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FINAL
Preliminary Assessment Report For Potential Radiological Contamination at Great Kills Park

ECL Site No. 1580
Gateway National Recreation Area
Staten Island, New York

National Park Service
Washington Office
Boulder, Colorado

Prepared by

Michael Baker Jr., Inc.
Moon Township, PA

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LIST OF ABBREVIATIONS/ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
Baker	Michael Baker Jr., Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	curie
cpm	counts per minute
DOE	Department of Energy
dpm	disintegrations per minute
dps	disintegrations per second
ECL	Environmental Cleanup Liability
g	gram
GATE	Gateway National Recreation Area
GSA	General Services Administration
µCi	microcurie (µCi)
mCi	millicurie
MCL	Maximum Contaminant Level
mrem/yr	milli-roentgen equivalent man per year
mR/hr	milliRoentgen per hour
mR/yr	milliReongten per year
NCP	National Contingency Plan
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NORM	naturally occurring radioactive material
NTCRA	Non-Time-Critical Removal Action
NYC	New York City
NYCDOHMH	New York City Department of Health and Mental Hygiene
NYPD	New York City Police Department
NYSDEC	New York State Department of Environmental Conservation
PA	Preliminary Assessment
PCBs	polychlorinated biphenyls
pCi	picocurie
R	Reontgen
Ra-226	Radium-226
RAP	Radiological Assistance Program
rem	roentgen equivalent man
SVOCs	Semivolatile Organic Compounds

LIST OF ABBREVIATIONS/ACRONYMS
(Continued)

TAGM	Technical Administrative Guidance Memorandum
TCRA	Time-Critical Removal Action
TENORM	technically enhanced naturally occurring radioactive material
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WASO	Washington Area Support Office, National Park Service

1.0 INTRODUCTION

Michael Baker Jr., Inc. (Baker) has been tasked by the National Park Service (NPS), Washington Area Support Office (WASO), to provide a Preliminary Assessment (PA) Report for Potential Radiological Contamination at Great Kills Park (Environmental Cleanup Liability [ECL] Site 1580). The Great Kills Park is located within the Staten Island Unit of Gateway National Recreation Area (GATE). The purpose of the PA is to investigate suspected radiological contamination possibly associated with an area of the park previously landfilled (Site) and provide recommendations on future action if necessary. Based upon available information related to the Site, it is believed that radium wastes resulting from Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) and its decay products have been disposed of, and are present at the Site. Specifically, Radium-226 (Ra-226) has been detected. This document provides a site history, technical review, current status, and recommendations for the Site. The PA Report is based on a compilation and review of available literature and interviews with persons knowledgeable about the Site. The work was performed under General Services Administration (GSA) Contract Number GS-00F-0032M, Task Order T2420060100.

2.0 SITE BACKGROUND, ENVIRONMENTAL SETTING, AND FINDINGS

This section presents specific information on the GATE, Staten Island Unit and Great Kills Park, including a discussion of history, background, environmental settings, topography, surface hydrology, drainage, and geology. Figure 1 presents a General Location Map of GATE and Figure 2 presents a General Location Map of Great Kills Park.

2.1 Gateway National Recreational Area

2.1.1 Description and History

GATE, which was established by the NPS on October 27, 1972, provides recreational and learning opportunities including swimming, boating, fishing, team sports, bicycling, and nature study. The living world can be explored in a wildlife refuge, holly forest, ocean beaches, dunes and wooded coastal uplands. In addition, GATE has historical structures including the nation's oldest operating lighthouse, forts, and two historic airfields (NPS, 2007). GATE is a 26,607 acre National Recreation Area in the New York City (NYC) metropolitan area comprised of three separate units including the Jamaica Bay Unit (Brooklyn and Queens), Staten Island Unit and Sandy Hook Unit which is located on the northern shore of New Jersey (Figure 1). The Staten Island Unit is located on the southeast shore of Staten Island within Lower New York Bay (Wikipedia, 2007). It includes Fort Wadsworth, Miller Field, Hoffman and Swinburne Island, and Great Kills Park on Great Kills Harbor. Great Kills Park is located on the east and south (Crookes Point) of Great Kills Harbor and on the shoreline of Lower New York Bay (Figure 2). Great Kills Park has a seasonal, guarded swimming beach, a marina, athletic fields, a public boat ramp, nature trails, a model airplane field, fishing area, and trails for walking and jogging.

