water on site.

The Mohawk River is classified by the New York State Department of Environmental Conservation (NYSDEC) as a Class A stream. The best usages of Class A waters are considered to be: a source of water 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 Knolls Site discharges water from its various operations within the concentration, mass loading, and flow limits set by the state wastewater discharge permit, Reference (6).

LIQUID EFFLUENT MONITORING

Origins

The principal sources of effluent water are:

1. *Cooling Towers* - Cooling water, used for central air conditioning, is treated to maintain a pH range of 7.5 to 8.2 to minimize scale buildup, prevent corrosion of systems materials, and to inhibit the growth of algae and slime.

2. *Site Boiler Plant* - Site boiler water is chemically treated, softened and de-alkalized water. Operations that result in releases are (1) periodic blowdowns to control boiler chemistry and (2) ion exchange resin regeneration effluent. The waters generated by these operations are neutralized before release.

3. *Sewage Pumping Station* - The Knolls Site sewage is pumped to the Town of Niskayuna sewage treatment facilities. The untreated sewage consists primarily of wastewater from restrooms and janitorial sinks. A small portion (<4%) may also consist of dilute non-hazardous laboratory rinse water, dilute non-hazardous analytical waste, environmental samples and ammoniated or phosphated process water.

4. *Non-contact Cooling Water* - Mohawk River and site service waters are used as non-contact cooling media for several heat exchangers.

5. *Process Water* - Treated/untreated wastewater, primarily from cooling tower blow down and river water strainer system, is generated on-site. Process water treatment typically consists of one or more of the following processes; sedimentation, filtration, ion exchange, activated carbon and/or neutralization.

6. *Site Drainage Water* - Storm drainage water and groundwater also make up a portion of the liquid effluent.

Approximate flows and chemical characteristics of the discharges to the Mohawk River were incorporated in the Reference (6) State Pollutant Discharge Elimination System (SPDES) permit application.

The concentrations of radioactivity in liquids released from the Knolls Site have always been below all applicable limits. A water reuse system is used whereby liquids from current laboratory operations that may contain radioactivity are collected, processed, and reused in certain laboratory operations to the maximum extent practicable. This minimizes the quantities of radioactivity released from the Knolls Site.

Where practicable, liquids from sources other than current laboratory operations that may contain radioactivity are collected in holdup tanks and are processed in batches. The processing system consists of a series of filters and demineralizers. Each batch of processed liquid is held in tanks and sampled to ensure that the radioactivity content is minimal and in compliance with applicable water quality standards. In addition, each tank of processed water is sampled during release to provide a sensitive determination of the radioactivity

actually released. The samples are combined into one or more monthly composite samples that are analyzed to determine the quantity and identity of the radionuclides present.

In addition, small amounts of groundwater that contains low level residual radioactivity from operations conducted during the 1950's and 1960's are released in the site drainage water. The principal radioactive constituents released to the Mohawk River from all sources are the longer lived fission products, notably strontium-90 and cesium-137.

Effluent Monitoring

The Knolls Site wastewater discharged to the Mohawk River is regulated by a State Pollutant Discharge Elimination System (SPDES) Permit, Reference (6). The SPDES permit specifies the required sampling locations, parameters, and minimum sampling frequencies. The current permit became effective on January 1, 1995 and is effective for 5 years. The permit was last modified on July 31, 1997 to set permit limits for suspended solids for Outfalls 003X and 003B.

Liquid effluent from the Knolls Site enters the Mohawk River through a submerged drain line (Outfall 002), five small surface outfalls (Outfalls 003A, 003B, 003D, 003E, and 003X), and three natural storm water streams (Outfalls 004, 005, and 006) as shown in Figure 1.

Outfall 002 discharges non-contact cooling water, process water, storm water, and groundwater through a submerged drain line directly to the Mohawk River. The Outfall 002 monitoring station consists of a Parshall flume which provides for the measurement and recording of effluent flow rate, total flow, and for the collection of samples proportional to effluent flow. The Outfall 002 monitoring station is also equipped with pH and radioactivity monitoring equipment. This equipment alarms to provide an alert in the event of out-of-specification pH levels and radioactivity concentrations and of sampling equipment malfunctions. A monthly composite sample is prepared from the proportional samples collected at the monitoring station and is analyzed for radioactivity. In addition, periodic grab samples are taken at Outfall 002 and analyzed for the constituents specified in the SPDES Permit.

Outfalls 003B and 003D discharge Mohawk River water used for once-through non-contact cooling, groundwater, and stormwater. These outfalls are monitored on a monthly basis. In 1995 a suspended solids settling tank was installed to remove concentrated river water sediment from a strainer backwash effluent. The river water used for non-contact cooling must be strained to remove large particles (>250 microns). This prevents clogging of Knolls Site heat exchangers and instrumentation lines. The inlet and outlet of the settling tank have been designated as Outfalls 003S and 003T. The discharge from 003T is directed to Outfall 003B. The minimum sampling frequency for this tank is twice per month. Outfalls 003A and 003E discharge groundwater and storm water. These outfalls are monitored quarterly. All monitoring is in accordance with the SPDES permit. Outfalls 003A, 003B, 003D, and 003E are also sampled at least quarterly for radioactivity.

Outfall 003X is used to intermittently discharge river water used to backwash a traveling screen located at the river water cooling system intake. This screen is used to remove large debris such as twigs and leaves from the intake river water. Outfall 003X is monitored at least monthly when in operation. This outfall did not operate during 1997.

Three Knolls Site stormwater outfalls are designated as 004, 005, and 006, and correspond to the West Boundary Stream Ditch, Midline Stream and East Boundary Stream, respectively. The flow in these surface water streams at times becomes intermittent and they are sampled quarterly, when possible. The sampling location for Outfall 004 is the ditch which is on KAPL property. This ditch joins the West Boundary Stream. Therefore, the water which is monitored is only from KAPL operations and is not influenced by the GE Research & Development Center. The West Landfill Stream is also sampled quarterly, when possible.

The Outside User's Agreement negotiated with the Town of Niskayuna specifies the parameters and sampling frequency for the untreated sewage. The minimum sampling frequency is monthly for chemical constituents and at least quarterly for radioactivity. A 24 hour flow-composited sample is collected weekly. The pumping station is

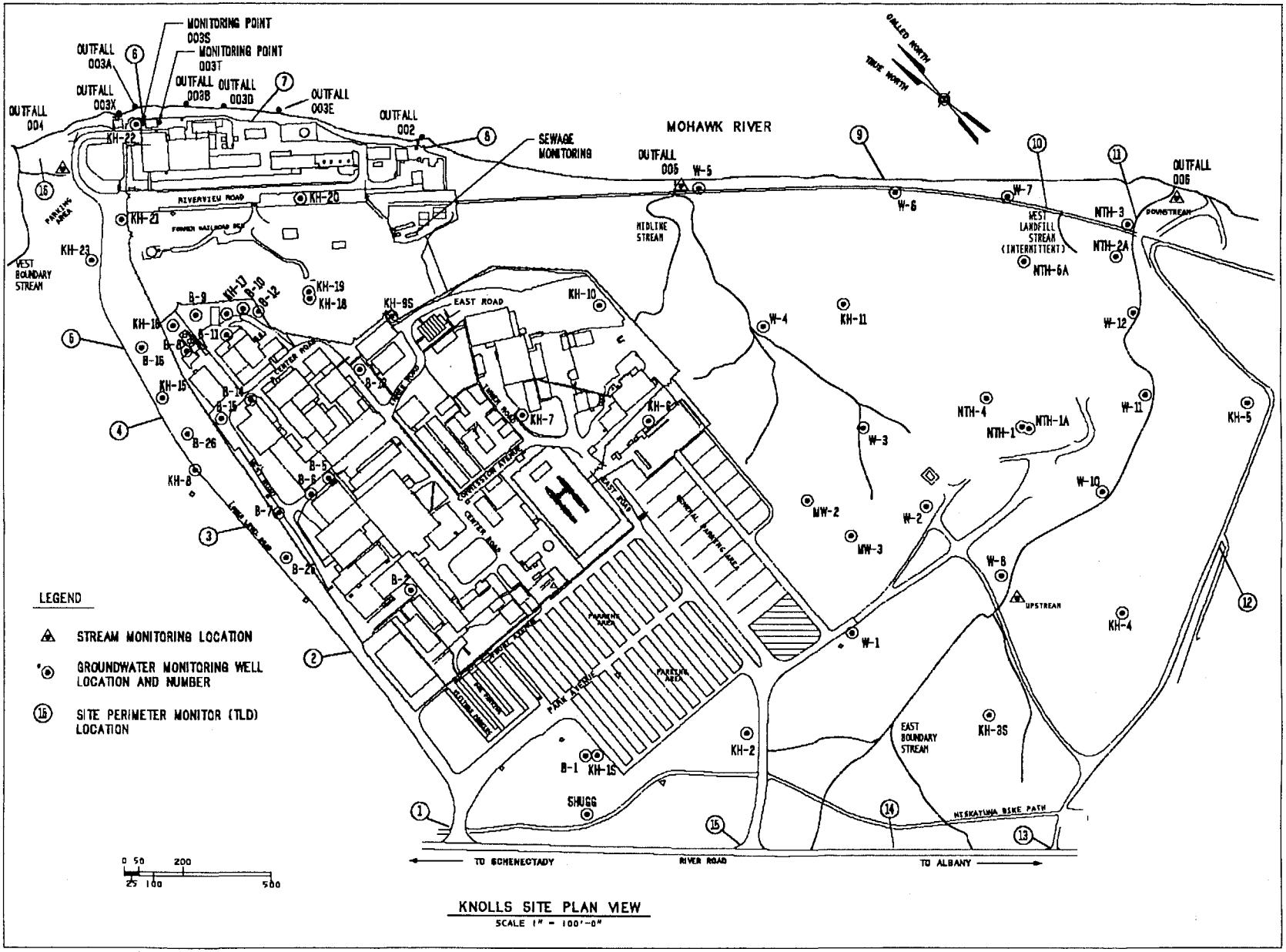


Figure 1

Knolls Site, Niskayuna, New York
Stream and Outfall, Groundwater, and Perimeter TLD Monitoring Locations

equipped with a pH alarm which will divert the sewage to a holding tank if the pH is out of the specified band.

Effluent Analyses

Periodic grab samples collected from Outfalls 002, 003A, 003B, 003D, 003E, 003S, 003T, 004, 005 and 006 are analyzed for the chemical constituents listed in Reference (6). Outfall 003X was not operated during 1997. Samples from various outfalls are analyzed for additional parameters for informational purposes only and are presented in the appropriate data tables. Twenty-four hour flow-composited samples of the sewage pumped to the Town of Niskayuna are collected and analyzed as required by Reference (38).

The monthly composite sample collected at the Outfall 002 is analyzed for (1) strontium-90, (2) cesium-137 and other gamma-emitting radionuclides, (3) tritium, (4) gross beta radioactivity and (5) alpha radioactivity. In addition, samples from the small cooling and drainage water outfalls are analyzed for alpha radioactivity and gross beta radioactivity. If the gross beta radioactivity exceeds a specified concentration, analyses for strontium-90, cesium-137 and other gamma emitting radionuclides are performed. Analyses for strontium-90 are performed routinely for those outfalls that drain water from areas containing residual strontium radioactivity from prior operations at the site.

The quarterly composite sample of the sanitary sewage effluent to the Town of Niskayuna Municipal Treatment Plant is analyzed for strontium-90 by chemical separation and subsequent beta counting, cesium-137 and cobalt-60 by gamma spectrometry, tritium by liquid scintillation spectrometry, and uranium by chemical separation and mass spectrometry.

Assessment

The analytical results for the chemical constituents, flow and temperature monitored in the Knolls Site sewage effluent during 1997 are summarized in Table 1. The pumping station has operated within all parameters specified in the Outside User's Agreement.

The average radioactivity concentrations in the sanitary sewage effluent to the Town of Niskayuna are shown in Table 2. Only naturally occurring uranium and strontium-90 at concentration levels typically found in surface water from past atmospheric weapons testing were detected in the effluent. No radionuclides attributable to KAPL operations were detected in the effluent composite sample. The radioactivity concentrations in the sanitary sewage effluent were less than one percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 2) as required by the User's Agreement (Reference 38).

The analytical results for the chemical constituents, flow and temperature monitored in the Knolls Site liquid effluent during 1997 are summarized in Table 3. The annual average values of all parameters were within the appropriate effluent standards where standards exist for Outfalls 002, 003A, 003B, 003D, 003E, 003S, and 003T.

In September 1997, KAPL treated the river water cooling system to control the zebra mussel population within the river water piping system. This treatment was conducted in accordance with the site SPDES permit (Reference 6). The process was effective in controlling the zebra mussel population within the river water piping system.

The analytical results for chemical constituents, flow, and temperature for Knolls Site storm water monitoring of surface water streams as required by the SPDES permit were within the specified parameters. These results are summarized in Tables 5 and 6 and discussed on pages 17 and 18 of this report.

The radioactivity released in effluent water during 1997 consisted of: (1) less than 0.001 curie of fission and activation products with half lives greater than three hours including those listed under Effluent Analyses, and (2) less than one microcurie each of uranium and plutonium. The radioactivity was contained in approximately 6.53×10^9 liters of water released from the site and was further diluted by mixing in river water following release. The annual average radioactivity concentration in that effluent, prior to additional dilution in Mohawk River water, corresponded to less than 0.1 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 2) for the mixture of radionuclides present.

Liquid effluent monitoring data are reported as

required in Reference (6).

AIRBORNE EFFLUENT MONITORING

Origins

The principal source of industrial gaseous effluent is the Knolls Site steam-generating boiler system. The Knolls Site boilers burn natural gas with number 2 fuel oil used as a backup. The combustion gas products are released through elevated stacks. Another stationary combustion installation source is two natural gas water heaters which exhaust through a common stack. Other operations at the site which result in gaseous effluents include a vacuum induction melting/gas atomization (VIM/GA) system, a paint spray booth, carpenter shop, metal cut-off wheels, belt grinders and welding. Numerous non-radiological analytical chemistry laboratory hoods comprise another source of air emissions.

Laboratory operations involving radioactive materials result in a small amount of airborne radioactivity being released. Operations capable of generating airborne radioactivity are serviced by controlled exhaust systems that discharge through elevated 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.

Effluent Monitoring

The Knolls Site has six air emission permits, as specified in Table 44. Under the terms of the permits for these emission sources, emission monitoring is not required. The NYSDEC regulations do not require air emission permits for laboratory hoods used for normal analytical or research and development operations.

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 may be present. Exhaust systems servicing major facilities are also continuously monitored for particulate, iodine, and noble gas radioactivity, as appropriate. 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 the low emissions.

Effluent Analyses

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 minimum detectable concentrations 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 and antimony-125 by gamma spectrometry, which provide a minimum detectable concentration 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 gas monitor.

Assessment

The New York State emission standards for stationary combustion installations are listed in Reference (10).

Two operations at the Knolls Site are currently "capped", or limited, to the following conditions in accordance with an air emission permit issued by NYSDEC:

Boiler Operations

1. A maximum heat input of 162.4 billion BTU's during any 12 month period,

2. The quantity of fuel used during any 12 month period shall not exceed 154.7 million standard cubic feet (SCF) of natural gas or 1.16 million gallons of Number 2 fuel oil or any combination of the two, and

3. The sulfur content of any fuel oil burned shall not exceed 0.5 percent by weight.

VIM/GA Operations

1. The emission source is limited to 365 atomization cycles per year.

2. Total solid particulates with a "B" environmental rating shall not exceed 0.050 grains of particulates per cubic foot of

exhaust gas, expressed at standard conditions on a dry gas basis.

3. The emission control equipment shall be kept in a satisfactory state of maintenance and repair and shall not be removed without prior approval from the NYSDEC Regional Air Pollution Control Engineer.

Records are required to be maintained for a period of five years to verify compliance with the permit conditions.

Fuel analyses for oil used by the Knolls Site boilers confirm that the number 2 fuel oil contained less than 0.5 percent sulfur by weight.

The radioactivity released in exhaust air during 1997 consisted of: (1) less than 0.00001 curie of uranium, (2) less than 0.000001 curie of plutonium, (3) less than 0.0001 curie each of particulate fission and activation products with half lives greater than 3 hours, and (4) approximately 0.24 curie of krypton-85.

The airborne radioactivity was contained in a total air exhaust volume of 1.55×10^{12} liters. The average radioactivity concentration in the exhaust air was well below the applicable standards listed in Reference (2). The radioactivity concentration for the year at the nearest site boundary, based on the annual diffusion parameters, averaged less than 0.01 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 2) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required in Reference (3).

All other point source emissions are operated with the appropriate air emissions control equipment.

ENVIRONMENTAL MONITORING

Scope

The Knolls Site environmental monitoring program includes: a) the routine collection and analysis of samples of Mohawk River water, sediment, and fish; groundwater; and local municipal waters; b) continuous monitoring of radiation levels off-site and at the perimeter of the site, and c) the continuous sampling of air at stations located in the predominant upwind and downwind directions from the Knolls Site.

Mohawk River water and bottom sediment samples are collected for radioactivity analyses at locations upriver and downriver from the main Knolls Site outfall as shown in Figure 2. Samples are collected during each of three 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 × 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 upriver and downriver from the Knolls Site outfall for gamma spectrometry and radiochemical analyses.

The municipal water systems servicing the area surrounding the Knolls Site are those of Schenectady, Niskayuna and Latham/Colonie, New York. Supply wells for the Schenectady and Niskayuna systems are located upriver and downriver, respectively, from the Knolls Site. Although there is no direct mechanism for Knolls Site 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 which obtains a portion of its water from the Mohawk River approximately five miles downriver from the Knolls Site. Monthly samples are composited quarterly and analyzed for radioactivity.

Surface water is sampled quarterly for water quality and monthly for radioactivity (except Mohawk River samples which are collected quarterly) at the following locations: Mohawk River upriver and downriver from the Knolls Site outfall, the West Boundary and Midline Streams near the point of entry to the Mohawk River, and the East Boundary Stream upstream and downstream of the landfill. The West Boundary Stream Ditch sample point is on KAPL property, prior to where the ditch enters the West Boundary Stream. The West Boundary Stream enters the Mohawk River upstream from the Knolls Site. A fourth intermittent surface drainage stream, the West Landfill Stream, is also monitored when possible. Stream sample points are shown on Figure 1.

Radiation levels at the boundary of the Knolls Site are monitored with thermoluminescent dosimeters (TLDs) at the 16 locations shown in Figure 1. Six lithium fluoride TLD chips, selected for uniform sensitivity, are placed at each monitoring location, and the dosimeters are changed and processed quarterly. Dosimeters are also placed at off-site locations to determine typical background radiation levels.

TABLE 1 - CHEMICAL CONSTITUENTS KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT IN 1997

Parameter (Units)	Number of Samples	Value[1] Discharge Point J8 Knolls Site Sewage Lift Station Minimum	Maximum	Average[2]		Permit Limit[6]	Percent of Limit[3]
Discharge Permit Requirements (Reference 38)							
Flow (GPD)*[7]	12	17,100	33,100	22,900	± 3060	45,000	51
pH (SU)**	252	7.1	8.8	8.0	± 0.0	6.0-9.5[4]	--
Biochemical Oxygen Demand (mg/l)	53	172	715	368	± 32	700	53
Chemical Oxygen Demand (mg/l)	53	402	1520	877	± 57	1800	49
Total Suspended Solids (mg/l)	53	193	1440	723	± 77	1600	45
Ammonia (mg/l) (as N)	53	38	118	84.4	± 4.7	200	42
Nitrate (mg/l) (as N)	53	0.09	3.4	0.59	± 0.17	4	15
Nitrite (mg/l) (as N)	53	<0.02	0.31	<0.05	± 0.01	4	<2
Total Kjeldahl Nitrogen (as N) (mg/l)	53	72	151	118	± 5	250	47
Total Organic Nitrogen (as N) (mg/l)	53	16	53	33.6	± 2.6	175	19
Total Nitrogen (mg/l) (as N)[5]	53	72.8	<151	<119	± 5	250	<48
Phosphate as P (mg/l)	53	6.0	20	14	± 1	30	47
Oil & Grease (mg/l)	53	26	111[8]	48	± 4.7	No Limit	--
Sulfate (mg/l)	26	18	73	47.9	± 4.0	No Limit	--
Sulfide (mg/l)	26	<0.1	<0.1	<0.1	± 0.0	No Limit	--

*GPD = Gallons per day
**SU = Standard units

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.
(3) Percent of limit for the average value, unless otherwise noted.
(4) All values are required to be within this range.
(5) Daily average limit; calculated as the sum of nitrate + nitrite + total Kjeldahl nitrogen.
(6) Outside User's Agreement allows for monthly averaging of data unless noted.
(7) Flow is calculated using daily pumping hours for the month times a calibrated pumping rate.
(8) The high oil & grease concentration was caused by a failure in the cafeteria oil & grease separator. This unit was replaced.

TABLE 2 KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT, QUARTERLY COMPOSITE SAMPLE RADIOACTIVITY RESULTS, 1997

Radionuclide	No. of Samples	Average Radioactivity Concentration[1] (x 10^{-9} μCi/ml)	DOE Order 5400.5 Derived Concentration Guide (DCG) (x 10^{-9} μCi/ml)	Percent of DCG
Cs-137	53	<0.69	3000	<0.023
Sr-90	53	<0.26 ± 0.13	1000	<0.026
Co-60	53	<0.73	5000	<0.015
H-3	53	<139	2000000	<0.007
U-234[2]	53	0.147 ± 0.173[4]	500	0.029
U-235[2]	53	0.0051 ± 0.0054[4]	600	<0.001
U-236[2]	53	0.0001 ± 0.0001	500	<0.001
U-238[2]	53	0.110 ± 0.116[4]	600	0.018
			Total Percentage[3]	**<0.12%**

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.

(2) The weight percentages of the uranium isotopes in the sample analyzed by mass spectrometry indicate that only naturally occurring uranium is present. The concentrations of the uranium isotopes are typical of background environmental samples.

(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 38).

(4) The lowest possible value for any parameter is zero.

TABLE 3 - CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS SITE LIQUID EFFLUENT, 1997

Parameter (Units)	Number of Samples	Value[1] Discharge Points 002 and 003A -E Minimum	Maximum	Average[2]		Permit Limit[9]	Percent of Limit[3]
Discharge Permit Requirements (Reference 6)							
Discharge Point 002							
Intake pH (SU)*	57	6.7	7.9	7.4	± 0.1	Monitor	--
pH (SU)*	58	6.7	8.3	7.5	± 0.1	6.5-8.5[5]	--
Flow (GPD)**	Continuous	850,700	3,910,800	2,443,758	± 60,196	Monitor	--
Temperature (°F)	56	34.5	83.7	55.8	± 4.1	90	93
Total Residual Chlorine (mg/l)	63	<0.02	0.09	<0.04	± 0.00	0.2[7]	45
Intake Iron (mg/l)	9	0.06	0.64	0.22	± 0.14	Monitor	--
Iron (mg/l)	53	<0.05	0.39	<0.16	± 0.01	4.0[4]	10
Manganese (mg/l)	8	<0.02	0.03	<0.02	± 0.00	0.35	9[12]
Dissolved Sulfide (mg/l)	53	<0.1	<0.1	<0.1	± 0.0	2.0	<5
Surfactants (mg/l)	8	<0.02	<0.02	<0.02	± 0.00	0.4	<5[12]
Bromide (mg/l)	8	<1	<1	<1	± 0.0	1.4	<71[12]
Copper (mg/l)	8	<0.05	<0.05	<0.05	± 0.00	0.2	<25[12]
Oil & Grease (mg/l)	53	<1	1.6	<1.0	± 0.02	15	11
Suspended Solids (mg/l)	53	<1	18	<4.1	± 1.2	Monitor	--
Discharge Point 003A							
Flow (GPD)**	4	3,086	13,292	6,956	± 7,108	Monitor	--
pH (SU)*	4	7.3	7.7	7.5	± 0.3	6.5-8.5[8]	--
Temperature (°F)	4	45.1	61.2	54.8	± 11.8	90[6]	--
Oil & Grease (mg/l)	4	<1	<1	<1	± 0.0	15	<7
Suspended Solids (mg/l)	4	<1	2.5	<1.4	± 1.2	Monitor	--
Discharge Point 003B							
Flow (MGD)***	Continuous	0.57	3.06	1.68	± 0.03	Monitor	--
pH (SU)*	12	7.0	7.6	7.2	± 0.1	6.5-8.5[5]	--
Temperature (°F)	Continuous	33.4	81.6	53.8	± 1.7	90	91
Oil & Grease (mg/l)	12	<1	1.0	<1.0	± 0.0	15	7
Suspended Solids (mg/l)	21	<1	22	<6.0	± 3.2	35	63
Iron (mg/l)	4	0.06	0.27	0.15	± 0.16	2.0	14[12]
Discharge Point 003D							
Flow (MGD)***	105	0.01	2.39	0.79	± 0.12	Monitor	--
pH (SU)*	12	6.9	7.6	7.2	± 0.13	6.5-8.5[5]	--
Temperature (°F)	285	33.3	85.4	52.5	± 1.7	90	95
Oil & Grease (mg/l)	12	<1	1.2	<1.0	± 0.0	15	8
Suspended Solids (mg/l)	12	1.5	30	11.4	± 6.4	Monitor	--
Iron (mg/l)	4	0.13	0.38	0.24	± 0.17	2.0	19[12]
Discharge Point 003E							
Flow (GPD)**	4	1,037	2,282	1,653	± 874	Monitor	--
pH (SU)*	4	7.2	7.9	7.5	± 0.5	6.5-8.5[8]	--
Temperature (°F)	4	38.5	68.4	55.7	± 20.5	90[6]	--
Oil & Grease (mg/l)	4	<1	<1	<1	± 0.0	15	<7
Suspended Solids (mg/l)	4	<1	3.0	<1.8	± 1.5	Monitor	--

TABLE 3 - CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS SITE LIQUID EFFLUENT, 1997 (continued)

Parameter (Units)	Number of Samples	Value[1] Discharge Points 002, 003B, 003D, 003S, 003T, and 003X Minimum	Maximum	Average[2]		Permit Limit[9]	Percent of Limit[3]
Discharge Permit Requirements (Reference 6)							
Discharge Points 002, 003B, and 003D[13]							
Clam-Trol CT-1 (mg/l)	23	<0.2	<0.2	<0.2	± 0.0	0.2[10]	<100
Discharge Point 003S							
Flow (GPD)**	27	109,440	452,160	376,533	± 27,163	Monitor	--
Suspended Solids (mg/l)	27	<1	107	<11.2	± 8.3	Monitor	--
Discharge Point 003T							
Flow (GPD)**	27	109,440	452,160	376,533	± 27,163	Monitor	--
Suspended Solids (mg/l)	27	<1	25	<6.8	± 2.9	Monitor	--
Suspended Solids (% removal)	27	0	84	33	± 12	Monitor	--
Discharge Point 003X[11]							
pH (SU)*	0					6.5-8.5[5]	--
Oil & Grease (mg/l)	0					15	--
Suspended Solids (mg/l)	0					50	--
Flow (GPD)**	0					Monitor	--
Temperature (°F)	0					90	--

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.
(3) Percent of limit for the maximum value, unless otherwise noted.
(4) Daily average value shall not exceed 2.0 mg/l. Daily maximum value shall not exceed 4.0 mg/l.
(5) If intake pH 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.
(6) Additional monitoring and permit restrictions are imposed if non-contact cooling water is discharged via this outfall. KAPL currently does not discharge non-contact cooling water from this outfall. Percent of limit cannot be calculated using only ground or storm water temperature data.
(7) Daily average value shall not exceed 0.1 mg/l. Daily maximum total residual chlorine value shall not exceed 0.2 mg/l.
(8) When non-contact cooling water is discharged via this outfall and the intake pH 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.
(9) Daily maximum limit unless noted.
(10) Daily maximum value. Monitoring is required during chemical application and discharge.
(11) This outfall was not operated during 1997.
(12) Action level specified by Reference (6); percent of limit based on maximum value.
(13) On 09/16/97 chemical addition was performed for zebra mussel control using Betz Clam-Trol CT-1 and Betz DTS detoxifying agent.

*SU = Standard Units
**GPD = Gallons per day
***MGD = Million gallons per day.

Environmental air samplers are operated in the predominant upwind and downwind directions from the site to measure normal background airborne radioactivity, and to confirm that Knolls Site effluents have no measurable effect on normal background airborne radioactivity levels.

The Knolls Site 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 on October 25, 1993. The groundwater surrounding the landfill is routinely monitored and the results are reported quarterly in compliance with Reference (26). Knolls Site groundwater data are presented in Tables 15 to 21 and will be discussed separately.

During 1997, non-hazardous solid waste from office and cafeteria trash collection operations and construction and demolition debris generated by Knolls Site personnel were disposed of by Waste Management Inc. at High Acres Landfill near Rochester, New York. Waste Management Inc. also uses various locations to recycle such products as glass, tin, newspapers, plastic and cardboard. Office paper and wood are recycled under other contracts.

Analyses

The individual quarterly samples of Mohawk River water and quarterly composite samples of Schenectady, Niskayuna and Latham/Colonie municipal waters are analyzed for alpha and gross beta radioactivity. The boundary stream samples are analyzed for alpha and gross beta radioactivity, and for other radionuclides as appropriate. The methods used are described under Effluent Analyses, page 10.

The Mohawk River sediment samples are analyzed for alpha radioactivity by chemical extraction with subsequent alpha counting and mass spectrometry, for gross beta radioactivity by direct counting of a dried sample, and for cesium-137 and other gamma emitting radionuclides with a gamma spectrometer system. Selected samples collected at seven locations upriver, opposite and downriver from the Knolls Site outfall are also analyzed for strontium-90 by chemical extraction and beta counting. The downriver samples for strontium analysis are selected from locations that previous monitoring had indicated would be locations of highest concentrations. In addition, a more sensitive gamma spectrometry analyses is performed annually on some of the sediment samples. This more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma emitting radionuclides in the sediment.

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-239 and plutonium-240 by chemical separation followed by mass spectrometry.

The water samples collected from the Mohawk River and the three main surface water streams are analyzed for the constituents listed in Tables 4, 5 and 6. Additional parameters were monitored in the East Boundary Stream during the first quarter of 1997 in accordance with the Knolls Site Landfill Closure Plan. Samples are also collected from the West Landfill stream when possible. The results of these samples are listed in Table 7. The analyses are performed using the procedures provided in Standard Methods, Reference (16) or other EPA approved methods.

The environmental air sample filters are changed and analyzed on a routine basis by direct counting for gross alpha and gross beta radioactivity using the method described under Effluent Analyses, page 11.

Assessment

The results of the analyses of Mohawk River water for chemical quality are summarized in Table 4. The results show no significant difference between the average values for chemical constituents upriver and downriver from the Knolls Site. Results of routine analyses for chemical constituents, radioactivity and temperature in the East Boundary Stream, West Boundary Stream Ditch, Midline Stream and West Landfill Stream are summarized in Tables 5, 6 and 7. Except as discussed below, analyzed parameters were well below comparable standards for Class A waters such as that section of the Mohawk River which borders the Knolls Site. The surface water data base shows that there is no water quality degradation attributable to the Knolls Site.

Surface water monitoring data from samples analyzed during 1997 continued to indicate there is no adverse impact from the landfill on the Mohawk River or the East Boundary Stream (EBS). The New York State surface water quality standard for iron was occasionally exceeded in both the Mohawk River and East Boundary Stream

upstream and downstream sample locations, and in the West Landfill Stream. The State standard for manganese was also exceeded in several East Boundary Stream upstream samples and in the West Landfill Stream. Additionally, the State standard for total dissolved solids was exceeded in the East Boundary Stream upstream and downstream locations and Midline Stream. The high iron, manganese and total dissolved solids are attributed to a naturally high mineral content in the surface water and possibly winter snow/ice removal operations. These data are consistent with previous monitoring results. The Mohawk River and the East Boundary Stream upstream sample data show that a number of parameters are elevated above downstream sample results. The elevated upstream results are not related to KAPL operations and represent contributions from off-site water sources. Some of the elevated metal results may be attributed to variations in water quality chemistry caused by naturally occurring metals, either dissolved or suspended in the samples. During the first, second, and fourth quarters, sufficient water was present in the West Landfill Stream (WLS) to allow sampling to occur. Most results were lower or comparable to EBS upstream and EBS downstream. However, some results from the West Landfill Stream ditch suggest that water quality in this drainage ditch may be influenced by a leachate component. All baseline parameters were below detectable levels except for barium and two VOC's. Barium was detected at 0.03 mg/l which is consistent with historical data and below the groundwater standard of 1 mg/l. Trans 1,2-dichloroethene (DCE) and trichloroethylene (TCE) were detected for the first time at the 1 μg/l detection limit, which is below the state guidance values for these parameters. Guidance values are 5 μg/l for DCE and 3 μg/l for TCE. These VOC's had been detected in the former in-fill well, NTH-7A. The surface water from the West Landfill Stream does not directly enter the Mohawk River. Additional discussions are included within the table notes as needed.

Results of the radioactivity analyses performed on samples of Mohawk River and municipal waters are summarized in Table 8. The results for the alpha and gross beta radioactivity concentrations show no significant difference between river water samples upstream and downstream from the Knolls Site or in Schenectady, Niskayuna and Latham/Colonie municipal waters.

The results of radioactivity measurements for alpha, gross beta, strontium-90, cesium-137, plutonium, and uranium in Mohawk River bottom sediment samples are summarized in Table 9. The 1997 data show no significant differences between upstream and downstream radioactivity concentrations for gross beta, strontium-90, and cesium-137. Some alpha, plutonium, and uranium downstream concentrations are slightly higher than those measured upstream. However, the 1997 downstream results for uranium and plutonium are within the range of prior year upstream results. Slightly higher concentrations of radioactivity have been measured in the past in samples collected from locations within one thousand feet downriver from the site outfall. This localized concentration of radioactivity is attributable to operations conducted prior to 1964, when, subject to applicable federal regulations and state and local agreements through the Mohawk River Advisory Committee, limited amounts of radioactivity were 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.

The results of the detailed gamma spectrum analyses performed on Mohawk River bottom sediment samples also indicated low levels of potassium-40 and daughters of uranium and thorium. The potassium-40 and the daughters of uranium and thorium are naturally occurring radionuclides. No detectable cobalt-60 was found in any sample. However, localized low levels of cobalt-60, which are 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 Table 10 and Table 11. The results indicate the presence of naturally occurring potassium-40. The results of sensitive analyses for strontium-90 and plutonium indicate little or no detectable strontium-90 and very low levels of plutonium-239 and plutonium-240 in both upriver and downriver fish. The measured concentrations of radioactivity indicate no effect from site operations. In addition, the results of a previous biological survey (Reference (33)) confirm that the low levels of radioactivity in the Mohawk River bottom sediment near the Knolls Site outfall are not taken up and propagated through the food chain.

The results for the Knolls Site perimeter and off-site radiation monitoring locations are summa-

rized in Table 12. There is no statistically significant difference between the perimeter and the off-site measurements. This shows that Knolls Site operations in 1997 had no measurable effect on natural background radiation levels at the site perimeter.

The analytical results for the environmental air samples indicate that there were no significant differences between the average upwind and downwind radioactivity concentrations. Gamma spectrometry analyses performed on groups of environmental samples indicated only background quantities of naturally occurring radionuclides.

Special Mohawk River Survey

KAPL conducted an extensive sediment and biological sampling program of the Mohawk River during the summer of 1992. This sampling program was performed to update information on the quantity and distribution of radioactivity in the river sediment attributable to KAPL operations prior to 1964 and to demonstrate that the residual radioactivity has no effect on man or the environment. Samples included 185 sediment core samples and numerous samples of fish, macrophyton, periphyton, plankton, benthic macroinvertebrates, and water.

The results of this sampling program, as discussed in Reference (35), show that the distribution of residual radioactivity in the Mohawk River sediment in the vicinity of the Knolls Site is well understood. The majority of radioactivity present is confined to an area, along the south side of the Mohawk River, that extends from the KAPL Building J-6 outfall to 500 feet downriver. The radioactivity generally is located at least 8 inches below the top of the sediment surface. Elevated radioactivity concentrations were also detected further downriver; however, the concentrations are lower, and the radioactivity is located even deeper in the sediment. Comparison of the sediment sampling results to those obtained from a similar survey done in 1981 generally show that the residual radioactivity is located deeper in the sediment, due to deposition of new sediment in the outfall area. The total radioactivity of KAPL origin present in the sediment above the Lock 7 dam is estimated to be less than 0.65 curies, of which greater than 90% is attributable to cesium-137 and strontium-90 (and its short-lived decay product yttrium-90). Cesium-137 and strontium-90 have half-lives of about 30 years and 29 years, respectively. The remainder of the radioactivity content is comprised of plutonium, uranium, americium-241, and cobalt-60. The total radioactivity present in the sediment of KAPL origin 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 KAPL origin 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 the radioactivity in the sediment were released back into the river water. The major conclusion of the radiological assessment is that the radioactivity of KAPL origin in the Mohawk River sediment does not pose a health risk to any member of the public.

TABLE 4
CHEMICAL CONSTITUENTS AND TEMPERATURE
MOHAWK RIVER WATER, 1997

Parameter[14] (Units)	No. of Samples Upstream/ Downstream	Value[1] Upstream Minimum	Upstream Maximum	Upstream Average[2]	Downstream Minimum	Downstream Maximum	Downstream Average[2]	Standard[3]	Percent of Standard[4]
pH (SU)*	57/4	6.7	7.9	7.4 ± 0.1	7.1	7.5	7.3 ± 0.3	6.5-8.5	--
Cadmium (mg/l)	4/4	<0.005	<0.005	<0.005 ± 0.000	<0.005	<0.005	<0.005 ± 0.000	0.01	<50
Ammonia (as N) (mg/l)	4/4	<0.1	0.1	<0.1 ± 0.00	<0.1	0.1	<0.1 ± 0.0	2.0[12]	<5
Temperature (°C)	57/4	0.3	26.4	11.0 ± 2.4	0	23	9.4 ± 17.8[18]	See Note[7]	--
Oil & Grease (mg/l)	4/4	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	See Note[8]	--
Phosphorus (as P) (mg/l)	4/4	<0.02	0.10	<0.05 ± 0.06[18]	<0.02	0.40	<0.12 ± 0.30[18]	See Note[13]	--
Suspended Solids (mg/l)	31/4	<1	93	<13 ± 8	<1	445[5]	<114 ± 352[18]	See Note[10]	--
Iron (mg/l)	9/4	0.06	0.64[5]	0.22 ± 0.14	0.10	2.42[5]	0.75[5] ± 1.78[18]	0.3	250[5]
Manganese (mg/l)	4/4	0.02	0.03	0.03 ± 0.01	0.03	0.30	0.10 ± 0.21[18]	0.3	33
Chemical Oxygen Demand (mg/l)	4/4	<5	7.5	<5.6 ± 2.0	<5	47	<16 ± 33[18]	No Standard	--
Surfactants (mg/l)	4/4	<0.02	<0.02	<0.02 ± 0.00	<0.02	<0.02	<0.02 ± 0.00	No Standard	--
Bromide (mg/l)	4/4	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	2.0[9]	<50
Dissolved Oxygen (mg/l)	4/4	7.5	14.7	11.7 ± 5.2	9.3	13.9	11.9 ± 3.6	See Note[15]	--
Eh (mv)**	4/4	307	401	352 ± 67	317	392	356 ± 51	No Standard	--
Turbidity (ntu)***	4/4	1.4	13	5.7 ± 8.0[18]	2.5	180[5]	48 ± 140[18]	See Note[16]	--
Specific Conductance (μmhos/cm)****	4/4	217	333	292 ± 82	226	354	310 ± 91	No Standard	--
Total Dissolved Solids (mg/l)	4/4	103	178	147 ± 51	108	175	147 ± 49	500[17]	29
Total Organic Carbon (mg/l)	4/4	2.6	5.1	3.4 ± 1.8	2.8	6.6	4.4 ± 2.6	No Standard	--
Sulfate (S, mg/l)	4/4	14	30	23 ± 12	15	36	25 ± 16	250	10
Alkalinity ($CaCO_3$, mg/l)	4/4	68	90	79 ± 17	65	90	79 ± 18	No Standard	--
Chloride (mg/l)	4/4	15	32	27 ± 13	16	34	27 ± 12	250	11
Total Hardness ($CaCO_3$, mg/l)	4/4	77	132	104 ± 40	93	125	110 ± 23	No Standard	--
Nitrate (N, mg/l)	4/4	0.57	0.88	0.71 ± 0.21	0.55	0.88	0.67 ± 0.23	10	7
Total Phenols (mg/l)	4/4	<0.001	<0.001	<0.001 ± 0.000	<0.001	<0.001	<0.001 ± 0.000	0.001	<100
Calcium (mg/l)	4/4	24	39.4	32.3 ± 11.9	29	37.2	33.8 ± 6.3	No Standard	--
Lead (mg/l)	4/4	<0.005	<0.005	<0.005 ± 0.000	<0.005	0.007	<0.006 ± 0.002	0.05	<12
Magnesium (mg/l)	4/4	4.1	8.2	5.8 ± 2.9	5.0	8.1	6.3 ± 2.1	35	18
Potassium (mg/l)	4/4	<0.5	2.4	<1.2 ± 1.5	<0.5	2.6	<1.2 ± 1.6[18]	No Standard	--
Sodium (mg/l)	4/4	9.3	18.2	15.8 ± 6.9	9.6	19.3	16.4 ± 7.3	No Standard	--
Dissolved Sulfide (mg/l)	4/4	<0.1	<0.1	<0.1 ± 0.0	<0.1	<0.1	<0.1 ± 0.0	0.05[11]	[6]

TABLE 4 - Continued

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.

(3) Per Reference (8), New York State Quality Standards 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.

(4) Percent of standard for the average value of downriver samples.

(5) Water quality of the Mohawk River is variable. The extremely high suspended solids, iron, and turbidity occurred during the fourth quarter sample event only at the downstream Mohawk River location. The high maximum values are not indicative of KAPL operations and may be naturally occurring. However, the large difference between upriver and downriver results is unusual.

(6) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

(7) Per Reference (8), the thermal discharge limits relating to site operations are as follows:
   (a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.
   (b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.
   (c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(8) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.

(9) Guidance value.

(10) None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.

(11) Guidance value for total sulfides expressed as hydrogen sulfide.

(12) $NH_3 + NH_4^+$ as N.

(13) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

(14) The Knolls Site also performed sampling and analyses of 51 additional baseline parameters as listed in Reference (17) during February 1997. All results were within any existing water quality standards as specified by Reference (8). Table 14 lists the parameters included in the baseline scan.

(15) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(16) No increase that will cause a substantial visible contrast to natural conditions.

(17) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(18) The lowest possible value for any parameter is zero.

*SU = Standard Units.
**mv = millivolts.
***ntu = nephelometric turbidity units.
****μmhos/cm = micromhos per centimeter.

TABLE 5
CHEMICAL CONSTITUENTS, RADIOACTIVITY & TEMPERATURE
WEST BOUNDARY STREAM DITCH AND MIDLINE STREAM, 1997

Parameter[18] (Units)	No. of Samples WBSD[7]/ Midline Stream	Value[1] West Boundary Stream Ditch (WBSD) Minimum	Maximum	Average[2]	Midline Stream Minimum	Maximum	Average[2]	Standard[3,8]	Percent of Standard[4] WBSD/ Midline Stream
pH (SU)	6/4	6.9	8.3	7.6 ± 0.5	7.6	8.1	7.9 ± 0.3	6.5-8.5[17]	--
Cadmium (mg/l)	3/4	<0.005	<0.005	<0.005 ± 0.000	<0.005	<0.005	<0.005 ± 0.000	0.01	<50/<50
Ammonia (N, mg/l)	3/4	<0.1	<0.1	<0.1 ± 0.0	<0.1	<0.1	<0.1 ± 0.0	2.0[5]	<5/<5
Temperature (°C)	6/4	0.9	14	6.0 ± 5.6	-1	14	6.4 ± 12.3[19]	See Note[10]	--
Oil & Grease (mg/l)	6/4	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	15[11]	--
Phosphorus (P, mg/l)	3/4	0.02	0.02	0.02 ± 0.00	<0.02	0.03	<0.03 ± 0.01	See Note[12]	--
Suspended Solids (mg/l)	6/4	<1	26	<12 ± 11	<1	7.0	3.0 ± 4.3[19]	Monitor[11]	--
Iron (mg/l)	3/4	<0.05	0.16	<0.11 ± 0.14[19]	<0.05	0.12	<0.08 ± 0.05	0.3	<37/<27
Manganese (mg/l)	3/4	<0.02	<0.02	<0.02 ± 0.00	<0.02	<0.02	<0.02 ± 0.00	0.3	<7/<7
Chemical Oxygen Demand (mg/l)	6/4	<5	15	<7 ± 4	<5	<5	<5 ± 0.0	Monitor[11]	--
Surfactants (mg/l)	3/4	<0.02	<0.02	<0.02 ± 0.00	<0.02	<0.02	<0.02 ± 0.00	No Standard	--
Bromide (mg/l)	3/4	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	2.0[6]	<50/<50
Dissolved Oxygen (mg/l)	3/4	10.2	13.3	11.7 ± 3.9	4.2	14.3	9.8 ± 6.7	See Note[13]	--
Eh (mv)	3/4	254	384	323 ± 163	325	397	359 ± 58	No Standard	--
Turbidity (ntu)	3/4	1.6	5.1	3.3 ± 4.3[19]	1.4	7.9	3.4 ± 4.8[19]	See Note[14]	--
Specific Conductance (µmhos/cm)	3/4	1085	1775	1392 ± 872	1180	1872	1416 ± 519	No Standard	--
Total Dissolved Solids (mg/l)	3/4	570[16]	920[16]	713[16] ± 457	650[16]	965[16]	777[16] ± 214	500[15]	148/155
Total Organic Carbon (mg/l)	3/4	1.9	3.4	2.8 ± 2.0	2.6	7.3	5.0 ± 3.8	No Standard	--
Sulfate (S, mg/l)	3/4	62	119	85 ± 75	67	106	88 ± 26	250	34/35
Alkalinity ($CaCO_3$, mg/l)	3/4	180	260	223 ± 100	190	245	229 ± 41	No Standard	--
Chloride (mg/l)	3/4	184	387[21]	279[21] ± 254	231	394[21]	289[21] ± 122	250	112/116
Total Hardness ($CaCO_3$, mg/l)	3/4	210	302	262 ± 118	262	488	385 ± 148	No Standard	--
Nitrate (N, mg/l)	3/4	0.06	0.25	0.17 ± 0.24[19]	0.07	0.20	0.14 ± 0.10	10	2/1
Total Phenols (mg/l)	3/4	<0.001	<0.001	<0.001 ± 0.000	<0.001	<0.001	<0.001 ± 0.000	0.001	<100/<100
Calcium (mg/l)	3/4	59	85	74 ± 34	74	137	107 ± 41	No Standard	--
Lead (mg/l)	3/4	<0.005	<0.005	<0.005 ± 0.000	<0.005	<0.005	<0.005 ± 0.000	0.05	<10<10
Magnesium (mg/l)	3/4	15.0	22.0	18.7 ± 8.8	19.0	35.5[22]	28.9 ± 11.2	35	53/83
Potassium (mg/l)	3/4	<0.5	<0.5	<0.5 ± 0.0	<0.5	1.0	<0.6 ± 0.4	No Standard	--
Sodium (mg/l)	3/4	109	208	150 ± 128	86	171	118 ± 60	No Standard	--
Dissolved Sulfide (mg/l)	3/4	<0.1	<0.1	<0.1 ± 0.00	<0.1	<0.1	<0.1 ± 0.0	0.05[17]	[9]
Flow (Estimated) GPD[20]	6/4	1650	53557	15339 ± 20348[19]	26662	418831	143238 ± 293636[19]	Monitor[11]	--
Radioactivity									
(10^{-9} µCi/ml)									
Alpha	8/12	0.67	1.34	0.94 ± 0.45	0.42	1.08	0.86 ± 0.49	30	3/3
Beta	8/12	3.41	7.03	5.46 ± 2.91	3.52	6.68	4.92 ± 2.11	1000	0.5/0.5
Strontium-90	8/12	<0.09	0.52	<0.26 ± 0.31[19]	0.25	0.46	0.32 ± 0.15	1000	<0.1/<0.1
Cesium-137	8/12	<0.35	<0.92	<0.55 ± 0.40	<0.18	<0.37	<0.31 ± 0.14	3000	<0.1/<0.1

TABLE 5 - Continued

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.

(3) New York State Quality Standards 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. West Boundary and Midline Streams join the Mohawk River, which is a Class A water.

(4) Percent of standard for the average value.

(5) NH_3 + NH_4^+ as N.

(6) Guidance value.

(7) Flow was extremely intermittent at the West Boundary Stream Ditch sampling location. Therefore, samples were only taken in February, March, April, May, and November.

(8) The radioactivity standard is the derived concentration guide (DCG) listed in DOE Order 5400.5, Reference (2). The DCG for unidentified alpha and beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of KAPL operations.

(9) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

(10) Per Reference (8), the thermal discharge limits relating to site operations are as follows:
   (a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.
   (b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.
   (c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(11) Required by Reference (6) NYSDEC SPDES permit.

(12) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

(13) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(14) No increase that will cause a substantial visible contrast to natural conditions.

(15) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(16) Elevated levels of total dissolved solids were seen in the Midline Stream during February, May, September, and November 1997. Elevated levels of total dissolved solids were seen in the West Boundary Stream Ditch during March, May, and November 1997. The surface water and groundwater of the Knolls Site naturally have a high mineral content.

(17) Guidance value for total sulfides expressed as hydrogen sulfide.

(18) The Knolls Site also performed sampling and analysis of 51 additional baseline parameters as listed in Reference (17) during February 1997. All results were within existing water quality standards as specified by Reference (8). Table 14 lists the parameters included in the baseline scan.

(19) The lowest possible value for any parameter is zero.

(20) Flow is estimated by measuring stream depth, width, and velocity. Flow is measured only when samples are collected.

(21) The high maximum value may be due to a data anomaly or from winter de-icing operations.

(22) The high maximum value is not judged to be the result of KAPL operations, is consistent with the historical database and is attributed to the naturally high mineral content of the Knolls Site surface water and ground water.

TABLE 6
CHEMICAL CONSTITUENTS, RADIOACTIVITY & TEMPERATURE
EAST BOUNDARY STREAM, 1997

Parameter[21] (Units)	No. of Samples Upstream[11]/ Downstream	Value[1] Upstream Minimum	Upstream Maximum	Upstream Average[2]	Downstream Minimum	Downstream Maximum	Downstream Average[2]	Standard[3,8]	Percent of Standard[4] Upstream/ Downstream
pH (SU)	6/6	7.1	7.8	7.5 ± 0.3	7.3	8.2	7.5 ± 0.3	6.5-8.5[14]	--
Cadmium (mg/l)	6/6	<0.005	<0.005	<0.005 ± 0.000	<0.005	<0.005	<0.005 ± 0.000	0.01	<50/<50
Ammonia (N, mg/l)	6/6	<0.1	0.2	<0.12 ± 0.04	<0.1	0.2	<0.1 ± 0.1	2.0[9]	<6/<5
Temperature (°C)	6/6	-1	17	8.1 ± 9.2[12]	0	15	7.2 ± 8.2[12]	See Note[10]	--
Oil & Grease (mg/l)	6/6	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	15 [14]	--
Phosphorus (P, mg/l)	6/6	<0.02	0.16	<0.05 ± 0.06[12]	<0.02	0.04	<0.02 ± 0.01	See Note[13]	--
Suspended Solids (mg/l)	6/6	1.5	540	97 ± 228[12]	<1	31	<10 ± 14[12]	Monitor[14]	--
Iron (mg/l)	6/6	0.12	3.5[7]	0.77[7] ± 1.41[12]	<0.05	0.28	<0.15 ± 0.11	0.3	257/<50[7]
Manganese (mg/l)	6/6	0.08	1.18[6]	0.33[6] ± 0.45[12]	<0.02	0.19	0.08 ± 0.09[12]	0.3	110/27[6]
Chemical Oxygen Demand (mg/l)	6/6	7.5	92	23 ± 35[12]	<5	7.5	<6.3 ± 1.4	Monitor[14]	--
Surfactants (mg/l)	6/6	<0.02	<0.02	<0.02 ± 0.00	<0.02	<0.02	<0.02 ± 0.00	No Standard	--
Bromide (mg/l)	6/6	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	2.0[5]	<50/<50
Dissolved Oxygen (mg/l)	6/6	7.5	13.1	10.7 ± 2.4	9.1	14.3	11.7 ± 2.6	See Note[15]	--
Eh (mv)	6/6	320	404	360 ± 42	339	399	371 ± 21	No Standard	--
Turbidity (ntu)	6/6	3.3	300	59 ± 124[12]	1.9	20	8.1 ± 9.3[12]	See Note[16]	--
Specific Conductance (µmhos/cm)	6/6	817	1104	941 ± 128	742	999	885 ± 119	No Standard	--
Total Dissolved Solids (mg/l)	6/6	445	543[19]	506[19] ± 45	398	530[19]	501[19] ± 58	500[17]	101/100[19]
Total Organic Carbon (mg/l)	6/6	2.8	6.5	4.7 ± 1.4	2.4	7.7	4.3 ± 2.2	No Standard	--
Sulfate (S, mg/l)	6/6	46	94	66 ± 20	64	118	95 ± 23	250	26/38
Alkalinity ($CaCO_3$, mg/l)	6/6	185	225	204 ± 20	210	265	237 ± 25	No Standard	--
Chloride (mg/l)	6/6	74	188	127 ± 54	55	82	67 ± 12	250	51/27
Total Hardness ($CaCO_3$, mg/l)	6/6	190	334	271 ± 66	217	379	337 ± 66	No Standard	--
Nitrate (N, mg/l)	6/6	0.03	0.17	0.11 ± 0.07	0.10	0.22	0.17 ± 0.05	10	1/2
Total Phenols (mg/l)	6/6	<0.001	<0.001	<0.001 ± 0.000	<0.001	<0.001	<0.001 ± 0.000	0.001	<100/<100
Calcium (mg/l)	6/6	53	93.5	76.3 ± 18.8	61	107	94 ± 18	No Standard	--
Lead (mg/l)	6/6	<0.005	0.018	<0.007 ± 0.006	<0.005	<0.005	<0.005 ± 0.000	0.05	--
Magnesium (mg/l)	6/6	14.0	24.5	19.6 ± 4.8	16.0	28.6	24.9 ± 5.0	35	56/71
Potassium (mg/l)	6/6	<0.5	2.8	<0.98 ± 0.97	<0.5	2.0	<1.0 ± 0.8	No Standard	--
Sodium (mg/l)	6/6	55.8	97	72.1 ± 18.1	33.1	71	49.2 ± 17.5	No Standard	--
Dissolved Sulfide (mg/l)	6/6	<0.1	<0.1	<0.1 ± 0.00	<0.1	<0.1	<0.1 ± 0.0	0.05[20]	[22]
Flow (Estimated) GPD[18]	4/4	59384	266623	121103 ± 155063[12]	46150	261708	123119 ± 157248[12]	Monitor[14]	--
Radioactivity									
(10^{-9} µCi/ml)									
Alpha	11/12	0.73	1.33	1.10 ± 0.43	0.93	1.63	1.21 ± 0.51	30	4/4
Beta	11/12	5.26	9.52	6.61 ± 3.17	3.19	5.41	4.29 ± 1.57	1000	0.7/0.4
Strontium-90	11/12	0.13	0.40	0.29 ± 0.19	0.22	0.44	0.34 ± 0.18	1000	<0.1/<0.1
Cesium-137	11/12	<0.36	<0.45	<0.38 ± 0.07	<0.30	<0.38	<0.34 ± 0.07	3000	<0.1/<0.1

TABLE 6 - Continued

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.

(3) New York State Quality Standards 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. East Boundary Stream joins Mohawk River, which is a Class A water.

(4) Percent of standard for the average value.

(5) Guidance value.

(6) Manganese exceeded the standard in East Boundary Upstream during February 1997. This is attributable to manganese naturally present in the groundwater and surface water.

(7) Iron exceeded the standard in East Boundary Upstream during February 1997. This is attributable to iron naturally present in groundwater and surface water.

(8) The radioactivity standard is the derived concentration guide (DCG) listed in DOE Order 5400.5, Reference (2). The DCG for unidentified alpha and beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of KAPL operations.

(9) NH_3 + NH_4^+ as N.

(10) Per Reference (8), the thermal discharge limits relating to site operations are as follows:

- (a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.
- (b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.
- (c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(11) The increased number of upstream samples for chemical parameters is due primarily to duplicate analysis as part of KAPL's quality assurance.

(12) The lowest possible value for any parameter is zero.

(13) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

(14) Required by Reference(6) NYSDEC SPDES permit.

(15) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(16) No increase that will cause a substantial visible contrast to natural conditions.

(17) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(18) Flow differences are due to the estimating technique. Flow is estimated by measuring stream depth, width, and velocity. Flow is measured only when samples are collected.

(19) Total dissolved solids frequently exceeded the standard in both East Boundary Upstream and Downstream samples. The surface water and groundwater of the Knolls Site naturally have a high mineral content.

(20) The standard listed is as hydrogen sulfide in the undissociated form.

(21) The Knolls Site also performed sampling and analysis of 51 additional baseline parameters as listed in Reference (17) during February 1997. All results were within any existing water quality standards as specified by Reference (8). Table 14 lists the parameters included in the baseline scan.

(22) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

TABLE 7
CHEMICAL CONSTITUENTS AND TEMPERATURE IN THE WEST LANDFILL STREAM, 1997

Parameter[18] (Units)	No. of Samples[15]	Value[1] Minimum	Maximum	Average[2]			Standard	Percent of Standard[3]
pH (SU)	4	6.6	7.9	7.3	±	0.8	6.5-8.5	--
Cadmium (mg/l)	4	<0.005	<0.005	<0.005	±	0.000	0.01	<50
Ammonia (N, mg/l)	4	<0.1	<0.1	<0.1	±	0.0	2.0[5]	<5
Temperature (°C)	4	1	16	5.0	±	11.7[17]	See Note[6]	--
Oil & Grease (mg/l)	4	<1	<1	<1	±	0.0	See Note[7]	--
Phosphorus (P, mg/l)	4	0.02	0.07	0.04	±	0.03	See Note[8]	--
Suspended Solids (mg/l)	4	9.5	23	15	±	10	See Note[9]	--
Iron (mg/l)	4	0.11	2.06[16]	0.70[16]	±	1.47[17]	0.3	233[16]
Manganese (mg/l)	4	0.23	0.78[16]	0.38[16]	±	0.43[17]	0.3	127[16]
Chemical Oxygen Demand (mg/l)	4	<5	114	<35.3	±	83.6[17]	No Standard	--
Surfactants (mg/l)	4	<0.02	<0.02	<0.02	±	0.00	No Standard	--
Bromide (mg/l)	4	<1	<1	<1	±	0.0	2.0[4]	<50
Dissolved Oxygen (mg/l)	4	9.1	13.2	11.8	±	2.9	See Note[10]	--
Eh (mv)	4	314	397	361	±	67	No Standard	--
Turbidity (ntu)	4	6.6	13	9.3	±	4.6	See Note[11]	--
Specific Conductance (μmhos/cm)	4	468	815	660	±	228	No Standard	--
Total Dissolved Solids (mg/l)	4	245	475	367	±	150	500[12]	73
Total Organic Carbon (- mg/l)	4	<1	8.7	<6.1	±	5.5	No Standard	--
Sulfate (S, mg/l)	4	35	61	50	±	21	250	20
Alkalinity ($CaCO_3$, mg/l)	4	190	385	280	±	127	No Standard	--
Chloride (mg/l)	4	12	33	20	±	15	250	8
Total Hardness ($CaCO_3$, mg/l)	4	198	428	266	±	175	No Standard	--
Nitrate (N, mg/l)	4	0.17	0.31	0.24	±	0.11	10	2
Total Phenols (mg/l)	4	<0.001	<0.001	<0.001	±	0.000	0.001	<100
Calcium (mg/l)	4	57	122	76	±	49	No Standard	--
Lead (mg/l)	4	<0.005	<0.005	<0.005	±	0.000	0.05	<10
Magnesium (mg/l)	4	14	30	19	±	12	35	54
Potassium (mg/l)	4	<0.5	<0.5	<0.5	±	0.0	No Standard	--
Sodium (mg/l)	4	7.9	24	18	±	11	No Standard	--
Dissolved Sulfide (mg/l)	4	<0.1	<0.1	<0.1	±	0.0	0.05[13]	(14)

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.

(3) Percent of standard for the average value.

(4) Guidance value.

(5) NH_3 + NH_4^+ as N.

(6) Per Reference (8), the thermal discharge limits relating to site operations are as follows:

(a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.

(b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.

(c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(7) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.

(8) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

(9) None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.

(10) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(11) No increase that will cause a substantial visible contrast to natural conditions.

(12) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(13) The standard listed is as hydrogen sulfide in the undissociated form.

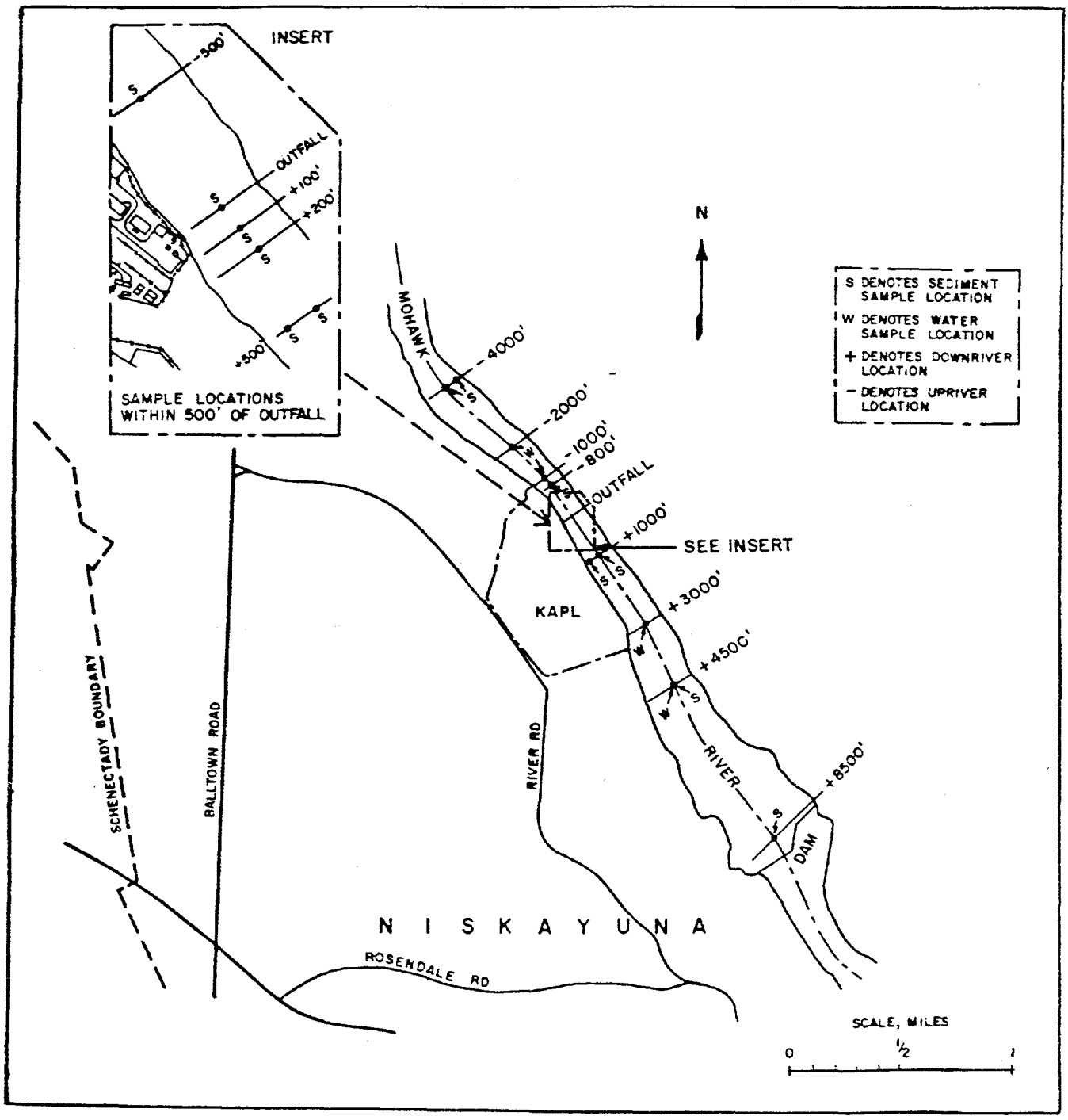
(14) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

(15) This stream is intermittent. It is checked at least quarterly for flow.

(16) Iron exceeded the standard during March and May 1997. Manganese exceeded the standard during May 1997. This is attributable to iron and manganese naturally present in the groundwater and surface water.

(17) The lowest possible value for any parameter is zero.

(18) The Knolls Site also performed sampling and analysis of 51 additional baseline parameters as listed in Reference (17). All parameters were below detectable levels except for barium which was detected at 0.03 mg/l, and DCE and TCE which were each detected at 1μg/l. The surface water standard for barium is 1 mg/l. The surface water guidance value for DCE is 5 μg/l and for TCE is 3 μgl.



Knolls Site, Niskayuna, New York
Mohawk River Sampling Locations

Figure 2

TABLE 8 - RESULTS OF MONITORING MOHAWK RIVER WATER AND MUNICIPAL WATER, 1997

Location and Source of Water Samples	Number of Samples	Radioactivity Concentrations (10^{-9} μCi/ml)					
		Gross Beta Values[1]			Alpha Values[1,2]		
		Minimum	Maximum	Average	Minimum	Maximum	Average[3]
Mohawk River Water							
Upstream	6	1.7 ± 0.6	3.1 ± 0.7	2.4 ± 0.6	<0.1	0.4 ± 0.3	<0.26 ± 0.11
Downstream	6	1.7 ± 0.6	3.0 ± 0.7	2.2 ± 0.5	<0.1	0.3 ± 0.2	<0.22 ± 0.05
Schenectady Municipal Water	12	2.2 ± 0.8	2.6 ± 0.7	2.3 ± 0.4	0.2 ± 0.2	0.4 ± 0.3	0.31 ± 0.14
Niskayuna Municipal Water	12	1.3 ± 0.6	2.8 ± 0.8	2.1 ± 1.0	<0.1	0.5 ± 0.3	<0.31 ± 0.29
Latham/Colonie Water	12	1.6 ± 0.7	2.6 ± 0.7	2.1 ± 0.8	0.1 ± 0.2[4]	0.3 ± 0.2	<0.18 ± 0.11

Notes:
(1) The (±) value represents the statistical error at two standard deviations.
(2) A value preceded by < is less than the minimum detection level for that sample and parameter.
(3) Average values preceded by < contain at least one less than minimum detection level value in the average.
(4) The lowest possible value for any parameter is zero.

TABLE 9 - RESULTS OF ANALYSES OF MOHAWK RIVER SEDIMENT, 1997

Number of Samples and Type of Results	Radioactivity Concentration (pCi/g, dry wt.)[1] Area Sampled Relative to Effluent Point					
	Upstream		Opposite		Downstream	
Alpha Concentration						
Number of Samples	12		3		24	
Average Concentration	0.50	± 0.07	0.45	± 0.49[3]	0.69	± 0.15
Minimum Concentration	0.34	± 0.06	0.29	± 0.05	0.37	± 0.06
Maximum Concentration	0.71	± 0.08	0.67	± 0.08	2.07	± 0.13
Gross Beta Concentration						
Number of Samples	12		3		24	
Average Concentration	25.2	± 3.0	22.5	± 7.0	26.1	± 1.6
Minimum Concentration	16.9	± 4.0	20.3	± 4.3	17.5	± 4.0
Maximum Concentration	32.3	± 5.4	25.7	± 4.8	34.0	± 5.5
Strontium-90 Concentration						
Number of Samples	12		3		6	
Average Concentration	<0.02	± 0.01	<0.01	± 0.01	0.02	± 0.01
Minimum Concentration	<0.01		<0.01		0.01	± 0.02[3]
Maximum Concentration	0.04	± 0.02	0.01	± 0.02[3]	0.03	± 0.02
Cesium-137 Concentration						
Number of Samples	12		3		24	
Average Concentration	<0.11	± 0.04	0.04	± 0.01	<0.10	± 0.02
Minimum Concentration	<0.03		0.04	± 0.01	<0.04	
Maximum Concentration	0.21	± 0.03	0.05	± 0.01	0.24	± 0.05
Plutonium Concentration[2]						
Number of Samples	6		3		6	
Average Concentration	0.002	± 0.001	0.001	± 0.001	0.004	± 0.001
Minimum Concentration	0.001	± 0.001	0.001	± 0.001	0.003	± 0.001
Maximum Concentration	0.003	± 0.001	0.001	± 0.001	0.006	± 0.001
Uranium Concentration						
Number of Samples	6		3		6	
Average Concentration	0.56	± 0.22	0.35	± 0.09	0.78	± 0.10
Minimum Concentration	0.27	± 0.01	0.31	± 0.01	0.69	± 0.01
Maximum Concentration	0.76	± 0.01	0.37	± 0.01	0.90	± 0.02

Notes:

(1) The sediment is sampled to a depth of approximately 2.5 cm. The (±) values represent the statistical error at two standard deviations. A value preceded by < is less than the minimum detectable activity. Average values preceded by < contain at least one less than minimum detectable activity value in the average.

(2) Plutonium concentration values are the sum of results for Pu-239 and Pu-240.

(3) The lowest possible value for any parameter is zero.

TABLE 10 - GAMMA SPECTROMETRY RESULTS FOR MOHAWK RIVER FISH, 1997

Sample[2] Location	Fish (#)	No. of Samples	Radioactivity Concentrations (pCi/g, wet weight)[1]			
			K-40		Cs-137	
			Maximum	Average	Maximum	Average
Upriver	White Sucker (4) Redhorse Sucker (3) Carp (2)	4	1.97 ± 0.20	1.82 ± 0.30	<0.007	<0.007
Upriver	Smallmouth Bass (5)	3	2.07 ± 0.21	1.79 ± 0.50	<0.008	<0.007
Upriver	Walleye (3) Rock Bass (3) Yellow Perch (15)	2	2.18 ± 0.22	1.84 ± 0.96	<0.007	<0.007
Downriver	White Sucker (7) Carp (2)	4	1.87 ± 0.20	1.75 ± 0.21	<0.006	<0.006
Downriver	Smallmouth Bass (2) Largemouth Bass (2)	3	1.84 ± 0.20	1.70 ± 0.24	<0.007	<0.007
Downriver	Largemouth Bass (2) Smallmouth Bass (3) Rock Bass (6) Yellow Perch (12)	3	1.83 ± 0.19	1.69 ± 0.30	<0.008	<0.008

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter. Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.

(2) Upriver samples were obtained on July 30, 1997 above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upriver respectively, from the Knolls Site outfall.) Downriver samples were obtained on July 29, 1997; these fish were collected along the KAPL shoreline from 3000 feet downriver of KAPL Outfall 002 to Lock 7.

TABLE 11 - RADIOCHEMICAL ANALYSIS RESULTS FOR MOHAWK RIVER FISH, 1997

Sample Location[2]	Fish Type	Radioactivity Concentration[1] (pCi/g, wet weight) Sr-90	Pu-239 & Pu-240
Upriver	Carp	<0.005	0.00005 ± 0.00002
Upriver	Smallmouth Bass	<0.006	0.00003 ± 0.00001
Upriver	Yellow Perch	<0.003	0.00012 ± 0.00008
	Average	<0.005 ± 0.003	0.00007 ± 0.00012[3]
Downriver	Carp	<0.005	0.00003 ± 0.00001
Downriver	Smallmouth Bass	0.008 ± 0.005	0.00002 ± 0.00001
Downriver	Yellow Perch	0.008 ± 0.005	0.00004 ± 0.00002
	Average	<0.007 ± 0.004	0.00003 ± 0.00002

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) Upriver samples were obtained on July 30, 1997 above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upriver respectively, from the Knolls Site outfall.) Downriver samples were obtained on July 29, 1997; these fish were collected along the KAPL shoreline from 3000 feet downriver of KAPL Outfall 002 to Lock 7.
(3) The lowest possible value for any parameter is zero.

TABLE 12 - PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KNOLLS SITE, 1997

Monitoring Location No.[1]	Total Annual Exposure,[2] (millirem)
1	76 ± 2
2	77 ± 2
3	76 ± 2
4	87 ± 3
5	84 ± 2
6	84 ± 3
7	84 ± 4
8	74 ± 2
9	77 ± 3
10	82 ± 8
11	82 ± 2
12	81 ± 3
13	73 ± 2
14	73 ± 3
15	89 ± 3
16	78 ± 2
Off Site locations	72 ± 18[3]

Notes:
(1) See Figure 1 for monitoring locations.
(2) The (±) values for individual locations are expressed at the 2 σ confidence level based on the calculated measurement error.
(3) Approximately 95% of the natural background measurements are expected to be within this range.

GROUNDWATER MONITORING

Scope

The Knolls Site groundwater monitoring network consists of 56 wells as follows:

(1) three Niskayuna test holes (NTH-A), located around the Knolls Site Landfill to assess any potential impact of the landfill on groundwater quality,

(2) thirteen groundwater assessment wells (W and MW) installed to assess any effect of previous waste handling and disposal practices on groundwater quality,

(3) sixteen hillside wells (B), which are used to establish hydraulic gradients for the determination of the direction of groundwater flow around a former radioactive material processing facility and determine water quality parameters,

(4) a dug well (Shugg),

(5) twenty wells (KH) installed to evaluate site-wide hydrogeological conditions, and

(6) three original (1978) landfill monitoring wells (NTH) which are now inactive.

Groundwater from 33 of the 56 wells is sampled and analyzed for either chemical quality or radioactivity. Only the landfill groundwater monitoring portion of the program is a regulatory agency requirement; the remainder of the program is voluntary. Figure 1 is a map showing the location of the Knolls Site monitoring wells.

Origin

Generally, groundwater underlying the Knolls Site 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, to the Mohawk River. Because of 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 site. 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 deicing compounds, fertilizers, and pesticides. The second route is leaching of shallow non-radioactive buried wastes in the Knolls Site sanitary 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. Also, in parts of the Knolls Site, soil contains low levels of radioactivity from operations over 30 years ago which are detectable above background levels. There are no radioactive waste burial grounds at the Knolls Site, and therefore there is no groundwater contamination from such a source.

Analyses

During 1997 KAPL conducted quarterly radiological and chemical monitoring of the 5 landfill wells plus annual monitoring for selected other on-site wells to ensure that KAPL operations do not have any adverse effect on the groundwater quality in the area. As part of the continuing groundwater monitoring program, Knolls Site conducted sampling for leachate indicators, volatile organics and metals, per Reference (26), from the landfill wells, and select W, MW, B and KH wells. The B, W, MW and KH wells were selected based on their locations and consideration of subsurface hydrogeologic conditions. For data discussion purposes, the wells are grouped into the following categories in Table 13: Landfill, Land Area, Hillside, Lower Level, and Background.

As part of the Knolls Site Landfill post-closure monitoring program approved by the NYSDEC, KAPL monitors 5 overburden wells, one up-gradient and four down-gradient wells. The wells NTH-1A (up-gradient), NTH-2A, NTH-5A, W-11 and W-12 are monitored annually for the baseline scan parameters and quarterly for the routine scan parameters listed in Table 14.

When all monitoring wells are sampled, groundwater level, temperature, pH, Eh and specific conductivity are measured in the field. Samples are analyzed for radiological parameters using the methods described under Effluent Analyses, page 10. Chemical parameters are analyzed by a vendor laboratory using procedures provided in Standard Methods, Reference (16), or other EPA approved methods. The vendor analytical laboratory is required to be State

certified in potable water analyses and wastewater chemical analyses.

Assessment

Results of the groundwater monitoring for radioactivity are summarized in Table 15. Some wells had slightly higher gross beta and/or 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 beta, alpha, strontium-90, and tritium results were within the range of previously reported values. The maximum concentration of strontium-90, which has the most restrictive derived concentration guide of any radionuclide, measured in any well was less than one percent of the DOE derived concentration guide (Reference 2).

Tables 16, 17, 18, 19, 20 and 21 summarize the groundwater monitoring results for routine and baseline chemical parameters. 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 minimum detection limit or interferences 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 can show elevated metal results that are not indicative of dissolved, mobile metals. Also, monitoring wells in proximity to roadways and parking lots commonly show elevated salt parameters (e.g., total dissolved solids, sodium, chlorides, specific conductivity) related to winter road maintenance operations. Further, some monitoring wells located in the vicinity of former material/waste staging areas contain elevated levels of dissolved manganese.

The standards and guidance values used to compare groundwater monitoring results are those in 6 NYCRR Part 703.5, quality standards for class GA groundwater, Water Quality Standards in 6 NYCRR Part 703.3 and the standards and guidance values in the Technical and Operational Guidance Series (1.1.1) Water Quality Standards and Guidance Values.

Tables 20 and 21 summarize the results of the baseline toxic metals and volatile organic compounds (VOCs) analyses. Only the constituents that were reported by the vendor analytical laboratory as present at or above the minimum detectable level in any one well are listed.

Landfill

Knolls Site Landfill well results (Tables 16, 20 and 21) for some parameters (such as specific conductivity, nitrate, TOC, TDS, alkalinity, chloride, hardness, sodium, calcium, potassium, magnesium, boron, sulfate, and barium) were elevated in most down-gradient wells compared to the up-gradient well, NTH-1A. The TDS, turbidity, iron, manganese, sodium and magnesium results of several wells exceeded NYSDEC groundwater quality standards and guidance values. The turbidity and in part the iron results in NTH-1A samples indicate that such exceedances are attributable to natural groundwater quality. Filtered iron results show that elevated iron results are caused in part by sample turbidity.

Overall, results for the landfill wells are within representative ranges for inorganic constituents typical of leachate from sanitary landfills per Reference (31).

Historically, phenols have been infrequently and sporadically detected. The 1997 results show phenols were not detected in the landfill wells. These results are consistent with the infrequent detection of phenols, which is most likely due to natural degradation of organic material within the landfill, or to analytical variability at reported levels at or near the minimum detection limit.

The VOC, dichlorodifluoromethane, was not detected in downgradient well NTH-5A in 1997. Historically, this VOC has been detected in downgradient well NTH-5A at concentrations below the corresponding groundwater standard.

Land Area

Other than the natural water quality variations, the turbidity/elevated metal relationship and road salting effects, the Land Area well data (Tables 17, 20 and 21) show some effect associated with the former land disposal areas and a former staging area on groundwater water quality. Some

wells show slightly elevated nitrate, alkalinity, hardness, sulfate, boron, manganese, calcium, potassium and magnesium results. In down-gradient well W-3, three VOCs, trichloroethylene, t-1,2-dichloroethylene and tetrachloroethylene, were detected, of which only t-1,2-dichloroethylene was above the water quality standard. This well is in the vicinity of an area where small amounts of laboratory chemicals were buried years ago. VOC migration is believed to be limited since results from a monitoring well (i.e., W-4) down-gradient of W-3 are less than the minimum detection limit. Of the toxic metals, only barium is marginally elevated in well W-8, with results from all wells below the corresponding groundwater standard.

Hillside

The Hillside well (B) data (Tables 18, 20, and 21) show the effects of road salting, former staging practices and the turbidity/elevated metals relationship on overburden water quality. For the filtered iron samples only the result for KH-18 exceeds the water quality standard. This result may be caused by the slightly acidic pH, which also exceeds the water quality standard. There has been no facility operational changes to account for these results. Annual KH-18 water quality monitoring will continue to further assess the significance of this apparent change. Baseline toxic metals detected in filtered samples were less than groundwater standards; trace levels of barium and zinc are attributed to natural groundwater quality. VOC results for monitoring wells B-5 and B-15 are consistent with previous years, with the exception of chloroform not being detected in monitoring well B-15. The origin of these VOCs is attributed to historical solvent storage and dispensing operations and not to waste burial. No VOCs were detected in monitoring wells down-gradient of B-5 and B-15. An investigation in the vicinity of B-5 and B-6 to assess the potential migration mechanism for solvent migration beneath this portion of the site was completed in 1994. The investigation revealed that the reported VOCs are mostly restricted to porous backfill associated with building foundations and utility lines, not migration through indigenous soils. An agreement was made with the New York State Department of Environmental Conservation for KAPL to remediate an impacted area near well B-5. Remediation commenced in 1996 and was completed in February 1997.

Lower Level

Tables 19 and 20 show the sample results for the Lower Level wells. These wells monitor bedrock water quality. No volatile organic compounds were detected, and, therefore, results are not listed in Table 21. The data show the effects of turbidity, road salting, former staging practices and natural groundwater compositional variations. The data are generally consistent with that previously reported.

The overall conclusion of the groundwater monitoring program is that previous operations and waste disposal practices have resulted in some small, although measurable, effects on the groundwater quality in localized areas of the Knolls Site. 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 Site operations. The groundwater is limited in quantity and is not used as a drinking water supply. In addition, the Knolls Site is not located over any principal or primary bedrock or overburden aquifers. Therefore, the groundwater associated with the Knolls Site does not pose a significant threat to public health.

CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

Origins

Chemicals are not manufactured at the Knolls Site. Minimal quantities of hazardous wastes do result from the necessary use of chemicals in site operations. To ensure the safe use of chemicals and disposal of the resulting wastes, Knolls Site maintains a hazardous waste control program. Hazardous wastes are not disposed of through any KAPL sewer systems or disposed of on-site.

Control Program

The control program minimizes the quantity of waste material generated, ensures safe use and storage of the materials on site and provides for proper disposal of the wastes by vendors that operate under permits issued by state and federal agencies.

A principal part of the waste minimization program is the control of acquisition of hazardous substances for use at the Knolls Site. Purchase orders for chemicals are reviewed to ensure that

the materials are actually necessary for site operations, that 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, revetment as appropriate, segregation based on compatibility, limited storage volumes and weather protection as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the New York State Chemical Bulk Storage regulations as specified in Reference (36) and the Petroleum Bulk Storage regulations in Reference (37). Additionally, in the past few years, many hazardous substances have been replaced by non-hazardous substitutes. KAPL also formally evaluates the hazardous waste that is generated and provides NYSDEC with an annual Hazardous Waste Reduction Plan. Progress in reducing waste at the Knolls Site is tracked in this plan. Significant reductions in hazardous waste streams have been accomplished since the early 1990's. The replacement of the Knolls Site Boiler House make-up water treatment system and the addition of a dealkalizer has resulted in over a 90% reduction of the hazardous waste generated at the Knolls Site since 1994. Reductions of more than 99% have also been achieved in photographic hazardous waste streams by the installation of three silver recovery units, and the replacement of one photographic waste stream with a dry type laser system.

All personnel are provided with general information on Knolls Site 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 volume for shipment to a waste disposal vendor. Hazardous and mixed (radioactive/hazardous) waste storage facilities are operated at the Knolls Site under interim status provisions of the regulation implementing the Resource Conservation and Recovery Act (RCRA) and the Federal Facility Compliance Act. Appropriate permit applications have been submitted to NYSDEC. The Knolls Site has an inspection program to routinely verify that hazardous substances are properly stored and controlled in accordance with approved procedures. In addition, the Knolls Site hazardous waste control program is subject to annual on-site inspections by NYSDEC.

Disposal

Disposal of hazardous waste is in compliance with the Resource Conservation and Recovery Act (RCRA). The waste generated is transported by vendors to treatment/storage/disposal facilities for final disposition. The transportation vendors and the treatment/storage/disposal facilities operate under permits issued by the cognizant state and federal regulatory agencies. KAPL requires the disposal facility to provide itemized written verification that the waste was actually received. During 1997 the Knolls Site shipped approximately 1626 tons of RCRA and New York State hazardous waste for off-site disposal. Approximately 1615 tons of this waste consisted of waste from one-time planned activities or remedial corrective actions such as PCB transformer removals and remediation of historic spills. The remaining 11 tons of chemical hazardous waste sent for disposal was generated as a result of routine operations and processes. This quantity includes 0.6 tons of photograph solutions sent for precious metal recovery and 0.1 tons of universal waste nickel cadmium and mercury batteries which were exempt from inclusion in the Knolls Site New York State Hazardous Waste Report. The Knolls Site reduces the potential environmental impact of the waste by selecting the ultimate disposal methods that minimize or eliminate future environmental intrusion.

Elementary neutralization of a small volume of laboratory waste also occurs on site. This process is exempt from regulation as a RCRA treatment process. The neutralized solution is discharged under the Knolls Site wastewater discharge permit or discharged to the Town of Niskayuna sewer system under an Outside User's Agreement.

TRANSPORTATION OF RADIOACTIVE MATERIALS

Operation of the Knolls Site results in the generation of various types of radioactive materials that require detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government operated disposal site.

Radioactive materials that do not require disposal are handled and transferred in accordance

with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive material from the Knolls Site, to ensure that the material is properly identified, surveyed, and packaged in accordance with federal requirements.

Low level radioactive solid waste materials that require disposal include filters, metal scrap, rags, resin, paper, and plastic materials. The volume of this 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. In addition, loose waste is mechanically compacted to minimize the volume being disposed. Radioactive liquids are solidified in cement prior to shipment. All radioactive wastes are packaged in accordance with written procedures to meet applicable regulations of the DOT given in Reference (14). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

The shipments of low level radioactive solid wastes were made by authorized common carriers to government owned disposal sites located outside New York State. During 1997 approximately 110 cubic meters (143 cubic yards) of low level radioactive waste containing approximately 3.4 curies were shipped from the site for disposal. A mixed waste shipment of approximately 0.65 cubic meters (0.85 cubic yards) containing approximately 0.23 curies was sent to Idaho National Engineering and Environmental Laboratory for incineration. Mixed waste is waste that contains both radioactive constituents regulated by the Department of Energy and hazardous constituents regulated by the New York State Department of Environmental Conservation. The ash is being treated to meet land disposal restrictions at the Hanford Site in Richland, Washington. In addition, approximately 22 tons of slightly radioactive metal was sent to the Scientific Ecology Group (SEG) facility in Tennessee as recyclable material.

RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity present in liquid and gaseous effluents from 1997 operations at the Knolls Site had no measurable effect on normal background radioactivity levels. Therefore, any radiation doses from site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of: (1) the radiation dose to the maximally exposed individual in the vicinity of the Knolls Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site and (3) the collective dose to the population residing in the assessment area are summarized in Tables 40 and 41. See Figure 11 for a map of the assessment area surrounding the Knolls Site.

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 (2) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Knolls Site 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 (4) for whole-body dose, demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (3).

The collective radiation dose to the public along the travel route from Knolls Site shipments of radioactive materials during 1997 was calculated using data given by the NRC in Reference (18). 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.

TABLE 13 - KNOLLS SITE GROUNDWATER SAMPLING PLAN - 1997

Well Category	Well ID	Radioactivity	Routine	Baseline
Landfill	NTH-1A	Q	Q	A
	NTH-2A	Q	Q	A
	NTH-5A	Q	Q	A
	W-11	Q	Q	A
	W-12	Q	Q	A
Land Area	W-1	Q		A
	W-2	A		A
	W-3	A		A
	W-4	A		A
	W-8	A		A
	W-10	A		A
	MW-2	A		A
	MW-3	A		A
	KH-1S	A		A
	KH-2	A		
	KH-3S	A		
Hillside	B-5	A		A
	B-6	A		A
	B-15	A		A
	B-16	A		A
	B-26	A		A
	KH-6	A		A
	KH-9S	A		A
	KH-15	A		A
	KH-16	A		A
	KH-17	A		A
	KH-18	A		A
Lower Level	KH-19	A		A
	KH-20	A		A
	KH-21	A		A
	KH-22	A		A
	KH-23	A		A
Background	SHUGG	A		

Note:

A = Annually
Q = Quarterly

TABLE 14 - GROUNDWATER MONITORING PARAMETERS

Parameters Tested

A Baseline Scan		B Routine Scan
Static Water Level[1]	Volatile Organic Compounds	Static Water Level[1]
Specific Conductance[1]	Chloromethane	Specific Conductance[1]
Temperature[1]	Bromomethane	Temperature[1]
pH[1]	Dichlorodifluoromethane	pH[1]
Eh[1]	Vinyl Chloride	Eh[1]
Total Kjeldahl Nitrogen (TKN)	Chloroethane	Ammonia
Ammonia	Methylene Chloride	Nitrate
Nitrate	Trichlorofluoromethane	COD
Chemical Oxygen Demand (COD)	1,1-Dichloroethane	TOC
Biochemical Oxygen Demand (BOD)	1,1-Dichloroethene	TDS
Total Organic Carbon (TOC)	t-1,2-Dichloroethene	Sulfate
Total Dissolved Solids (TDS)	Chloroform	Alkalinity
Sulfate	1,2-Dichloroethane	Phenols
Alkalinity	1,1,1-Trichloroethane	Chloride
Phenols	Carbon Tetrachloride	Hardness
Chloride	Bromodichloromethane	Turbidity
Hardness	1,2-Dichloropropane	Potassium
Turbidity	t-1,3-Dichloropropene	Sodium
Color	Trichloroethylene	Iron
Boron	Dibromochloromethane	Manganese
Potassium	1,1,2-Trichloroethane	Magnesium
Sodium	cis-1,3-Dichloropropene	Lead
Iron	2-Chloroethylvinylether	Cadmium
Manganese	Bromoform	Calcium
Magnesium	1,1,2,2-Tetrachloroethane	
Calcium	Tetrachloroethylene	
Aluminum	Benzene	
Cyanide	Toluene	
Toxic Metals:	Ethylbenzene	
Antimony	Chlorobenzene	
Arsenic	p-Dichlorobenzene	
Beryllium	m-Dichlorobenzene	
Barium	o-Dichlorobenzene	
Cadmium	Xylenes	
Chromium (total and hexavalent)		
Copper		
Lead		
Mercury		
Nickel		
Selenium		
Silver		
Thallium		
Zinc		

(1) Measured in the field.