2.1.2 Regional Geology/Hydrogeology

GATE consists of over 28 miles of open to near open ocean shoreline at the entrance of New York Harbor. Park geology includes Pleistocene glacial/terrace deposits and Quaternary alluvium at Breezy Point, Jamaica Bay, and Sandy Hook Units. The Staten Island Unit is comprised of glacial outwash sands and gravels left over from a terminal moraine of the Laurentide icesheet that passed across

Staten Island (Figure 3). The glacial material is underlain by Cambrian/Ordovician metamorphic rocks. (Benimoff, 2003).

2.2 Great Kills Park Landfill History

In 1933, the Marine Park Project was initiated to develop the Great Kills Harbor and vicinity as a shorefront recreation area. The project was administrated by the New York City Department of Parks and consisted of dredging over 1,500,000 cubic yards of sand from the harbor to fill low areas of Crooke's Neck and attach Crooke's Point to the Mainland. A steel bulkhead was constructed along the harbor side of the spit to impede the disposition of sand into the harbor. A filling and grading operation (i.e., the Great Kills Landfill) was initiated on the mainland to make the lowland areas accessible as a public park (NPS, not dated). Figures 4 and 5 show the prelandfill and current conditions, respectively (NPS, 1992). Appendix A includes historical topographic maps (two dated 1900 and one date 1905) showing Crooke's Point, Crooke's Neck and the wetland conditions of the mainland. Note that the historical topographic maps generally show Crooke's Point attached to the mainland. It is assumed, based on the Marine Park Project, that this area was low-lying, similar to a tidal flat.

Placement of sanitation controlled fill at Great Kills began in November 1944 and was completed in July 1948. Additional bulkheading, unloading and other facilities were constructed prior to initiating the backfilling operations. The landfill operations were moved from the Sound View Park located in lower Bronx. Reportedly, 15 million cubic yards of refuse material from the boroughs of New York City were transported by barges and trucks to the landfill to bring the park up to grade. The thickness of the fill material ranged between 8 and 15 feet and was covered with a layer of topsoil composed of clay and sludge obtained from the city sewage. Appendix A includes a historical topographic map dated 1947 that shows the wetland conditions and the location of an incinerator. Appendix B provides historical aerial photographs of Great Kills Park. The aerial photograph dated 1949 shows barren, landfill type conditions (note the growth of vegetation and development of the Park in the subsequent aerial photographs). Figure 6 shows the extent of landfill soils as determined by the soil survey conducted by the Natural Resources Conservation Service (NRCS) in 2000.

A letter from the Park Commissioner to the Mayor of New York City dated July 1, 1949, stated that the landfilling operation resulted in a savings of at least $5,000,000 in construction costs and that the park

would not have been opened to public use for many years if the grading had been completed by any other method (Moses, 1949).

2.3 Previous Great Kills Park Landfill Study

Based on available documentation (e.g., web search and documentation provided by the NPS), one environmental study has been performed at Great Kills Park. The results are presented in the *Structural Engineering Services Report for the Beach and Bathhouse Facility* (Johnson, 1985). The primary purpose of the study was to assess and address erosion impacts to the bathhouse and a portion of a sewer line. The secondary purpose of the report was to characterize the nature and boundaries of the landfill; although the investigation did not include the entire landfill area, and the report does not explain why. It is understood that the 1985 investigation focused only on the portion of the landfill where construction was planned at that time.

Field investigations in the 1985 Johnson study included a magnetometer survey, test trenching at 41 locations, installation of four groundwater monitoring wells, and the collection of three soil and four groundwater samples for analyses. The samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs) and metals. In addition, one trip blank and one equipment blank were analyzed for VOCs. Figure 7 shows the investigation area including the locations of the 41 test trenches and four groundwater samples.

No detections or regulatory exceedances were reported for the three soil samples. VOCs including toluene (4.8 μg/L, 7.4 μg/L, and 20.3 μg/L) and tetrachloroethene (PCE) (9.1 μg/L, 4.8 μg/L and 3.3 μg/L) were reported in three of four groundwater samples. However, toluene (9.2 μg/L) and PCE (10.8 μg/L) also were detected in the "Equipment Blank" sample, indicating that the VOCs reported for the groundwater samples likely were the result of cross-contamination or other nongroundwater sources. A Field Blank was not collected and analyzed; consequently, the specific source of the artificially introduced VOCs cannot be determined. As a point of reference, the Maximum Contaminant Levels (MCLs) for toluene and PCE are 1,000 μg/L and 5 μg/L, respectively.