TABLE 15 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING FOR RADIOACTIVITY, 1997

Locations		Radioactivity Concentrations[1]							
		Gross Beta		Alpha		Sr-90		Cs-137	H-3
		($\times 10^{-9}$ µCi/ml)							($\times 10^{-7}$ µCi/ml)
Landfill Area									
January	NTH-1A	<0.8		<0.1		<0.2		<1.0	<1.5
	NTH-2A	4.4	± 1.8	2.5	± 0.6	0.6	± 0.5	<1.0	<1.5
	NTH-5A	<0.8		0.3	± 0.3	<0.2		<1.0	<1.4
	W-11	3.3	± 1.6	0.5	± 0.3	<0.2		<1.0	<1.5
	W-12	3.3	± 1.3	1.0	± 0.4	0.4	± 0.3	<1.0	<1.4
June	NTH-1A	0.8	± 1.0	0.2	± 0.2	<0.2		<1.0	<1.6
	NTH-2A	7.9	± 2.0	1.8	± 0.5	0.6	± 0.3	<1.0	<1.6
	NTH-5A	1.1	± 1.3	0.4	± 0.3	<0.2		<1.0	<1.6
	W-11	4.5	± 1.8	0.1	± 0.2	0.3	± 0.3	<1.0	<1.6
	W-12	3.8	± 1.4	0.7	± 0.3	0.4	± 0.3	<1.0	<1.6
September	NTH-1A	<0.9		0.8	± 0.4	0.6	± 0.3	<1.0	<1.3
	NTH-2A	6.0	± 1.9	1.8	± 0.5	0.7	± 0.3	<1.0	<1.3
	NTH-5A	2.8	± 1.6	1.4	± 0.5	<0.2		<1.0	<1.3
	W-11	3.0	± 1.6	0.3	± 0.3	<0.2		<1.0	<1.3
	W-12	12.9	± 2.4	2.4	± 0.6	0.8	± 0.4	<1.0	<1.3
November	NTH-1A	2.5	± 1.3	0.6	± 0.3	0.3	± 0.2	<0.9	<1.1
	NTH-2A	3.7	± 1.6	3.5	± 0.7	0.6	± 0.3	<1.0	<1.1
	NTH-5A	<1.1		0.6	± 0.3	0.4	± 0.3	<1.0	<1.1
	W-11	6.1	± 1.8	0.3	± 0.2	0.3	± 0.2	<1.0	<1.1
	W-12	4.1	± 2.2	1.1	± 0.4	0.6	± 0.3	<1.0	<1.1
Land Area									
January	W-2	6.1	± 1.7	1.4	± 0.5	<0.2		<1.0	<1.4
	W-3	5.7	± 1.8	1.0	± 0.4	0.5	± 0.3	<1.0	<1.5
	W-4	2.0	± 1.4	0.6	± 0.3	<0.2		<1.0	<1.5
	W-8	2.4	± 1.3	0.2	± 0.2	<0.3		<1.0	<1.5
	W-10	3.3	± 1.5	1.0	± 0.4	<0.2		<1.0	<1.4
	MW-2	1.0	± 1.0	0.1	± 0.2	<0.2		<1.0	<1.5
	MW-3	<0.8		0.2	± 0.2	0.2	± 0.2	<1.0	<1.4
Hillside Area									
January	B-5	17.7	± 4.9	1.6	± 0.5	<0.2		<1.1	<1.4
	B-6	10.0	± 2.4	7.6	± 1.0	0.3	± 0.4	<1.0	<1.4
	B-15	24.3	± 3.7	2.8	± 0.6	3.6	± 0.6	<1.0	<1.4
	B-16	4.1	± 1.7	3.1	± 0.7	<0.2		<1.0	<1.4
	B-26	4.5	± 1.7	2.2	± 0.6	<0.2		<1.0	<1.5
	KH-6	<1.0		1.3	± 0.4	<0.2		<1.0	<1.4
	KH-9S	3.8	± 1.8	0.9	± 0.4	<0.2		<1.0	<1.4
	KH-15	4.0	± 1.4	1.0	± 0.4	<0.2		<1.0	<1.5
	KH-16	3.9	± 1.7	2.9	± 0.6	<0.2		<1.0	<1.5
	KH-17	2.3	± 1.4	1.1	± 0.4	<0.2		<1.0	<1.4
	KH-18	7.5	± 2.2	2.1	± 0.5	0.6	± 0.3	<1.0	<1.5
Lower Level									
January	KH-19	4.1	± 1.7	0.5	± 0.3	<0.2		<1.0	<1.5
	KH-20	7.9	± 2.5	<0.1		0.3	± 0.3	<1.0	<1.5
	KH-21	28.6	± 0.3	3.0	± 0.6	9.6	± 0.8	<1.0	<1.5
	KH-22	3.5	± 1.4	0.9	± 0.4	0.6	± 0.3	<1.0	<1.5
	KH-23	4.9	± 1.6	0.3	± 0.3	0.6	± 0.4	<1.0	<1.5
Background Wells - for comparison									
January	W-1	1.6	± 1.3	0.8	± 0.3	<0.2		<1.0	<1.5
	KH-1S	1.4	± 1.3	0.9	± 0.4	<0.2		<1.0	<1.4
	KH-2	2.3	± 1.3	0.2	± 0.2	<0.2		<1.0	<1.5
	KH-3S	13.6	± 2.5	<0.1		<0.3		<1.0	<1.5
February	Shugg	1.8	± 1.2	0.6	± 0.3	<0.2		<1.0	<1.5
June	W-1	1.8	± 1.3	0.4	± 0.3	<0.2		<1.0	<1.6
September	W-1	2.7	± 1.3	0.5	± 0.3	0.3	± 0.3	<1.0	<1.3
November	W-1	2.4	± 1.4	0.3	± 0.2	0.2	± 0.2	<1.0	<1.1

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.

TABLE 16 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, BASELINE/ROUTINE SCAN OF LANDFILL WELLS, 1997

Parameter (all units are mg/l except where indicated)[1,9]

Well	Sample Date	Elev. (Feet)	Temp. (C)	pH (su)	Specific Conductivity (μmhos/cm)	Eh (mv)	Ammonia	Nitrate	COD	TOC	TDS	Sulfate	Alkalinity	Chloride	Hardness	Turbidity (NTU)[2]	Phenols	Color (cpu)[3]	BOD
NTH-1A	01/14/97	319.22	8	6.1	223	309	<0.1	<0.02	<5	1.8	163	34	95	3.0	102	6.4	<0.001	<5	2
	05/14/97	320.72	9	7.0	292	340	<0.1	<0.02	7.5	6.4	130	25	98	2.9	115	15	<0.001		
	09/03/97	311.61	12	6.7	560	329	<0.1	0.07	<5	3.8	363	78	225	15	290	3.2	<0.001		
	11/20/97	310.64	10.0	7.0	554	281	<0.1	0.08	<5	1.0	320	82	204	10	262	60	<0.001		
NTH-5A	01/14/97	268.79	7	6.8	224	309	<0.1	<0.02	<5	2.7	148	26	70	2.5	124	40	<0.001	<5	<2
Dup.	01/14/97	NA	7	6.6	217	308	<0.1	<0.02	19	1.8	138	26	74	2.5	124	52	<0.001	<5	<2
	05/14/97	269.15	10	6.2	217	333	<0.1	<0.02	11	2.8	130	26	100	2.7	126	6.0	<0.001		
	09/03/97	263.78	13	6.9	1060	367	<0.1	0.51	11	2.6	718	80	555	24	512	2.0	<0.001		
Dup.	09/03/97	NA	13	7.0	1059	366	<0.1	0.49	7.5	2.1	730	84	565	31	517	2.6	<0.001		
	11/20/97	265.86	9.0	6.9	1084	300	<0.1	<0.02	<5	1.5	623	76	525	10	443	4.4	<0.001		
NTH-2A	01/14/97	233.13	9	6.6	1160	287	<0.1	0.13	7.5	6.4	795	71	510	66	619	11	<0.001	<5	18
	05/14/97	233.40	7	6.8	957	338	<0.1	0.10	7.5	9.6	683	73	475	84	557	22	<0.001		
Dup.	05/14/97	NA	7	6.8	964	362	<0.1	0.14	7.5	5.6	698	69	480	94	553	22	<0.001		
	09/03/97	232.04	14	6.8	1399	381	<0.1	1.0	11	4.9	913	72	530	156	603	1.7	<0.001		
Dup.	11/20/97	233.98	9.7	6.8	892	336	<0.1	0.03	11	5.2	633	151	445	36	461	83	<0.001		
	11/20/97	NA	9.7	6.8	894	342	<0.1	0.02	<5	4.5	590	153	450	27	465	66	<0.001		
W-12	01/14/97	240.93	7	6.4	547	317	<0.1	0.03	94	3.9	375	93	260	6.1	298	46	<0.001	<5	<2
	05/14/97	240.96	10	6.8	523	345	<0.1	0.03	59	5.3	330	81	250	5.0	291	8.5	<0.001		
	09/03/97	239.57	16	7.0	1016	346	<0.1	0.36	64	1.7	725	278	275	31	490	4.1	<0.001		
	11/20/97	241.67	7.0	7.0	487	411	<0.1	0.03	15	4.6	285	109	158	5.9	205	1.2	<0.001		
W-11	01/14/97	258.19	6	6.7	1022	327	0.6	0.04	<5	2.4	620	52	445	50	524	12	<0.001	<5	<2
	05/14/97	258.35	11	7.0	1019	270	0.4	0.04	<5	1.3	595	54	440	69	522	40	<0.001		
	09/03/97	257.42	17	7.0	1022	309	<0.1	0.38	<5	<1	623	52	425	76	449	19	<0.001		
	11/20/97	258.19	7.9	6.9	1018	365	0.6	0.05	<5	1.6	555	46	445	53	446	16	<0.001		
FIELD[11]	01/14/97	NA	3	6.3	2	320	<0.1	<0.02	<5	<1	<5	<2	3.0	<1	<5	1.0	<0.001	<5	<2
BLANK	05/14/97	NA	13	6.0	2	365	<0.1	<0.02	<5	<1	<5	<2	4.0	<1	<5	1.1	<0.001		
	09/03/97	NA	21	7.3	4	414	<0.1	<0.02	<5	1.9	<5	<2	3.0	<1	<5	0.45	<0.001		
	11/20/97	NA	11.1	8.9	2	377	<0.1	0.02	<5	<1	<5	<2	2.0	<1	<5	<0.1	<0.001		
Standards[4]		[5]	[5]	6.5-8.5[6]	[5]	[5]	2	10	[5]	[5]	500[6]	250	[5]	250	[5]	5[6]	0.001	15[6]	[5]

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Nephelometric Turbidity Unit.
(3) Cobalt Platinum Unit.
(4) Water Quality Standards, 6 NYCRR 703.5.
(5) No groundwater standard or guidance value available.
(6) Water Quality Standards, 6 NYCRR 703.3.
(7) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(8) Unfiltered/filtered results.
(9) See Tables 20 and 21 for additional parameters.
(10) Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
(11) Field blanks were collected at NTH-5A on 1/14/97 and 9/3/97, and at NTH-2A on 5/14/97 and 11/20/97.

NA - Not Applicable
NR - Not Reported by lab

TABLE 16 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, BASELINE/ROUTINE SCAN OF LANDFILL WELLS, 1997 (Continued)

Well	Sample Date	Parameter (all units are mg/l except where indicated)[1,9] Iron[8]	Lead[8]	Manganese[8]	Sodium[8]	Calcium[8]	Potassium[8]	Magnesium[8]	Cadmium[8]	Aluminum[8]	Boron[8]	TKN	Cyanide
NTH-1A	01/14/97	0.12/0.14	<0.005<0.005	<0.02/<0.02	11/11	26/27	<0.5/<0.5	9.0/9.3	<0.005/<0.005	0.1/0.1	<0.05/<0.05	1.4	<0.01
	05/14/97	0.60	<0.005	0.09	8.6	28.4	0.6	10.7	<0.005				
	09/03/97	0.93	<0.005	0.41	6.2	81.6	<0.5	20.9	<0.005				
	11/20/97	1.34	<0.005	0.39	7.1	72	0.7	20	<0.005				
NTH-5A	01/14/97	0.49/<0.05	<0.005/<0.005	0.06/<0.02	3.2/3.6	36/38	<0.5/<0.5	8.2/8.6	<0.005/<0.005	0.2/<0.1	<0.05/<0.05	<1	<0.01
Dup.	01/14/97	0.52/<0.05	<0.005/<0.005	0.06/<0.02	3.2/3.5	36/36	<0.5/<0.5	8.2/8.5	<0.005/<0.005	0.3/<0.1	<0.05/<0.05	<1	<0.01
	05/14/97	0.13	<0.005	<0.02	3.5	34.3	<0.5	8.9	<0.005				
	09/03/97	0.77	<0.005	0.25	22.2	139	<0.5	40.1	<0.005				
Dup.	09/03/97	0.96	<0.005	0.25	22.6	140	<0.5	40.6	<0.005				
	11/20/97	0.35	<0.005	0.30	27	118	1.3	36	<0.005				
NTH-2A	01/14/97	0.09/<0.05	<0.005/<0.005	0.29/0.30	28/33	177/187	<0.5/<0.5	43/49	<0.005/<0.005	0.1/0.2	0.12/0.14	<1	<0.01
	05/14/97	0.99	<0.005	0.61	18.9	161	<0.5	37.6	<0.005				
Dup.	05/14/97	1.10	<0.005	0.69	18.7	160	<0.5	37.2	<0.005				
	09/03/97	0.50	<0.005	1.26	36.1	168	<0.5	44.8	<0.005				
	11/20/97	1.35	<0.005	0.60	12	143	<0.5	25	<0.005				
Dup.	11/20/97	1.15	<0.005	0.46	8.2	148	<0.5	23	<0.005				
W-12	01/14/97	0.13/<0.05	<0.005<0.005	0.02/<0.02	13/13	85/89	<0.5/<0.5	21/22	<0.005/<0.005	0.1/<0.1	0.11/0.11	1.7	<0.01
	05/14/97	0.12	<0.005	<0.02	11.8	80.9	1.0	21.7	<0.005				
	09/03/97	1.02	<0.005	0.11	21.9	145	6.2	31.2	<0.005				
	11/20/97	0.53	<0.005	0.07	12	54	<0.5	17	<0.005				
W-11	01/14/97	0.45/<0.05	<0.005/<0.005	0.19/0.15	27/28	134/138	<0.5/<0.5	46/48	<0.005/<0.005	0.3/0.1	0.11/0.13	1.4	<0.01
	05/14/97	0.77	<0.005	0.17	25.0	129	<0.5	48.5	<0.005				
	09/03/97	0.22	<0.005	0.12	24.0	116	<0.5	38.7	<0.005				
	11/20/97	0.36	<0.005	0.16	26	114	1.9	39	<0.005				
FIELD BLANK[11]	01/14/97	<0.05/<0.05	<0.005 <0.005	<0.02/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.005/<0.005	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	05/14/97	<0.05	<0.005	<0.02	<0.5	<0.5	1.7	<0.5	<0.005				
	09/03/97	<0.05	<0.005	<0.02	<0.5	1.0	<0.5	<0.5	<0.005				
	11/20/97	<0.05	<0.005	<0.02	<0.5	<0.5	<0.5	<0.5	<0.005				
Standards[4]		0.3[10]	0.025	0.3[10]	20	[5]	[5]	35[7]	0.01	[5]	1	[5]	0.1

See notes on previous page.

TABLE 17 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, BASELINE SCAN OF LAND AREA ASSESSMENT WELLS, 1997

Parameter (all units are mg/l except where indicated)[1,9]

Well	Sample Date	Elev. (Feet)	Temp. (C)	pH (su)	Specific Conductivity (μmhos/cm)	Eh (mv)	Ammonia	Nitrate	COD	TOC	TDS	Sulfate	Alkalinity	Chloride	Hardness	Turbidity (NTU)[2]	Phenols	Color (cpu)[3]	BOD
KH-1S	01/20/97	334.28	8	6.7	484	388	< 0.1	0.42	19	1.8	325	30	250	<1	273	590	<0.001	<5	<2
W-1	01/14/97	314.92	8	7.1	848	415	0.1	0.04	<5	2.4	605	124	280	39	368	14	<0.001	<5	<2
MW-3	01/16/97	308.58	7	6.6	315	353	<0.1	0.02	26	2.0	178	39	125	2.7	156	2.3	<0.001	<5	<2
MW-2	01/16/97	309.26	7	6.8	185	364	<0.1	0.02	<5	1.5	133	32	115	1.9	86	12	<0.001	<5	<2
W-2	01/16/97	307.53	10	7.2	846	381	0.2	0.14	<5	2.5	490	199	275	7.7	361	7.8	<0.001	5	2
W-3	01/16/97	304.50	8	6.7	1005	369	0.2	0.07	<5	3.1	648	224	345	6.0	483	5.2	<0.001	<5	<2
W-3 Dup.	01/16/97	NA	8	6.8	1003	365	0.2	0.08	7.5	3.3	643	220	340	6.0	478	4.8	<0.001	<5	2
W-4	01/16/97	282.90	4	6.8	776	320	<0.1	0.04	7.5	1.8	565	199	285	6.9	469	69	<0.001	5	<2
W-8	01/16/97	Flowing[12]	11	7.4	499	372	0.3	0.11	<5	1.1	305	67	200	3.9	181	12	<0.001	10	<2
W-10	01/16/97	287.13	10	7.0	850	386	<0.1	0.26	<5	1.6	515	117	310	24	405	6.0	<0.001	<5	<2
FIELD BLANK[11]	01/14/97	NA	3	6.3	2	320	<0.1	<0.02	<5	<1	<5	<2	3.0	<1	<5	1.0	<0.001	<5	<2
	01/16/97	NA	7	5.5	3	421	<0.1	<0.02	<5	1.0	23	<2	3.0	<1	<5	0.35	<0.001	5	<2
	01/20/97	NA	3	6.4	2	383	<0.1	<0.02	<5	<1	<5	<2	3.0	<1	<5	0.23	<0.001	<5	<2
Standards[4]		[5]	[5]	6.5-8.5[6]	[5]	[5]	2	10	[5]	[5]	500[6]	250	[5]	250	[5]	5[6]	0.001	15[6]	[5]

Well	Sample Date	Iron[8]	Manganese[8]	Sodium[8]	Calcium[8]	Potassium[8],[13]	Magnesium[8]	Aluminum[8]	Boron[8]	TKN	Cyanide
KH-1S	01/20/97	3.08/<0.05	0.45/<0.02	4.7/5.2	71.9/65.6	<0.5/<0.5	22.5/21.6	1.6/<0.1	<0.05/<0.05	<1	<0.01
W-1	01/14/97	0.24/<0.05	0.10/0.05	46/48	106/108	<0.5/<0.5	25/25	0.2/<0.1	<0.05/<0.05	<1	<0.01
MW-3	01/16/97	<0.05/<0.05	<0.02/<0.02	8.0/8.4	46.1/45.5	<0.5/<0.5	9.9/10.3	<0.1/<0.1	<0.05/<0.05	<1	<0.01
MW-2	01/16/97	<0.05/<0.05	<0.02/<0.02	4.6/4.8	26.1/25.7	<0.5/<0.5	5.2/5.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
W-2	01/16/97	0.14/<0.05	0.36/0.23	52.3/53.6	94.0/93.6	<0.5/3.7	30.5/31.6	<0.1/<0.1	0.26/0.26	<1	<0.01
W-3	01/16/97	0.06/<0.05	0.48/0.41	41.3/42.5	137/140	<0.5/<0.5	34/35.9	<0.1/<0.1	0.20/0.19	<1	<0.01
W-3 Dup.	01/16/97	0.07/<0.05	0.48/0.40	41.0/42.3	135/139	<0.5/<0.5	34.2/35.8	<0.1/<0.1	0.20/0.20	<1	<0.01
W-4	01/16/97	1.28/<0.05	0.15/0.07	11.1/10.9	127/121	<0.5/<0.5	36.9/36.0	0.4/<0.1	0.07/0.05	<1	<0.01
W-8	01/16/97	0.44/<0.05	0.05/0.03	39.8/39.8	48.9/48.1	1.3/2.6	14.4/14.6	0.7/<0.1	0.18/0.16	<1	<0.01
W-10	01/16/97	<0.05/<0.05	0.05/0.03	35.9/36.6	112/112	<0.5/2.8	30.4/31.2	<0.1/<0.1	<0.05/<0.05	<1	<0.01
FIELD BLANK[11]	01/14/97	<0.05/<0.05	<0.02/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	01/16/97	<0.05/<0.05	<0.02/<0.02	0.5/0.5	<0.5/<0.5	1.4/0.6	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	01/20/97	<0.05/<0.05	<0.05/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
Standards[4]		0.3[10]	0.3[10]	20	[5]	[5]	35[7]	[5]	1	[5]	0.1

Notes:

(1) A value preceded by < is less than the minimum detection level.
(2) Nephelometric Turbidity Unit.
(3) Cobalt Platinum Unit.
(4) Water Quality Standards, 6 NYCRR 703.5.
(5) No groundwater standard or guidance value available.
(6) Water Quality Standards, 6 NYCRR 703.3.
(7) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(8) Unfiltered/filtered results.
(9) See Tables 20 and 21 for additional parameters.
(10) Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
(11) *Field blanks were collected at NTH-5A on 1/14/97, at W-3 on 1/16/97 and at KH-21 on 1/20/97.*
(12) The groundwater was flowing over the top of the casing.
(13) Filtered potassium results exceeding unfiltered results is considered an artifact of the filtration process.

TABLE 18 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, BASELINE SCAN OF HILLSIDE WELLS, 1997

Parameter (all units are mg/l except where indicated) [1,9]

Well	Sample Date	Elev. (Feet)	Temp. (C)	pH (su)	Specific Conductivity (µmhos/cm)	Eh (mv)	Ammonia	Nitrate	COD	TOC	TDS	Sulfate	Alkalinity	Chloride	Hardness	Turbidity (NTU)[2]	Phenols	Color (cpu)[3]	BOD
KH-6	01/22/97	314.56	8	6.8	977	342	<0.1	0.24	<5	1.2	515	40	410	44	456	14	<0.001	<5	<2
B-5	01/22/97	324.61	16	6.9	3330	295	0.1	<0.02	<5	1.4	1920	351	270	695	856	23	<0.001	10	<2
B-5 Dup.	01/22/97	NA	16	7.0	3300	289	0.1	<0.02	<5	1.3	1990	346	275	689	839	23	<0.001	<5	<2
B-6	01/22/97	322.85	14	7.1	1289	386	0.1	0.03	15	5.0	750	78	270	286	327	67	<0.001	10	5
B-15	01/22/97	317.62	12	6.6	3430	360	0.4	0.02	<5	3.3	2400	907	470	540	1440	21	<0.001	<5	3
B-26	01/20/97	290.98	6	7.3	1088	288	0.2	<0.02	11	1.2	668	83	350	127	655	>1000	<0.001	<5	<2
KH-15	01/20/97	281.89	10	7.3	898	346	0.2	<0.02	7.5	<1	633	143	470	16	754	250	<0.001	<5	<2
B-16	01/20/97	269.54	7	7.1	1079	369	<0.1	0.02	22	2.2	705	182	410	46	501	120	<0.001	<5	<2
KH-16	01/22/97	317.88	8	7.0	1272	386	<0.1	0.03	<5	1.5	678	105	370	191	1890	>1000	<0.001	5	3
KH-17	01/22/97	321.65	9	6.7	987	317	<0.1	0.08	<5	3.4	598	145	380	51	527	300	<0.001	<5	<2
KH-9S	01/22/97	325.22	8	6.9	2710	394	<0.1	0.78	11	<1	1520	114	280	609	1130	>1000	<0.001	<5	<2
KH-18	01/22/97	280.70	8	6.2	2200	204	0.2	<0.2	47	3.9	1390	441	420	336	1080	290	<0.001	5	<2
FIELD BLANK[11]	01/20/97	NA	3	6.4	2	383	<0.1	<0.02	<5	<1	<5	<2	3.0	<1	<5	0.23	<0.001	<5	<2
	01/22/97	NA	4	6.6	3	450	<0.1	<0.02	<5	1.2	<5	<2	4.0	<1	<5	0.80	<0.001	<5	<2
Standards[4]		[5]	[5]	6.5-8.5[6]	[5]	[5]	2	10	[5]	[5]	500[6]	250	[5]	250	[5]	5[6]	0.001	15[6]	[5]

Well	Sample Date	Iron[8]	Manganese[8]	Sodium[8]	Calcium[8]	Potassium[8], [12]	Magnesium[8]	Aluminum[8]	Boron[8]	TKN	Cyanide
KH-6	01/22/97	0.15/<0.05	0.03/0.03	36.4/39.9	126/128	<0.5/<0.5	34.3/39.7	<0.1/<0.1	<0.05/<0.05	<1	<0.01
B-5	01/22/97	1.64/0.07	0.15/0.13	381/378	228/231	<0.5/<0.5	69.7/69.1	<0.1/<0.1	<0.05/<0.05	<1	<0.01
B-5 Dup.	01/22/97	1.62/0.07	0.15/0.15	370/406	224/225	<0.5/<0.5	68.0/70.5	<0.1/<0.1	<0.05/0.06	<1	<0.01
B-6	01/22/97	0.71/<0.05	0.08/0.02	158/157	93.6/91.3	0.5/0.6	22.6/22.2	0.2/<0.1	0.61/0.60	<1	<0.01
B-15	01/22/97	0.85/<0.05	1.29/1.15	228/231	361/368	2.3/4.4	130/133	0.2/<0.1	0.25/0.24	<1	<0.01
B-26	01/20/97	7.50/0.10	0.71/0.02	31.5/32.6	142/89.9	<0.5/<0.5	72.8/65.2	1.1/<0.1	0.05/0.07	<1	<0.01
KH-15	01/20/97	4.63/0.09	0.22/0.04	14.3/16.0	211/105	<0.5/<0.5	55.2/58.5	0.7/<0.1	0.06/0.06	<1	<0.01
B-16	01/20/97	0.40/<0.05	0.02/<0.02	34.6/36.4	115/119	<0.5/<0.5	52.1/54.1	0.2/0.1	0.08/0.07	<1	<0.01
KH-16	01/22/97	58.4/<0.05	5.81<0.02	49.9/50.8	554/126	<0.5/<0.5	123/68.0	20.8/<0.1	<0.05/<0.05	<1	<0.01
KH-17	01/22/97	1.99/<0.05	0.57/<0.02	32.0/33.3	146/138	<0.5/<0.5	39.3/40.2	2.1/<0.1	<0.05/<0.05	<1	<0.01
KH-9S	01/22/97	8.27/<0.05	4.02/0.08	136/139	314/271	<0.5/<0.5	84.2/79.8	1.64/<0.1	<0.05/<0.05	<1	<0.01
KH-18	01/22/97	3.19/0.41	1.93/1.87	66.2/67.8	308/310	<0.5/<0.5	75.8/80.0	0.6/<0.1	<0.05/<0.05	<1	<0.01
FIELD BLANK[11]	01/20/97	<0.05/<0.05	<0.05/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	01/22/97	<0.05/<0.05	<0.02/<0.02	0.7/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
Standards[4]		0.3[10]	0.3[10]	20	[5]	[5]	35[7]	[5]	1	[5]	0.1

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Nephelometric Turbidity Unit.
(3) Cobalt Platinum Unit.
(4) Water Quality Standards, 6 NYCRR 703.5.
(5) No groundwater standard or guidance value available.
(6) Water Quality Standards, 6 NYCRR 703.3.
(7) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(8) Unfiltered/filtered results.
(9) See Tables 20 and 21 for additional parameters.
(10) Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
(11) Field blanks were collected at KH-21 on 1/20/97, and at B-5 on 1/22/97.
(12) Filtered potassium results exceeding unfiltered results is considered an artifact of the filtration process.

TABLE 19 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, BASELINE SCAN OF LOWER LEVEL WELLS, 1997

Parameter (all units are mg/l except where indicated) [1,9]

Well	Sample Date	Elev. (Feet)	Temp. (C)	pH (su)	Specific Conductivity (μmhos/cm)	Eh (mv)	Ammonia	Nitrate	COD	TOC	TDS	Sulfate	Alkalinity	Chloride	Hardness	Turbidity (NTU)[2]	Phenols	Color (cpu)[3]	BOD
KH-23	01/20/97	244.39	7	7.4	782	292	1.2	0.42	<5	<1	473	46	210	80	244	51	<0.001	<5	3
KH-21	01/20/97	242.11	10	6.6	1742	395	<0.1	<0.02	<5	2.7	1020	163	255	348	339	30	<0.001	<5	<2
KH-21 Dup.	01/20/97	NA	10	6.6	1734	393	<0.1	<0.02	<5	2.6	1040	162	250	340	337	24	<0.001	5	<2
KH-19	01/22/97	235.85	9	9.0	1210	334	1.0	0.02	<5	6.8	3120	2.2	535	44	84	>1000	<0.001	5	5
KH-20 [12]	01/27/97	234.16	11	11.1	1020	266	0.5	0.35	83	10	395	71	220	82	301	89	<0.001	<5	13
KH-20 [12]	04/16/97	227.69	13	8.4	746	334	<0.1	0.47	<5	2.2	510	83	245	88	418	13	<0.001	5	<2
KH-20 Dup.	04/16/97	NA	13	8.4	746	339	<0.1	0.47	<5	2.5	475	82	240	87	411	14	<0.001	5	<2
KH-22	01/20/97	225.52	8	7.3	528	348	<0.1	0.95	11	2.2	338	47	140	51	184	320	<0.001	5	<2
FIELD BLANK[11]	01/20/97	NA	3	6.4	2	383	<0.1	<0.02	<5	<1	<5	<2	3.0	<1	<5	0.23	<0.001	<5	<2
	01/22/97	NA	4	6.6	3	450	<0.1	<0.02	<5	1.2	<5	<2	4.0	<1	<5	0.80	<0.001	<5	<2
	01/27/97	NA	9	8.3	2	427	<0.1	<0.02	<5	2.4	13	<2	3.0	<1	<5	0.37	<0.001	<5	<2
	04/16/97	NA	16	8.2	3	425	<0.1	<0.02	<5	<1	<5	<2	3.0	<1	<5	1.2	<0.001	<5	<2
Standards[4]		[5]	[5]	6.5-8.5[6]	[5]	[5]	2	10	[5]	[5]	500[6]	250	[5]	250	[5]	5[6]	0.001	15[6]	[5]

Well	Sample Date	Iron[8]	Manganese[8]	Sodium[8]	Calcium[8]	Potassium[8]	Magnesium[8]	Aluminum[8]	Boron[8]	TKN	Cyanide
KH-23	01/20/97	1.29/<0.05	0.23/0.16	67.6/70.7	73.5/62.4	<0.5/<0.5	14.6/14.9	0.1/<0.1	0.25/0.24	<1	<0.01
KH-21	01/20/97	0.49/<0.05	2.65/1.42	214/218	93.0/90.8	<0.5/<0.5	26.1/26.4	0.6/<0.1	<0.05/<0.05	<1	<0.01
KH-21 Dup.	01/20/97	0.41/<0.05	2.42/1.50	211/219	92.2/90.6	<0.5/<0.5	26.1/26.4	0.6/<0.1	0.05/<0.05	<1	<0.01
KH-19	01/22/97	6.19/0.07	0.34/<0.02	267/313	28.6/2.9	<0.5/<0.5	3.0/<0.5	2.4/0.3	0.88/0.99	2.5	<0.01
KH-20 [12]	01/27/97	<0.05/<0.05	0.02/<0.02	19.0/19.0	115/106	0.7/<0.5	3.3/1.6	<0.1/<0.1	<0.05/<0.05	1.7	<0.01
KH-20 [12]	04/16/97	<0.05/<0.05	0.23/0.27	19.7/21.1	109/113	2.1/1.6	35.4/39.4	0.4/0.2	0.06/0.06	<1	<0.01
KH-20 Dup.	04/16/97	<0.05/<0.05	0.22/0.26	19.5/21.1	107/111	0.8/0.6	34.9/39.0	0.3/0.1	0.06/0.06	<1	<0.01
KH-22	01/20/97	1.82/<0.05	1.28/0.06	31.9/33.7	55.4/54.0	<0.5/<0.5	11.2/11.2	1.6/<0.1	<0.05/<0.05	<1	<0.01
FIELD BLANK[11]	01/20/97	<0.05/<0.05	<0.05/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	01/22/97	<0.05/<0.05	<0.02/<0.02	0.7//<0.5	<0.5<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	01/27/97	<0.05/<0.05	<0.02/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.1/<0.1	<0.05/<0.05	<1	<0.01
	04/16/97	<0.05/<0.05	<0.02/<0.02	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	0.1/<0.1	<0.05/<0.05	<1	<0.01
Standards[4]		0.3[10]	0.3[10]	20	[5]	[5]	35[7]	[5]	1	[5]	0.1

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Nephelometric Turbidity Unit.
(3) Cobalt Platinum Unit.
(4) Water Quality Standards, 6 NYCRR 703.5.
(5) No groundwater standard or guidance value available.
(6) Water Quality Standards, 6 NYCRR 703.3.
(7) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
(8) Unfiltered/filtered results.
(9) See Tables 20 and 21 for additional parameters.
(10) Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
(11) Field blanks were collected at KH-21 on 1/20/97, at B-5 on 1/22/97, and at KH-20 on 1/27/97 and 4/16/97.
(12) KH-20 was sampled on 1/27/97 and 4/16/97. The 1/27/97 sample results (e.g., pH, ammonia, COD, BOD, manganese, magnesium) reflect stagnant water conditions. Poor well recovery combined with loss of well water purging tool prevented adequate purging of the well to ensure a representative water sample. The well was adequately purged to support the 4/16/97 sampling. The 4/16/97 sample results are more representative of formation water and compare with historical results.

TABLE 20 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, LANDFILL, LAND AREA ASSESSMENT, HILLSIDE AND LOWER LEVEL WELLS, BASELINE TOXIC METALS, 1997

		Parameter (all units are mg/l except where indicated)[1,2,5]						
Well	Sample Date	Arsenic[3]	Barium[3]	Copper	Lead[3]	Mercury	Nickel	Zinc[3]
NTH-1A	01/14/97	<0.005/<0.005	0.02/0.02	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
NTH-5A	01/14/97	<0.005/<0.005	0.02/0.02	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
NTH-5A Dup.	01/14/97	<0.005/<0.005	0.02/0.02	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
NTH-2A	01/14/97	<0.005/<0.005	0.15/0.15	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
W-12	01/14/97	<0.005/<0.005	0.05/0.04	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/0.01
W-11	01/14/97	<0.005/<0.005	0.32/0.27	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
KH-1S	01/20/97	<0.005/<0.005	0.08/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.03/<0.01
W-1	01/14/97	<0.005/<0.005	0.10/0.08	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/0.01
MW-3	01/16/97	<0.005/<0.005	<0.01/<0.01	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/0.02
MW-2	01/16/97	<0.005/<0.005	<0.01/<0.01	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
W-2	01/16/97	<0.005/<0.005	0.04/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
W-3	01/16/97	<0.005/<0.005	0.05/0.04	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
W-3 Dup.	01/16/97	<0.005/<0.005	0.05/0.04	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
W-4	01/16/97	<0.005/<0.005	0.05/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
W-8	01/16/97	<0.005/<0.005	0.13/0.10	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
W-10	01/16/97	<0.005/<0.005	0.04/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
KH-6	01/22/97	<0.005/<0.005	0.04/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/0.01
B-5	01/22/97	<0.005/<0.005	0.03/0.02	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.03/0.01
B-5 Dup.	01/22/97	<0.005/<0.005	0.03/0.04	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.03/0.01
B-6	01/20/97	<0.005/<0.005	0.16/0.12	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
B-15	01/22/97	<0.005/<0.005	0.02/0.04	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/0.01
B-26	01/20/97	0.017/<0.005	0.11/0.05	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.04/<0.01
KH-15	01/20/97	0.020/<0.005	0.14/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
B-16	01/20/97	<0.005/<0.005	0.03/0.02	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
KH-16	01/22/97	0.024/<0.005	0.41/0.03	0.21/<0.05	0.154/<0.005	0.0010/<0.0004	0.10/<0.05	0.31/0.01
KH-17	01/22/97	<0.005/<0.005	0.06/0.03	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
KH-9S	01/22/97	<0.005/<0.005	0.17/0.09	<0.05/<0.05	0.041/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.04/<0.01
KH-18	01/22/97	<0.005/<0.005	0.09/0.08	<0.05/<0.05	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
KH-23	01/20/97	<0.005/<0.005	0.73/0.49	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
KH-21	01/20/97	<0.005/<0.005	0.10/0.05	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
KH-21 Dup.	01/20/97	<0.005/<0.005	0.09/0.11	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
KH-19	01/22/97	0.010/<0.005	0.32/0.08	<0.005/<0.005	0.063/<0.005	0.0005/<0.0004	<0.05/<0.05	0.05/<0.01
KH-20	01/27/97	<0.005/<0.005	0.15/0.14	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
KH-20	04/16/97	<0.005/<0.005	0.19/0.20	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/0.02
KH-20 Dup.	04/16/97	<0.005/<0.005	0.19/0.20	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/0.02
KH-22	01/20/97	<0.005/<0.005	0.10/0.02	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.04/<0.01
FIELD BLANK[6]	01/14/97	<0.005/<0.005	<0.01/<0.01	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
	01/16/97	<0.005/<0.005	<0.01/<0.01	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
	01/20/97	<0.005/<0.005	<0.01/<0.01	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.02/<0.01
	01/22/97	<0.005/<0.005	<0.01/<0.01	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
	01/27/97	<0.005/<0.005	<0.01/<0.01	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/<0.01
	04/16/97	<0.005/<0.005	<0.01/<0.01	<0.005/<0.005	<0.005/<0.005	<0.0004/<0.0004	<0.05/<0.05	0.01/0.01
Standards[4]		0.025	1	0.20	0.025	0.002	(7)	0.3

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) The only parameters listed are those for which any of the Knolls Site wells exceeded the minimum detection level for that parameter.

(3) Unfiltered/filtered results.

(4) Water Quality Standards, 6 NYCRR 703.5.

(5) In addition to the parameters listed in the table, the following metals were also analyzed: antimony, beryllium, cadmium, chromium, hexavalent chromium, selenium, silver, and thallium. The results were less than the minimum detection level. Cadmium and lead are analyzed on a quarterly basis for the landfill. See Table 16 for a complete data set.

(6) The field blanks were collected at NTH-5A area on 1/14/97, at W-3 on 1/16/97, at KH-21 on 1/20/97, at B-5 on 1/22/97, and at KH-20 on 1/27/97 and 4/16/97.

(7) No standard or guidance value for this parameter in groundwater.

TABLE 21 - RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, LANDFILL, LAND AREA ASSESSMENT, HILLSIDE AND LOWER LEVEL WELLS, VOLATILE ORGANIC ANALYSES, 1997

Well	Sample Date	Carbon Tetrachloride	1,1-Dichloro-ethene	t-1,2-Dichloro-ethene	Tetrachloro-ethylene	Methylene Chloride	Trichloro-ethylene
		Parameter (all units are µg/l except where indicated)[1,2]					
W-3	01/15/97	<1	<1	12	2	<1	2
Dup.	01/15/97	<1	<1	10	2	<1	1
B-5	01/22/97	<1	6	120	<1	<1	2700
Dup.	01/22/97	<50	<50	120	<50	<50	2500
B-15	01/22/97	1	<1	13	<1	<1	130
FIELD BLANKS[4]	01/21/97	<1	<1	<1	<1	3	<1
Standards[3]		5	5	5	5	5	5

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) The only parameters listed are those for which any of the Knolls Site wells exceeded the minimum detection level (MDL) for that parameter. An additional 27 volatile organic compounds were analyzed and were less than the MDL. Table 14 lists the names of all compounds analyzed.

(3) Groundwater Standards, 6 NYCRR 703.5.

(4) Field blank was done at B-5 on 1/21/97.

KESSELRING SITE EFFLUENT AND ENVIRONMENTAL MONITORING

SITE DESCRIPTION

The Kesselring Site (Figure 11) consists of 3900 acres on which are located four pressurized-water naval nuclear propulsion plants and support facilities, including administrative offices, machine shops, waste storage facilities, oil storage facilities, training facilities, equipment service buildings, chemistry laboratories, a boiler house, cooling towers, and wastewater treatment facilities. Two of the four nuclear propulsion plants are permanently shut down and defueled. The Site is located near West Milton, New York, approximately 17 miles (27.4 kilometers) north of the City of Schenectady, and 9 miles (14.5 kilometers) southwest of Saratoga Springs. The surrounding area is a rural, sparsely populated region of wooded lands through which flow the Glowegee Creek and several small streams that empty into the Kayaderosseras Creek.

As a result of the end of the Cold War and the downsizing of the Navy, the S3G and D1G Prototype reactor plants were shutdown in May 1991 and March 1996, respectively. All spent nuclear fuel was removed from the S3G Prototype reactor and shipped off-site in July 1994. All spent nuclear fuel was removed from the D1G Prototype reactor and shipped off-site in February 1997. Since there was no further need for these plants, a decision was needed on their disposal. The National Environmental Policy Act (NEPA) requires Federal agencies to analyze the potential environmental impacts of their proposed actions to assist them in making informed decisions. The U.S. Department of Energy Office of Naval Reactors (Naval Reactors) evaluated the alternatives for disposal of the S3G and D1G Prototype reactor plants. These alternatives included: promptly dismantling the plants, deferring dismantlement for 30 years, and the "no-action" alternative which would keep the plants in a protective storage condition on-site indefinitely. A key element of Naval Reactors' decision making has been a thorough understanding of the environmental impacts associated with each alternative. In following the NEPA process, Naval Reactors prepared a Draft Environmental Impact Statement to assess the various alternatives and to provide necessary background, data and analysis to help decision makers and the public understand the potential environmental impacts of each alternative. Following consideration of public comments, Naval Reactors prepared a Final Environmental Impact Statement, Reference (40), which identified prompt dismantlement as the preferred alternative. In a Record of Decision dated January 20, 1998, Naval Reactors decided to promptly dismantle the defueled S3G and D1G reactor plants. Dismantlement operations began, starting on the S3G plant, shortly after this decision was made. The project is planned to be completed as soon as practicable subject to available appropriated funding. Two additional nuclear propulsion plants, S8G and MARF, will continue to be operated at the Site for the foreseeable future.

The climate in the region of the Kesselring Site is primarily continental in character, but is subjected to some modification from the maritime climate which prevails in the extreme southeastern portion of New York State. Winters are usually cold and occasionally fairly severe. Maximum temperatures during the colder winter months often are below freezing and nighttime low temperatures frequently drop to 10°F or lower. Sub-zero temperatures occur rather infrequently, about a dozen times a year. Snowfall in the area is quite variable, averaging approximately 65 inches per year. Over some of the higher elevation areas nearby, snow fall ranges up to 75 inches or more for a season. The mean annual precipitation for the area is approximately 36 inches per year. The prevailing winds are from the west.

The area surrounding the Kesselring Site has a complex geological history due to the processes of erosion, glaciation, folding and faulting. The geological formations of the West Milton area are comprised of two major types; bedrock, which ranges in age from Precambrian to Ordovician, and unconsolidated deposits of Pleistocene and Recent age. Bedrock underlying the area crop out only on some steep hillsides and in some stream valleys. They are covered by the unconsolidated deposits in the remainder of the area. These unconsolidated deposits range in thickness from zero to 200 feet with an average thickness of 50 feet. Bedrock underlying the West Milton area may be divided into two groups; (1) metamorphosed rocks of Precambrian age, and (2) sedimentary rocks of Paleozoic age. The older metamorphosed rocks consist of gneiss, schist, quartzite, and limestone

(marble) of sedimentary origin; and syenite and granite of igneous origin. These rocks are referred to as crystalline rocks. The Paleozoic rocks likewise consist of several types of rocks including sandstone, dolomite, limestone and shale. The unconsolidated deposits can be subdivided into four groups: (1) till - an unstratified, dense heterogeneous mixture of glacially deposited rock particles ranging in size from clay to gravel, (2) ice-contact deposits - kames and eskers composed of stratified sand and gravel, (3) glaciolacustrine deposits - a homogeneous stratified layer of sand silt and clay, and (4) recent fluvial deposits consisting of sand and gravel.

Generally, the coarser grained, stratified, unconsolidated deposits form better aquifers than the fine grained and unstratified unconsolidated deposits or bedrock foundations. Only small areas are underlain by these coarse grained deposits. Percolating water from rainfall and snow-melt recharge the shallow, unconfined aquifers beneath the site and in turn, the various site streams are recharged by shallow groundwater. The Kayaderosseras Creek valley is underlain by coarse grained glacial and fluvial deposits from which all site service water is produced. The site well-field is located near the eastern boundary of the site within the Creek's floodplain.

The Kesselring Site is located in the transition zone between the Adirondack Mountains and the Hudson-Mohawk Valley lowland. The Kayaderosseras Creek forms the main drainage system in the vicinity of the Site. The average flow in the Kayaderosseras Creek is 144 cubic feet per second (cfs) and the minimum recorded seven-day average flow for a 10 year period is 17 cfs.

The Glowegee Creek, Crook Brook and Hogback Brook drain the Site. Crook Brook directly joins the Kayaderosseras. Hogback Brook is a tributary to the Glowegee which are the receiving waters for site drainage. The average flow in the Glowegee is 50.7 cfs and the minimum recorded seven-day average flow for a 10 year period is 0.92 cfs. The Glowegee Creek joins with the Kayaderosseras approximately one mile east of West Milton.

The Glowegee and Kayaderosseras Creeks are classified under New York State Codes, Rules and Regulations as Class C - Trout Streams. Under this classification the waters are suitable for fishing and fish propagation. Additionally the water quality shall be suitable for primary and secondary contact recreation, even though other factors may limit the use for that purpose. The New York State Department of Environmental Conservation (NYSDEC) has permitted the Site to discharge effluent from various site operations to the Glowegee Creek as specified in the Site *State* Pollution Discharge Elimination System (SPDES) permit. Environmental monitoring has shown no measurable water quality degradation in the Glowegee Creek due to Site Operations. The Kesselring Site obtains all water for its operation from on-site production wells which are hydrogeologically separate from other portions of the Site.

LIQUID EFFLUENT MONITORING

Origins

The primary sources of the effluent water at the Kesselring Site are:

1. *Site Boiler Discharges* - Site boiler water is treated demineralized water. Operations that result in releases are (1) periodic blowdowns to control the concentration of solids and (2) neutralization of ion exchange resin regeneration effluent. The water generated by these operations is neutralized before discharge.

2. *Sewage Treatment Plant* - The plant is a tertiary treatment facility employing extended aeration/contact stabilization activated sludge process and chemical precipitation of phosphorous followed by sand filtration. Waste sludge is stored in a holding tank and is periodically removed by a licensed subcontractor for disposal at a state-approved facility.

3. *Cooling Tower Water* - Cooling water is treated to minimize scale formation, to prevent corrosion of system materials and to inhibit the growth of algae and slime. The pH is normally maintained in the range of 7.4 to 8.2.

4. *Retention Basin Liquids* - The retention basins receive wastewater from reactor plant facilities including blowdown water from steam generators and drainage water from the engine rooms.

5. *Site Drainage Water* - Storm water and groundwater also make up a portion of the liquid effluent.

6. *Site Service Water* - Site service water is used for drinking water and non-contact

cooling purposes. Chlorine is added to the site service water system as a drinking water disinfectant.

With the exception of the sewage treatment plant effluent, all of the above sources of effluent water are discharged into the Kesselring Site Lagoon before ultimate off site discharge into the Glowegee Creek. The site lagoon is a five million gallon holding basin that was designed to accumulate effluent water for the purposes of pH control, thermal equalization, chlorine dissipation, and settling of solid particles.

Some of the liquid effluent discharged from the retention basins contains low levels of radioactivity. The source of this radioactivity is small quantities of activation products. The activation products may include tritium, and radionuclides of corrosion and wear products.

Tritium is present in the reactor coolant as the result of neutron interaction with naturally occurring deuterium present in the water. Corrosion and wear activation products are present as small insoluble metal oxide particles, with cobalt-60 the predominant radionuclide.

To minimize releases of radioactivity to the environment, a water reuse system is employed. Water is collected and processed through the process system consisting of a series of filters and demineralizers. After purification, the majority of water is reused as reactor coolant make-up and in other radioactive systems, thereby reducing the amount of radioactivity that could be released as liquid effluent.

Liquid discharges that might contain tritium are either sampled and analyzed individually, or sampled and combined into a monthly composite which is then analyzed for tritium.

The low concentrations of radioactivity in the liquids released from the Kesselring Site have always been below all applicable state and federal limits and have not resulted in any detectable radioactivity in the Glowegee Creek.

Effluent Monitoring

Liquid effluents from the Kesselring Site enter the Glowegee Creek through two surface channels (discharges 001 and 002) and a submerged drain line from the sewage treatment plant (discharge 003) shown in Figure 3.

A series of gates are located in the discharge channels upstream and downstream of the lagoon to provide a means to contain effluent if concentrations should ever exceed applicable discharge limits. In addition, continuous pH and temperature monitoring systems are installed in discharge channels to and from the lagoon. These systems automatically control the gates and provide an alarm if there is ever an out-of-specification pH or temperature level.

During 1997, the Kesselring Site started construction of a wastewater treatment system at the outlet of the lagoon. This treatment system is designed primarily to minimize total suspended solids levels which result from algae blooms. This is necessary in order to maintain Site operations and to ensure continued compliance with the SPDES permit requirements. This system is intended to minimize the growth of algae by means of spray recirculation and indirect chlorination. The system also removes residual chlorine from the lagoon effluent using an automated sodium bisulfite system. This wastewater treatment system is expected to become operational during 1998.

Effluent samples from the lagoon (outfalls 001 and 002) and the sewage treatment plant (outfall 003) are collected and analyzed as required by the SPDES permit (Reference 7).

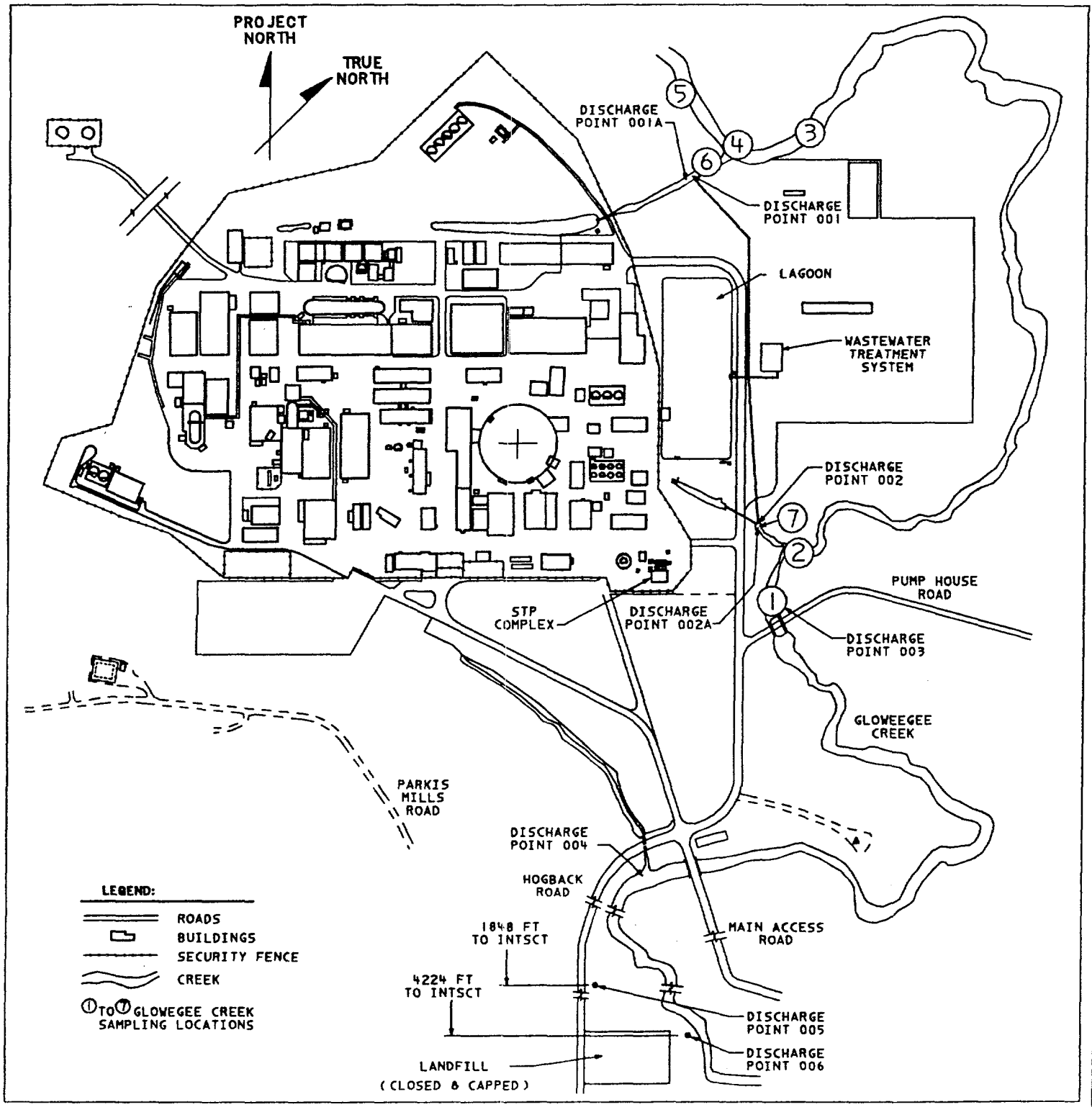
Additional liquid effluents from the Kesselring Site enter the Glowegee Creek from stormwater outfalls 001A, 002A, 004, 005, and 006 (Figure 3).

Outfalls 001A and 002A were used for Site discharge prior to the construction of the lagoon. These outfalls currently collect only stormwater.

Outfall 004, which discharges into the Glowegee Creek just below the main access road bridge, collects drainage from the parking lot. Discharges through this outfall are controlled locally or remotely by a sluice gate. This gate provides control for contaminants (i.e., oils and chemicals) which could reach this drainage way in the event of a spill, fire, or other emergency.

Stormwater also collects in outfall 005 from Hogback Road and enters the Glowegee Creek.

Outfall 006 collects stormwater runoff from the landfill which was closed and capped in 1993.



Kesselring Site, Near West Milton, New York Glowegee Creek
Sampling Locations and Discharge Points

Figure 3

TABLE 22 - CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE LIQUID EFFLUENT, 1997

Parameters/Units	Number of Samples	Permit Limit[10]	Discharge Point 001[1] Minimum	Maximum	Average[2]	Percent of Limit[3]	Discharge Point 002[1] Minimum	Maximum	Average[2]	Percent of Limit[3]
Discharge Requirements (Ref. 7)										
Flow (MGD)*	365	Report[9]	0.00	3.19	0.25 ± 0.02	--	0.00	3.54	0.28 ± 0.03	--
Temperature (°F)	349/349	(4)	37	72	53 ± 1	--	37	73	53 ± 1	--
pH (SU)**	52/52	6.0-9.0	7.0	8.7	7.6 ± 0.09	--	7.0	8.7	7.7 ± 0.08	--
Suspended Solids (mg/l)	14/14	100	5.0	14.0	9.0 ± 1.9	9	5.0	35.0	9.8 ± 4.4	10
Grease and Oil (mg/l)	50/51	15	<1	2	<1 ± 0.02	<7	<1	3	<1 ± 0.09	<7
Residual Chlorine (mg/l)	351/351	0.04	<0.02	<0.02	<0.02 ± 0.00	<50	<0.02	<0.02	<0.02 ± 0.00	<50
Total Phosphorus										
concentration (mg/l)	14/14	Report[9]	0.08	0.24	0.15 ± 0.03	--	0.06	0.24	0.14 ± 0.03	--
mass (Kg/month)	12/12	(5)	1.5	6.8	3.9 ± 1.1	--	1.2	8.5	4.4 ± 1.4	--
Nitrite-N (mg/l)	12/12	Report[8]	<0.02	0.02	<0.02 ± 0.00	--	<0.02	0.02	<0.02 ± 0.00	--
Zinc										
concentration (mg/l)	12/13	Report[9]	<0.01	0.04	<0.02 ± 0.01	--	<0.01	0.04	<0.02 ± 0.01	--
mass (lbs/day)	12/13	(7)	<0.01	0.09	<0.04 ± 0.02	--	<0.01	0.11	<0.05 ± 0.02	--
Iron (mg/l)	12/13	0.4	0.08	0.26	<0.17 ± 0.04	42	0.08	0.22	0.15 ± 0.03	38
Boron (mg/l)	12/12	0.5	<0.05	0.11	<0.06 ± 0.01	<12	<0.05	0.11	<0.06 ± 0.01	<12
Additional Parameters Monitored										
Ammonia-N (mg/l)	12/12	(6)	<0.1	0.2	<0.1 ± 0.02	--	<0.1	0.2	<0.1 ± 0.02	--
Copper (mg/l)	12/13	(6)	<0.05	<0.05	<0.05 ± 0.00	--	<0.05	<0.05	<0.05 ± 0.00	--
Cadmium (mg/l)	12/13	(6)	<0.005	<0.005	<0.005 ± 0.000	--	<0.005	<0.005	<0.005 ± 0.000	--
Specific Conductance										
(umhos/cm)	12/12	(6)	451	1390	887 ± 172	--	448	1190	820 ±146	--
Total Chromium (mg/l)	12/13	(6)	<0.005	0.007	<0.005 ± 0.000	--	<0.005	<0.005	<0.005 ± 0.000	--
Detergent (MBAS) (mg/l)	12/12	(6)	<0.02	<0.02	<0.02 ± 0.00	--	0.02	0.02	<0.02 ± 0.00	--

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical variation of the results at two standard deviations.
(3) Percent of limit for the average value.
(4) (a) During the period from May through October, the temperature of discharges from site operations shall not exceed 23.9°C (75°F) except that if the ambient stream temperature exceeds 23.9°C (75°F), the temperature of the discharge shall be equal to the stream temperature, to a maximum of 25.6°C (78°F).
(b) During the period from November through April, the temperature of the discharge from site operations shall not exceed 23.9°C (75°F). In addition, no discharges will occur which will raise the temperature of the stream by more than 2.8°C (5°F), or to a maximum of 12.8°C (55°F), whichever is less, except that if the upstream temperature is >12.8°C (55°F), the discharge to the stream shall be such that the downstream temperature is ≤ to the upstream temperature.
(5) An action level of 50 kg/month has been assigned for the total mass discharged from outfalls 001, 002 and 003 (Table 23). An action level is not a limit but a specified effluent level, exceedance of which requires additional short term monitoring.
(6) Permit does not specify limits for the additional parameters monitored.
(7) Total site mass discharge limit of 0.5 lbs/day for discharge points 001, 002 and 003.
(8) The Reference 7 permit requires the data be reported for each outfall. In addition, a flow-weighted average limit of 0.40 mg/l for all three outfalls (001, 002 and 003) is also specified.
(9) The Reference 7 permit requires the data to be reported but does not specify a limit for this discharge point.
(10) Limits in accordance with SPDES permit modified 11/14/97.
* MGD = Million gallons per day.
** SU = Standard Units.

TABLE 23 - CHEMICAL CONSTITUENTS IN KESSELRING SITE SEWAGE TREATMENT PLANT EFFLUENTS, 1997

Parameters/Units	Number of Samples	Permit[13] Limit	Discharge Point 003[1] Minimum	Maximum	Average[2]	Percent of Limit[3]
Discharge Requirements (Ref. 7)						
Flow (MGD)*	365	0.09[12]	0.003	0.047	0.016 ± 0.001	18
pH (SU)**	355	6.0-9.0	6.6	7.8	7.1 ± 0.02	--
BOD5 (mg/l)	51	30[5]	<2	4	<2 ± 0.1	<7
Suspended Solids (mg/l)	51	30[5]	<1.0	6.5	<1.9 ± 0.4	<6
Settleable Solids (ml/l)	355	<0.1	<0.1	<0.1	<0.1 ± 0.0	<100
Dissolved Oxygen (mg/l)	252	5.0 (minimum)	8.1	13.1	10.3 ± 0.2	(4)
Ammonia (mg/l as N)	50	24.4	<0.1	0.3	<0.1 ± 0.01	<1
Total Phosphorus						
concentration (mg/l)	50	Report[11]	0.16	4.7	0.45 ± 0.17	--
mass (Kg/month)	12	(6)	4.6	17.2	10.3 ± 2.7	--
Soluble Phosphorous (mg/l)	12	Report[11]	0.20	0.63	0.36 ± 0.087	--
Nitrite-N (mg/l)	12	Report[10]	<0.02	0.02	<0.02 ± 0.00	--
Detergent (MBAS) (mg/l)	12	0.7	<0.02	0.02	<0.02 ± 0.00	<3
Zinc						
concentration (mg/l)	13	Report[11]	<0.01	0.03	<0.01 ± 0.004	--
mass (lbs/day)	13	Report [9]	<0.001	0.005	<0.002 ± 0.001	--
Iron	13	0.3[8]	<0.05	0.05	<0.05 ± 0.00	<17
Boron (mg/l)	12	1.2[8]	<0.05	0.07	<0.05 ± 0.004	<4
Total Copper (lbs/day)	13	0.06	<0.005	<0.01	<0.008 ± 0.001	<13
Dissolved Copper (mg/l)	12	Report[11]	<0.05	<0.05	<0.05 ± 0.00	--
Cyanide, Free (mg/l)	12	0.09	<0.01	<0.02	<0.01 ± 0.002	<11
Additional Parameters Monitored						
Temperature (°F)	252	(7)	40	74	54 ± 1	--
Turbidity (NTU)***	12	(7)	0.20	2.50	0.90 ± 0.43	--

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.

(3) Percent of limit for the average value.

(4) The average value is well above the limit which is a minimum value.

(5) The maximum limit for the 30-day arithmetic mean is 30 mg/l, the maximum daily limit is 45 mg/l.

(6) An action level of 50 kg/month has been assigned for the total mass discharged from outfalls 001, 002 and 003. An action level is not a limit but a specified effluent level, exceedance of which requires additional short term monitoring.

(7) Permit does not specify limits for the additional parameters monitored.

(8) Values are Action Levels which are not a limit but a specified effluent level, exceedance of which requires additional short term monitoring.

(9) Total mass discharge limit of 0.5 lbs/day for Outfalls 001, 002 and 003.

(10) Flow-weighted average limit of 0.04 mg/l for all three outfalls (001, 002 and 003).

(11) The Reference 7 permit requires that the data be reported but does not specify a separate limit for this discharge point.

(12) 30-day average

(13) Limits in accordance with SPDES permit modified 11/14/97.

*MGD = Million gallons per day

**SU = Standard Units

***NTU = Nephelometric turbidity units

Currently, no routine sampling or monitoring is required for stormwater outfalls 001A, 002A, 004, 005, and 006.

Effluent Analyses

The analyses performed for chemical constituents on effluent samples from each discharge point and the sewage treatment plant are listed in Tables 22 and 23, respectively. Analyses for chemical constituents are performed using procedures described in Standard Methods, Reference (16) or other EPA approved procedures.

Each liquid discharge that might contain tritium is sampled. The samples are combined into a monthly composite for each frequently used release point. Samples from other tritium release points are analyzed individually. Tritium analyses are performed by liquid scintillation counting.

Assessment

The analytical results for the measurements of chemical constituents summarized in Tables 22 and 23 and temperature in the Kesselring Site liquid effluents show that all average values are within the applicable effluent standards.

The radioactivity released in Kesselring Site liquid effluent during 1997 totaled less than 0.04 curies of tritium. The activity was contained in approximately 7.3×10^8 liters of water. The resulting annual average radioactivity concentration in the effluent corresponded to less than 0.1 percent of the DOE derived concentration guide for effluent released to unrestricted areas, (Reference 2) for the mixture of radionuclides present.

Liquid effluent monitoring data are reported as required in Reference (7).

AIRBORNE EFFLUENT MONITORING

Origins

The principal sources of industrial gaseous effluents are two 21 million and one 30 million BTU/hr steam generating boilers. A previously utilized 110 million BTU/hr steam generating boiler was permanently shut down in 1997 and its operating permit was surrendered. The Number 2 fuel oil that is used to fire all of the boilers contains less than 0.5 weight percent sulfur. Combustion gases from the boilers are released through three elevated exhaust stacks. Other operations such as carpenter shops, welding hoods, abrasive cleaning, and spray painting constitute point sources of airborne effluents.

Small quantities of particulate radioactivity, principally cobalt-60, are processed through controlled exhaust systems during reactor coolant sampling, draining, and venting operations. Gaseous radioactivity contained in the exhaust air consists principally of carbon-14, short-lived isotopes of xenon and krypton, argon-41 and tritium. Carbon-14 and argon-41 are the result of neutron interaction with isotopes of dissolved oxygen, nitrogen, and argon in the coolant. Other radioactive gases such as xenon and krypton are produced by neutron interaction with trace quantities of uranium impurities in structural members within the reactor. Prior to release from the exhaust stacks, the exhaust air is passed through high efficiency particulate air (HEPA) filter systems to minimize particulate radioactivity content.

Effluent Monitoring

Emissions of oxides of nitrogen (NO_x) from the Site's steam boilers are controlled by NYSDEC issued permits which limit total fuel use to no more than 700,000 gallons in any 12 month period. Volatile organic compound (VOC) emissions from three paint spray operations are similarly controlled by NYSDEC issued permits which limit hours of operation of these facilities. One of the three paint spray operations was determined to no longer be necessary and its permit was surrendered in 1997. For both the Site boilers and paint spray operations, monthly usage records are tracked and tabulated to ensure permit compliance. Emissions of oxides of sulfur (SO_x) are also monitored in the Site boiler units via analysis of fuel sulfur content. These results are submitted to the EPA on a quarterly basis as required by EPA's New Source Performance Standards (NSPS) for these size stationary combustion installations. Due to a change in New York State regulations in July 1996, all other industrial emission points at the Kesselring Site do not require permits due to very low emission levels.

The air exhausted from the reactor plants is continuously monitored for particulate radioactivity with monitors that are equipped with alarm functions to provide an alert should an out-of-specification release occur. The air exhausted from all radiological facilities is continuously sampled for particulate radioactivity. Reactor plant air emissions are also continuously sampled for radioiodine with activated charcoal cartridges. Sampling is performed for tritium and carbon-14 using appropriate absorbers.

Effluent Analyses

The air particulate sample filters are changed routinely and analyzed by direct counting for beta-gamma radioactivity. A minimum detectable concentration of approximately 5×10^{-15} μCi/ml is achieved for cobalt-60. The activated charcoal cartridges are analyzed for radioiodine by gamma spectrometry to a minimum detection level of approximately 5×10^{-15} μCi/ml for iodine-131. The tritium and carbon-14 absorbers are analyzed by liquid scintillation spectrometry. The minimum detectable concentrations of tritium and carbon-14 in air are approximately 5×10^{-11} μCi/ml for typical sampling parameters. The quantity of gaseous radioactivity released is calculated based on reactor plant operating parameters. Periodic noble gas measurements are performed to confirm the calculated values.

Assessment

Emissions of NO_x and VOCs continue to be well within the limits established by NYSDEC in the respective permits associated with the Site boiler units and paint spray operations. Emissions of SO_x from the Site boiler units are also well within the EPA's NSPS emission standards for stationary combustion installations.

The radioactivity contained in exhaust air during 1997 consisted of: (1) less than 0.001 curie each of krypton-85 and particulate fission and activation products having half lives greater than three hours, (2) approximately 1.6 curie of noble gases with half lives of 12 days or less, principally argon-41, xenon-133 and xenon-135, (3) approximately 0.2 curie of tritium and (4) approximately 0.7 curie of carbon-14. Iodine-131 is not normally detected and none was detected during 1997.

The radioactivity was contained in a total volume of 6.4×10^{11} liters of air. The average radioactivity concentration in the effluent air was well below the applicable standards listed in Reference (2). The average annual radioactivity concentration at the nearest Site boundary, based on average annual diffusion parameters, was less than 0.01 percent of the DOE derived concentration guide for effluent release to unrestricted areas (Reference 2) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required in Reference (3).

All other point source emissions also conform to the applicable state and federal clean air standards.

ENVIRONMENTAL MONITORING

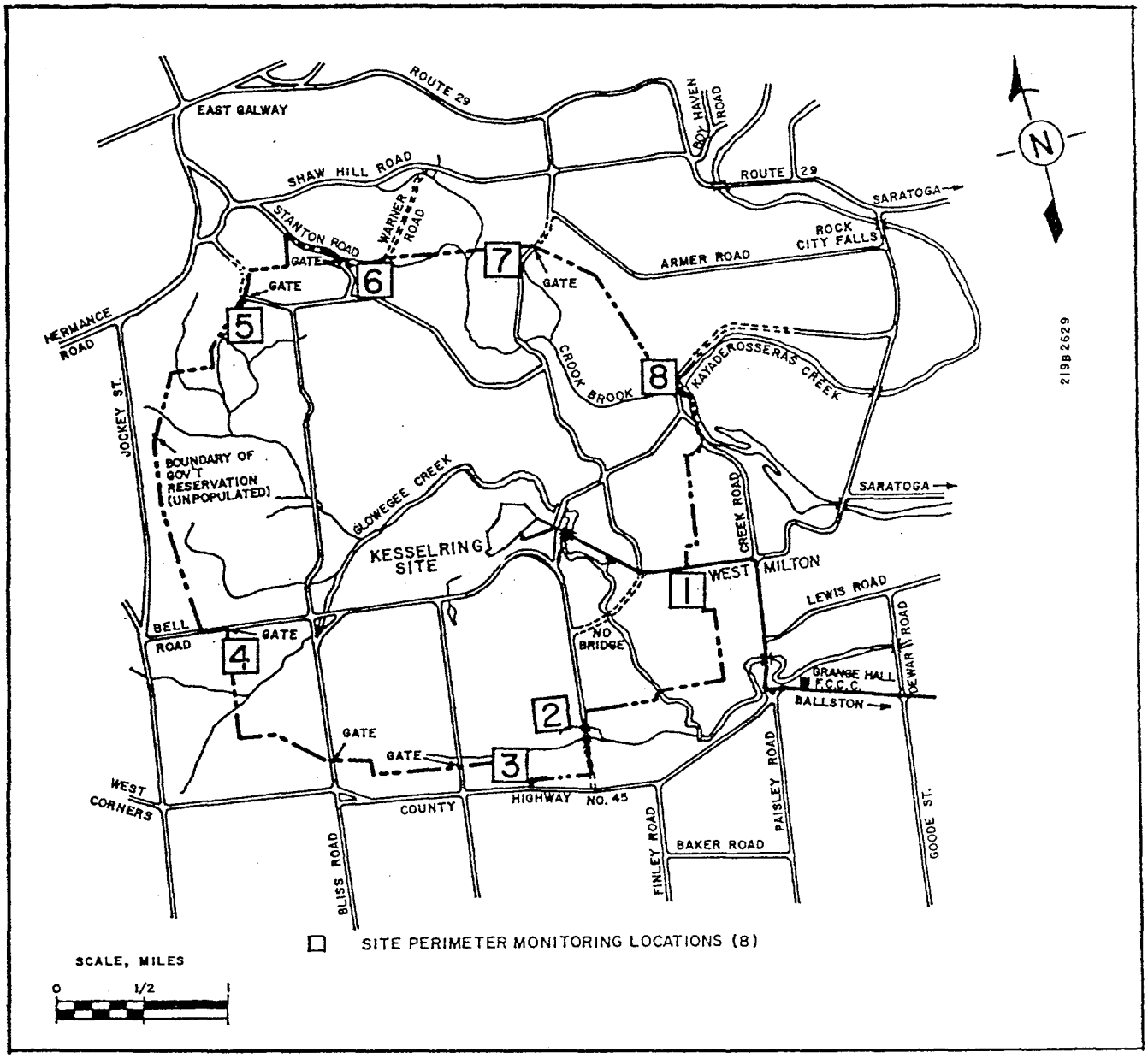
Scope

The environmental monitoring program at the Kesselring Site includes: (1) the periodic collection of Glowegee Creek water samples for chemical analyses, (2) the continuous monitoring and recording of water temperature and pH above and below the site discharge locations to the Glowegee Creek, (3) a survey of the aquatic life upstream, near the discharge channels and downstream in the Glowegee Creek, (4) the collection of fish upstream and downstream of discharge locations to the Glowegee Creek, (5) the collection of quarterly samples of Glowegee Creek water and sediment at five locations, (6) the continuous monitoring of radiation levels at perimeter and off-site locations and (7) the operation of continuous air samplers at stations located in the primary upwind and downwind directions from the Site.

Grab samples of Glowegee Creek water are collected weekly and monthly upstream and downstream of the discharge outfalls for chemical analysis. In addition, continuous monitoring and recording of the Creek temperature are conducted upstream of the Site, between the discharge channels, and downstream of the Site. pH is monitored and recorded continuously above and below the Site. Flow measuring equipment is installed in both discharge channels. In addition, flow is monitored by the U.S. Geological Survey (USGS) one half mile downstream of the Site at the West Milton Road gaging station (USGS No. 01330000).

An aquatic life sampling and evaluation program is conducted in the Glowegee Creek. This survey includes the identification and population assessment of periphyton, benthic macroinvertebrates, and fish. The periphyton samples are collected from rocks located along the stream bottom and the benthic macroinvertebrates are collected using a Surber bottom sampler and kick sampling techniques. Chain electro-fishing techniques are used to collect the fish, which are identified, measured, and returned to the Creek unharmed. Only a few of the fish from one upstream and one downstream location are retained for radioanalysis.

Three samples of sediment and one composite water sample are collected quarterly for



Kesselring Site, Near West Milton, New York
Perimeter Monitoring Locations

Figure 4

radioanalysis across the creek at the five locations shown in Figure 3.

Radiation levels at the eight site perimeter locations shown in Figure 4 and four off-site locations are monitored with sensitive, thermoluminescent dosimeters (TLDs).

Environmental air samplers are operated in the primary upwind and downwind directions from the site to measure normal background airborne radioactivity and to confirm that Kesselring Site effluents have no measurable effect on normal background levels.

The Kesselring Site operated its own sanitary landfill for the disposal of non-radioactive and non-hazardous solid wastes until October 1993, when landfill operations were permanently ceased. The NYSDEC approved the final Landfill Closure Plan, and landfill closure construction was completed in October 1994. The closed landfill is maintained in accordance with draft Post Closure Monitoring and Maintenance Manual, which has been submitted to NYSDEC for approval. However, groundwater monitoring of the landfill continues to be performed in accordance with the applicable requirements of Reference (17) until the post closure manual is approved by NYSDEC.

Analyses

The routine quarterly samples of Glowegee Creek water and bottom sediment samples are analyzed with a high purity germanium gamma spectrometer system. In addition, a more sensitive gamma spectrometry analyses is performed annually on the fish and some of the water and sediment samples collected from the Glowegee Creek. The more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma-emitting radionuclides. Creek water samples are also analyzed for the chemical constituents listed in Table 24 using the analytical techniques described in Standard Methods, Reference (16) or other EPA approved methods.

The environmental air particulate sample filters are changed and analyzed routinely by direct counting for beta radioactivity and by high purity germanium gamma spectrum analysis.

Assessment

The 1997 analytical results for the Glowegee Creek water samples for chemical constituents, pH, and temperature are summarized in Table 24. The Glowegee Creek fish survey results from 1997 are summarized in Table 25. The concentrations of chemical constituents in liquid effluent from the Kesselring Site resulted in no adverse effect on the quality of Glowegee Creek observable aquatic life. This is substantiated by results of the fish and aquatic life surveys that confirmed the existence of a diverse and healthy aquatic community in the creek water. The 1997 survey data are consistent with historical *fish and* aquatic life survey data. The different relative abundances of fish at each sampling location reflect their different preferred habitats.

Only naturally occurring radionuclides were detected in the Glowegee Creek water samples. The gamma spectrum analysis results for fish collected from the Glowegee Creek are shown in Table 26. The results show no radioactivity attributable to Site operations. The only radionuclide observed in both fish samples was potassium-40. This naturally occurring radionuclide is frequently observed in fish.

Results of the gamma analysis of sediment samples are shown in Table 27. The data show that there is no significant difference between radioactivity concentrations measured upstream and downstream. Results of the detailed gamma spectrum analyses performed on sediment samples also indicate low concentrations of potassium-40, cesium-137, and daughters of uranium and thorium. Potassium-40 and the daughters of uranium and thorium are naturally occurring radionuclides and are not associated with site operations. The EPA has attributed similar low levels of cesium-137 to fallout from low yield atmospheric nuclear weapon tests. Since the beginning of prototype operations more than 35 years ago, the release of radioactivity into the Glowegee Creek has been small and has had no significant effect on the natural background radioactivity in the sediment.

The total annual radiation exposures measured with TLDs at the boundary of the Kesselring Site and at remote, off-site monitoring locations are summarized in Table 28. There is no statistically significant difference between the perimeter and the off-site measurements. This shows that Kesselring Site operations in 1997 had no measurable effect on natural background radiation levels at the Site perimeter.

The results for the environmental air samples show that there was no significant difference between the average upwind and downwind radioactivity concentrations. Gamma spectrum analyses indicated the presence of small quantities of radium-226, thorium-232 and their daughter products. Also present were small quantities of beryllium-7 and potassium-40. These radionuclides are all naturally occurring.

TABLE 24 - CHEMICAL CONSTITUENTS AND TEMPERATURE IN GLOWEGEE CREEK WATER,[3] 1997

Parameters/Units	Number of Samples Upstream/ Downstream	Upstream[1] Minimum	Upstream[1] Maximum	Upstream[1] Average[2]	Downstream[1] Minimum	Downstream[1] Maximum	Downstream[1] Average[2]	Standard	Percent of Standard[4]
New York State DEC Water Quality Standard (Ref. 8)									
pH (SU)*	233/243	6.8	8.9[11]	8.0 ± 0.06	6.2	9.0[11]	7.8 ± 0.06	6.5-8.5	--
Grease and Oil (mg/l)	12/12	<1	<1	<1 ± 0.0	<1	<1	<1 ± 0.0	See Note[5]	--
Dissolved Oxygen (mg/l)	12/12	7.4	15.4	10.9 ± 1.6	7.2	13.3	10.1 ± 1.4	6.0 (avg. min.)	See Note[6]
Ammonia-N (mg/l)	12/12	<0.1	<0.2	<0.1 ± 0.02	<0.1	<0.1	<0.1 ± 0.0	1.6[8]	See Note[8]
Total Copper (mg/l)	12/12	<0.05	<0.05	<0.05 ± 0.00	<0.05	<0.05	<0.05 ± 0.00	No Standard	--
Total Zinc (mg/l)	12/12	<0.01	<0.01	<0.01 ± 0.00	<0.01	0.01	<0.01 ± 0.00	No Standard	--
Total Cadmium (mg/l)	12/12	<0.005	<0.005	<0.005 ± 0.000	<0.005	<0.005	<0.005 ± 0.000	No Standard	--
Color (cpu)**	12/12	10	50	24 ± 7	15	50	25 ± 7	See Note[7]	--
Residual Chlorine (mg/l)	51/51	<0.02	<0.02	<0.02 ± 0.00	<0.02	<0.02	<0.02 ± 0.00	See Note[10]	<100%
Specific Conductance (umhos/cm)	12/12	221	406	297 ± 38	214	642	336 ± 71	No Standard	--
Total Phosphorus (mg/l)	12/12	<0.02	0.08	<0.03 ± 0.01	<0.02	0.06	<0.03 ± 0.01	See Note [12]	--
Hardness (mg/l as CaCO3)	12/12	96	177	131 ± 15	99	187	134 ± 20	No Standard	--
Total Chromium (mg/l)	12/12	<0.005	<0.005	<0.005 ± 0.000	<0.005	<0.005	<0.005 ± 0.000	No Standard	--
Temperature (°F)	348/348	31	73	47 ± 1	31	73	48 ± 1	See Note[9]	--
Total Organic Carbon (mg/l)	12/12	2.4	7.7	4.1 ± 1.0	2.6	8.1	4.3 ± 1.1	No Standard	--

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical variation of the results at two standard deviations.

(3) New York State Class C water: suitable for fishing and all other uses except as a source of water supply for drinking, and culinary or food processing purposes.

(4) Comparison of downstream average data with standard, Reference (8).

(5) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.

(6) The average value is well above the standard which is a minimum value.

(7) None in the amounts that will adversely affect the color thereof, or impair the waters for their best usage.

(8) The standard is a calculated value for un-ionized ammonia, based on water temperature and pH. The standard expressed in terms of total ammonia (as N) at the given temperature and pH is 1.6 mg/l, Reference (8).

(9) During the winter months (November-April) no increase >5°F (2.8°C) shall occur up to 55°F (12.8°C), unless stream temperature is 55°F; if so, downstream temperature must be ≤ upstream temperature. There is no limit on summer Creek temperature.

(10) Kesselring Site State Pollutant Discharge Elimination System Permit #NY-0005843 (modified 11/14/97) is 0.04 mg/l

(11) Upstream and downstream pH maximum values exceeded standard on a few separate occasions. This was most likely caused by algae buildup on the pH probe. Probe was cleaned and reading returned to normal band.

(12) None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages.

*SU = Standard Units

**cpu = Cobalt Platinum Units

TABLE 25 - GLOWEGEE CREEK FISH SURVEY - 1997

Station Location	Fish Species	Number Collected	Length (mm)
400 ft. Upstream of Discharge Channel 001	Blacknose Dace	252	23-77
	Bluntnose Minnow	-	-
	Brook Stickleback	-	-
	Brook Trout	1	152
	Brown Trout	3	55-360
	Common Shiner	135	48-101
	Creek Chub	58	46-135
	Cutlips Minnow	37	51-120
	Fathead Minnow	15	46-67
	Longnose Dace	26	62-101
	Northern Redbelly Dace	-	-
	Pearl Dace	4	55-64
	Pumpkinseed	1	97
	Tessellated Dater	39	54-77
	White Sucker	11	31-102
20 ft. Upstream of Discharge Channel 001	Blacknose Dace	361	21-77
	Bluntnose Minnow	12	50-85
	Brook Stickleback	7	28-52
	Brook Trout	-	-
	Brown Trout	8	54-288
	Common Shiner	184	43-93
	Creek Chub	40	27-95
	Cutlips Minnow	24	54-120
	Fathead Minnow	52	48-73
	Longnose Dace	10	55-91
	Northern Redbelly Dace	1	45
	Pearl Dace	9	52-58
	Pumpkinseed	-	-
	Tessellated Darter	23	52-74
	White Sucker	26	26-185
Between Discharge Channels 001 and 002	Blacknose Dace	472	22-70
	Bluntnose Minnow	1	68
	Brook Stickleback	14	27-38
	Brook Trout	-	-
	Brown Trout	-	-
	Common Shiner	197	22-97
	Creek Chub	31	19-93
	Cutlips Minnow	18	54-85
	Fathead Minnow	12	47-68
	Longnose Dace	9	57-88
	Northern Redbelly Dace	15	42-47
	Pearl Dace	13	55-64
	Pumpkinseed	-	-
	Tessellated Darter	23	24-74
	White Sucker	54	29-86
2900 ft. Downstream from Discharge Channel 002	Blacknose Dace	251	22-76
	Bluntnose Minnow	18	56-70
	Brook Stickleback	-	-
	Brook Trout	-	-
	Brown Trout	-	-
	Common Shiner	77	41-86
	Creek Chub	29	25-110
	Cutlips Minnow	45	42-122
	Fathead Minnow	12	56-73
	Longnose Dace	74	50-109
	Northern Redbelly Dace	1	58
	Pearl Dace	-	-
	Pumpkinseed	-	-
	Tessellated Darter	30	23-76
	White Sucker	48	28-118

TABLE 25 - GLOWEGEE CREEK FISH SURVEY - 1997

Station Location	Fish Species	Number Collected	Length (mm)
3200 ft. Downstream from Discharge Channel 002	Blacknose Dace	108	25-75
	Bluntnose Minnow	83	54-72
	Brook Stickleback	-	-
	Brook Trout	-	-
	Brown Trout	-	-
	Common Shiner	553	22-119
	Creek Chub	75	28-122
	Cutlips Minnow	66	41-113
	Fathead Minnow	4	50-66
	Longnose Dace	1	48
	Northern Redbelly Dace	-	-
	Pearl Dace	1	51
	Pumpkinseed	-	-
	Tessellated Darter	102	24-78
	White Sucker	207	30-100
5500 ft. Downstream from Discharge Channel 002	Blacknose Dace	486	22-73
	Bluntnose Minnow	-	-
	Brook Stickleback	-	-
	Brook Trout	-	-
	Brown Trout	2	71-354
	Common Shiner	110	45-110
	Creek Chub	41	57-156
	Cutlips Minnow	47	52-112
	Fathead Minnow	-	-
	Longnose Dace	140	52-99
	Northern Redbelly Dace	-	-
	Pearl Dace	1	56
	Pumpkinseed	-	-
	Tessellated Darter	7	50-62
	White Sucker	17	28-212

TABLE 26 - RESULTS OF ANALYSES OF GLOWEGEE CREEK FISH, 1997

Sample Location	Radioactivity Concentration (pCi/g wet wt.)[1] K-40	Cs-137	Co-60
Combination of 400 ft. and 20 ft. Upstream of Discharge Channel 001	1.77 ± 0.19	<0.01	<0.01
5500 ft. Downstream from Discharge Channel 002	2.07 ± 0.21	<0.01	<0.01

Note:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.

TABLE 27 - RESULTS OF ANALYSES OF GLOWEGEE CREEK SEDIMENT, 1997

Sample Location	No. of Samples	Radioactivity Concentration (pCi/g, dry wt.)[1,2] Cobalt-60 Minimum	Maximum	Average
Upstream of Discharge Channel 001	9	<0.02	<0.02	<0.02 ± 0.01
Opposite Discharge Channel 001	12	<0.02	<0.02	<0.02 ± 0.01
Between Discharge Channels 001 and 002	12	<0.02	<0.02	<0.02 ± 0.01
Opposite Discharge Channel 002	9	<0.02	<0.03	<0.02 ± 0.01
Downstream of Discharge Channel 003	12	<0.02	<0.02	<0.02 ± 0.01

Notes:

(1) Dry weight is based on sample weight with free water removed.

(2) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.

TABLE 28 - PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KESSELRING SITE, 1997

Perimeter Location No.[1]	Total Annual Exposure,[2] (millirem)
1	72 ± 5
2	64 ± 2
3	67 ± 1
4	70 ± 2
5	69 ± 3
6	74 ± 4
7	74 ± 2
8	74 ± 3
Off-Site locations	72 ± 5[3]

Notes:
(1) See Figure 4 for monitoring locations.
(2) The (±) values for individual locations are expressed at the 2 σ confidence level based on the calculated measurement error.
(3) Approximately 95% of natural background radiation measurements are expected to be within this range.

GROUNDWATER MONITORING

Scope

The Kesselring Site groundwater monitoring program focuses on the closed Site landfill, other inactive solid waste disposal sites and the security area. Several groundwater monitoring wells (the KTH series wells and a number of LMW series wells installed in 1991 during the Phase 1 landfill closure investigation) were abandoned in 1993 as part of the Phase 2 closure investigation. Thirty-two overburden and bedrock monitoring wells (HB-Series) were installed as part of the Phase 2 closure investigation. The locations of all existing monitoring wells are shown in Figure 5. The HB-Series monitoring wells HB-2A, HB-3A, HB-5A2, and HB-7A are used in conjunction with the remaining three LMW wells for current landfill monitoring. The remaining surficial monitoring wells (HB-Series "A") and all of the shallow bedrock monitoring wells (HB-Series "B") will be used for post closure monitoring in accordance with the post closure monitoring plan, when approved by NYSDEC. There are an additional 14 monitoring wells at 4 inactive (former) disposal sites located within the reservation, as shown in Figure 6. There are 19 monitoring wells currently in place within and adjacent to the Kesselring Site security area to monitor groundwater quality in the areas of active site facilities (Figure 7).