The 1985 report concluded that the fill area is confined to the northwest quadrant of the park and stated that garbage was not observed in the Crooke's Point area or the approach spit (i.e., Crooke's Neck).

Much of the garbage fill was described as black and well-reduced and may be an incinerator residue (recall the incinerator shown on the Appendix A historical topographic map dated 1947). Appendix C provides three test pit photographs showing the black and brown garbage fill. This conclusion supports the reported history of the park (i.e., dredging the harbor to attach Crooke's Point to the mainland with a landfilling operation on the mainland to make the lowland areas accessible as a public park).

3.0 HISTORY OF RADIOLOGICAL MEASUREMENTS

This section presents a chronology and summary of radiological measurements collected at the Site. Figure 8 shows the approximate locations of the five areas as referenced below.

On August 2, 2005, the U. S. Department of Energy (DOE) and New York City Police Department (NYPD) Counter Terrorism Team detected a radioactive emission near the Great Kills Park Model Airplane Field while performing an aerial background radiation survey of the New York City metropolitan area. Further investigation by the NYPD Department of Emergency Services, DOE, and NPS revealed a maximum reading of 1.2 microrems (Figure 8, NYPD Flyover). It was concluded that the level of radioactivity was not dangerous to humans unless ingested or direct exposure occurred for more that 100 hours, and they recommended restricting access to the Site as a preventive measure.

NPS fire management activities involving the widening of fire roads in the vicinity of the Model Airplane Field had been conducted on August 1, 2005. As a typical maintenance activity during the growing season, a front-end loader and riding mower were used to clear the road and maintain access. Additional information indicated that a bulldozer was used to widen the roads and excavate buried phragmites root systems. It is suspected that these activities exposed the radiological source detected on August 2, 2005.

On August 3, 2005, the NYPD Department of Emergency Services, DOE, NPS and the U.S. Environmental Protection Agency (USEPA) continued to survey the area where the radioactive emission was detected. A reading of 1.18 milliRoentgen per hour (mR/hr) was obtained with an Exploranium GR-135 meter. This meter is used to detect the presence of radioactive emissions in field operations. It allows the user to survey the area (locate the source), measure dose (exposure hazard level), and analyze (identify) nuclides. It was concluded that the radionuclide contaminant was Radium-226 (Ra-226). A summary of USEPA's Radiation Response Investigation, including screening results and a location map, is provided in Appendix D. The USEPA also recovered several small pieces of rusted metal (Bomar, 5/2/06) and advised the NPS to erect a fence/barrier, allow vegetation to grow, and monitor the area every 90 days.

On August 4, 2005, the Office of Health, Safety and Ranger Services determined that the risk of exposure is low and provided the following recommendations, which were implemented by NPS:

- Employees should be directed to erect a barrier fence. No need for Personal Protective Equipment was identified.

- Keep Out signs should be placed in and around the area, but should be removed once the area is completely revegetated.

- All employees who worked on the fire road widening project should be given the opportunity (if they wish) to meet with the Park Public Health Officer, the Park Safety Officer, or the Park Environmental Protection Specialist.

On March 15, 2007, NPS employees detected an emission during a survey of an area where a brush fire had occurred on March 6, 2007 (Figure 8, Brush Fire). The NYPD was notified and they responded along with the DOE Radiological Assistance Program (RAP) team. The highest gamma reading obtained by the RAP Team was 0.2mR/hr. Readings by the NYPD Counter Terrorism Division were not reported.

In response to the March 15, 2007 detections, New York City Department of Health and Mental Hygiene (NYCDOHMH) conducted a survey on March 21, 2007. The NYCDOHMH observed readings of 10 mR/hr (contact on the grass) and 0.5 mR/hr (one meter above ground) at a spot "just off the road leading to the model airplane field" (Figure 8, Sewerline Road #1). NYCDOHMH also stated that natural background readings for the area are normally 0.01 mR/hr. NYCDOHMH requires its radioactive materials licensees and registrants to limit exposure to the public to 2mR/hr and 100mR/year. A copy of the NYCDOHMH's March 22, 2007 survey summary letter is provided in Appendix E.