Origin

The potential source of contaminants in the landfill wells is due to past disposal practices. The landfill, operated since 1951 and closed in 1994, has been used as a sanitary landfill. Prior to enactments of state and federal regulations for solid waste disposal activities which banned disposal of hazardous material in such facilities, the landfill was used to dispose of asbestos scraps, scrap metal including lead, some oil and oily water, solvents, paint and chemicals.

The inactive disposal sites at the Kesselring Site were used for construction and demolition wastes, limited amounts of acid waste, and some waste burning. These disposal practices were conducted prior to enactment of state and federal regulations governing the disposal of these materials.

The sources of elevated parameters in and adjacent to the security area are the result of historical and present activities. Identified potential sources are historical material handling practices, construction, and the use of deicing materials (i.e., road salt, calcium chloride).

Analyses

Analyses are performed on all groundwater samples in accordance with standard analytical methods as described in Reference (16) or other EPA approved methods and are performed by a New York State Department of Health Certified laboratory. The groundwater monitoring plan shown in Table 29 identifies the monitoring wells and summarizes the frequency of analysis. The results for all samples taken in 1997 are presented in Table 30, Table 31, and Table 32.

As required by the New York State regulations of Reference (17), the landfill monitoring wells are sampled on a quarterly basis. The samples were analyzed for baseline parameters as defined in Reference (17). The 14 wells associated with the former disposal sites were also sampled and analyzed for baseline parameters. The results are presented in Table 31. The monitoring program for these wells is currently focused on site assessment. Within the security area, a total of 19 monitoring wells exist. These wells are currently sampled annually for baseline parameter analyses per Reference (17). The results are shown in Table 32.

The Kesselring Site conducts radiological monitoring on the groundwater monitoring wells at the landfill area, the four former disposal sites and the security area. The monitoring well locations are shown in Figures 5, 6, and 7. The results of the analyses are shown in Table 33.

Site service water is used to supply the drinking water system at the Kesselring Site and is monitored to ensure conformance with the applicable drinking water standards defined in Reference (19). The analytical results of these required samples are given in Table 34.

Assessment

Landfill:

Landfill monitoring well sample analytical results shown in Table 30 indicate that certain parameters are consistently elevated in most of the downgradient wells compared to the upgradient well. These parameters include: specific conductivity, alkalinity, hardness, total dissolved solids, chloride, sulfate, iron, manganese, sodium, barium, calcium, magnesium, TOC, and several volatile chlorinated organic compounds. A number of other parameters, including BOD, COD, TKN, ammonia, nitrate, boron, and zinc, while elevated in 1997, often exhibit variability and are generally elevated in fewer downgradient wells.

Groundwater quality standards per Reference (8) or guidance values per Reference (20) were exceeded for a number of parameters. Standards for turbidity and iron were exceeded in samples from both upgradient and downgradient wells. Other parameters which exceeded standards only in downgradient well samples included: total dissolved solids, sodium, magnesium, chloride, lead, manganese, dichlorodifluoromethane, 1,1-dichloroethane, and chloroethane, and infrequently mercury, phenols, and beryllium. Most detected metals, including iron, manganese, lead, chromium, aluminum, barium, zinc, and occasionally mercury are associated with suspended solids in the samples. Filtered sample analyses typically show either non-detectable results or significantly lower levels of these metals.

The groundwater contaminants observed in downgradient wells are predominantly inorganic. The observed levels of these parameters are within representative ranges for inorganic constituents typical of leachate from sanitary landfills per Reference (31).

Total phenols were detected in one downgradient well. The results are consistent with previous sampling data. Data from wells that show phenols at or below levels detected in downgradient wells are attributed to natural origins. Data from the existing landfill wells that show phenols elevated above levels detected in upgradient wells may be attributed to leachate, or to analytical variability at reported levels which are at or near the method detection limit (MDL).

A small number of volatile organic compounds at low parts per billion (ppb) concentrations were detected in samples collected in 1997. Consistent with historical monitoring results, only volatile chlorinated hydrocarbons were detected in downgradient monitoring well samples. Levels were in the low ppb range for all detected compounds. Those wells that consistently showed the presence of volatile compounds during 1997 are LMW-4, HB-5A2, LMW-6, and HB-7A.

Inactive Disposal Sites:

The groundwater analysis results for samples collected at the four inactive disposal sites are shown in Table 31. In general, the data from 1997 is consistent with historical analytical data. Two wells, KBH-3 and KBH-9, continue to show pH values above the groundwater quality standard (pH of 8.5). Historical data show that these results are likely not attributable to past waste disposal practices. Sodium continues to be above the groundwater quality standard in well KBH-3 consistent with historical data. A number of monitoring wells continue to exhibit elevated sample turbidities. This results in elevated concentrations or detection of certain metals. These metals typically include aluminum, iron, manganese, and calcium, which can exhibit large variations in concentration based on sample turbidity. In addition, for unfiltered, turbid samples, arsenic, chromium, and lead are at times detected at low levels. In 1995, mercury was

detected at the Silo location at a low level, below the groundwater quality standard, but has not been detected since. Analysis of filtered samples for 1997, consistent with historical data, show non-detectable or low levels of these metals (less than corresponding groundwater standards), indicating an interference caused by turbidity in whole samples. The 1997 data compares with historical data collected since 1988 and indicates no significant impact by these sites on local groundwater quality.

Security Area:

The following parameters were found to be elevated in most of the 19 security area monitoring wells sampled in 1997 (Table 32) and are consistent with historical data: turbidity, conductivity, total dissolved solids, alkalinity, hardness, chloride, sulfate, ammonia, total kjeldahl nitrogen, sodium, iron, manganese and magnesium. Other parameters which are periodically elevated in a number of monitoring wells include: color, COD, TOC, BOD, aluminum, barium, calcium and potassium. A number of the elevated metals, including iron, manganese and low levels of chromium, lead, zinc, and occasionally copper and nickel, detected in whole samples are associated with suspended solids in the samples. Filtered samples analyzed for these metals demonstrate significantly lower results, often at or near the minimum detection limit and at times non-detectable. As a result of the high turbidity of most of the samples, filtered results are reported in Table 32.

Several volatile chlorinated organic compounds were detected at low concentrations in three of the security area monitoring wells. The detected compounds include trichloroethylene, tetrachloroethylene, 1,1,1 trichloroethane, trichlorofluoromethane, and di-chlorodifluoromethane. Results are consistent with historical data from 1990 through 1996.

The cause of the observed elevated inorganic parameters is believed to be the application of deicing materials, including urea, rock salt and calcium chloride. Elevated levels of BOD_5, TKN and ammonia are attributable to the past application of urea. The source of the detected chlorinated organics is attributed to past incidental spills and not to any on-site waste disposal operations.

Radioactivity:

Results of groundwater monitoring for radioactivity are summarized in Table 33. The levels of cesium-137 and cobalt-60 were below the detection limit in all wells. Tritium was detectable in nine wells at levels very close to the detection limit. These low levels are attributed to naturally occurring tritium. The concentrations for these radionuclides were less than 0.1 percent of the respective Reference (2) derived concentration guide values.

Site Service Water:

Since site service water supplies the Kesselring Site drinking water system, monitoring is performed to ensure conformance with the New York State drinking water standards of Reference (19). The results of all required site service water monitoring are shown in Table 34. The site service water well field is hydrogeologically separate from the site landfill and inactive disposal sites and is consequently not influenced by materials at those locations.

Conclusion:

It is concluded that past waste disposal practices at the landfill have resulted in observable effects on groundwater quality downgradient of the landfill. Based on monitoring results, disposal at the four inactive areas has resulted in no apparent impact on groundwater quality. Monitoring results within the security area indicate some elevated parameters. These are the combined results of current winter de-icing operations and other past practices. The 1997 data demonstrate no noticeable changes from prior year monitoring results.

CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

Chemicals are not manufactured or disposed of at the Kesselring Site. To ensure the safe use of chemicals and disposal of the resulting wastes, Kesselring Site maintains hazardous substance control and waste minimization programs similar to those at the Knolls Site. Since 1990, significant reductions in hazardous waste streams have been accomplished at the Kesselring Site. Some hazardous waste streams have been eliminated through the use of non-hazardous

substitutes. Reclamation of silver from photographic and silver nitrate hazardous waste has resulted in a 100% reduction in these waste streams. Hazardous substance storage controls include as a minimum; labeling, revetment as appropriate, segregation based on compatibility, limited storage volumes and weather protection, as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the New York State Chemical Bulk Storage regulations as specified in Reference (36) and the Petroleum Bulk Storage regulations in Reference (37). Minimal quantities of hazardous wastes do result from the necessary use of chemicals in site operations. Hazardous and mixed (radioactive and hazardous) waste storage facilities are operated at the Kesselring Site under provisions of the regulation implementing the Resource Conservation and Recovery Act (RCRA) and the Federal Facility Compliance Act. The Kesselring Site operates a hazardous waste storage facility under a permit issued in 1995 by NYSDEC. Mixed radioactive and hazardous waste is managed for greater than 90 day periods under the RCRA interim status provisions. During 1997 the Kesselring Site shipped approximately 479 tons of RCRA and New York State hazardous waste offsite for disposal.

Elementary neutralization of small volume laboratory waste, boiler house blowdown, and acid regeneration wastewater also occur on site. This process is exempt from regulation as a RCRA treatment process. The neutralized discharge is controlled under the Kesselring Site wastewater discharge permit. The boiler house is the primary source of wastewater with a pH prior to neutralization of less than 2 or greater than 12.5.

TRANSPORTATION OF RADIOACTIVE MATERIALS

Operations at the Kesselring Site results in the generation of various types of radioactive materials that require detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government operated disposal site.

Radioactive materials that do not require disposal are handled and transferred in accordance with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive material from the Site, to ensure that the material is properly identified, surveyed and packaged in accordance with federal, state and local requirements.

Low level radioactive solid waste material that requires disposal includes filters, metal scrap, resin, rags, paper, and plastic materials. The volume of waste contaminated with radioactivity that is generated and shipped is minimized through recycling and the use of special work procedures that limit the amount of material that becomes contaminated during work on radioactive systems and reactor components. In addition, compressible wastes are compacted in order to further reduce the volume of waste to be disposed. Radioactive liquids are solidified prior to shipment. All radioactive wastes are packaged to meet applicable regulations of the DOT given in Reference (14). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

The shipments of low level radioactive solid wastes were made by authorized common carriers to government owned disposal sites located outside of New York State. During 1997, approximately 113 cubic meters (147.9 cubic yards) of routine low level radioactive waste containing 2.7 curies were shipped from the site for disposal. Additionally, 0.3 cubic meters (0.4 cubic yards) of mixed waste containing 0.000092 curies were also shipped for disposal. Mixed waste is waste that contains both radioactive constituents regulated by the Department of Energy and hazardous constituents regulated by the New York State Department of Environmental Conservation. The Kesselring Site also ships out slightly radioactive metal to the Scientific Ecology Group (SEG) in Tennessee for recycling. During 1997, approximately 25.3 tons of slightly radioactive metal and 19.7 tons of radioactive lead was sent to SEG as recyclable material.

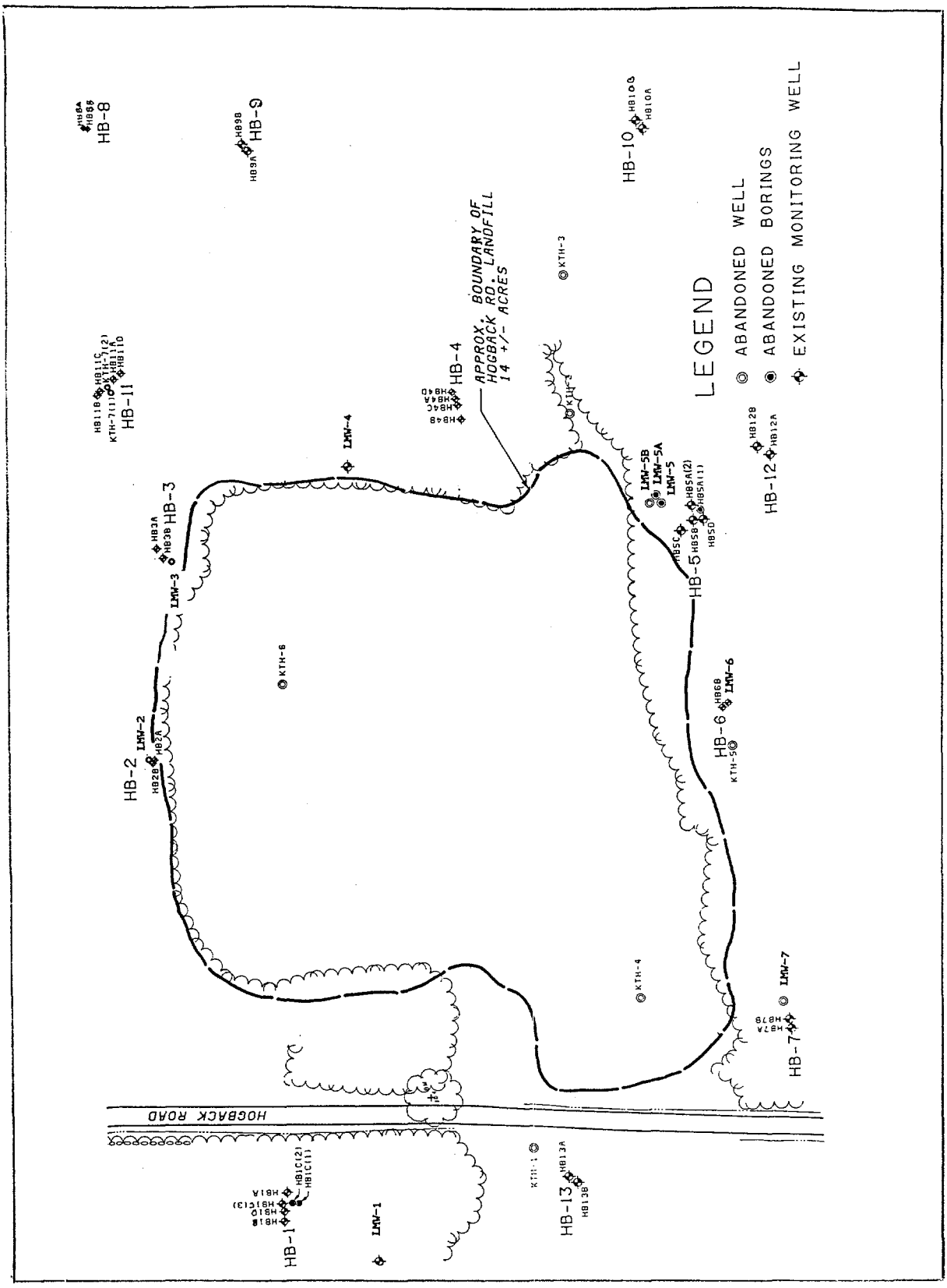
RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that the radioactivity in liquid and gaseous effluents from 1997 operations at the Kesselring Site had no measurable effect on background radioactivity levels. Therefore, any radiation doses from site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of: (1) the radiation dose to the maximally exposed individual in the vicinity of the Kesselring

Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site and (3) the collective dose to the population residing in the assessment area are summarized in Tables 40 and 41. See Figure 11 for a map of the assessment area surrounding the Kesselring Site.

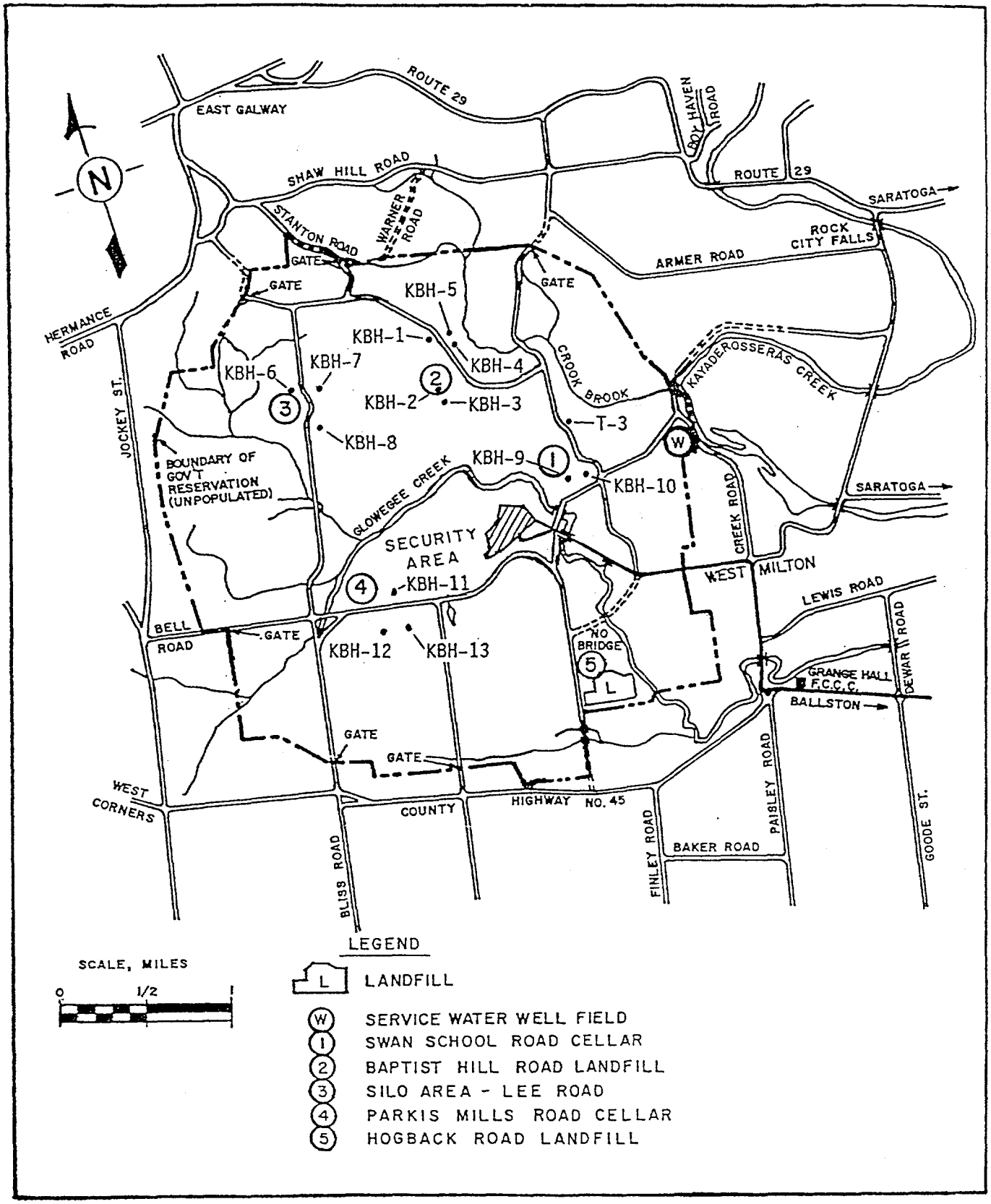
The results show that the estimated doses were less than 0.1 percent of that permitted by the DOE radiation protection standards listed in Reference (2) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Kesselring Site was less than 0.001 percent of the natural 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 (4) for whole-body dose demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (3).

The collective radiation dose to the public along travel routes from Kesselring Site shipments of radioactive materials during 1997 was calculated using data given by the NRC in Reference (18). 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.

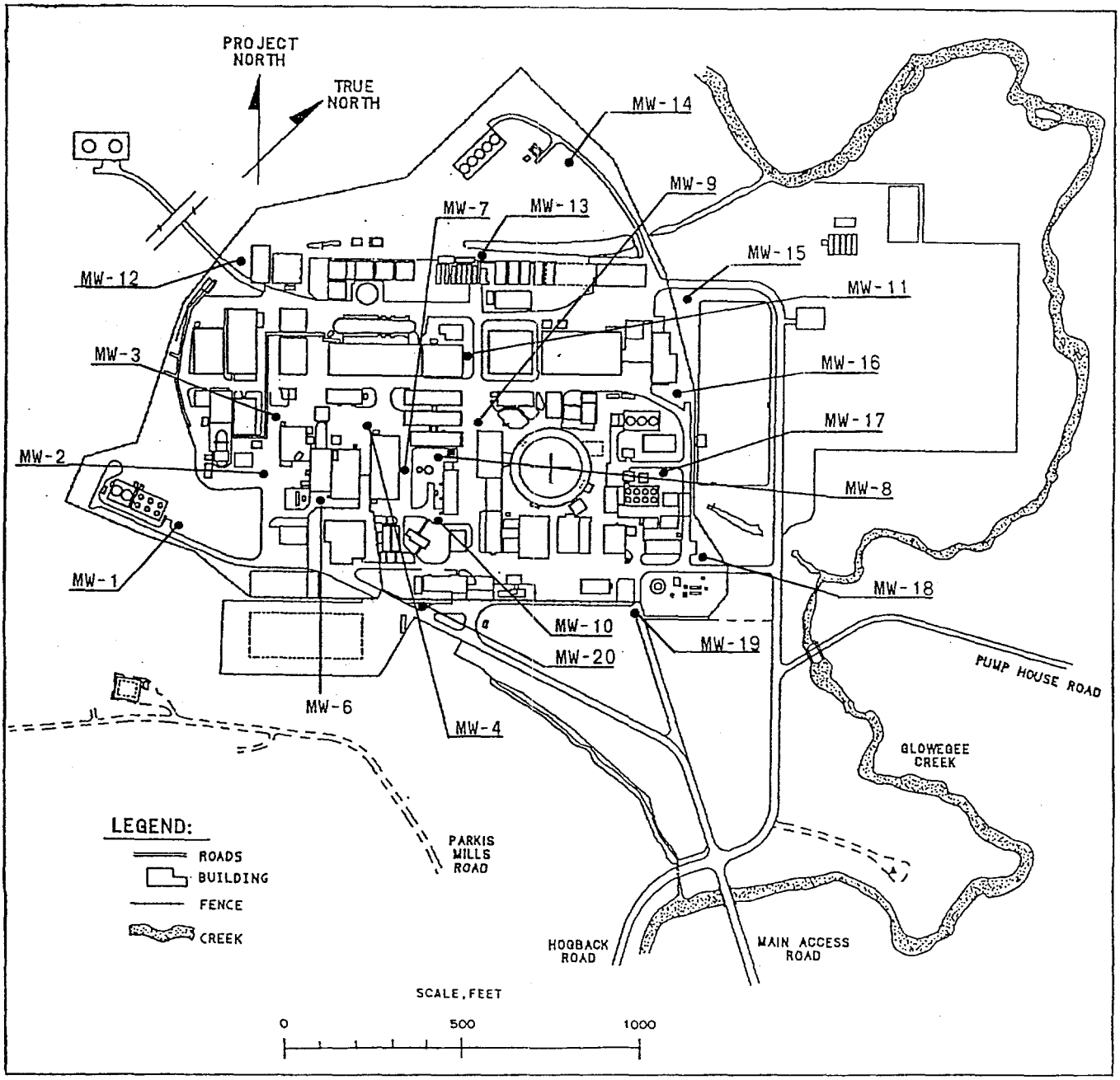


Kesselring Site, Near West Milton, New York
Landfill Groundwater Monitoring Wells

Figure 5



Kesselring Site, Near West Milton, New York
Disposal Areas - Groundwater Monitoring Wells
Figure 6



Kesselring Site, Near West Milton, New York
Security Area Groundwater Monitoring Wells
Figure 7

TABLE 29 - KESSELRING SITE GROUNDWATER MONITORING PLAN - 1997

Well ID	Radioactivity	Baseline[1]	Other[3]
MW-1[2]	A	A	
MW-2 to 4	A	A	
MW-6 to 20	A	A	
KBH-1[2]	A	A	
KBH-2	A	A	
KBH-3	A	A	
KBH-4	A	A	
KBH-5	(WELL SCREEN COLLAPSED - NO SAMPLING POSSIBLE)		
KBH-6[2]	A	A	
KBH-7	A	A	
KBH-8	A	A	
KBH-9	A	A	
KBH-10	A	A	
T-3[2]	A	A	
KBH-11[2]	A	A	
KBH-12	A	A	
KBH-13	A	A	
LMW-1[2]	A	Q	Q
(HB-2A)[4]	A	Q	Q
(HB-3A)[4]	A	Q	Q
LMW-4	A	Q	Q
(HB-5A2)[4]	A	Q	Q
LMW-6	A	Q	Q
(HB-7A)[4]	A	Q	Q

Notes: A = Annual
Q = Quarterly

(1) Parameters defined in 6 NYCRR Part 360-2.11(c).
(2) Background well.
(3) Filtered metals are performed as necessary for verification of elevated metals as attributable to silt or suspended solids in the sample.
(4) Some LMW monitoring wells were abandoned as part of the second phase of the landfill hydrogeologic investigation. The HB-A series monitoring wells which were installed during the second phase of the landfill hydrogeologic investigation, replaced most LMW wells for routine monitoring starting in 1994.

TABLE 30 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, LANDFILL WELLS, 1997

Parameter (all units are mg/l except where indicated)[1]

WELL NUMBER		Sampling Date	Elev. ft.	Temp. F	pH (SU)	EH (mv)	Turbidity (NTU)	Color (cpu)	Specific Conductivity (µmhos/cm)	TDS	COD	BOD5	TOC	Alkalinity mg	Hardness CaCO3/l	Sulfate	Chloride
LMW-1		3/27/97	487.64	48.2	8.04	296	140	<5	226	125	<5	<2	<1	110	121	15	<1
(upgradient)		6/5/97	485.94	48.2	8.30	264	130	<5	241	125	<5	<2	<1	135	154	15	1.2
		7/29/97	476.84	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		11/6/97	486.04	49.8	7.97	100	190	<5	218	118	<5	<2	<1	110	187	14	1.2
HB-2A [5]		3/27/97	471.38	41.0	6.98	306	>1000	<5	615	325	331.0	3	20.0	200	257	21	52
(downgradient)		6/5/97	No Data	54.0	7.50	291	270	5	634	285	32.0	3	4.0	180	179	19	52
		7/29/97	469.60	57.7	7.13	169	250	5	534	288	35.0	<2	5.7	145	209	12	56
		11/6/97	469.88	55.4	7.12	155	700	5	439	295	447.0	<2	11.0	185	232	32	26
	QA	3/27/97	--	--	--	304	670	<5	602	300	88.0	3	5.7	165	196	18	63
HB-3A [5]		3/27/97	466.68	43.3	6.51	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
(downgradient)		6/5/97	466.63	57.2	7.10	NS	NS	NS	NS	NS	R1140	NS	NS	NS	NS	NS	NS
		7/29/97	466.28	66.7	7.41	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		11/6/97	466.23	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-4		3/27/97	466.81	46.0	6.59	303	>1000	<5	942	555	130.0	8	3.8	680	949	82	38
(downgradient)		6/5/97	466.21	58.3	7.30	289	>1000	<5	1170	655	<5	6	5.2	745	1960	102	60
		7/29/97	464.41	64.6	7.32	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		11/6/97	464.61	54.1	6.56	156	>1000	<5	1440	870	112.0	12	13	910	980	121	120
	QA	7/29/97	--	--	--	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5A2 [5]		3/27/97	452.15	48.2	6.35	305	>1000	<5	1900	1040	11.0	<2	3.7	660	1050	39	328
(downgradient)		6/5/97	451.85	59.5	7.00	290	>1000	5	1380	953	<5	<2	3.1	560	845	30	142
		7/29/97	450.85	51.8	6.98	182	620	<5	1050	638	15.0	<2	1.7	570	790	33	40
		11/6/97	450.60	--	--	166	920	<5	1630	1210	<5	2	5.6	630	639	42	376
	QA	11/6/97	--	--	--	167	>1000	10	1630	1230	7.5	<2	2.3	635	655	42	379
LMW-6		3/27/97	457.94	51.3	6.22	304	160	<5	1160	653	<5	<2	2.3	420	396	59	77
(downgradient)		6/5/97	459.29	55.9	6.90	282	190	<5	1300	690	11.0	<2	3.5	455	542	109	90
		7/29/97	457.14	54.1	6.69	187	110	<5	1320	773	19.0	<2	3.2	465	578	97	103
		11/6/97	457.49	51.4	6.43	159	130	<5	1440	800	11.0	2	4.8	480	360	85	161
	QA	6/5/97	--	--	6.70	291	140	5	1300	695	7.5	<2	3.0	450	377	108	90
HB-7A [5]		3/27/97	464.76	43.9	7.14	294	190	<5	771	455	<5.0	<2	1.5	335	374	51	31
(downgradient)		6/5/97	463.66	56.7	7.60	278	130	<5	755	403	<5.0	<2	1.8	330	421	45	26
		7/19/97	462.26	55.5	7.32	168	140	<5	746	415	<5.0	<2	3.0	375	418	42	20
		11/6/97	462.96	50.9	6.96	116	900	5	803	492	<5.0	<2	3.8	365	351	51	24
Standards		(2)	NA	NA	6.5-8.5	(3)	5	15	(3)	500	(3)	(3)	(3)	(3)	(3)	250	250

Notes:

(1) A value preceded by < is the minimum detectable level for that sample and parameter.
(2) Groundwater standards and guidance values taken from 6 NYCRR Part 703.
Additional standards and guidance values will be taken from Technical & Operational Guidance Series (TOGS) 1.1.1., Ambient Water Quality and Guidance Values.
(3) *No groundwater standards or guidance values per 6 NYCRR Part 703 or TOGS 1.1.1.*
(4) Samples for metals are whole (unfiltered) unless indicated.
(5) Some LMW monitoring wells were abandoned as part of the second phase of the landfill hydrogeologic investigation prior to closure as of October 1994. The HB-A series monitoring wells which were installed during the same work effort have replaced the LMW wells for routine monitoring as of the 2nd quarter 1993.
(6) All other organic compounds listed in 40 CFR, Part 136, Appendix A, Methods 601 and 602 were not detected above the analytical subcontractor's minimum detectable level for that compound.
(7) Analytical results for companion filtered samples were less than the MDL for the indicated parameter.
(8) Results for filtered samples are less than MDL.

QA = quality assurance sample, NA = not applicable, R = Rejected Data, -- = analysis not performed, G = Groundwater Guidance Value, NS = no sample.

TABLE 30 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, LANDFILL WELLS, 1997 (continued)

Parameter (all units are mg/l except where indicated)[1,4]

WELL NUMBER	Sampling Date	TKN	Ammonia-N	Nitrate-N	Phenols	Cyanide	Aluminum	Filtered Aluminum	Antimony	Arsenic	Filtered Arsenic	Barium	Filtered Barium	Beryllium
LMW-1	3/27/97	<1	<0.1	<0.02	<0.001	<0.01	<0.1	<0.1	<0.060	<0.005	<0.005	<0.01	<0.01	<0.0050
(upgradient)	6/5/97	<1	<0.1	<0.02	<0.001	<0.01	0.6	<0.1	<0.060	<0.005	<0.005	0.02	<0.01	<0.0050
	7/29/97	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	11/6/97	1	<0.1	<0.02	<0.001	<0.01	2.1	<0.1	<0.060	<0.005	<0.005	0.05	<0.01	<0.0050
HB-2A [5]	3/27/97	5.0	0.5	0.02	0.004	<0.01	<0.1	<0.1	<0.060	0.005	<0.005	0.28	0.08	<0.0050
(downgradient)	6/5/97	1.7	0.3	<0.02	<0.001	<0.01	0.4	<0.1	<0.060	<0.005	<0.005	0.10	0.05	<0.0050
	7/2997	2.5	0.2	0.03	<0.001	<0.01	0.07	<0.1	<0.060	<0.005	<0.005	0.11	0.07	<0.0050
	11/6/97	4.2	0.2	0.10	<0.001	<0.01	2.2	<0.1	<0.060	0.012	<0.005	0.30	0.07	<0.0050
QA	3/27/97	3.1	0.2	0.05	<0.001	<0.01	<0.1	<0.1	<0.060	0.005	<0.005	0.28	0.05	<0.0050
HB-3A [5]	3/27/97	NS	NS	NS	NS	NS	4.7	<0.1	<0.060	<0.005	<0.005	0.33	0.01	<0.0050
(downgradient)	6/5/97	NS	NS	NS	<0.001	NS	13.4	0.1	<0.060	<0.005	<0.005	0.61	0.04	<0.0050
	7/29/97	NS	NS	NS	NS	NS	10.5	<0.1	<0.060	<0.005	<0.005	0.51	0.04	<0.0050
	11/6/97	NS	NS	NS	NS	NS	11.0	<0.1	<0.060	<0.005	<0.005	0.38	0.06	<0.0050
LMW-4	3/27/97	6.2	0.8	0.15	<0.001	<0.01	1.1	<0.1	<0.060	<0.005	<0.005	0.33	0.05	<0.0050
(downgradient)	6/5/97	7.6	1.0	0.23	<0.001	<0.01	6.3	0.1	<0.060	<0.005	<0.005	0.45	0.09	0.0118
	7/29/97	NS	NS	NS	NS	NS	5.0	<0.1	<0.060	<0.005	<0.005	0.88	0.08	<0.0050
	11/6/97	4.2	0.6	0.18	<0.001	NS	6.1	<0.1	<0.060	<0.005	<0.005	0.47	0.17	<0.0050
QA	7/29/97	NS	NS	NS	NS	NS	31.8	<0.1	<0.060	0.06	<0.005	1.23	0.07	<0.0050
HB-5A2 [5]	3/27/97	2.5	0.2	<0.02	<0.001	<0.01	0.9	<0.1	<0.060	<0.005	<0.005	0.44	0.20	<0.0050
(downgradient)	6/5/97	2.0	0.3	<0.02	<0.001	<0.01	2.1	0.1	<0.060	<0.005	<0.005	0.27	0.14	<0.0050
	7/29/97	1.1	0.3	0.13	<0.001	<0.01	2.0	<0.1	<0.060	<0.005	<0.005	0.24	0.14	<0.0050
	11/6/97	1.4	0.2	0.05	NS	NS	0.3	<0.1	<0.060	<0.005	<0.005	0.31	0.27	<0.0050
QA	11/6/97	1.1	0.2	0.03	NS	NS	1.4	<0.1	<0.060	<0.005	<0.005	0.33	0.26	<0.0050
LMW-6	3/27/97	1.7	0.2	0.04	<0.001	<0.01	<0.1	<0.1	<0.060	<0.005	<0.005	0.12	0.11	<0.0050
(downgradient)	6/5/97	1.4	<0.1	0.07	<0.001	<0.01	0.2	0.1	<0.060	<0.005	<0.005	0.08	0.09	<0.0050
	7/29/97	1.1	0.1	0.06	<0.001	<0.01	0.6	<0.1	<0.060	<0.005	<0.005	0.11	0.10	<0.0050
	11/6/97	<1.0	<0.1	0.06	<0.001	<0.01	0.2	<0.1	<0.060	<0.005	<0.005	0.15	0.17	<0.0050
QA	6/5/97	2.0	0.1	0.08	<0.001	NS	0.4	0.2	<0.060	<0.005	<0.005	0.08	0.09	<0.0050
HB-7A [5]	3/27/97	1.1	<0.1	1.1	<0.001	<0.01	<0.1	<0.1	<0.060	<0.005	<0.005	0.04	0.02	<0.0050
(downgradient)	6/5/97	1.7	<0.1	1.0	<0.001	<0.01	0.6	0.1	<0.060	<0.005	<0.005	0.05	0.04	<0.0050
	7/29/97	1.1	<0.1	0.92	<0.001	<0.01	0.3	<0.1	<0.060	<0.005	<0.005	<0.01	0.03	<0.0050
	11/6/97	<1.0	<0.1	0.73	<0.001	<0.01	1.17	<0.1	<0.060	<0.005	<0.005	0.07	0.02	<0.0050
Standards	[2]	[3]	2.0	10.0	0.001	0.1	[3]	[3]	0.003G		0.025	1.0		0.003G

*See previous page for table notations.

TABLE 30 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, LANDFILL WELLS, 1997 (continued)

Parameter (all units are mg/l except where indicated)[1,4]

WELL NUMBER	Sampling Date	Boron	Filtered Boron	Cadmium	Calcium	Filtered Calcium	Chromium	Filtered Chromium	Hexavalent Chromium	Copper	Iron	Filtered Iron	Lead	Magnesium	Filtered Magnesium
LMW-1	3/27/97	<0.05	<0.05	<0.010	35.2	25.5	<0.005	<0.005	<0.02	<0.05	1.20	<0.05	<0.005	8.1	5.9
(upgradient)	6/5/97	<0.05	<0.05	<0.005	44.7	33.9	<0.005	<0.005	<0.02	<0.05	1.42	<0.05	<0.005	10.3	8.3
	7/29/97	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	11/6/97	<0.05	<0.05	<0.005	52.0	26.0	<0.005	<0.005	<0.02	<0.05	3.51	<0.05	<0.005	14.0	7.0
HB-2A [5]	3/27/97	<0.05	<0.05	<0.005	82.6	73.4	<0.005	<0.005	<0.02	<0.05	55.80	<0.05	0.009[8]	12.50	10.70
(downgradient)	6/5/97	<0.05	<0.05	<0.005	55.3	53.3	<0.005	<0.005	<0.02	<0.05	12.60	<0.05	<0.005	10.00	9.80
	7/29/97	<0.05	<0.05	<0.005	66.0	58.8	<0.005	<0.005	<0.02	<0.05	5.65	<0.05	0.005[8]	10.70	9.00
QA	11/6/97	<0.05	<0.05	<0.005	71.0	58.0	<0.005	<0.005	<0.02	<0.05	37.00	<0.05	0.038[8]	13.00	8.80
	3/27/97	<0.05	<0.05	<0.005	62.3	60.8	<0.005	<0.005	<0.02	<0.05	<0.05	<0.05	<0.005	9.60	9.10
HB-3A [5]															
(downgradient)	3/27/97	<0.05	<0.05	<0.005	321.0	91.5	0.008	<0.005	<0.02	<0.05	3.33	<0.05	0.006[8]	38.30	17.80
	6/5/97	<0.05	<0.05	<0.005	443.0	145.0	0.012	<0.005	<0.02	<0.05	11.80	<0.05	0.014[8]	45.90	26.40
	7/29/97	0.07	<0.05	<0.005	527.0	131.0	0.011	<0.005	<0.02	<0.05	17.00	<0.05	0.038[8]	50.90	23.10
	11/6/97	<0.05	<0.05	<0.005	254.0	107.0	<0.005	<0.005	<0.02	<0.05	16.00	<0.05	0.016[8]	26.00	21.00
LMW-4	3/27/97	0.06	<0.05	<0.005	330.0	88.4	<0.005	<0.005	<0.02	<0.05	16.50	<0.05	0.034[8]	30.40	14.70
(downgradient)	6/5/97	<0.05	0.32	<0.005	674.0	166.0	0.006	<0.005	<0.02	0.05[8]	48.70	<0.05	0.039[8]	69.20	30.80
	7/29/97	0.62	0.44	<0.005	2950.0	163.0	<0.005	<0.005	<0.02	<0.05	75.00	<0.05	<0.005	236.00	33.70
	11/6/97	0.22	0.27	<0.005	330.0	188.0	<0.005	<0.005	<0.02	0.05[8]	22.00	<0.05	0.038[6]	38.00	30.00
QA	7/29/97	0.66	0.41	<0.005	1730.0	155.0	0.012	<0.005	NS	0.19[8]	186.00	<0.05	<0.005	223.00	31.40
HB-5A2 [5]	3/27/97	<0.05	<0.05	<0.005	334.0	182.0	<0.005	<0.005	<0.02	<0.05	9.51	<0.05	0.008[8]	53.00	27.90
(downgradient)	6/5/97	<0.05	0.07	<0.005	260.0	176.0	<0.005	<0.005	<0.02	<0.05	16.00	<0.05	<0.005	47.40	25.70
	7/29/97	0.07	<0.05	<0.005	250.0	154.0	<0.005	<0.005	<0.02	<0.05	11.20	<0.05	0.018[8]	40.40	21.60
	11/6/97	<0.05	0.06	<0.005	203.0	204.0	<0.005	<0.005	<0.02	<0.05	6.73	<0.05	<0.005	32.00	32.00
QA	11/6/97	<0.05	0.05	<0.005	207.0	209.0	<0.005	<0.005	<0.02	<0.05	11.00	<0.05	<0.005[8]	33.00	32.00
LMW-6	3/27/97	<0.05	<0.05	<0.005	120.0	120.0	<0.005	<0.005	<0.02	<0.05	10.60	<0.05	<0.005	23.40	23.30
(downgradient)	6/5/97	<0.05	<0.05	<0.005	160.0	167.0	<0.005	<0.005	<0.02	<0.05	<0.05	<0.05	<0.005	34.50	37.00
	7/29/97	<0.05	<0.05	<0.005	169.0	152.0	<0.005	<0.005	<0.02	<0.05	4.79	0.41	0.005	37.80	32.70
	11/6/97	<0.05	<0.05	<0.005	108.0	138.0	<0.005	<0.005	<0.02	<0.05	2.86	<0.05	<0.005	22.00	29.00
QA	6/5/97	<0.05	<0.05	<0.005	129.0	165.0	<0.005	<0.005	<0.02	<0.05	3.84	<0.05	<0.005	27.20	35.60
HB-7A [5]	3/27/97	<0.05	<0.05	<0.005	106.0	95.3	<0.005	<0.005	<0.02	<0.05	1.62	<0.05	<0.005	26.50	24.20
(downgradient)	6/5/97	<0.05	<0.05	<0.005	120.0	110.0	<0.005	<0.005	<0.02	<0.05	1.46	<0.05	<0.005	29.50	28.50
	7/29/97	<0.05	<0.05	<0.005	119.0	103.0	0.005	<0.005	<0.02	<0.05	0.75	<0.05	<0.005	29.40	24.90
	11/6/97	<0.05	<0.05	<0.005	96.0	54.0	<0.005	<0.005	<0.02	<0.05	1.85	<0.05	<0.005	27.00	14.00
Standards	[2]	1.00		0.01	[3]	[3]	0.05	0.05	0.05	0.20	0.30		0.025	35G	

TABLE 30 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, LANDFILL WELLS, 1997 (continued)

WELL NUMBER	Sampling Date	Parameter (all units are mg/l except where indicated)[1,4] Manganese	Filtered Manganese	Mercury	Nickel[7]	Filtered Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Zinc	Filtered Zinc
LMW-1	3/27/97	0.05	<0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	1.1	<0.01	0.03	0.01
(upgradient)	6/5/97	0.07	<0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	1.9	<0.01	<0.01	<0.01
	7/29/97	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	11/6/97	0.18	<0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	7.4	<0.01	0.03	<0.01
HB-2A [5]	3/27/97	1.50	0.91	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	25.6	<0.01	0.04	0.01
(downgradient)	6/5/97	1.22	0.86	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	52.5	<0.01	<0.01	<0.01
	7/29/97	1.34	1.04	<0.0004	<0.05	<0.05	2.1	<0.005	<0.02	33.9	<0.01	0.02	<0.01
	11/6/97	0.88	0.10	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	84.0	<0.01	0.08	0.01
QA	3/27/97	0.75	0.68	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	31.9	<0.01	0.01	0.02
HB-3A [5]	3/27/97	2.36	<0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	10.7	<0.01	0.12	<0.01
(downgradient)	6/5/977	4.53	0.02	<0.0004	0.07	<0.05	<0.5	<0.005	<0.02	17.4	<0.01	0.17	<0.01
	7/29/97	6.00	0.69	<0.0004	0.06	<0.05	1.5	<0.005	<0.02	24.7	<0.01	0.15	<0.01
	11/6/97	4.40	1.05	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	50.0	<0.01	0.12	0.02
LMW-4	3/27/97	1.28	0.11	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	41.8	<0.01	0.08	0.01
(downgradient)	6/5/97	2.53	0.32	<0.0004	0.05	<0.05	<0.5	<0.005	<0.02	60.0	<0.01	0.17	<0.01
	7/29/97	9.10	0.38	0.0026[8]	0.10	<0.05	5.2	<0.005	<0.02	93.6	<0.01	0.45	0.01
	11/6/97	0.99	0.26	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	78.0	<0.01	0.18	0.03
QA	7/29/97	9.05	0.32	<0.0024	0.14	<0.50	8.8	<0.005	<0.02	88.9	0.034[8]	0.88	<0.01
HB-5A2 [5]	3/27/97	1.72	0.66	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	92.7	<0.01	0.05	0.01
(downgradient)	6/5/97	1.62	0.59	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	75.4	<0.01	0.04	<0.01
	7/29/97	1.83	1.26	<0.0004	<0.05	<0.05	1.1	<0.005	<0.02	42.5	<0.01	0.12	0.04
	11/6/97	1.97	1.98	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	194.0	<0.01	0.04	0.04
QA	11/6/97	1.94	2.10	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	209.0	<0.01	0.04	0.04
LMW-6	3/27/97	6.27	3.79	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	48.3	<0.01	0.05	0.02
(downgradient)	6/5/97	5.72	5.88	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	54.5	<0.01	<0.01	0.03
	7/29/97	7.30	6.40	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	71.0	<0.01	0.07	0.04
	11/6/97	4.69	5.49	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	224.0	<0.01	0.02	0.03
QA	6/5/97	5.17	5.63	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	39.7	<0.01	<0.01	0.04
HB-7A [5]	3/27/97	0.15	0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	13.0	<0.01	0.03	0.02
(downgradient)	6/5/97	0.17	0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	14.6	<0.01	<0.01	<0.01
	7/29/97	0.12	<0.02	<0.0004	<0.05	<0.05	0.7	<0.005	<0.02	16.8	<0.01	0.04	0.01
	11/6/97	0.20	<0.02	<0.0004	<0.05	<0.05	<0.5	<0.005	<0.02	52.0	<0.01	0.03	<0.01
Standards	[2]	0.30	0.30	0.002	[3]		[3]	0.01	0.05	20.0	0.004G	0.3	

*See first page for table notations.

TABLE 30 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, LANDFILL WELLS, 1997 (continued)

WELL NUMBER	Sampling Date	Parameter[1,6] 1,1 Dichloroethane	Chloroethane	Dichlorodifluoro-methane	Trichloro-ethylene	Chloro-form
		µg/l				
LMW-1	3/27/97	<1.0	<1.0	<1.0	<1.0	<1.0
(upgradient)	6/5/97	<1.0	<1.0	<1.0	<1.0	<1.0
	7/29/97	NS	NS	NS	NS	NS
	11/6/97	<1.0	<1.0	<1.0	<1.0	<1.0
HB-2A [5]	3/27/97	<1.0	<1.0	<1.0	<1.0	<1.0
(downgradient)	6/5/97	<1.0	<1.0	<1.0	<1.0	<1.0
	7/29/97	<1.0	<1.0	<1.0	<1.0	<1.0
	11/6/97	<1.0	<1.0	<1.0	<1.0	<1.0
QA	3/27/97	<1.0	<1.0	<1.0	<1.0	<1.0
HB-3A [5]	3/27/97	<1.0	<1.0	<1.0	<1.0	<1.0
(downgradient)	6/5/97	<1.0	<1.0	1.0	<1.0	<1.0
	7/29/97	<1.0	<1.0	<1.0	<1.0	<1.0
	11/6/97	<1.0	<1.0	<1.0	<1.0	<1.0
LMW-4	3/27/97	<1.0	<1.0	<1.0	<1.0	<1.0
(downgradient)	6/5/97	2.0	3.0	10.0	<1.0	<1.0
	7/29/97	1.0	4.0	22.0	<1.0	<1.0
	11/26/97	3.0	3.0	34.0	<1.0	<1.0
QA	7/29/97	1.0	4.0	14.0	<1.0	<1.0
HB-5A2 [5]	3/27/97	4.0	5.0	<1.0	<1.0	<1.0
(downgradient)	6/5/97	4.0	7.0	3.0	<1.0	<1.0
	7/29/97	6.0	8.0	4.0	<1.0	<1.0
	11/6/97	7.0	15.0	18.0	<1.0	<1.0
QA	11/6/97	7.0	15.0	16.0	<1.0	<1.0
LMW-6	3/27/97	1.0	<1.0	<1.0	2.0	<1.0
(downgradient)	6/5/97	<1.0	<1.0	2.0	<1.0	<1.0
	7/29/97	1.0	<1.0	3.0	1.0	<1.0
	11/6/97	1.0	1.0	16.0	1.0	<1.0
QA	6/5/97	1.0	<1.0	<1.0	1.0	<1.0
HB-7A [5]	3/27/97	<1.0	<1.0	<1.0	3.0	<1.0
(downgradient)	6/5/97	<1.0	<1.0	<1.0	2.0	<1.0
	7/29/97	<1.0	<1.0	<1.0	3.0	<1.0
	11/6/97	<1.0	<1.0	<1.0	2.0	<1.0
Standards	[2]	5	5	5	5	5

*See first page for table notations.

TABLE 31 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, INACTIVE DISPOSAL SITES, 1997

		Parameter (all units are mg/l except where indicated)[1,6]												
	MONITORING WELL NUMBER	Sampling Date	Temp. F	pH (SU)	EH (mv)	Turbidity (NTU)	Color (cpu)	Specific Conductivity (μmhos/cm)	TDS	COD	BOD5	TOC	Alkalinity ----mg CaCO3/l	Hardness ----
BAPTIST HILL ROAD LANDFILL	KBH-1[7]	6/27/97	53.06	7.76	186	100.0	5	620	303	<5.0	<2	4.2	265	321
	KBH-2	6/27/97	53.24	8.32	173	59.0	<5	323	138	<5.0	2	1.0	140	153
	KBH-3	6/27/97	50.36	8.99	167	>1000.0	15	272	158	11.0	<2	<1.0	150	153
	KBH-4	6/27/97	55.22	8.31	170	680.0	15	285	130	<5.0	<2	<1.0	120	135
	KBH-5	---------- WELL SCREEN COLLAPSED, NO SAMPLE AVAILABLE ----------												
SILO AREA	KBH-6[7]	6/17/97	48.74	8.37	246	160.0	10	299	148	11.0	<2	2.1	125	316
	KBH-7	6/17/97	46.40	8.09	252	>1000.0	10	318	138	15.0	<2	16.0	132	272
	KBH-8	6/17/97	47.66	7.58	249	>1000.0	<5	323	158	<5.0	<2	9.2	145	148
SWAN SCHOOL ROAD CELLAR	T-3[7]	6/20/97	52.88	8.04	242	>1000.0	5	418	268	56.0	<2	11.0	335	1820
	KBH-9	6/20/97	49.64	8.57	255	<1000.0	5	163	78	<5.0	<2	2.6	60	203
	KBH-10	6/20/97	50.36	7.90	239	71.0	5	410	208	<5.0	<2	<1.0	147	200
PARKIS MILLS ROAD CELLAR	KBH-11[7]	6/11/97	49.64	8.08	241	220.0	10	403	205	7.5	<2	1.6	155	248
	KBH-12	6/11/97	50.36	7.84	232	140.0	10	205	120	<5.0	<2	1.2	75	105
	KBH-13	6/11/97	47.66	7.95	240	>1000.0	10	364	180	<5.0	<2	1.5	190	553
	QA	6/11/97	--	--	246	>1000.0	10	325	173	<5.0	<2	3.7	225	461
	Standards	[2]	NA	6.5-8.5	[4]	5	15	[4]	500	[4]	[4]	[4]	[4]	[4]

Notes:
(1) A value preceded by < is the minimum detectable level for that sample and parameter.
(2) Groundwater standards, 6 NYCRR 703.5.
(3) Analysis not performed.
(4) No groundwater standard
(5) Samples for metals are unfiltered unless otherwise stated.
(6) All other organic compounds listed in 40 CFR, Part 136, Appendix A, Methods 601 and 602 were not detected above the analytical subcontractors minimum detectable level for that compound.
(7) Background well.

TABLE 31 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, INACTIVE DISPOSAL SITES, 1997 (continued)

		Parameter (all units are mg/l except where indicated)[1,5,6]										
	WELL NUMBER	Sampling Date	Sulfate	Chloride	TKN	Ammonia	Nitrate-N	Phenols	Cyanide	Aluminum	Filtered Aluminum	Antimony
BAPTIST HILL ROAD LANDFILL	KBH-1[7]	6/27/97	13.0	1.4	<1.0	0.1	6.20	<0.001	<0.02	0.2	<0.1	<0.06
	KBH-2	6/27/97	12.0	1.1	<1.0	0.1	0.19	<0.001	<0.01	0.6	<0.1	<0.06
	KBH-3	6/27/97	19.0	2.2	<1.0	0.1	0.10	<0.001	<0.02	3.8	2.6	<0.06
	KBH-4	6/27/97	18.0	<1.0	<1.0	0.1	0.06	<0.001	<0.02	0.7	<0.1	<0.06
	KBH-5	---------- WELL SCREEN COLLAPSED, NO SAMPLE AVAILABLE ----------										
SILO AREA	KBH-6[7]	6/17/97	21.0	1.1	1.7	<0.1	0.03	0.003	<0.01	1.8	<0.1	<0.06
	KBH-7	6/17/97	15.0	1.0	7.6	<0.1	0.03	0.002	<0.01	<0.1	<0.1	<0.06
	KBH-8	6/17/97	7.8	<1.0	<1.0	<0.1	0.03	<0.001	<0.01	1.7	<0.1	<0.06
SWAN SCHOOL ROAD CELLAR	T-3[7]	6/20/97	111.0	1.0	1.7	<0.1	0.16	<0.001	<0.01	13.8	0.1	<0.06
	KBH-9	6/20/97	11.0	<1.0	<1.0	<0.1	0.19	0.002	<0.01	4.6	0.4	<0.06
	KBH-10	6/20/97	41.0	1.4	<1.0	<0.1	0.08	0.005	<0.01	0.3	0.1	<0.06
PARKIS MILLS ROAD CELLAR	KBH-11[7]	6/11/97	32.0	3.0	<1.0	<0.1	0.05	<0.001	<0.01	1.7	0.2	<0.06
	KBH-12	6/11/97	16.0	1.1	<1.0	<0.1	<0.02	<0.001	<0.01	1.6	0.2	<0.06
	KBH-13	6/11/97	12.0	1.2	<1.0	<0.1	0.50	<0.001	<0.01	5.6	0.2	<0.06
QA		6/11/97	12.0	1.3	<1.0	<0.1	<0.02	<0.001	<0.01	6.6	0.2	<0.06
Standards		[2]	250	250	[4]	2.0	10.0	0.001	0.1	[4]	[4]	0.003G

*See first page for table notations.

TABLE 31 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, INACTIVE DISPOSAL SITES, 1997 (continued)

		Parameter (all units are mg/l except where indicated)[1,5,6]											
	WELL NUMBER	Sampling Date	Arsenic	Barium	Filtered Barium	Beryllium	Boron	Cadmium	Calcium	Filtered Calcium	Chromium	Filtered Chromium	Hexavalent Chromium
BAPTIST HILL ROAD LANDFILL	KBH-1[7]	6/27/97	<0.005	0.05	0.03	<0.005	<0.05	<0.005	86.5	74.7	<0.005	<0.005	<0.02
	KBH-2	6/2797	<0.005	0.07	0.03	<0.005	<0.05	<0.005	35.2	25.3	<0.005	<0.005	<0.02
	KBH-3	6/27/97	<0.005	0.19	0.03	<0.005	<0.05	<0.005	43.6	10.2	<0.005	<0.005	<0.02
	KBH-4	6/27/97	<0.005	0.02	<0.01	<0.005	<0.05	<0.005	24.8	24.3	<0.005	<0.005	<0.02
	KBH-5	---------- WELL SCREEN COLLAPSED, NO SAMPLE AVAILABLE ----------											
SILO AREA	KBH-6[7]	6/17/97	<0.005	0.03	<0.01	<0.005	<0.05	<0.005	74.3	37.0	0.01	<0.005	<0.02
	KBH-7	6/17/97	<0.005	0.04	<0.01	<0.005	<0.05	<0.005	63.2	35.1	<0.005	<0.005	<0.02
	KBH-8	6/17/97	<0.005	0.03	<0.01	<0.005	<0.05	<0.005	39.7	39.9	<0.005	<0.005	<0.02
SWAN SCHOOL ROAD CELLAR	T-3[7]	6/20/97	<0.005	0.34	<0.01	<0.005	<0.05	<0.005	488.0	48.5	0.021	<0.005	<0.02
	KBH-9	6/20/97	<0.005	0.09	<0.01	<0.005	<0.05	<0.005	50.4	15.8	0.005	<0.005	<0.02
	KBH-10	6/20/97	<0.005	<0.01	<0.01	<0.005	<0.05	<0.005	48.1	47.4	<0.005	<0.005	<0.02
PARKIS MILLS ROAD CELLAR	KBH-11[7]	6/11/97	<0.005	0.02	<0.01	<0.005	<0.05	<0.005	61.4	46.5	0.006	<0.005	<0.02
	KBH-12	6/11/97	<0.005	0.02	<0.01	<0.005	<0.05	<0.005	25.3	20.1	<0.005	<0.005	<0.02
	KBH-13	6/11/97	<0.005	0.11	<0.01	<0.005	<0.05	<0.005	145.0	42.8	0.013	<0.005	<0.02
	QA	6/11/97	<0.005	0.11	<0.001	<0.005	<0.05	<0.005	124.0	42.9	0.013	<0.005	<0.02
	Standards	[2]	0.025	1.0	1.0	0.003G	1.00	0.01	[4]	[4]	0.05	0.05	0.02

*See first page for table notations.

TABLE 31 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, INACTIVE DISPOSAL SITES, 1997 (continued)

		Parameter (all units are mg/l except where indicated)[1,5,6]								
	WELL NUMBER	Sampling Date	Copper	Iron	Filtered Iron	Lead	Filtered Lead	Magnesium	Filtered Magnesium	Manganese	Filtered Manganese
BAPTIST HILL ROAD LANDFILL	KBH-1[7]	6/27/97	<0.05	0.96	<0.05	<0.005	<0.005	25.6	22.5	0.09	0.03
	KBH-2	6/27/97	<0.05	0.70	<0.05	<0.005	<0.005	15.9	13.9	0.10	<0.02
	KBH-3	6/27/97	<0.05	5.24	2.09	<0.005	<0.005	10.7	2.6	0.33	0.03
	KBH-4	6/27/97	<0.05	1.02	<0.05	<0.005	<0.005	11.6	7.8	0.10	<0.02
	KBH-5	----------WELL SCREEN COLLAPSED, NO SAMPLE AVAILABLE ----------									
SILO AREA	KBH-6[7]	6/17/97	<0.05	5.69	<0.05	<0.005	<0.005	31.5	14.0	0.34	<0.02
	KBH-7	6/17/97	<0.05	4.17	<0.05	<0.005	<0.005	27.6	13.4	0.43	<0.02
	KBH-8	6/17/97	<0.05	2.93	<0.05	<0.005	<0.005	11.8	11.7	0.16	<0.02
SWAN SCHOOL ROAD CELLAR	T-3[7]	6/20/97	<0.05	27.20	0.08	<0.005	<0.005	146.0	18.9	2.54	<0.02
	KBH-9	6/20/97	<0.05	6.45	0.33	<0.005	<0.005	18.6	5.3	0.62	<0.02
	KBH-10	6/20/97	<0.05	0.63	<0.05	<0.005	<0.005	19.3	19.4	0.03	<0.02
PARKIS MILLS ROAD CELLAR	KBH-11[7]	6/11/97	<0.05	3.78	0.05	<0.005	<0.005	23.2	18.5	0.11	<0.02
	KBH-12	6/11/97	<0.05	2.82	0.09	<0.005	<0.005	10.2	7.9	0.13	<0.02
	KBH-13	6/11/97	<0.05	11.60	0.08	<0.005	<0.005	46.5	14.1	0.79	<0.02
	QA	6/11/97	<0.05	13.30	0.13	0.006	<0.005	36.8	14.2	0.70	<0.02
	Standards	[2]	0.2	0.30	0.30	0.025	0.025	35G	35G	0.30	0.30

*See first page for table notations.

TABLE 31 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, INACTIVE DISPOSAL SITES, 1997 (continued)

		Parameter (all units are mg/l except where indicated)[1,5,6]									
	WELL NUMBER	Sampling Date	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Zinc	Filtered Zinc
BAPTIST HILL ROAD LANDFILL	KBH-1[7]	6/27/97	<0.0004	<0.05	<0.05	<0.005	<0.02	1.6	<0.01	<0.01	<0.01
	KBH-2	6/27/97	<0.0004	<0.05	<0.05	<0.005	<0.02	10.8	<0.01	<0.01	<0.01
	KBH-3	6/27/97	<0.0004	<0.05	<0.05	<0.005	<0.02	42.8	<0.01	<0.01	<0.01
	KBH-4	6/27/97	<0.0004	<0.05	<0.05	<0.005	<0.02	14.8	<0.01	<0.01	<0.01
	KBH-5	---------- WELL SCREEN COLLAPSED, NO SAMPLE AVAILABLE ----------									
SILO AREA	KBH-6[7]	6/17/97	<0.0004	<0.05	<0.5	<0.005	<0.02	3.2	<0.01	0.04	<0.01
	KBH-7	6/17/97	<0.0004	<0.05	<0.5	<0.005	<0.02	1.8	<0.01	0.04	<0.01
	KBH-8	6/17/97	<0.0004	<0.05	<0.5	<0.005	<0.02	1.3	<0.01	0.03	<0.01
SWAN SCHOOL ROAD CELLAR	T-3[7]	6/20/97	<0.0004	<0.05	<0.5	<0.005	<0.02	3.3	<0.01	0.14	<0.01
	KBH-9	6/20/97	<0.0004	<0.05	1.6	<0.005	<0.02	1.3	<0.01	0.03	<0.01
	KBH-10	6/20/97	<0.0004	<0.05	<0.5	<0.005	<0.02	2.6	<0.01	0.02	<0.01
PARKIS MILLS ROAD CELLAR	KBH-11[7]	6/11/97	<0.0004	<0.05	<0.5	<0.005	<0.02	2.7	<0.01	0.02	<0.01
	KBH-12	6/11/97	<0.0004	<0.05	<0.5	<0.005	<0.02	1.5	<0.01	0.04	0.01
	KBH-13	6/11/97	<0.0004	<0.05	<0.5	<0.005	<0.02	2.1	<0.01	0.05	<0.01
	QA	6/1197	<0.0004	<0.05	<0.5	<0.005	<0.02	2.1	<0.01	0.06	<0.01
	Standards	[2]	0.002	[4]	[4]	0.01	0.05	20.0	0.004G	0.3	0.3

*See first page for table notations.

TABLE 32 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, SECURITY AREA WELLS, 1997

MONITORING WELL NUMBER	Sampling Date	pH (SU)	Temp. F	EH (mv)	Turbidity (NTU)	Color (cpu)	Specific Conductivity (μmhos/cm)	TDS	COD	BOD5	TOC	Alkalinity --- mg CaCO3/l ---	Hardness --- mg CaCO3/l ---
		Parameter (all units are mg/l except where indicated)[1]											
MW-1[7]	7/31/97	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.5	NS	NS
MW-2	7/31/97	7.3	71.8	188	>1000	10	1860	1100	86	4	6.4	350	1050
QA	7/31/97			184	>1000	15	1700	1090	83	4	8.1	390	1000
MW-3	7/31/97	6.6	73.9	208	900	30	7540	4350	22	3	18.0	440	1160
MW-4	7/31/97	7.5	71.6	184	675	10	2650	1480	29	<2	3.4	310	533
MW-6	7/31/97	7.3	70.0	183	>1000	10	2130	1260	388.0	2	4.4	360	1040
MW-7	8/12/97	7.2	67.3	275	>1000	50	5299	2540	44.0	12	27.0	450	1040
MW-8	8/12/97	7.1	68.0	213	>1000	30	944	572	47.0	11	18.0	180	317
MW-9	8/12/97	7.1	65.3	242	320	30	10300	6560	74.0	10	21.0	730	1130
MW-10	8/12/97	6.4	57.2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-11	8/12/97	7.0	64.2	233	>1000	25	8700	4980	71.0	4	20.0	570	862
MW-12	8/12/97	7.7	54.9	207	720	5	760	548	<5.0	<2	1.6	270	424
MW-13	8/12/97	6.9	57.6	220	580	5	3480	2270	11.0	<2	<1.0	250	620
MW-14	8/19/97	7.4	58.8	218	>1000	10	1880	1520	11.0	<2	8.4	400	1320
MW-15	8/19/97	7.1	64.9	232	>1000	40	2010	1290	81.0	10	45.0	350	544
MW-16	8/19/97	7.0	60.4	234	450	50	2850	1790	88.0	4	41.0	470	651
MW-17	819/97	7.1	67.3	227	510	10	1910	1230	22.0	<2	7.0	410	805
MW-18	8/19/97	7.1	60.3	237	>1000	25	6500	3840	146.0	<2	48.0	330	554
MW-19	8/19/97	6.8	64.4	244	340	30	5650	3240	35.0	3	24.0	410	777
MW-20	8/19/97	7.3	68.2	231	>1000	15	6350	4000	32.0	<2	29.0	470	1280
Standards	[2]	6.5-8.5	NA	[4]	5	15	[4]	500	[4]	[4]	[4]	[4]	[4]

Notes:
(1) A value preceded by < is the minimum detectable level for that sample and parameter.
(2) Groundwater standards, 6 NYCRR 703.5.
(3) Analysis not performed.
(4) No groundwater standard.
(5) Analysis for metals are reported for filtered samples due to high sample turbidity and its bias on analysis .
(6) All other organic compounds listed in 40 CFR, Part 136, Appendix A, Methods 601 and 602 were not detected above the analytical subcontractor's minimum detectable level for that compound.
(7) Background well.

NA = not applicable, QA = quality assurance sample, G = Groundwater Guidance Value per NYSDEC TOGS 1.1.1.

TABLE 32 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, SECURITY AREA WELLS, 1997 (continued)

WELL NUMBER	Sampling Date	Parameter (all units are mg/l except where indicated)[1,5] Sulfate	Chloride	TKN	Ammonia	Nitrate-N	Phenols	Total Cyanide	Aluminum	Antimony	Arsenic
MW-1[7]	7/31/97	NS	NS	NS	NS	NS	NS	NS	<0.1	<0.06	<0.005
MW-2	7/31/97	30	484	29.0	29.0	0.06	<0.001	<0.01	<0.1	<0.06	<0.005
QA	7/31/97	33	445	30.0	31.0	0.10	<0.001	<0.01	<0.1	<0.06	<0.005
MW-3	7/31/97	66	2590	47.0	53.0	0.05	<0.001	<0.01	<0.1	<0.06	<0.005
MW-4	7/31/97	40	672	20.0	21.0	7.3	<0.001	<0.01	<0.1	<0.06	<0.005
MW-6	7/31/97	78	530	7.3	2.0	0.19	<0.001	<0.01	<0.1	<0.06	<0.005
MW-7	8/12/97	50	1830	7.3	0.5	1.60	<0.001	<0.01	0.5	<0.06	<0.005
MW-8	8/12/97	69	204	5.9	2.0	1.80	<0.001	<0.01	0.3	<0.06	<0.005
MW-9	8/12/97	137	4260	24.0	22.0	0.84	<0.001	<0.01	0.6	<0.06	0.009
MW-10	8/12/97	319	2160	NS	NS	NS	NS	NS	NS	NS	NS
MW-11	8/12/97	196	3430	6.7	1.3	0.11	<0.001	<0.01	0.3	<0.06	<0.005
MW-12	8/12/97	21	75	<1	<0.1	5.70	<0.001	<0.01	0.2	<0.06	<0.005
MW-13	8/12/97	68	939	<1	<0.1	2.00	<0.001	<0.01	0.3	<0.06	<0.005
MW-14	8/19/97	167	53	1.4	<0.1	0.05	<0.001	<0.01	0.5	<0.06	<0.005
MW-15	8/19/97	79	544	25.0	26.0	0.04	<0.001	<0.01	0.2	<0.06	<0.005
MW-16	8/19/97	161	630	11.0	10.0	0.07	<0.001	<0.01	0.2	<0.06	<0.005
MW-17	8/19/97	173	461	1.1	0.2	0.07	<0.001	<0.01	0.3	<0.06	<0.005
MW-18	8/19/97	131	2920	3.6	1.0	0.43	0.003	<0.01	0.3	<0.06	<0.005
MW-19	8/19/97	94	2280	45.0	22.0	0.11	<0.001	<0.01	0.3	<0.06	<0.005
MW-20	8/19/97	93	2720	2.8	<0.1	0.19	<0.001	<0.01	0.4	<0.06	<0.005
Standards	[2]	250	250	[4]	2.0	10.0	0.001	0.1	[4]	0.003G	0.025

*See first page for table notations.

TABLE 32 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, SECURITY AREA WELLS, 1997(Continued)

WELL NUMBER	Sampling Date	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Hexavalent Chromium	Copper	Iron	Lead	Magnesium
		Parameter (all units are mg/l except where indicated)[1,5]										
MW-1[7]	7/31/97	0.01	<0.005	0.09	<0.005	72.1	0.005	NS	<0.05	0.05	<0.005	11.0
MW-2	7/31/97	0.11	<0.005	<0.05	<0.005	113	<0.005	<0.02	<0.05	0.67	<0.005	38.9
QA	7/31/97	0.10	<0.005	<0.05	<0.005	110	<0.005	<0.02	<0.05	0.47	<0.005	38.4
MW-3	7/31/97	0.65	<0.005	0.05	<0.005	248	<0.005	<0.02	<0.05	0.75	<0.005	80.0
MW-4	7/31/97	0.17	<0.005	0.29	<0.005	65	<0.005	<0.02	<0.05	0.07	<0.005	7.6
MW-6	7/31/97	0.16	<0.005	0.08	<0.005	81.1	<0.005	<0.02	<0.05	0.17	<0.005	17.4
MW-7	8/12/97	0.14	<0.005	<0.05	<0.005	106	<0.005	<0.02	<0.05	0.31	<0.005	12.1
MW-8	8/12/97	0.04	<0.005	<0.05	<0.005	59.6	<0.005	<0.02	<0.05	0.70	<0.005	7.3
MW-9	8/12/97	0.43	<0.005	0.08	<0.005	441	<0.005	<0.02	<0.05	0.17	<0.005	52.4
MW-10	8/12/97	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-11	8/12/97	0.49	<0.005	0.05	<0.005	226	<0.005	<0.02	<0.05	0.64	<0.005	25.3
MW-12	8/12/97	0.03	<0.005	0.19	<0.005	133	<0.005	<0.02	<0.05	<0.05	<0.005	22.9
MW-13	8/12/97	0.09	<0.005	0.05	<0.005	188	<0.005	<0.02	<0.05	0.08	<0.005	35.3
MW-14	8/19/97	0.05	<0.005	0.06	<0.005	187	<0.005	<0.02	<0.05	0.25	<0.005	67.8
MW-15	8/19/97	0.16	<0.005	0.07	<0.005	143	<0.005	<0.02	<0.05	2.72	<0.005	20.9
MW-16	8/19/97	0.15	<0.005	0.09	<0.005	211	<0.005	<0.02	<0.05	1.12	<0.005	44.1
MW-17	8/19/97	0.18	<0.005	0.17	<0.005	247	<0.005	<0.02	<0.05	<0.05	<0.005	40.7
MW-18	8/19/97	0.17	<0.005	0.51	<0.005	169	<0.005	<0.02	<0.05	0.37	<0.005	29.5
MW-19	8/19/97	0.53	<0.005	0.09	<0.005	255	<0.005	<0.02	<0.05	2.06	<0.005	37.3
MW-20	8/19/97	0.24	<0.005	0.07	<0.005	348	<0.005	<0.02	<0.05	<0.05	<0.005	40.1
Standards	[2]	1.0	0.003G	1.00	0.01	[4]	0.05	0.05	0.20	0.30	0.025	35G

*See first page for table notations.

TABLE 32 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, SECURITY AREA WELLS, 1997 (Continued)

WELL NUMBER	Sampling Date	Parameter (all units are mg/l except where indicated)[1,5] Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Zinc
MW-1[7]	7/31/97	<0.02	<0.0004	<0.05	3.4	<0.005	<0.02	329	<0.01	0.01
MW-2	7/31/97	0.39	<0.0004	<0.05	9.1	<0.005	<0.02	171	<0.01	<0.01
QA	7/31/97	0.38	<0.0004	<0.05	6.7	<0.005	<0.02	175	<0.01	<0.01
MW-3	7/31/97	3.13	<0.0004	<0.05	14.2	<0.005	<0.02	1080	<0.01	0.02
MW-4	7/31/97	<0.02	<0.0004	<0.05	13.1	<0.005	<0.02	483	<0.01	0.01
MW-6	7/31/97	0.84	<0.0004	<0.05	3.7	<0.005	<0.02	413	<0.01	0.01
MW-7	8/12/97	0.41	<0.0004	<0.05	3.9	<0.005	<0.02	657	<0.01	0.01
MW-8	8/12/97	0.24	<0.0004	<0.05	6.4	<0.005	<0.02	122	<0.01	0.01
MW-9	8/12/97	2.12	<0.0004	<0.05	10.8	<0.005	<0.02	1840	<0.01	0.12
MW-10	8/12/97	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-11	8/12/97	4.06	<0.0004	<0.05	6.6	<0.005	<0.02	1490	<0.01	0.01
MW-12	8/12/97	<0.02	<0.0004	<0.05	2.4	<0.005	<0.02	9.8	<0.01	0.01
MW-13	8/12/97	<0.02	<0.0004	<0.05	4.6	<0.005	<0.02	487	<0.01	0.01
MW-14	8/19/97	0.02	<0.0004	<0.05	2.5	<0.005	<0.02	170	<0.01	<0.01
MW-15	8/19/97	2.42	<0.0004	<0.05	2.4	<0.005	<0.02	254	<0.01	<0.01
MW-16	8/19/97	2.08	<0.0004	<0.05	4.3	<0.005	<0.02	326	<0.01	0.01
MW-17	8/19/97	0.16	<0.0004	<0.05	3.5	<0.005	<0.02	125	<0.01	0.01
MW-18	8/19/97	0.63	<0.0004	<0.05	5.1	<0.005	<0.02	1370	<0.01	0.02
MW-19	8/19/97	6.8	<0.0004	<0.05	5.7	<0.005	<0.02	694	<0.01	<0.01
MW-20	8/19/97	0.03	<0.0004	<0.05	3.8	<0.005	<0.02	1480	<0.01	<0.01
Standards	[2]	0.30	0.002	[4]	[4]	0.01	0.05	20.0	0.004(G)	0.3

*See first page for table notations.

TABLE 32 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, SECURITY AREA WELLS, 1997 (Continued)

WELL NUMBER	Sampling Date	Parameter (all units are µg/l)[1,6] Dichloro-Difluoromethane	Trichloro-ethylene	Tetrachloro-ethylene	Trichloro-fluoromethane	111-Trichloro-ethane
MW-1[7]	7/31/97	<1	<1	<1	<1	<1
MW-2	7/31/97	<1	<1	<1	<1	<1
QA	7/31/97	<1	<1	<1	<1	<1
MW-3	7/31/97	<1	<1	<1	<1	<1
MW-4	7/31/97	19	12	<1	<1	1
MW-6	7/31/97	<1	2	<1	<1	<1
MW-7	8/12/97	<1	<1	<1	<1	<1
MW-8	8/12/97	<1	<1	<1	<1	<1
MW-9	8/12/97	<1	<1	<1	<1	<1
MW-10	8/12/97	<1	<1	<1	<1	<1
MW-11	8/12/97	<1	<1	<1	<1	<1
MW-12	8/12/97	<1	<1	<1	<1	<1
MW-13	8/12/97	<1	<1	<1	<1	<1
MW-14	8/19/97	<1	<1	<1	<1	<1
MW-15	8/19/97	<1	<1	<1	<1	<1
MW-16	8/19/97	<1	4	<1	<1	<1
MW-17	8/19/97	<1	<1	<1	<1	<1
MW-18	8/19/97	<1	<1	<1	<1	<1
MW-19	8/19/97	<1	<1	<1	<1	<1
MW-20	8/19/97	<1	<1	<1	<1	<1
Standards	[2]	5	5	5	5	5

*See first page for table notations.

TABLE 33 - RESULTS OF KESSELRING SITE GROUNDWATER MONITORING FOR RADIOACTIVITY, 1997

Location	Cs-137	Co-60	Tritium
	----------(× 10^{-9} μCi/ml)[1]----------		(× 10^{-7} μCi/ml)[1]
LANDFILL AREA			
LMW-1[2]	<1.0	<1.0	2.7± 1.9
HB-2A	<1.0	<1.0	<1.5
HB-3A	WELL DRY, NOT SAMPLED		
LMW-4	WELL DRY, NOT SAMPLED		
HB-5A2	<1.0	<1.0	<1.5
HB-6A	WELL DRY, NOT SAMPLED		
HB-7A	<1.0	<1.0	2.2 ± 1.9
LMW-6	<0.8	<0.8	2.0 ± 1.9
SECURITY AREA			
MW-1[2]	WELL DRY, NOT SAMPLED		
MW-2	<1.0	<1.0	<1.6
MW-3	<1.0	<1.0	<1.6
MW-4	<0.9	<1.0	<1.6
MW-6	<1.0	<0.9	<1.6
MW-7	<1.0	<1.0	<1.7
MW-8	<1.0	<1.0	<1.6
MW-9	<0.8	<0.9	<1.6
MW-10	WELL DRY, NOT SAMPLED		
MW-11	<1.0	<1.0	<1.7
MW-12	<1.0	<1.0	<1.7
MW-13	<1.0	<1.0	<1.7
MW-14	<1.0	<1.0	<1.6
MW-15	<1.0	<1.0	<1.6
MW-16	<1.0	<1.0	<1.6
MW-17	<1.0	<1.0	<1.6
MW-18	<0.9	<1.0	<1.6
MW-19	<1.0	<1.0	<1.6
MW-20	<1.0	<1.0	<1.6
BAPTIST HILL ROAD LANDFILL			
KBH-1[2]	<1.0	<1.0	<1.8
KBH-2	<1.0	<1.0	<1.8
KBH-3	<1.0	<1.0	<1.8
KBH-4	<1.0	<1.0	<1.8
KBH-5	WELL DAMAGED, NOT SAMPLED		
SILO AREA			
KBH-6[2]	<1.0	<1.0	2.8 ± 1.9
KBH-7	<1.0	<1.0	2.7 ± 1.9
KBH-8	<1.0	<1.0	<2.6
SWAN SCHOOL ROAD CELLAR			
T-3[2]	<1.0	<1.0	2.8 ± 1.9
KBH-9	<1.0	<1.0	<1.8
KBH-10	<1.0	<0.9	<1.8
PARKIS MILLS ROAD CELLAR			
KBH-11[2]	<1.0	<1.0	<1.5
KBH-12	<1.0	<1.0	2.6 ± 1.9
KBH-13	<1.0	<1.0	2.0 ± 1.9

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.
(2) Background well for comparison purposes.

TABLE 34 - CHEMICAL CONSTITUENTS IN KESSELRING SITE DRINKING WATER, 1997

Parameters/Units[6]	Number of Samples	Value[1] Minimum	Maximum	Average[2]		Standard[5]	Percent of Standard[3]
Drinking Water Standards (Reference 19)							
Nitrates (mg/l as N)	1	0.27	0.27	0.27	± 0.00	10	2.7
Nitrites (mg/l as N)	1	<0.02	<0.02	<0.02	± 0.00	1	<2.0
Total Coliform[4][7]	50	<1	<1	<1	± 0.00	None Detectable	--
Residual Chlorine (mg/l)[7][8]	604	<0.001	0.068	<0.007	± 0.0005	Detectable	--
Turbidity (NTU)*[7]	11	0.14	0.8	0.36	± 0.15	5	7
Lead (mg/l)[7]	10	<0.005	0.006	<0.005	± 0.0002	0.015[10]	<33.3
Copper (mg/l)[7]	10	0.18	0.76	0.41	± 0.13	1.3[9]	31.5
Alachlor (mg/l)	1	<0.001	<0.001	<0.001	± 0.00	0.002	<50
Aldicarb (mg/l)	1	<0.003	<0.003	<0.003	± 0.00	0.003	<100
Aldicarb Sulfoxide (mg/l	1	<0.004	<0.004	<0.004	± 0.00	0.004	<100
Aldicarb Sulfone (mg/l)	1	<0.002	<0.002	<0.002	± 0.00	0.002	<100
Atrazine (mg/l)	1	<0.001	<0.001	<0.001	± 0.00	0.003	<33
Carbofuran (mg/l)	1	<0.005	<0.005	<0.005	± 0.00	0.04	<1.25
Chlordane (mg/l)	1	<0.0005	<0.0005	<0.0005	± 0.00	0.002	<25
1,2-dibromo-3-chloropropane (mg/l)	1	<0.00002	<0.00002	<0.00002	± 0.00	0.0002	<10
2, 4D (mg/l))	1	<0.001	<0.001	<0.001	± 0.00	0.05	<2
Endrin (mg/l)	1	<0.0001	<0.0001	<0.0001	± 0.00	0.0002	<50
1,2-dibromoethane (mg/l)	1	<0.00002	<0.00002	<0.00002	± 0.00	0.00005	<40
Heptachlor (mg/l)	1	<0.00005	<0.00005	<0.00005	± 0.00	0.0004	<12.5
Heptachlor Epoxide (mg/l)	1	<0.00005	<0.00005	<0.00005	± 0.00	0.0002	<25
Lindane (mg/l)	1	<0.00005	<0.00005	<0.00005	± 0.00	0.0002	<25
Methoxychlor (mg/l)	1	<0.0005	<0.0005	<0.0005	± 0.00	0.04	<1.2
PCB-1016 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
PCB-1221 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
PCB-1232 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
PCB 1242 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
PCB-1248 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
PCB-1254 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
PCB-1260 (mg/l)	1	<0.000065	<0.000065	<0.000065	± 0.00	0.0005	<13
2,4,5-TP (Silver) (mg/l)	1	<0.001	<0.001	<0.001	± 0.00	0.01	<10
Pentachlorophenol (mg/l)	1	<0.001	<0.001	<0.001	± 0.00	0.001	<100
Toxaphene (mg/l)	1	<0.001	<0.001	<0.001	± 0.00	0.003	<33

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.
(3) Percent of standard for the average value.
(4) The minimum detectable concentration by the membrane filter method is one colony per 100 ml (N/100 ml). All fifty samples revealed non-detectable coliform.
(5) Maximum contaminant level per 10NYCRR Subpart 5
(6) All samples were collected at the entry point to the distribution system unless otherwise noted.
(7) Samples were collected at a location within the distribution system.
(8) The Kesselring Site has a disinfection waiver issued by the New York State Department of Health in accordance with 10 NYCRR Subpart 5.
(9) The specification for copper is that the 90th percentile sample result must be less than 1.3 ppm.
(10) The specification for lead is that the 90th percentile sample results must be less than 0.015 ppm.

*NTU = Nephelometric turbidity units

S1C SITE EFFLUENT AND ENVIRONMENTAL MONITORING

SITE DESCRIPTION

The S1C Site (Figure 8) is situated on 10.8 acres of land near Windsor, Connecticut, approximately five miles (eight kilometers) north of the City of Hartford. Facilities at the S1C Site include a defueled Naval nuclear propulsion plant prototype which was permanently shutdown in 1993 and is being dismantled, and support facilities such as administrative offices, craft shops, waste storage facilities, a sanitary waste septic system, and an equipment service building.

In early 1997, dismantlement operations began on the defueled prototype reactor plant after completion of the National Environmental Policy Act process in December 1996, similar to the process described for the Kesselring Site S3G and D1G Prototype reactor plants on page 47. After consideration of public comments on the Draft Environmental Impact Statement (EIS), Naval Reactors prepared the Final EIS, Reference (39) which identified prompt dismantlement as the preferred alternative. In a Record of Decision dated December 30, 1996, Naval Reactors decided to promptly dismantle the defueled reactor plant.

The area surrounding the S1C Site is a mixture of open land, industrial areas, tobacco and shrub farms, and suburban residential areas. The Combustion Engineering Site is adjacent to the S1C Site. The S1C Site lies in a broad basin of gently rolling terrain called the Connecticut River Valley. The valley begins well to the north, in Massachusetts, and follows the Connecticut River to Long Island Sound. The valley is bordered on the east by the Green Mountains and on the west by the Berkshire Mountains. The Farmington River's course is within a half mile of the S1C Site to the north and joins the Connecticut River about 5 miles east of the Site.

The climate in the region of the S1C Site is typical for a northern temperate climate zone. The prevailing west to east movement of air in the region carries the majority of weather systems into the area from the west. The location of the Site, relative to the continent and ocean is significant in that rapid weather changes can result when storms move northward along the Mid-Atlantic coast. Seasonally, weather characteristics vary from the cold and dry continental-polar air of winter to the warm, maritime air of summer. Typical minimum and maximum temperatures are 18°F and 83°F respectively and the average temperature is approximately 50°F. Annual snowfall is 50-55 inches per year and precipitation averages approximately 44 inches per year. Prevailing winds are north to northwest during the winter and south to southwest during the rest of the year.

The topography in the area of the S1C Site exhibits moderate relief due to the erosion of the hills formed during the Jurassic period. Most areas within two miles of the Site lie between 150 and 250 feet above sea level. A few hills to the west reach 400 feet. The Site elevation is approximately 180 feet.

The bedrock geology in the vicinity of the S1C Site is quite simple. Portland arkose lies in a broad belt at a depth of 90-150 feet. Successive layers under this arkose are as follows: (1) the Hampden basalt layer, which is about 100 to 150 feet thick, (2) the East Berline formation that is a gray to reddish-brown siltstone about 500 feet thick, (3) Holyoke basalt about 300 feet thick, and (4) the lowest level which is New Haven arkose. The combined layers comprise the Newark Group of the Triassic age.

The surficial makeup is primarily composed of Deltaic deposits of sand, silt, and gravel. Its origin is probably the western highlands and its accumulation resulted from glaciation. Surface drainage is good, and permeability varies with silt content. Terrace deposits occur immediately north of the Site, and the nearby creek banks are composed largely of till. Both contain varying amounts of clay in addition to the components found in the Deltaic deposits. These surficial deposits are mixed and layered in a complex manner.

Drainage water from the Site enters the Farmington River by the Combustion Engineering Site drainage brook. The length of the drainage path from the Site to the river is approximately three-quarters of a mile. The flow rate in the Farmington River, which has been monitored since August 1928 at Rainbow, Connecticut, located downstream from the S1C Site, averages approximately 1000 cubic feet per second (cfs). The Connecticut River is gauged upriver and downriver from its confluence with the Farmington River just east of

the Town of Windsor. The average flow rate past the upriver station is approximately 16,270 cfs.

Ground water is an important resource for the area in industrial usage. Three high priority aquifers are designated within ten miles of the S1C Site. They are at Bradley Airport, at Windsor Locks, and near Broad Brook in East Windsor. The valley of the Farmington River across the Talcott Mountains is also designated a high priority aquifer by the State of Connecticut Water Resources Planning Program of the Department of Environmental Protection. The "high priority" designation is defined as being a "large deposit of permeable rock, sand or gravel within which significant amounts of ground water may be found."

Water is supplied to the S1C Site by the municipal water supply from the Metropolitan District Commission (MDC).

LIQUID EFFLUENT MONITORING

Origins

The only source of effluent water during 1997 at the S1C Site was site drainage water. The site drainage system which receives stormwater is permitted under a State of Connecticut Department of Environmental Protection General Stormwater Discharge Permit.

Appropriate stormwater discharge information was incorporated in the Reference (34) State of Connecticut Department of Environmental Protection General Stormwater Discharge Permit Application. Effluent from the sanitary sewer is not discharged from the S1C Site but is treated in an anaerobic septic tank with an auxiliary clarification chamber and is released below ground through seepage trenches.

Liquids that may have contained radioactivity were collected in 55 gallon drums and solidified prior to disposal as a low level radioactive waste. The sources of radioactivity in liquids and the radionuclides associated with S1C Site were those associated with past prototype plant operations.

Effluent Monitoring

Stormwater from the S1C Site (Figure 8) is released through the permitted stormwater system which encompasses the entire Site, access road, and east parking lot. A total of five discharge locations in these areas are monitored annually as required by the permit. This system is governed by Reference (34) which includes a State of Connecticut Professional Engineer certified Site Stormwater Pollution Prevention Plan. Procedures for preventing pollution to the stormwater discharges are in place including bi-annual inspections of the Site, access road, and east parking lot; training programs; grounds keeping and control of all hazardous materials used on Site.

Effluent Analyses

The samples from the five discharge locations were analyzed for twelve parameters as required by the permit. The parameters analyzed are: oil and grease, chemical oxygen demand, total suspended solids, total phosphorous, total kjeldahl nitrogen, pH, nitrates, fecal coliform, total copper, total zinc, total lead, and aquatic toxicity. The analyses are performed using procedures described in Reference (16) or other EPA approved methods. The results are compared to the permit guidelines and transmitted to the Connecticut Department of Environmental Protection (CTDEP) for review.

Assessment

Some of the analytical results for the discharge monitoring points were above established stormwater discharge guidelines. Cleaning of selected catch basins, improvements in the Site grounds keeping practices, and additional training on stormwater discharge issues is being implemented to aid in the reduction of these levels in the future. These corrective actions should reduce the concentration of elevated stormwater parameters.