On March 30 and April 3, 2007, the NYCDOHMH conducted a limited gamma radiological survey of the public access areas including ball fields #1 through #5 and parking lot, Model Airplane Field and parking lot, fishing area (Harbor Beach) and access road, hiking trail, Sewerline Road, Fire Road, and the main Park access road (Buffalo Street). The survey confirmed the locations of the three previously identified areas and identified two additional areas; south of ball field #1 and east of the Model Airplane Field parking lot (Figure 8, South of Ball Field #1 and Sewerline Road #2). The NYCDOHMH concluded that while the radiation levels from the sources were many times above background, the levels were reduced to background when measured 3 feet from the source (NYCDOHMH, 2007). The NYCDOHMH recommended that a radiological contamination assessment be conducted at the park.

4.0 RADIUM BACKGROUND AND INFORMATION

Radium (chemical symbol Ra) is a naturally occurring radioactive metal. Its most common isotopes are radium-226, radium-224, and radium-228. Radium is a radionuclide formed by the decay of uranium and thorium in the environment. It occurs at low levels in virtually all rock, soil, water, plants, and animals. Ra-226 (the nuclide detected at Great Kills Park), the most common isotope, is an alpha emitter, with accompanying gamma radiation and has a half-life of about 1600 years. Radium decays to form isotopes, one of which is radioactive gas radon, which is not chemically reactive. Stable lead is the final product of this lengthy radioactive decay series. The decay progeny for Ra-226 and associated radiation types and energies are shown in Figures 9 and 10.

Radium was discovered in the early 1900s. At that time, the dangers of radium were not understood. It displayed seemingly mysterious properties, such as the luminescence produced when it is mixed with a phosphor. Industries sprang up to manufacture hundreds of consumer products containing radium. Glow in the dark watch and clock faces were very popular.

Most of its original uses have been halted for health and safety reasons, but its wide use in luminescent paints continued through World War II because the soft glow of radium's luminescence made aircraft dials, gauges and other instruments visible to their operators at night. Radium was also an early radiation source for cancer treatment. Small seeds were implanted in tumors to kill cancerous cells. Safer, more effective radiation sources, such as cobalt-60 have since mostly replaced it.

Radium emits several different kinds of radiation, in particular, alpha particles and gamma radiation. The alpha particle is only a concern if radium is taken into the body through inhalation or ingestion. Gamma radiation can penetrate the body, so gamma emitters like radium can result in exposures even when the source is a distance away or not properly shielded. Long-term exposure to radium increases the risk of developing several diseases. Inhaled or ingested radium increases the risk of developing such diseases as lymphoma, bone cancer, and diseases that affect the formation of blood, such as leukemia and aplastic anemia. These effects usually take years to develop. External exposure to radium's gamma radiation increases the risk of cancer to varying degrees in all tissues and organs.

However, the greatest health risk from radium is from exposure to its radioactive decay product radon. It is common in many soils and can accumulate in homes and other buildings.

Ra-226 is also identified as a naturally occurring radioactive material (NORM). NORM generally contains radionuclides found in nature. NORM is not regulated by the Nuclear Regulatory Commission (NRC). However, it is regulated by the state of New York. The New York State Department of Environmental Conservation (NYSDEC) Technical Administrative Guidance Memorandum (TAGM) 4003 recommends a maximum dose limit to the general public of 10 milliReongten per year (mR/yr) above background for free release of a site following the cleanup of radioactively contaminated materials.

4.1 Understanding the Measurements

For the purposes of this discussion, it is assumed that the greatest hazard presented is the gamma radiation being emitted from the unknown sources.

The roentgen (R) is a unit of measurement for exposure to ionizing radiation in air (X or gamma rays). Roughly, it is the amount of radiation required to liberate positive and negative charges in air. A dose of 500 R in 5 hours is lethal for humans.

Note that the absorbed dose (R) is not a good indicator of the likely biological effect. In order to describe biological effects, other methods are used. The measurement "roentgen equivalent man" or "rem" reflects the biological effects of radiation as opposed to the physical aspects, which are characterized by the absorbed dose, measured in R. The average radiation dose from exposure to natural and man-made background radiation in the United States is approximately 360 milli-roentgen equivalent man per year (mrem/yr) (Norris, 2007). The different forms of radiation (e.g., alpha, beta, gamma, X, neutron, etc.) have been assigned different quality factors in order to describe absorbed dose equivalents (Norris, 2007). Gamma radiation has a quality factor of 1. Generally speaking, 1 R of exposure to gamma radiation will result in an effective dose equivalent of 1 rem.