AIRBORNE EFFLUENT MONITORING

Origins

Operations having the potential for the release of airborne radioactivity are serviced by controlled exhaust systems. Prior to release, the exhaust air is passed through high efficiency particulate air (HEPA) filters, to minimize radioactivity content. The sources of airborne radioactivity and the radionuclides associated with S1C Site operations are those which are associated with prototype dismantlement operations.

Effluent Monitoring

The air exhausted from all radiological air emission points is continuously sampled for

particulate radioactivity. Air samples are collected for routine analysis using gamma spectrometry techniques.

Effluent Analyses

The air particulate sample filters are analyzed for radioactivity on a routine basis. The filters are analyzed for gamma radioactivity by direct counting with a system that provides a minimum detectable concentration for cobalt-60 of approximately 3.5×10^{-15} μCi/ml.

Assessment

The radioactivity contained in exhaust air during 1997 consisted of less than 0.001 curies of cobalt-60.

The airborne radioactivity was contained in a total air exhaust volume of 6.85×10^{10} liters. The average radioactivity concentration in the exhaust air was well below the applicable standards listed in Reference (2). The annual radioactivity concentration at the nearest Site boundary, allowing for typical diffusion conditions, was less than 0.01 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 2) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required in Reference (3).

ENVIRONMENTAL MONITORING

Scope

The environmental monitoring program for the S1C Site includes the routine collection and radioanalysis of water and sediment samples from the Combustion Engineering Site drainage brook and the Farmington River, fish from the Farmington River, periodic radiation surveys of the Combustion Engineering Site drainage brook, the continuous monitoring of radiation levels at twelve perimeter locations and at off-site locations ranging from 6.6 to 28.2 kilometers (4.1 to 17.5 miles) from the Site, and the routine monitoring of storm water.

Water and sediment samples were collected from the Combustion Engineering Site drainage brook and Goodwin Pond which is the source of the brook. Samples were collected from the Combustion Engineering Site drainage brook during all four calendar quarters of 1997 and during the last three calendar quarters from the Goodwin Pond; ice coverage on the pond prevented collection during the first quarter. Sediment samples are obtained from 15 locations along the approximately three-quarters of a mile length of the brook. Water samples are taken at five of these locations. Sediment samples are scooped from approximately the top two centimeters of sediment. Three additional sediment samples are taken in the mouth of the brook when accessible from the Farmington River. The Goodwin Pond samples are taken near the discharge point of an abandoned storm drain line which had discharged from the Site to the pond. This pipe was sealed in the early 1960's. Semi-annually, direct radiation measurements are made at the same 15 locations along the brook.

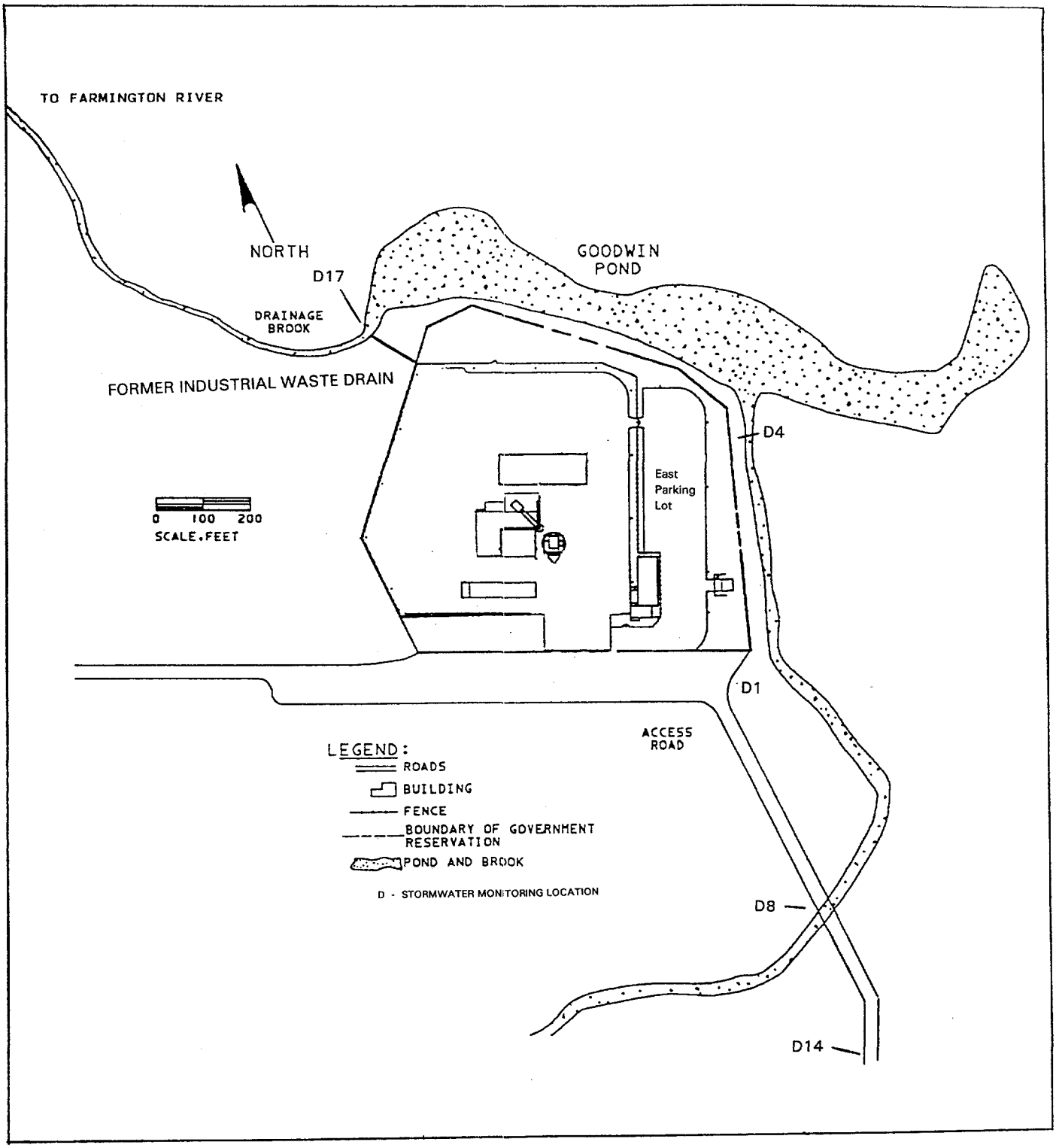
Farmington River water and sediment samples were collected at three locations across the river at locations upstream, opposite, and downstream from the release point, as shown in Figure 9. Samples were collected during the last three calendar quarters of 1997; ice coverage on the river prevented collection during the first quarter. Sediment samples were collected with a Birge-Ekman dredge that samples a 15 cm $\times$ 15 cm area to a depth of approximately 2.5 cm. In addition, fish were collected from the Farmington River upstream and downstream from the release point and analyzed for radioactivity.

Environmental air samplers are operated in the primary upwind and downwind directions from the Site to measure normal background airborne radioactivity and to confirm that S1C Site effluents have no measurable effect on normal background levels.

Radiation levels at the 12 site perimeter locations shown in Figure 10 and at several off-site locations are monitored with sensitive, thermoluminescent dosimeters (TLDs).

Analyses

The routine quarterly samples of the water and bottom sediment are analyzed with a high purity germanium gamma spectrometer system. In addition, a more sensitive gamma spectrometry analysis is performed annually on the fish and some of the water and sediment samples collected from the river. The more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma-emitting radionuclides. The environmental air sample filters are analyzed routinely by direct counting for gamma radioactivity analysis.



S1C Site, Windsor, Connecticut
Figure 8

Assessment

Low levels of cobalt-60 ranging from less than 0.01 to 1.09 picocuries per gram, with an average concentration of <0.11 picocuries per gram, were measured in sediment during 1997. This level of cobalt-60, which is similar to previously measured values, is attributable to operations conducted prior to 1979. No gamma emitting radionuclides were detected in the Combustion Engineering Site drainage brook or Goodwin Pond water samples. The radiation measurements were typical of normal background. The drainage brook flows through the property of Combustion Engineering and is not readily accessible to the public.

The results for the Farmington River sediment analyses are shown in Table 35. The data show that there is no significant difference between radioactivity concentrations measured upriver and downriver except for one localized area directly opposite the Combustion Engineering Site drainage brook outfall. The low levels of cobalt-60 present at this location are attributable to operations in previous years and are similar to previously observed values. Results of the detailed gamma spectrum analysis performed on the sediment samples indicated no radionuclides attributable to Site operations other than cobalt-60. Low levels of cesium-137, which are attributable to radioactive fallout from nuclear weapons tests, naturally occurring potassium-40 and daughters of uranium and thorium were also detected. No gamma emitting radionuclides were detected in the Farmington River water samples.

In addition, uranium-235 was measured in some of the Combustion Engineering Site drainage brook sediment samples at a maximum concentration of approximately 1.35 picocuries per gram. The uranium-235 is not found at the drainage brook locations closest to the S1C Site outfall and is not a result of S1C Site operations.

The results of analyses of fish collected from the river are shown in Table 36. There were no radionuclides attributable to S1C Site operations observed in the fish.

The results for the environmental air samples show that there was no significant difference between the average upwind and downwind radioactivity concentrations.

The results for the perimeter and off-site radiation monitoring program are summarized in Table 37. Radiation levels at the perimeter locations ranged from 64 to 81 mrem, with an average of 73 mrem for the year. There is no statistically significant difference between the perimeter and the off-site measurements. This shows that S1C Site operations in 1997 had no measurable effect on natural background radiation levels at the Site perimeter.

GROUNDWATER MONITORING

There are no radioactive or chemical waste disposal sites at the S1C Site. Accordingly, the groundwater monitoring program consists of sampling the groundwater for evidence of Stretford solution, a chemical used to remove sulfur from combustion gases. The source of the Stretford solution is a spill which occurred at a non-KAPL facility which was located adjacent to the S1C Site. Two pairs of monitoring wells, each pair consisting of one deep and one shallow well, were installed on the S1C Site to provide an early indication of any potential threat of the spreading of the spill to the Site. The location of these wells is shown in Figure 10. The 1997 groundwater monitoring program at the S1C Site is summarized in Table 38. It consisted of four sampling evolutions at the 4 monitoring wells with corresponding analyses for 23 organic and inorganic parameters.

Samples from the four monitoring wells have been taken by KAPL personnel and the owner of the adjacent facility since 1984. During 1997, results from these wells, as presented in Table 39, indicate that the groundwater in the vicinity of the former site production wells is not being influenced by the plume of contamination. Operation of an interceptor well, installed at the spill location by the owner, has been temporarily discontinued by the owner as agreed to by the State of Connecticut.

CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

Chemicals are not manufactured or disposed of at the S1C Site. The S1C Site maintains a hazardous substance control program similar to that at the Knolls Site. Hazardous wastes do result from Site demolition and dismantlement activities. In addition, KAPL initiated removal of paint containing regulated quantities of polychlorinated biphenyls (PCBs) from metal surfaces as approved by EPA Region I in 1996. This removal process significantly reduces the amount of PCB waste by allowing alternate disposal of clean substrate materials.

This activity continued throughout 1997 allowing alternate disposal and/or recycling of 18.5 tons of metal. This contributed to 160.6 tons of all metals recycled at the S1C Site in 1997. KAPL completed demolition and disposal of three buildings, one of which had been painted with paint which contained PCBs. The Site also reached one milestone in the development of mixed waste disposal capability which resulted in the first shipment of mixed waste off-site for treatment and disposal. During 1997 the S1C Site shipped approximately 15.8 tons of Resource Conservation and Recovery Act (RCRA) hazardous waste, 3 lbs of mixed waste, 1278.7 tons of PCB waste, 72.4 tons of PCB/asbestos waste, 6 tons of asbestos waste, and 3.8 tons of non-RCRA chemical waste off-site for disposal.

TRANSPORTATION OF RADIOACTIVE MATERIALS

Various types of radioactive materials are generated at the S1C Site that require detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government operated disposal site.

Radioactive materials are handled and transferred in accordance with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive materials from the S1C Site, to ensure that the material is properly identified, surveyed, and packaged in accordance with federal, state, and local requirements.

Low level radioactive solid waste materials either activated or contaminated with radioactivity that require disposal include filters, metal scrap, rags, paper and plastic. The Site minimizes the volume of solid waste that must be disposed of as radioactive through reuse, recycling and the use of special work procedures that limit the amount of material that becomes contaminated. All radioactive wastes are packaged in accordance with written site procedures to ensure that all applicable regulations of the DOT are met, Reference (14). The waste packages also comply with all applicable requirements of the DOE and the disposal sites.

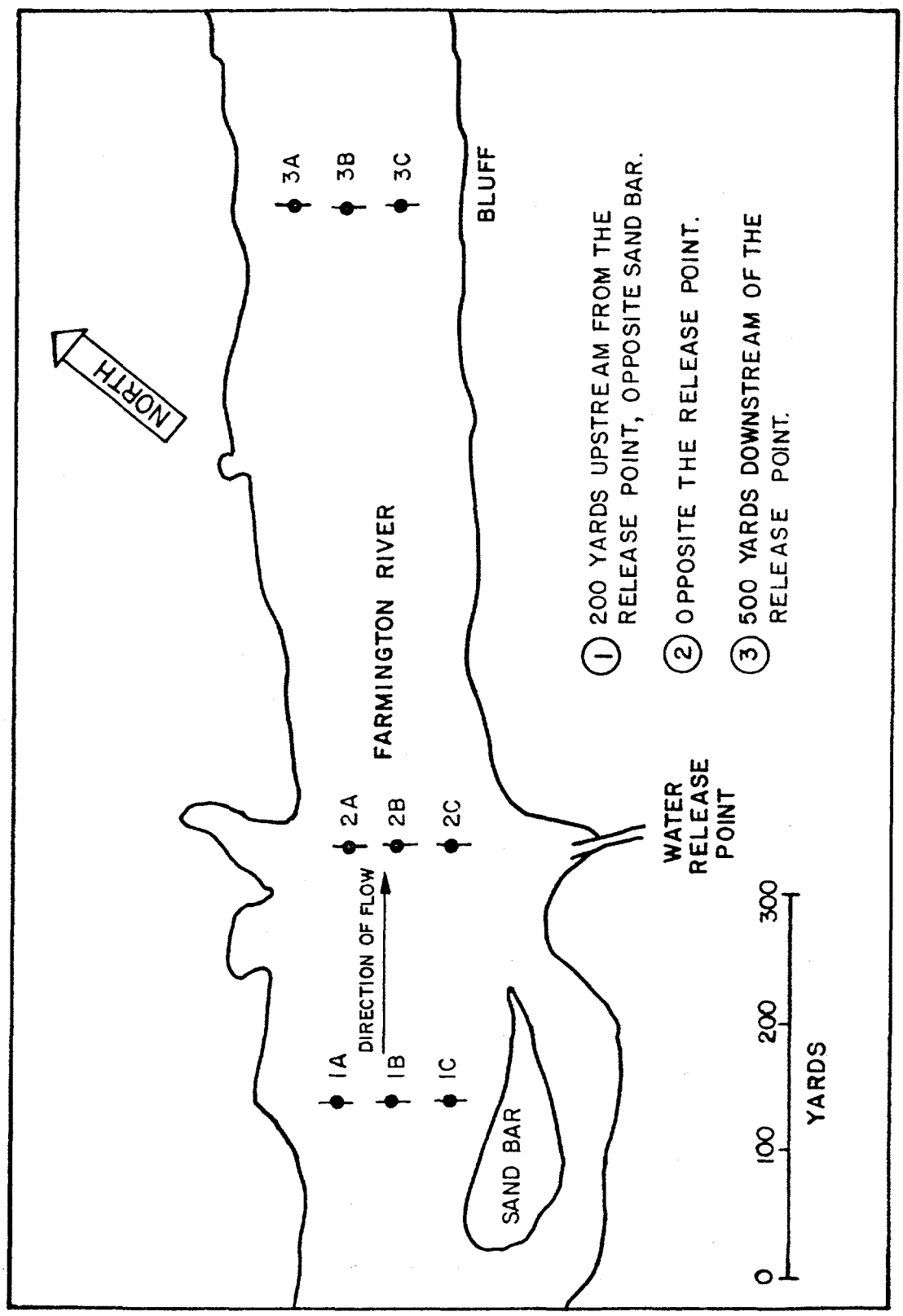
Shipments of low level radioactive solid wastes are made by authorized common carriers to government owned disposal sites located outside the State of Connecticut. During 1997, approximately 101 cubic meters (132 cubic yards) of routine low level waste containing 1.21 curies were shipped from the Site for disposal. In addition, approximately 42.6 tons of slightly radioactive metal were shipped to the Scientific Ecology Group (SEG) remelt facility in Tennessee as recyclable material.

RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity released in gaseous effluents from 1997 operations at the S1C Site had no discernible effect on normal background radioactivity levels. Therefore, radiation doses from S1C Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of: (1) the radiation dose to the maximally exposed individual in the vicinity of the S1C Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site and (3) the collective dose to the population residing in the assessment area are summarized in Tables 40 and 41. See Figure 12 for a map of the assessment area surrounding the S1C Site.

The results show that the estimated doses were less than 0.1 percent of that permitted by the DOE radiation protection standards listed in Reference (2), and that the estimated dose to the population residing within 80 kilometers (50 miles) of the S1C Site 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 (4) for whole-body dose demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (3).

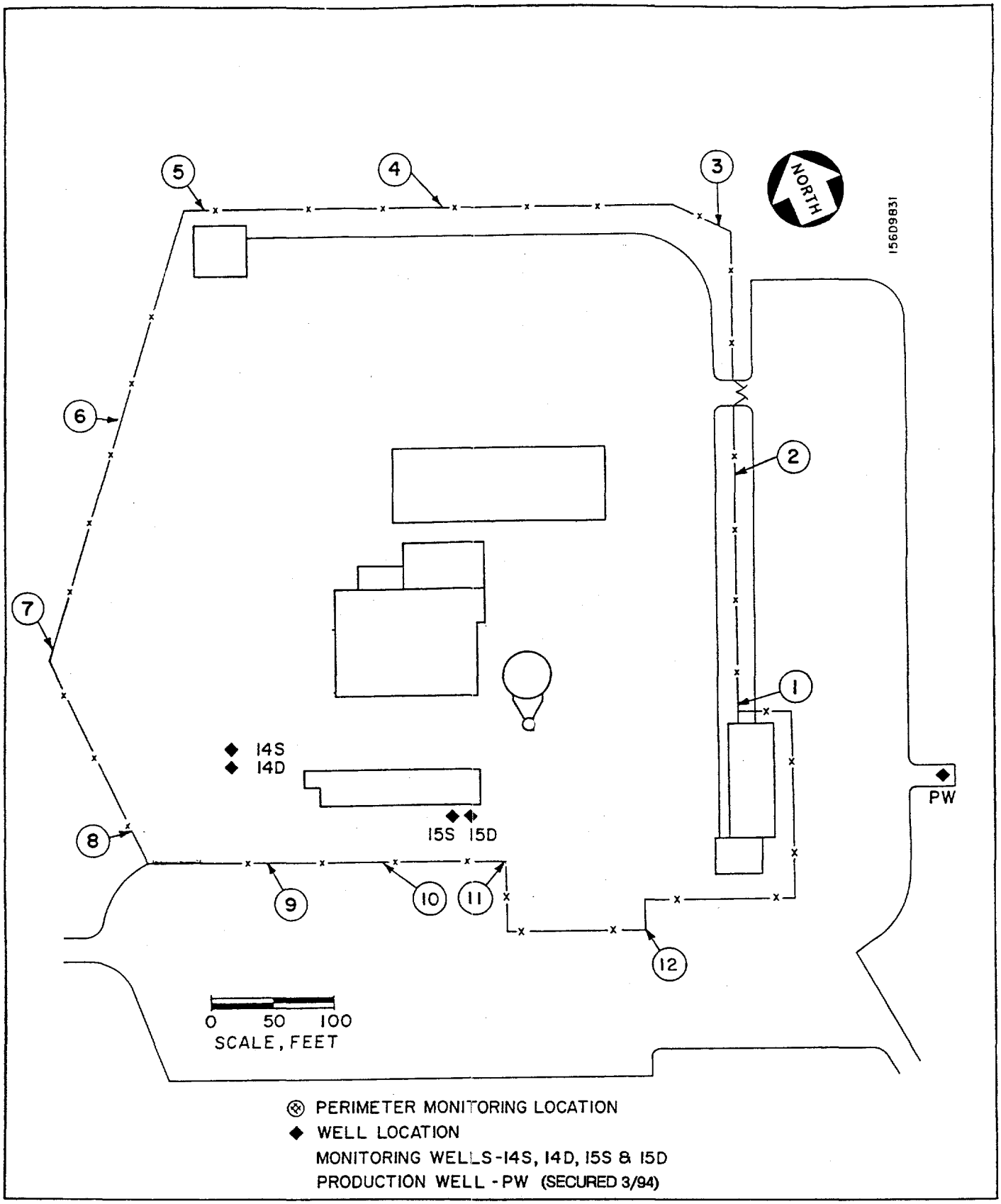
The collective radiation dose to the public along travel routes from S1C Site shipments of radioactive materials during 1997 was calculated using data given by the NRC in Reference (18). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation 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.



S1C Site, Windsor, Connecticut

Farmington River Sampling Locations

Figure 9



S1C Site, Windsor, Connecticut
Perimeter and Groundwater Monitoring Locations
Figure 10

TABLE 35 - RESULTS OF ANALYSES OF FARMINGTON RIVER SEDIMENT, 1997

Sample Location	Number of Samples	Radioactivity Concentration (pCi/g, dry wt.)[1,2] Cobalt-60 Minimum	Cobalt-60 Maximum	Cobalt-60 Average
Upriver from Site Release Location	9	< 0.015	< 0.024	< 0.020
Opposite Site Release Location	9	< 0.018	0.324 ± 0.040	< 0.060
Downriver from Site Release Location	9	<0.014	0.047 ± 0.010	<0.024

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.
(2) Dry weight is based on sample weight with free water removed.

TABLE 36 - RESULTS OF ANALYSES OF FARMINGTON RIVER FISH, 1997

Sample Location	Sample Number	Radioactivity Concentration[1][2] (pCi/g, wet wt.) K-40	Cs-137	Co-60
Upriver from Site Release Location	1	2.09±0.21	<0.008	< 0.008
Downriver from Site Release Location	1	1.69±0.19	0.009±0.010	< 0.007

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.
(2) The values presented are average values of the samples analyzed.

TABLE 37 - PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, S1C SITE, 1997

Perimeter Location [1]	Total Annual Exposure (millirem)[2]
1	81 ± 2
2	78 ± 5
3	64 ± 1
4	74 ± 3
5	69 ± 2
6	75 ± 3
7	76 ± 3
8	76 ± 2
9	71 ± 1
10	76 ± 4
11	71 ± 1
12	68 ± 3
Off-Site locations	75± 7[3]

Notes:
(1) Refer to Figure 10.
(2) The (±) value for individual locations are expressed at the 2 σ confidence level based on the calculated measurement error.
(3) Approximately 95% of natural background radiation measurements are expected to be within this range.

TABLE 38 - S1C SITE GROUNDWATER MONITORING - 1997

Parameter (All Results are mg/l unless noted)	14S	14D	15S	15D
pH (Standard Units)[1]	Q	Q	Q	Q
TDS[2]	Q	Q	Q	Q
Sodium	Q	Q	Q	Q
Nitrate	Q	Q	Q	Q
Sulfate	Q	Q	Q	Q
Cyanide	Q	Q	Q	Q
Chloride	Q	Q	Q	Q
ADA[3]	Q	Q	Q	Q
Vanadium	Q	Q	Q	Q
Conductivity (μmhos/cm)	Q	Q	Q	Q
Manganese	Q	Q	Q	Q
Calcium Hardness	Q	Q	Q	Q
Total Hardness	Q	Q	Q	Q
Manganese	Q	Q	Q	Q
COD[4]	Q	Q	Q	Q
Phosphorus	Q	Q	Q	Q
Iron	Q	Q	Q	Q
Silica Total	Q	Q	Q	Q
TOC[5]	Q	Q	Q	Q
MOA[6]	Q	Q	Q	Q
PA[7]	Q	Q	Q	Q
Temp (°F)[1]	Q	Q	Q	Q
Total Chromium	Q	Q	Q	Q

Notes: Q = Quarterly

(1) Determined in the field.
(2) TDS = Total Dissolved Solids
(3) ADA = Anthraquinone Disulfonic Acid
(4) COD = Chemical Oxygen Demand
(5) TOC = Total Organic Carbon
(6) MOA = Methyl Orange Alkalinity
(7) PA = Phenolphthalein Alkalinity

TABLE 39 - RESULTS OF S1C SITE GROUNDWATER MONITORING WELLS, 1997

		Parameter (all units are mg/l except where noted)[1][7]																					
Well	Sample Date	pH (SU)	[6] TDS	Sodium	(N) Nitrate	Sulfate	Cyanide	Chloride	[6] ADA	Vanadium	Specific Conductivity (μmhos/cm)	Manganese	Ca Hardness	Total Hardness	Magnesium	[6] COD	[6] MOA	[6] PA	Phosphorus	Iron	Total Silica	[6] TOC	Total Chromium	Temp. (°F)
14S	3/18/97	8.10	286	16.1	2.1	5	<0.01	32	<0.001	<0.02	426	<0.01	139	198	15.2	<5	150	ND	0.08	<0.06	42.8	0.8	<0.05	54
	6/3/97	7.40	308	13.4	2.7	29	<0.01	41	<0.001	<0.02	464	<0.01	174	224	15.0	<5	166	ND	<0.02	0.20	27.8	0.7	<0.05	57
	9/17/97	7.50	241	9.5	2.5	20	<0.01	17	<0.001	<0.02	389	<0.01	135	194	13.3	<5	154	ND	0.03	<0.06	17.0	0.7	<0.05	55
	12/17/97	7.60	242	8.4	2.5	20	<0.01	19	<0.001	<0.02	388	<0.01	134	192	14.7	<5	160	ND	0.03	<0.06	15.4	1.0	<0.05	55
14D	3/18/97	8.10	215	10.5	0.86	15	<0.01	33	<0.001	<0.02	340	<0.01	118	172	10.8	9	114	ND	0.30	<0.06	131	0.4	<0.05	54
	6/3/97	8.10	196	10.3	0.82	17	<0.01	33	<0.001	<0.02	356	<0.01	126	182	11.0	<5	116	ND	0.14	<0.06	161	0.5	<0.05	59
	9/17/97	8.00	198	11.3	0.95	24	<0.01	34	<0.001	<0.02	346	<0.01	117	156	10.7	5	108	ND	0.02	<0.06	19	0.3	<0.05	57
	12/17/97	8.10	217	10.4	0.97	18	<0.01	36	<0.001	<0.02	351	<0.01	108	160	12.1	<5	113	ND	0.03	<0.06	11.8	<0.1	<0.05	53
15S	3/18/97	7.90	223	9.8	1.00	<5	<0.01	23	<0.001	<0.02	351	<0.01	127	180	11.6	9	130	ND	0.06	<0.06	135	0.3	<0.05	52
	6/3/97	8.00	224	9.8	0.92	21	<0.01	23	<0.001	<0.02	367	<0.01	128	174	12.0	5	138	ND	<0.02	<0.06	15	0.4	<0.05	59
	9/17/97	7.90	199	10.0	0.95	17	<0.01	24	<0.001	<0.02	355	<0.01	117	178	11.5	<5	136	ND	0.03	<0.06	17	0.4	<0.05	64
	12/17/97	8.10	222	9.1	0.97	17	<0.01	24	<0.001	<0.02	359	<0.01	114	174	12.9	<5	138	ND	0.02	<0.06	12.4	<0.1	<0.05	53
15D	3/18/97	8.00	265	13.8	1.10	16	<0.01	45	<0.001	<0.02	408	<0.01	129	192	12.0	<5	122	ND	0.06	<0.06	77	0.4	<0.05	50
	6/3/97	8.10	265	13.8	1.13	18	<0.01	47	<0.001	<0.02	464	<0.01	136	184	12.0	<5	122	ND	<0.02	0.06	12.8	0.4	<0.05	57
	9/17/97	8.10	255	14.5	1.23	19	<0.01	49	<0.001	<0.02	415	<0.01	133	200	12.7	<5	118	ND	0.03	<0.06	17	0.4	<0.05	59
	12/17/97	7.90	225	14.3	1.31	18	<0.01	49	<0.001	<0.02	416	0.03	130	186	12.9	<5	128	ND	0.03	<0.06	14.2	<0.1	<0.05	52
Standards[2]		5.0-9.0	500[3]	20	10	250	0.2[4]	250	0.1[5]	0.1	–	0.05[3]	–	–	–	–	–	–	–	0.3	–	–	0.05	–

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) State of Connecticut, Department of Health, Standards for Quality of Private Drinking Water Supplies.
(3) USEPA Water Quality Standards.
(4) CT-DEP Action level is any detectable.
(5) Action level established by CT-DEP.
(6) See Table 38 notes for definition.
(7) ND = None Detected

RADIATION DOSE ASSESSMENT AND METHODOLOGY

Measurements for radioactivity in environmental media representing an exposure pathway to man indicated no radioactivity attributable to operations at any of the three sites that comprise the Knolls Atomic Power Laboratory. Therefore, potential doses to the general public from liquid and airborne effluents were too small to be measured and are estimated using conservative calculational techniques based on assumed pathways for releases to return to man.

The exposure pathways via air and water considered for purposes of estimating radiation exposures were:

1. *Air Pathways*

    a. External exposure from airborne radioactivity and radioactivity deposited on the ground.

    b. Ingestion of food products.

    c. Inhalation of airborne radioactivity.

2. *Water Pathways*

    a. Ingestion of water and fish

    b. Ingestion of food products grown on irrigated land.

    c. External exposure from irrigated land.

    d. Boating, swimming and shoreline recreation.

For each KAPL site, calculations were made to estimate: (1) the radiation dose to the maximally exposed individual in the vicinity of the site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the site and (3) the collective dose to the population residing in the assessment area. See Figures 11 and 12 for maps of the 80 kilometer (50 mile) assessment areas surrounding the KAPL sites.

The fundamental equation for calculation of the annual dose from a single radionuclide is:

$$D = XUK$$ where:

D = annual dose

X = the concentration of the radionuclide in the media of the exposure pathway of interest

U = the annual exposure time (hours) or intake (ml or kg) associated with the exposure pathway of interest

K = The annual dose factor for external exposure to a radionuclide or the dose commitment for a 50 year period from the current year's intake of a radionuclide

In estimating potential doses via the water pathway, the contribution from each radionuclide present in the liquid effluents to the effective dose equivalent was calculated using DOE dose conversion factors from References (21) and (22) and the Reference (23) liquid pathway model.

Estimates of potential doses via air pathways were calculated using CAP-88, the EPA approved computer code package provided in Reference (24). The code package was prepared to implement the dose assessment required to demonstrate compliance with Reference (3). It includes the computer code AIRDOS2 and a file of the 50-year committed effective dose equivalent conversion factors calculated by the computer code RADRISK using weighting factors from ICRP-26. AIRDOS2 is an updated version of AIRDOS-EPA that was used previously.

In AIRDOS2 the area surrounding the site is divided into a circular grid defined by 16 pie-shaped segments, which are subdivided into sectors by annular rings out to 80 kilometers (50 miles). The computer code calculates the air concentration and surface deposition in each sector for each radionuclide released from the site using site specific average atmospheric dispersion parameters. Dispersion parameters for each site are based on on-site meteorological data summarized in accordance with Reference (25). Next the radionuclide concentrations in meat, milk and fresh vegetables produced in each sector are estimated using the terrestrial food chain models given in Reference (23). The code then calculates the effective dose equivalent to persons residing in each sector through the following exposure modes: (1) immersion in air containing radionuclides, (2) exposure to radionuclides deposited on ground surfaces, (3) inhalation of radionuclides in air and (4) ingestion of food produced in the sector. The collective (population) effective dose equivalent is obtained by summing the product of the dose and

population for each sector. The population residing within 80 kilometers (50 miles) of each site is based on the 1990 census data as reported in Reference (27).

The calculated doses are summarized in Tables 40 and 41. Inhalation of airborne radioactivity was the calculated principal exposure pathway for the hypothetical maximally exposed individual at the Knolls site. At the Kesselring Site the calculated principal exposure pathway for this hypothetical person was the ingestion of foodstuffs. At the S1C Site, the calculated principal exposure pathway was external exposure to deposition on ground surfaces.

A comparison of the estimated (calculated) radiation dose to the maximum individual from KAPL operations with the average radiation dose received from other sources is shown in Figure 13. Data in Figure 13 show that the maximum radiation dose that may have been received as a result of KAPL operations is much lower than the DOE radiation protection standard and the drinking water and air emission standards established by the EPA, and considerably lower than the average dose received from other sources (natural and man-made) of radiation.

TABLE 40 - ESTIMATED ANNUAL DOSE TO THE MAXIMUM INDIVIDUAL AND AVERAGE MEMBERS OF THE ASSESSMENT AREA POPULATIONS, 1997

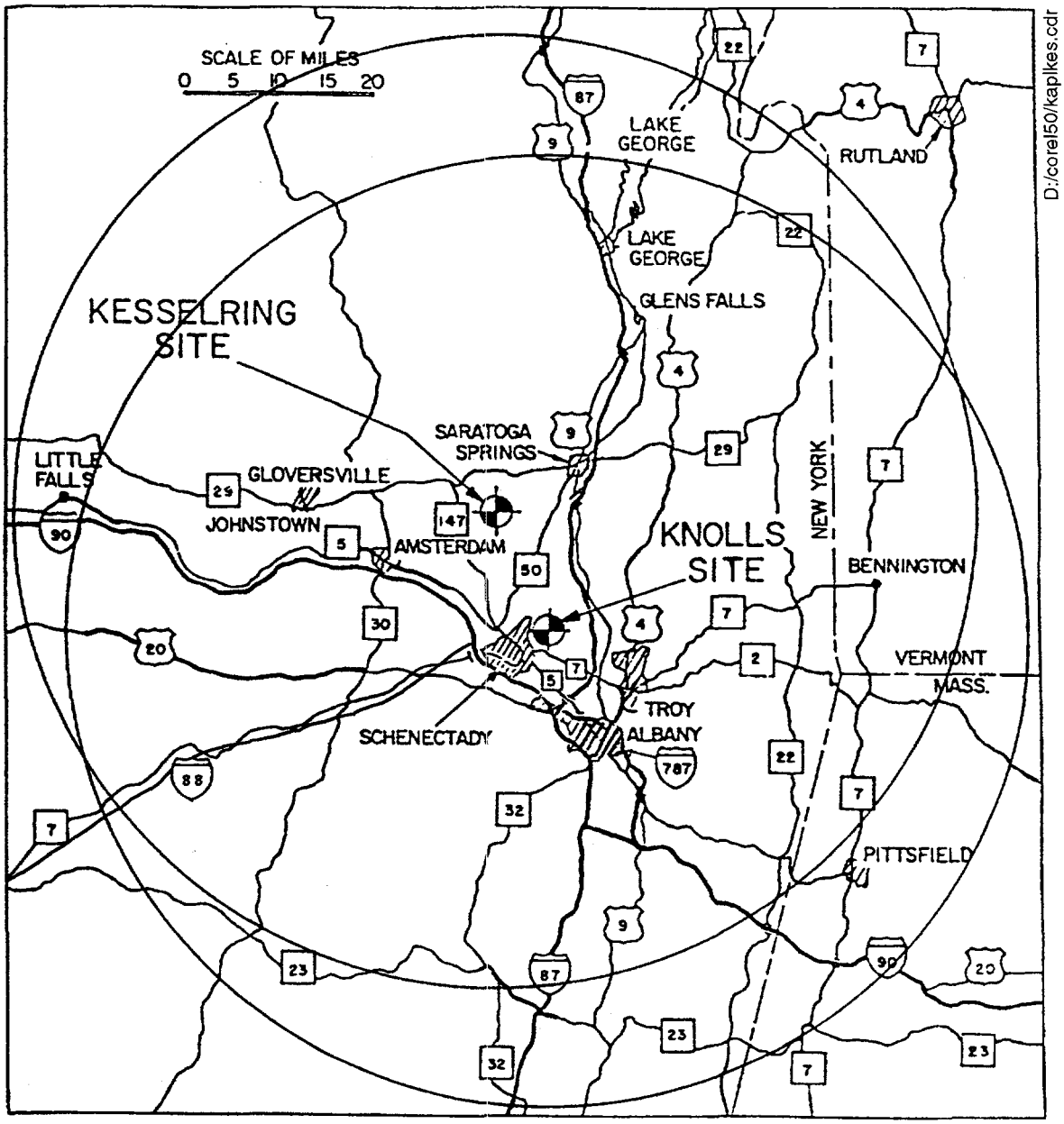
	All Pathways		Air Pathways Only		
KAPL Site	Effective Dose Equivalent Maximum Individual/ Average Member (mrem)	Percent of Standard[1,2]	Effective Dose Equivalent Maximum Individual/ Average Member (mrem)	Percent of Standard[3]	Effective Dose Equivalent From Natural Background Radiation (mrem)[4]
Knolls Site	<0.1/<0.001	<0.1/<0.001	<0.1/<0.001	<1.0/<0.01	72
Kesselring Site	<0.1/<0.001	<0.1/<0.001	<0.1/<0.001	<1.0/<0.01	72
S1C Site	<0.1/<0.001	<0.1/<0.001	<0.1/<0.001	<1.0/<0.01	75

Notes:
(1) Based on the DOE radiation protection standard for individuals in off-site areas of 100 mrem/yr effective dose equivalent as given in Reference (2).
(2) The maximum annual dose to an individual at each site did not exceed 1% of the NRC's guide for demonstrating that radioactive materials in effluents are "as low as is reasonably achievable," given in Reference (4).
(3) Based on the EPA national air emission standard for radionuclide emissions of 10 mrem/yr effective dose equivalent as given in Reference (3).
(4) Dose based on average off-site background radiation level determined for each site with TLDs as reported in prior sections for the respective sites. It does not include the estimated average annual effective dose equivalent of 39 mrem that a member of the population receives from naturally occurring radionuclides in the human body or the 200 mrem received from exposure to radon and its decay products as reported in Reference 32.

TABLE 41 - ESTIMATED ANNUAL COLLECTIVE (POPULATION) DOSES FOR RESIDENTS WITHIN 80 KILOMETERS OF KAPL SITES, 1997

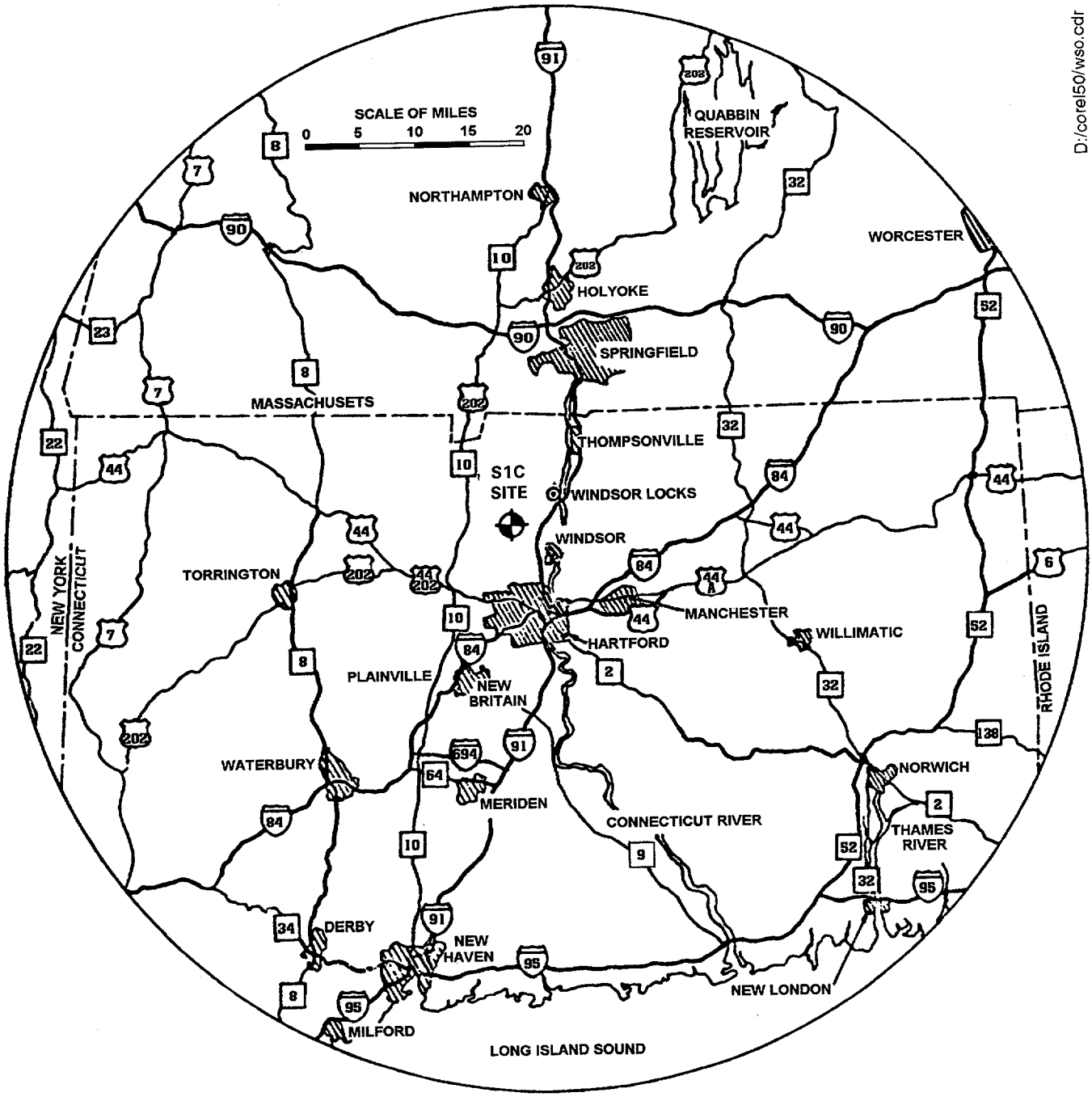
KAPL Site	Population[1] (Millions)	Effective Dose Equivalent From KAPL Operations (Person-Rem)	Effective Dose Equivalent From Natural Background Radiation[2] (Person-Rem)
Knolls Site	1.29	<0.1	93,000
Kesselring Site	1.15	<0.1	83,000
S1C Site	3.43	<0.1	257,000
		<0.3	433,000

Notes:
(1) Total population residing within 80 kilometers (50 miles) of each site based on 1990 census data as reported in Reference (27).
(2) Person-Rem estimate based on average off-site radiation level determined for each site with TLDs as reported in prior sections for the respective sites.



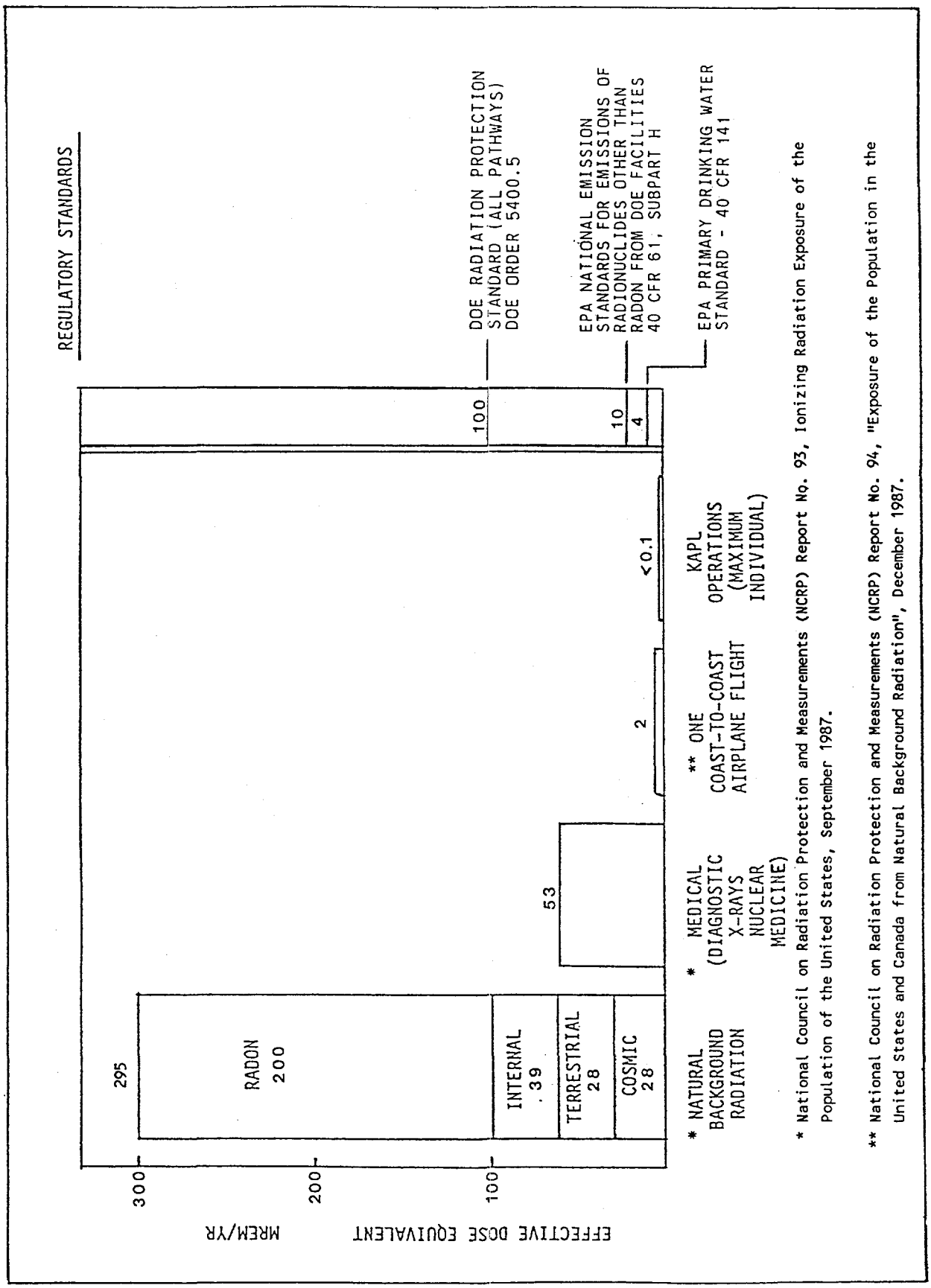
Eighty Kilometer (50 mile) Assessment Area Map for Knolls and Kesselring Sites

Figure 11



Eighty Kilometer (50 mile) Assessment Area Map for S1C Site

Figure 12



Comparison of the Estimated Radiation Dose From KAPL Operations With Doses From Other Sources

Figure 13

QUALITY ASSURANCE PROGRAM

This section contains a description of the KAPL Quality Assurance Program conducted to ensure the accuracy and precision of effluent and environmental sampling, analysis, and reporting. The program is based on the guidance contained in several DOE, EPA, and NRC documents on the subject. (References 28, 29 and 30, respectively)

The program consists of the following elements:

1. Internal quality assurance procedures
    a. Personnel training and qualification
    b. Written procedures for sampling, sample analysis, and computation methods
    c. Calibration of sampling and sample analysis equipment
    d. Internal quality assurance sample analyses
    e. Data review and computation check
2. Participation in interlaboratory quality assurance programs
    a. DOE Environmental Measurements Laboratory Quality Assurance Program
    b. EPA Environmental Monitoring Systems Laboratory Performance Evaluation Studies Program
3. Subcontractor quality assurance procedures
4. Program audits

The internal quality assurance procedures start with the training and qualification of all personnel involved in the collection and analysis of samples, in accordance with established KAPL policies. Personnel are not permitted to perform sampling and sample analysis until they are trained and have demonstrated the ability to properly perform their duties. Written procedures, based on the methods recommended in References (28) and (30), cover collection and analysis of samples, the computation of results, and the calibration of sampling and analytical equipment, as required. Radioactivity counting equipment is, whenever possible, calibrated using standards that are traceable to the National Institute of Standards and Technology. Internal quality assurance procedures also provide for a system of duplicate (or replicate) analyses of the same sample and the analyses of spiked samples to demonstrate precision and accuracy. All measurement data are assessed to detect anomalies, unusual results and trends.

KAPL participates in interlaboratory quality assurance programs, conducted by the DOE Environmental Measurements Laboratory and the EPA Environmental Sciences Division. This provides an independent verification of the accuracy and precision of KAPL analyses of effluent and environmental monitoring samples. The results of KAPL participation in the DOE and EPA quality assurance programs are summarized in Tables 42 and 43, respectively. The data demonstrate satisfactory KAPL performance.

Nonradioactive effluent and environmental sample analyses are performed by vendor subcontractor laboratories. KAPL maintains a quality assurance program to ensure the accuracy and precision of the subcontractor analytical results. This includes submitting known standards, blanks and replicate samples along with routine samples for analysis. If unsatisfactory results are obtained, follow-up investigations are performed to correct the problems. KAPL also requires that vendor laboratories performing analyses for the Knolls and Kesselring Sites be certified by the New York State Department of Health under the Environmental Laboratory Approval Program (ELAP) and that vendor laboratories performing effluent and environmental analyses for the S1C Site be certified by Connecticut Department of Health Services.

Periodic audits are conducted that examine all phases of the effluent and environmental monitoring programs to ensure compliance with all KAPL procedures and applicable state and federal regulations.

TABLE 42 - KAPL PERFORMANCE IN DOE ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM, 1997

Sample Date[1]	Sample Type	Analysis	KAPL Result[2]	EML Result[2][3]	Reported/ EML	Control Limit[4]
3/97	Soil	Potassium-40	10.2 ± 1.6	9.0	1.13	0.73 - 1.67
		Cobalt-60	0.0351 ± 0.0054	0.0286	1.23	0.80 - 2.00
		Strontium-90	1.21 ± 0.06	1.09	1.11	0.46 - 2.84
		Cesium-137	27.0 ± 2.2	22.3	1.21	0.80 - 1.34
		Plutonium-239	4.04 ± 0.08	3.65	1.11	0.66 - 1.93
3/97	Water	Tritium	9.46 ± 0.92	6.76	1.40	0.62 - 1.80
		Manganese-54	0.568 ± 0.081	0.564	1.01	0.80 - 1.22
		Iron-55	6.46 ± 0.32	6.35	1.02	0.32 - 1.52
		Cobalt-60	2.59 ± 0.11	2.46	1.06	0.80 - 1.18
		Strontium-90	0.616 ± 0.038	0.627	0.98	0.71 - 1.65
		Cesium-137	2.08 ± 0.27	1.89	1.10	0.80 - 1.27
		Plutonium-238	0.0377 ± 0.0027	0.0349	1.08	0.73 - 1.27
		Plutonium-239	0.0241 ± 0.0003	0.0230	1.05	0.78 - 1.41
		Uranium-total	0.048 ± 0.001	0.044	1.08	0.73 - 1.34
		Gross Alpha	34.9 ± 5.4	30.5	1.14	0.37 - 1.27
		Gross Beta	15.5 ± 2.2	20.1	0.76	0.55 - 1.63
3/97	Air Filter	Gross Alpha	28.1 ± 1.6	25.9	1.08	0.45 - 1.57
		Gross Beta	14.9 ± 1.1	12.2	1.22	0.50 - 1.77
9/97	Soil	Potassium-40	8.32 ± 2.60	8.51	0.97	0.73 - 1.67
		Cobalt-60	0.0351 ± 0.0081	0.0405	0.86	0.80 - 2.00
		Strontium-90	1.08 ± 0.10	0.939	1.15	0.46 - 2.84
		Cesium-137	23.0 ± 5.1	21.9	1.05	0.80 - 1.34
		Plutonium-239	0.319 ± 0.034	0.275	1.16	0.66 - 1.93
9/97	Water	Tritium	3.46 ± 0.70	3.11	1.11	0.62 - 1.80
		Manganese-54	1.03 ± 0.19	1.02	1.00	0.80 - 1.22
		Iron-55	3.30 ± 0.24	3.11	1.06	0.32 - 1.52
		Cobalt-60	0.621 ± 0.081	0.630	0.98	0.80 - 1.18
		Strontium-90	0.0768 ± 0.0162	0.0794	0.96	0.71 - 1.65
		Cesium-137	0.946 ± 0.081	0.927	1.02	0.80 - 1.27
		Plutonium-239	0.0230 ± 0.0005	0.0203	1.14	0.78 - 1.41
		Uranium-total	0.020 ± 0.001	0.020	1.04	0.73 - 1.34
		Gross Alpha	18.9 ±2.4	15.1	1.25	0.37 - 1.50
		Gross Beta	25.1 ± 1.8	19.2	1.30	0.50 - 1.63
9/97	Air Filter	Gross Alpha	50.8 ± 3.8	40.3	1.26	0.45 - 1.57
		Gross Beta	93.5 ± 3.8	81.1	1.15	0.50 - 1.77

Notes:
(1) The sample date is assigned by EML.
(2) The results are expressed in pCi/ml of water, or pCi/g of soil, except for uranium where the units are μg/ml and for air filters where the units are pCi/filter.
(3) The expected result is that reported by EML.
(4) The control limit range is provided by EML and is based on the reported result divided by the EML expected result.

TABLE 43 - KAPL PERFORMANCE IN EPA ENVIRONMENTAL SCIENCES DIVISION PERFORMANCE EVALUATION STUDIES, 1997

Sample Date[1]	Sample Type	Analysis	KAPL Result[2]	EMSL Result[2][3]	Normalized Deviation[4]
03/07/97	Water	Tritium	7709 ± 146	7900	-0.4
08/08/97	Water	Tritium	14405 ± 200	11010	5.3[5]
01/31/97	Water	Gross Alpha	4.9 ± 0.1	5.2	-0.1
		Gross Beta	14.9 ± 0.9	14.7	0.1
07/18/97	Water	Gross Alpha	3.6 ± 0.2	3.1	0.2
		Gross Beta	14.6 ± 0.6	15.1	-0.2
10/31/97	Water	Gross Alpha	12.5 ± 1.0	14.7	-0.8
		Gross Beta	48.3 ± 3.5	48.9	-0.2
06/06/97	Water	Cobalt-60	18.3 ± 0.6	18.0	0.1
		Zinc-65	96.0 ± 2.0	100.0	-0.7
		Barium-133	22.3 ± 0.6	25.0	-0.9
		Cesium-134	21.0 ± 0.0	22.0	-0.4
		Cesium-137	51.0 ± 1.0	49.0	0.7
11/07/97	Water	Cobalt-60	27.0 ± 0.0	27.0	0.0
		Zinc-65	73.0 ± 1.7	75.0	-0.4
		Barium-133	89.3 ± 0.6	99.0	-1.7
		Cesium-134	9.3 ± 0.6	10.0	-0.2
		Cesium-137	76.3 ± 1.5	74.0	0.8

Notes:

(1) The sample date is assigned by EMSL.

(2) The results are expressed in pCi/liter for water samples and pCi/filter for air sample filters.

(3) The expected result is that reported by EMSL.

(4) The normalized deviation from the EMSL known value is as reported by EMSL for each sample. The control limit is ±3.0.

(5) *The sample result was high due to the use of a degraded tritium counting standard. The tritium standard was replaced.*

TABLE 44 - ENVIRONMENTAL PERMITS

Permit Number	Permit Type	Issuing Agency	In Compliance	Expiration Date[16]	Other Information
KNOLLS SITE					
NY0005851	SPDES[1]	NYSDEC[2]	Yes	1/1/00	Site Outfalls
NY6890008992	RCRA[3]	NYSDEC	Yes	(4)	RCRA waste
EP-00001	AE[5]	NYSDEC	Yes	10/17/00[6]	Heating boiler
EP-00002	AE	NYSDEC	Yes	11/02/00[6]	Heating boiler
EP-00003	AE	NYSDEC	Yes	11/02/00[6]	Heating boiler
EP-00004	AE	NYSDEC	Yes	11/02/00[6]	Heating boiler
EP-00030	AE	NYSDEC	Yes	8/18/00[6]	Water Heater Exhaust
EP-00031	AE	NYSDEC	Yes	2/28/02[6]	VIM/GA[14]
443417	PBSF[7]	NYSDEC	Yes	8/23/98	Oil Storage
4-000020	BCSF[8]	NYSDEC	Yes	3/10/99	Freon-114 storage
(15)	PCB	EPA Region II	Yes	7/31/01	PCB Paint Removal
KESSELRING SITE					
NY 0005843	SPDES[1]	NYSDEC[2]	Yes	9/1/98	Site Outfalls
NY5890008993	RCRA[3]	NYSDEC	Yes	5/31/05	Hazardous waste
05A01	AE	NYSDEC	Yes	11/1/00[6]	Spray paint booth
GRB01	AE	NYSDEC	Yes	11/1/00[6]	Grit Blasting
BH002	AE	NYSDEC	Yes	11/1/00[6]	Heating Boiler
BH004	AE	NYSDEC	Yes	11/1/00[6]	Heating Boiler
5-000070	BCSF	NYSDEC	Yes	7/19/99	Chemical Storage
5-414506	PBSF	NYSDEC	Yes	8/17/02	Oil Storage
(15)	PCB	EPA Region II	Yes	7/31/01	PCB Paint Removal
BPB01	AE	NYSDEC	Yes	(16)	Paint Spray
BH003	AE	NYSDEC	Yes	(17)	Heating Boiler
S1C SITE					
HWM 164-021	RCRA [13]	CT-DEP[10]	Yes	6/7/01	RCRA waste EPA-ID CT 6890113792
CT GSW000407	SW[12]	CT-DEP	Yes	10/1/02	Stormwater Discharge
(9)	PCB[9]	EPA Region I	Yes[11]	08/31/01	PCB Paint Removal

Notes:

(1) State Pollutant Discharge Elimination System
(2) New York State Department of Environmental Conservation
(3) Resource Conservation and Recovery Act.
(4) Interim Status (Interim permission to operate authorized by cognizant agency.) The permit number listed is the EPA identification number.
(5) Air Emission
(6) Extended indefinitely in accordance with 6 NYCRR Part 201-4.3
(7) Petroleum Bulk Storage Facility
(8) Bulk Chemical Storage Facility
(9) EPA Region I approval to remove and dispose of PCB contaminated materials, dated 8/8/96.
(10) State of Connecticut, Department of Environmental Protection
(11) Non-conforming practices identified and satisfactorily explained in reports issued in accordance with the permit requirements.
(12) Stormwater permit modified 10/30/95 to incorporate stormwater runoff previously included in NPDES permit.
(13) S1C Site RCRA "Part B" authorization renewal effective 6/7/96.
(14) Vacuum induction melting / gas atomization system.
(15) EPA Region II approval to remove and dispose of PCB contaminated materials, dated 8/5/96.
(16) Permit surrendered 12/3/97.
(17) Permit surrendered 9/2/97.

APPENDIX
RADIATION AND RADIOACTIVITY - GENERAL INFORMATION

This section provides general information on radiation and radioactivity for those who may not be familiar with the terms and concepts.

Man has always lived in a sea of natural background radiation. This background radiation was and is as much a part of the earth's environment as the light and heat from the sun's rays. There are three principal sources of natural background radiation: cosmic radiation from the sun and outer space, radiation from the natural radioactivity in soil and rocks (called 'terrestrial radiation'), and internal radiation from the naturally radioactive elements that are part of our bodies. A basic knowledge of the concepts of radiation and radioactivity is important in understanding how effective control programs are in reducing radiation exposures and radioactivity releases to levels that are as low as is reasonably achievable.

RADIATION

In simple terms, radiation is a form of energy. Microwaves, radio waves, x-rays, light, and heat are all common forms of radiation. The radiation from radioactive materials (radionuclides) is in the form of particles or rays. During the decay of radionuclides, alpha, beta and gamma radiation are emitted.

Alpha radiation consists of small, positively charged particles of low penetrating power that can be stopped by a sheet of paper. Radionuclides that emit alpha particles include radium, uranium, and thorium.

Beta radiation consists of negatively charged particles that are smaller than alpha particles but are generally more penetrating and may require up to an inch of wood or other light material to be stopped. Examples of beta emitters are strontium-90, cesium-137, and cobalt-60.

Gamma radiation is an energy emission like an x-ray. Gamma rays have great penetrating power but are stopped by up to several feet of concrete or several inches of lead. The actual thickness of a particular shielding material required depends on the quantity and energy of the gamma rays to be stopped. Most radionuclides emit gamma rays along with beta or alpha particles.

Each radionuclide emits a unique combination of radiations that is like a "finger print" of that radionuclide. Alpha or beta particles and/or gamma rays are emitted in various combinations and energies. Radionuclides may be identified by measuring the type, relative amounts, and energy of the radiations emitted. Measurement of half-life and chemical properties may also be used to help identify radionuclides.

Radiation Dose Assessment

Body tissue can be damaged if enough energy from radiation is absorbed. The amount of energy absorbed by body tissue during radiation exposure is called "absorbed dose". The potential biological effect resulting from a particular dose is based on a technically defined quantity called "dose equivalent." The unit of dose equivalent is called the rem. Another quantity called "effective dose equivalent" is a dose summation that is used to estimate health-effects risk when the dose is received from sources that are external to the body and from radioactive materials that are within the various body tissues. The unit of effective dose equivalent is also the rem. As will be seen from the following discussion, the rem unit is relatively large compared with the level of doses received from natural background radiation or projected as a result of releases of radioactivity to the environment. The millirem (mrem), which is one thousandth of a rem, is frequently used instead of the rem. The rem and mrem are better understood by relating to concepts that are more familiar.

Radiation comes from both natural and man-made sources. Natural background radiation includes cosmic radiation from the sun and outer-space, terrestrial radiation from radioactivity in soil, radioactivity in the body and inhaled radioactivity.

The National Council on Radiation Protection and Measurements estimates that the average member of the population of the United States

receives an annual effective dose equivalent of approximately 300 mrem from natural background radiation. This is composed of approximately 28 mrem from cosmic radiation, 28 mrem from terrestrial radiation, 39 mrem from radioactivity within the body and 200 mrem from inhaled radon and its decay products. The cosmic radiation component varies from 26 mrem at sea level to 50 mrem in Denver (at 1600 meters). The terrestrial component varies from 16 mrem on the Atlantic and Gulf coastal plain to 63 mrem in the Rockies. The dose from inhaled radon and its decay products is the most variable.

The average natural background radiation level measured in the vicinity of the KAPL sites is approximately 70 mrem per year. Individual locations will vary based on soil composition, soil moisture content and snow cover.

In addition to natural background radiation, people are also exposed to man-made sources of radiation, such as medical and dental x-rays. The average radiation dose from these sources is about 53 mrem per year. Other man-made sources include consumer products, such as color television sets. An individual's radiation exposure from color television averages 0.3 mrem per year. An airplane trip results in increased radiation exposure. A round-trip flight between Los Angeles and New York results in a dose of about 5 mrem.

RADIOACTIVITY

All materials are made up of atoms. In the case of a radioactive material, these atoms are unstable and give off energy in the form of rays or tiny particles in order to reach a stable state. Each type of radioactive atom is called a radionuclide. Each radionuclide emits a characteristic form of radiation as it gives off energy. Radionuclides change as radiation occurs, and this transition is called radioactive decay. The rate at which a particular radionuclide decays is measured by its half-life. Half-life is the time required for one-half the radioactive atoms in a given amount of material to decay. For example, the half-life of the man-made radionuclide cobalt-60 is 5.3 years. This means that during a 5.3-year period, half of the cobalt-60 atoms initially present will have decayed. In the next 5.3 year period, half the remaining cobalt-60 atoms will have decayed, and so on.

The half-lives of radionuclides differ greatly. The half-life of naturally occurring radon-220, for instance, is only 55 seconds. In contrast, uranium-238, another naturally occurring radionuclide has a half life of 4.5 billion years.

Through the decay process, each radionuclide changes into a different nuclide or atom - often becoming a different chemical element. For example, naturally occurring radioactive thorium-232, after emitting its radiation, transforms to a second radionuclide, which transforms to a third, and so on. Thus, a chain of eleven radionuclides is formed including radon-220, before nonradioactive lead-208 is formed. Each of the radionuclides in the series has its own characteristic half-life and type of radiation. The chain finally ends when the newest nuclide is not radioactive. The uranium chain starts with uranium-238 and proceeds through 13 radionuclides, ending with stable lead-206. All of these naturally occurring radionuclides are present in trace amounts in the soil in your backyard as well as in many other environmental media.

Measuring Radioactivity

The curie (Ci) is the common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to work with conveniently and is broken down into smaller values such as the microcurie (μCi), which is one millionth of a curie (10^{-6} curie) and the pico-curie (pCi), which is one trillionth of a curie (10^{-12} curie). The typical radium dial wrist watch has about one microcurie (μCi) of radium on the dial. The average person has about one tenth (0.1) microcurie of naturally occurring potassium-40 in his body. Typical soil and sediment samples contain about one pico-curie of natural uranium per gram.

Sources of Radioactivity

Of the radioactive atoms that exist in nature, some have always existed and others are continually formed by natural processes. For example, uranium has always existed, is radioactive, and occurs in small but variable concentrations throughout the earth. Radioactive carbon and tritium, on the other hand, are formed by cosmic radiation striking atoms in the atmosphere. Radionuclides can also be created by man. For example, they are created in nuclear reactors and consist of fission products and activation products. The fission products are the residue of the uranium fission process that produces the energy

within the reactor. The fission process also produces neutrons that interact with structural and other materials in the reactor to form activation products. Because of the nature of the fission process, many fission products are unstable and, hence, radioactive. Most fission products have short lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of "background" fission-product radioactivity also exists in the environment, primarily due to atmospheric nuclear weapons testing. Although the level is very low, these fission products are routinely detected in air, food and water when analyzed with extremely sensitive instruments and techniques.

CONTROL OF RADIATION AND RADIOACTIVITY

To reduce to as low as is reasonably achievable the exposure of persons to ionizing radiation, controls on the use and disposal of radioactive materials and comprehensive monitoring programs to measure the effectiveness of these controls are required. Effluent streams that may contain radioactive materials must be treated by appropriate methods to remove the radioactive materials and the effluent monitored to ensure that these materials have been reduced to concentrations that are as low as is reasonably achievable and are well within all applicable guidelines and requirements.

GLOSSARY

Activation Products - As cooling water circulates through the reactor, certain impurities present in the water and even components of the water itself can be converted to radioactive nuclides (they become "activated"). Important activation products present in reactor coolant water include radionuclides of corrosion and wear products (cobalt-60, iron-59, cobalt-58, chromium-51), of impurities dissolved in the water (argon-41, sodium-24, carbon-14) and of atoms present in the water molecules (tritium). Of these, the predominant radionuclide and also the one with the most restrictive limits is cobalt-60.

Alpha Radioactivity - A form of radioactivity exhibited by certain radionuclides characterized by emission of an alpha particle. Many naturally occurring radionuclides including radium, uranium and thorium decay in this manner.

Benthic Macroinvertebrates - Small organisms inhabiting the bottom of lakes and streams or attached to stones or other submersed objects. The study of macroinvertebrate communities gives an indication of the overall quality of the body of water from which they are taken.

Beta-Gamma Radioactivity - A form of radioactivity characterized by emission of a beta particle and/or gamma rays. Many naturally occurring radionuclides such as lead-212, bismuth-212 and bismuth-214 decay in this manner.

Biochemical Oxygen Demand (BOD) - The BOD test is used to measure the content of organic material in both wastewater and natural waters. BOD is an important parameter for stream and industrial waste studies and control of waste treatment plants because it measures the amount of oxygen consumed in the biological process of breaking down organic materials in the water.

Birge-Ekman Dredge - A device used for sampling the bottom sediment in rivers, streams, lakes, etc. The Birge-Ekman dredge is lowered to the bottom on a line and its spring-loaded "jaws" are remotely tripped from the surface. It samples an area of approximately 230 cm^2 to an average depth of 2.5 cm.

BTU (British Thermal Unit) - A unit commonly used to quantify the heat output of boilers, furnaces, etc. Specifically, the amount of heat necessary to raise 1 lb. of water one degree Fahrenheit.

Chain Electro-Fishing Techniques - A technique of collecting samples of fish from a body of water whereby the fish are stunned with an electric current, categorized, and returned to the water unharmed.

Collective Dose Equivalent and Collective Effective Dose Equivalent* - Are the sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 80-km radius, for the purposes of this Order, and they are expressed in units of person-rem.

Committed Dose Equivalent* - Is the predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem.

Committed Effective Dose Equivalent* - Is the sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem.

Confidence Interval - Statistical terminology for the error interval (±) assigned to numerical data. A 2σ (σ, the lower case Greek letter "Sigma") confidence interval means there is 95% confidence that the true value (as opposed to the measured one) lies within the (±) interval. The 95% is the confidence level. (See (±) value, Standard Deviation of the Average.)

*Note: Definitions are from DOE 5400.5.

Corrosion and Wear Products - Piping and components used in construction of a nuclear reactor are fabricated from extremely durable, corrosion and wear resistant materials. Even under the best circumstances, however, small amounts of these materials enter the reactor cooling water due to wear of moving parts and corrosion of the water contact surfaces of reactor plant components. While in no way affecting operational characteristics or reactor plant integrity, some of these corrosion and wear products may become activated as they pass through the reactor core. This necessitates that the reactor coolant be processed by filtration or other methods of purification before it is discharged or reused. (See Activation Products).

Curie (Ci) - The curie is the common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to conveniently work with and is broken down to smaller values. (See Microcurie and Picocurie.)

Dendy Multiple Plate Samplers - A device for collecting bottom dwelling organisms (mostly larvae) by providing an artificial substrate on which these organisms can colonize.

Derived Concentration Guide (DCG) - is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem (0.1 rem).

Dose Equivalent - The quantity that expresses the biological effects of radiation doses from all types (alpha, beta-gamma) of radiation on a common scale. The unit of dose equivalent is the rem.

Ecosystem - The integrated, interdependent system of plant and animal life existing in an environmental framework. Understanding of an entire ecosystem is important because changes or damage to one component of the system may have effects on others.

Effective Dose Equivalent - The effective dose equivalent is the sum of the dose equivalent to the whole body from external sources plus the dose equivalents to specific organs times a weighting factor appropriate for each organ. The weighting factor relates the effect of individual organ exposure relative to the effect of exposure to the whole body. The unit of effective dose equivalent is the rem.

Eh - A measure of the oxidation-reduction potential of water expressed in units of millivolts. The oxidation-reduction potential affects the behavior of many chemical constituents present in water in the environment.

Fission Products - During operation of a nuclear reactor, heat is produced by the fission (splitting) of "heavy" atoms, such as uranium, plutonium or thorium. The residue left after the splitting of these "heavy" atoms is a series of intermediate weight atoms generally termed "fission products." Because of the nature of the fission process, many fission products are unstable and, hence, radioactive. Most fission products have short lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of "background" fission product radioactivity exists in the environment, primarily due to atmospheric nuclear weapons testing. The level is very low, but may be detectable when environmental samples are analyzed with extremely sensitive instruments and techniques such as those used by the Knolls Atomic Power Laboratory.

Half Life - A value assigned to a radionuclide that specifies how long it takes for one half of a given quantity of radioactivity to decay away. Half lives may range from fractions of a second to millions of years.

High Purity Germanium Gamma Spectrometer System - A High Purity Germanium gamma spectrometer system is a sophisticated set of components designed for characterizing and quantifying the radionuclides present in a sample. This system makes use of the fact that during the decay of most radionuclides, one or more gamma rays are emitted at energy levels characteristic of the individual radionuclide. For example, during the decay of cobalt-60, two gamma rays of 1.17 and 1.33 million electron volts (MeV) are emitted while the decay of argon-41 produces one gamma ray of 1.29 MeV. The high purity germanium detector used in this system is capable of detecting and very precisely resolving differences in gamma ray energy

levels and sending this information along to electronic components where it is processed and evaluated.

Long-Lived Gamma Radioactivity - Two very important characteristics of radionuclides are the length of time it takes for a given amount to decay away and the type of radiation emitted during decay. From an environmental standpoint, some of the most significant radionuclides are those whose "life" is relatively long and that also emit penetrating gamma radiation during decay. Two radionuclides of concern in these respects are cobalt-60 (a corrosion and wear activation product) and cesium-137 (a fission product). (See Half-Life, Beta-Gamma Radioactivity.)

mg/l (Milligrams per liter) - A unit of concentration commonly used to express the levels of impurities present in a water sample. A milligram is a thousandth of a gram. A milligram per liter is equal to a part per million.

Microcurie (μCi) - One millionth of a curie (10^{-6} curie). The typical radium dial watch might contain 1μCi of radioactive material. (See Curie and Pico-curie.)

Millirem (mrem) - One thousandth of a rem (10^{-3} rem).

Minimum Detectable Concentration (MDC) - For an observed value equal to the MDC there is 95% confidence that the true concentration is greater than zero; i.e., there is really something there. Analytical techniques and sampling and instrumentation errors all effect the MDC. (See (±) Value, Confidence Interval.)

Parshall Flume Outfall - A specially constructed channel designed such that discharge water flow rate can be accurately measured. The Parshall Flume may also be instrumented to record the total volume of flow over long periods of time.

Pasquill Stability Class - A classification that defines the relative stability and dispersive capability of the atmosphere. Classification is highly dependent upon the change in temperature with height.

PCBs - Also known as polychlorinated biphenyls, are halogenated aromatic hydrocarbons formed by the chlorination of biphenyl molecules. PCB's were commonly used in transformers as a dielectric fluid because of their stability.

Periphyton - Communities of microorganisms growing on stones, sticks and other submerged surfaces. The quantities and types of periphyton present are very useful in assessing the effects of pollutants on lakes and streams.

Person-Rem - The sum of the individual dose equivalents or effective dose equivalents received by each member of a certain group or population. It is calculated by multiplying the average dose per person by the number of persons within a specific geographic area. For example, a thousand people each exposed to 0.001 rem would have a collective dose of one person-rem.

pH - A measure of the acidity or alkalinity of a solution on a scale of 0 to 14 (low is acidic, high is alkaline or caustic, 7 is neutral.

Pico-curie (pCi) - One trillionth of a curie (10^{-12} curie). Typical soil and sediment samples contain approximately one pCi of natural uranium per gram. (See Curie and Millicurie.)

± Value (plus or minus value) - The (±) value is an expression of the error in sample results. The magnitude of the (±) value depends on the number of samples, the size of the sample, intrinsic analytical errors and the degree of confidence required. The (±) value assigned to data in this report is for the 95% confidence level. (See Confidence Interval.)

Priority Pollutant - This term refers to the list of chemicals in Tables II and III, 40 CFR 122, Appendix D. The EPA requires that discharges from facilities be evaluated for these chemicals.

Radionuclides - Atoms that exhibit radioactive properties. Standard practice for naming radionuclides is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt). There are several hundred known radionuclides, some of which are man-made and some of which are naturally occurring. Radionuclides can be differentiated by the types of radiation

they emit, the energy of the radiation and the rate at which a known amount of the radionuclide decays away. (See Half Life.)

Rem - The unit of dose equivalent and effective dose equivalent.

RCRA (Resource Conservation and Recovery Act) - A Federal law that established a structure to track and regulate hazardous wastes from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites.

Settleable Solids - A measurement of the amount of solids that will settle out of a sample of water in a certain interval of time. This parameter commonly applies to water being processed in sewage treatment plants and is used to control the operation and evaluate the performance of these plants.

Short-Lived Gamma Radioactivity - Radioactive material of relatively short life that decays with the emission of gamma rays. It is generally not important with respect to environmental discharges because of the short life span. Some examples of short-lived gamma emitting radionuclides are argon-41 (an activation product gas), krypton-88 (a fission product gas), and xenon-138 (a fission product gas).

Spiked Sample - A sample to which a known quantity of the material that is being analyzed for has been added for quality assurance testing.

Standard Deviation of the Average - A term used to characterize the error assigned to the mean of a set of analyzed data. (See Confidence Interval, (±) Value).

Suspended Solids - Particulate matter, both organic and inorganic suspended in water. High levels of suspended solids not only affect the aesthetic quality of water by reducing clarity, but may also indirectly indicate other undesirable conditions present. The analysis for suspended solids is performed by passing a sample of water through a filter and weighing the residue.

Surber Bottom Sampler - A device for collecting samples of benthic macroinvertebrates from the bottom of relatively shallow, fast moving streams.

Thermoluminescent Dosimeters (TLDs) - TLDs are sensitive monitoring devices that record accumulated dose due to radiation. The TLDs used by the Knolls Atomic Power Laboratory for environmental monitoring consist of small chips of calcium fluoride (CaF_2) or lithium fluoride (LiF) encased in appropriate materials and strategically located at site perimeter and off-site locations. Thermoluminescent Dosimeters derive their name from a property that CaF_2 and LiF crystals exhibit when exposed to radiation and subsequently heated-that of emitting light proportional to the amount of radiation exposure received (thermoluminescence). The emitted light can then be read out on special instrumentation and correlated to the amount of radiation dose accumulated. The TLDs used by the Knolls Atomic Power Laboratory for environmental monitoring are specially selected for their accuracy and consistency of results.

Volatile Organic Compound (VOC) - An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

Weight Percent - A term commonly used to describe the amount of a substance in a material. For example, oil containing 0.5 lb. sulfur per 100 lb. oil would contain 0.5 percent by weight sulfur.

Weighting Factor - Is tissue-specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue.

REFERENCES

1. U.S. DOE Order 5400.1, *General Environmental Protection Program.*

2. U.S. DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

3. Title 40, Code of Federal Regulations, Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy (DOE) Facilities.*

4. Title 10, Code of Federal Regulations, Part 50, Appendix I - *Numerical Guide for Design Objectives and Limiting Conditions for Operation to meet the criteria "As Low As Is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents.*

5. Title 40, Code of Federal Regulations, Parts 141 and 143, *National Primary and Secondary Drinking Water Regulations.*

6. New York State Department of Environmental Conservation, Authorization to Discharge under the State Pollutant Discharge Elimination System, Permit No. NY 0005851.

7. New York State Department of Environmental Conservation, Authorization to Discharge under the State Pollutant Discharge Elimination System, Permit No. N.Y. 0005843.

8. New York State Department of Environmental Conservation, *Water Quality Regulations for Surface Waters and Groundwaters*, 6 NYCRR, Parts 700-705.

9. New York State Department of Environmental Conservation, *Air Resources*, NYCRR Title 6 Chapter III

10. New York State Department of Environmental Conservation, *Stationary Combustion Installations*, 6 NYCRR, Part 227.

11. New York State Department of Environmental Conservation, *Collection and Transport of Industrial, Commercial and Certain other Wastes*, Title 6 NYCRR, Part 364.

12. New York State Department of Environmental Conservation, *Hazardous Waste Regulation*, 6 NYCRR, Parts 370, 371, 372, 373-1 and 373-3.

13. Regulation of Connecticut State Agencies. Chapter 22a-449(c), Sections 1-48, 100-110 and 22a-449 (c)-11, *Hazardous Waste Management.*

14. Title 49, Code of Federal Regulations, Parts 171-175 and 177-178, *Transportation of Hazardous Materials.*

15. Title 40, Code of Federal Regulations, Parts 260-271, *Hazardous Waste Management.*

16. *Standard Methods for the Examination of Water and Wastewater*, 19th Edition, American Public Health Association. 1995.

17. New York State Department of Environmental Conservation, *Solid Waste Management Facilities*, 6 NYCRR Part 360.

18. NUREG 0170, *Final Environmental Statement of the Transportation of Material by Air and Other Modes.* U.S. Nuclear Regulatory Commission. Vol. 1, December 1977.

REFERENCES (Con't)

19. New York State Department of Health, *Drinking Water Supplies*, Title 10, NYCRR, Part 5.

20. New York State Department of Environmental Conservation, *Division of Water Technical and Operational Guidance Series (1.1.1) Water Quality Standards and Guidance Values*, October 1993.

21. DOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public*, July 1988.

22. DOE/EH-0071, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, July 1988.

23. Nuclear Regulatory Guide 1.109, *Calculation of Annual Doses of Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I.* Rev. 1, October 1977.

24. CCC-542, Clean Air Act Assessment Package - 1988 (CAP-88), *A Dose and Risk Assessment Methodology for Radionuclide Emissions to Air*, ORNL, Reactor Shielding Information Center.

25. EPA-450/4-87-013, *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*, June 1987.

26. *Knolls Atomic Power Laboratory Existing Landfill Closure Report for the Knolls Site* - Revised August 2, 1991.

27. *Site Population Distribution Analysis*, 1990 Census Data, prepared by Oak Ridge National Laboratory. January 1993.

28. DOE/EP-0023, *A Guide For Environmental Radiological Surveillance at USDOE Installations*, July 1981.

29. EPA-600/7-77-088, *Handbook for Analytical Quality Control in Radioanalytical Laboratories*, August 1977.

30. Nuclear Regulatory Guide 4.15, *Quality Assurance For Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment*, February 1979.

31. EPA-625/6-87/016, *Handbook: Groundwater*, March 1987.

32. National Council on Radiation Protection and Measurements (NCRP) Report No. 93, *Ionizing Radiation Exposure of the Population of the United States*, September, 1987.

33. Knolls Atomic Power Laboratory, *Mohawk River Biological Survey*, ES-80-1, April 1980.

34. State of Connecticut Department of Environmental Protection General Stormwater Discharge Permit, Permit No. GSW000407.

35. Knolls Atomic Power Laboratory, *Mohawk River Survey Report*, KAPL-4808, May 1995

REFERENCES (Con't)

36. New York State Department of Environmental Conservation, Chemical Bulk Storage Regulations, 6NYCRR, Parts 595 to 599

37. New York State Department of Environmental Conservation, Petroleum Bulk Storage Regulations, 6NYCRR, Parts 612 to 614

38. Town of Niskayuna Sewer District No. 6 Outside Users Agreement No. 94 3850 between KAPL, Inc. and The Town Board of Niskayuna dated July 19, 1994.

39. DOE/EIS-0275, Final Environmental Impact Statement, S1C Prototype Reactor Plant Disposal, U. S. Department of Energy, Office of Naval Reactors, November 1996

40. DOE/EIS-0274, Final Environmental Impact Statement, Disposal of the S3G and D1G Prototype Reactor Plants, U. S. Department of Energy, Office of Naval Reactors, November 1997

EXTERNAL DISTRIBUTION

	No. of Copies
USDOE, Office of Environmental Guidance and Compliance	10
USDOE, Technical Information Center	3
USDOE, Headquarters Library	1
USDOE, Office of Naval Reactors	50
USDOE, Schenectady Naval Reactors Office	5
USDOE, Schenectady Naval Reactors Office West Milton Field Office	1
USDOE, Schenectady Naval Reactors Office Windsor Field Office	1
Mr. Alfonse D'Amato United States Senator	1
Mr. Daniel P. Moynihan United States Senator	1
Mr. Christopher Dodd United States Senator	1
Mr. Joseph Lieberman United States Senator	1
Mr. Michael R. McNulty United States Congressman	1
Mr. Gerald B. Solomon United States Congressman	1
Mrs. Barbara B. Kennelly United States Congresswoman	1
Mr. Hugh T. Farley New York State Senator	1
Mr. Joseph L. Bruno New York State Senator	1
Mr. Robert A. D'Andrea New York State Assemblyman	1
Mr. James Tedisco New York State Assemblyman	1
Mr. John Kissel Connecticut State Senate	1
Mr. Eric Coleman Connecticut State Senate	1

EXTERNAL DISTRIBUTION (Con't)

	No. of Copies
Ms. Mary Eberle Connecticut State Representative	1
Ms. Ruth C. Fahrbach Connecticut State Representative	1
Ms. Annette Carter Connecticut State Representative	1
County Manager Schenectady County, New York	1
Chairperson Schenectady County, New York, Legislature	1
Chairperson Environmental Advisory Council Schenectady County, New York	1
Director Environmental Health Schenectady County Public Health Service	1
Director Emergency Management Office Schenectady County, New York	1
Mayor Schenectady, New York	1
Supervisor Town of Niskayuna, New York	1
Commissioner of Public Works Town of Niskayuna, New York	1
Chairperson Conservation Advisory Council Niskayuna, New York	1
Mr. Robert Maswick Latham Water District Town of Colonie, New York	1
Chairperson Saratoga County, New York, Board of Supervisors	1
Chairperson Environmental Management Council Saratoga County, New York	1

EXTERNAL DISTRIBUTION (Con't)

	No. of Copies
Director Office of Emergency Services Saratoga County, New York	1
Director Environmental Management Services Saratoga County, New York	1
Mayor Saratoga Springs, New York	1
Mayor Ballston Spa, New York	1
Supervisor Town of Milton, New York	1
Mayor Bloomfield, Connecticut	1
Mayor Windsor, Connecticut	1
First Selectman East Granby, Connecticut	1
First Selectman Granby, Connecticut	1
First Selectman Simsbury, Connecticut	1
First Selectman Windsor Locks, Connecticut	1
Fire Marshal Windsor, Connecticut	1
Chairperson Air and Water Pollution Abatement Commission Windsor, Connecticut	1
Dr. C. Petrillo, Health Officer Windsor, Connecticut	1
Executive Director Connecticut State Council on Environmental Quality	1
Administrator Region I United States Environmental Protection Agency	5

EXTERNAL DISTRIBUTION (Con't)

	No. of Copies
Federal Facility Coordinator Region I United States Environmental Protection Agency	1
Mr. James J. Cherniack Region I United States Environmental Protection Agency	1
Ms. Kim Tisa Region I United States Environmental Protection Agency	1
Branch Chief Planning, Analysis and Grants Branch Region 1 United States Environmental Protection Agency	1
J. Gaffey, Chief Connecticut RCRA Section Region 1 United States Environmental Protection Agency	1
Administrator Region II United States Environmental Protection Agency	5
Federal Facility Coordinator Region II United States Environmental Protection Agency	1
Mr. Paul A. Giardina Region II United States Environmental Protection Agency	1
Mr. David Greenlaw Region II United States Environmental Protection Agency	1
Mr. James Reidy, Chief New York Section Region II United States Environmental Protection Agency	1
Commissioner New York State Department of Health	5
Director New York State Bureau of Environmental Radiation Protection New York State Department of Health	1

EXTERNAL DISTRIBUTION (Con't)

	No. of Copies
Mr. Glenn Bruso, Senior Sanitary Engineer Glens Falls District Office New York State Department of Health	1
Commissioner New York State Department of Environmental Conservation	5
Chief Bureau of Pesticides and Radiation New York State Department of Environmental Conservation	1
Mr. S. B. Hammond, Acting Director Division of Solid and Hazardous Materials New York State Department of Environmental Conservation	1
Mr. M. J. O'Toole, Director Division of Environmental Remediation New York State Department of Environmental Conservation	1
Mr. N. G. Kaul, Director Division of Water New York State Department of Environmental Conservation	1
Mr. Joseph Kelleher Physical Systems Section New York State Department of Environmental Conservation	1
Mr. Robert Warland, Director Division of Air Resources New York State Department of Environmental Conservation	1
Mr. Earle Barcomb Division of Environmental Remediation New York State Department of Environmental Conservation	1
Mr. Edwin Dassatti Division of Solid and Hazardous Materials New York State Department of Environmental Conservation	1
Mr. Roger Murphy, PE Bureau of Hazardous Waste Facilities New York State Department of Environmental Conservation	1
Mr. Carl Johnson, Director Region 4 New York State Department of Environmental Conservation	3
Mr. Cliff Van Guilder, Environmental Engineer Region 4 New York State Department of Environmental Conservation	1

EXTERNAL DISTRIBUTION (Con't)

	No. of Copies
Mr. Rick Leone, Environmental Engineer Region 4 New York State Department of Environmental Conservation	1
Mr. Peter Mack, Regional Environmental Quality Supervisor Region 4 New York State Department of Environmental Conservation	1
Mr. Frederick Sievers, Environmental Engineer Region 4 New York State Department of Environmental Conservation	1
Mr. Thomas Cullen, Environmental Engineer Region 4 New York State Department of Environmental Conservation	1
Ms. Margaret O'Brien, Engineering Geologist Region 4 New York State Department of Environmental Conservation	1
Regional Director Region 5 New York State Department of Environmental Conservation	3
Mr. Al Matrose, Environmental Engineer II Region 5 New York State Department of Environmental Conservation	1
Mr. George Stahler, Regional Solid and Hazardous Materials Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. William Wasilauski, Regional Water Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. Gus Caryaiannis, Regional Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. Michael Stawarz, Regional Engineer Region 5 New York State Department of Environmental Conservation	1
Commissioner Connecticut State Department of Health	1
Commissioner Connecticut State Department of Environmental Protection	3

EXTERNAL DISTRIBUTION (Con't)

	No. of Copies
Chief Bureau of Water Management Connecticut State Department of Environmental Protection	1
Chief Bureau of Waste Management Connecticut State Department of Environmental Protection	1
Chief Bureau of Air Management Connecticut State Department of Environmental Protection	1
Director Monitoring and Radiation Division Connecticut State Department of Environmental Protection	5
Combustion Engineering Windsor, Connecticut	1
Schenectady County Public Library Main Branch Schenectady, New York	1
Schenectady County Public Library Niskayuna Branch Niskayuna, New York	1
Windsor Public Library Windsor, Connecticut	1