The curie (Ci) is a unit for measuring the quantity of radioactivity. It was originally defined as the activity of 1 gram of Ra-226. One curie is equivalent to 37 billion (3.7×10^{10}) disintegrations per second (dps) or is a quantity of any radionuclide that decays at the rate of 37 billion dps. Nuclear disintegrations produce spontaneous emissions of alpha or beta particles, gamma radiation, or combinations of these. The curie is a very large amount of activity. Therefore, sub-multiples of the

curie are often used, such as the millicurie (mCi) = 10^{-03} Ci, microcurie (µCi) = 10^{-06} Ci, and picocurie (pCi) = 10^{-12} Ci.

Counts per minute (cpm) is another measure of radioactivity. It is the number of atoms in a given quantity of radioactive material that are detected to have decayed in one minute. Disintegrations per minute (dpm) is also a measure of radioactivity. It is the number of atoms in a given quantity of radioactive material that decay in one minute. Dpm is similar to cpm; however, the efficiency of the radiation detector must be accounted for when analyzing data in cpm. Dpm is the number of atoms that have decayed, not the number of atoms that have been measured as decayed. Dpm is commonly used as a measure of radioactive contamination.

4.2 Potential Risks to Exposure to Ra-226 in Soil at Great Kills Park

The USEPA classifies all radionuclides as Class A carcinogens, and methodologies currently are in place for assessing risks from radionuclides. Ingestion, inhalation, and external exposure cancer slope factors (risk coefficients for total cancer morbidity) have been developed for radionuclides in conventional units of pCi. For the purposes of this cursory risk evaluation, it is assumed that any risk from exposure to Ra-226 in the soil at Great Kills Park would likely be from potential external exposure to gamma radiation associated with Ra-226. Although Ra-226 is primarily an alpha emitter, it is assumed that the risk associated with the alpha radiation would be negligible because ingestion of soil is not a complete exposure pathway.

The slope factor for external exposure to Ra-226 (plus decay products) is 8.49 x 10^{-06} risk/year per pCi/g (USEPA, 2001). External exposure slope factors are central estimates of lifetime attributable radiation cancer incidence risk for each year of exposure to external radiation from photon-emitting radionuclides distributed uniformly in a thick layer of soil. When combined with site-specific media concentration data and appropriate exposure assumptions, slope factors can be used to estimate lifetime cancer risks to member of the general population due to radionuclide exposure.

At this time, sufficient information is not available to conduct a quantitative risk assessment using current methodologies provided by USEPA (USEPA, 1989). However, a cursory, qualitative assessment of potential risks to human health based on current information provided by NPS is provided in the following paragraphs.

As previously mentioned, in August 2005, during a ground survey of the area where the radioactive emission was detected, a soil sample (500 grams [g]) was collected from the area with the maximum detected radiation level. A reading of 1.18 mR/hr of Ra-226 (value includes background) was obtained with an Exploranium GR-135 meter. A measurement of 202,504 cpm (value includes background) was also taken at that same location (using a 2" x 2" Sodium Iodide coupled with a Ludlum 2221 Scaler/Ratemeter). The contamination was determined to be Ra-226.

In order to provide a cursory risk evaluation from exposure to the source at Great Kills Park, the concentration of Ra-226 in pCi/g was estimated using the measurements obtained in August 2005. The first step was determining that an efficiency of 20 percent is typical for the radiation detector used to obtain the cpm measurement. Applying this efficiency, a value of 1.01×10^{06} dpm was calculated. As noted above, one curie equals 3.7×10^{10} dps, or 2.22×10^{12} dpm. Therefore, the recorded cpm value would be roughly equal to 456,090 pCi. Assuming the quantity of soil collected was 500 g, the soil concentration could be roughly estimated to be 912 picocuries per gram (pCi/g).

The appropriate background for Ra-226 is approximately 1.2 pCi/g (for analytical methods that avoid U-235 interference) (Dreyer, 2007). Information provided by NPS indicated that the measurements obtained from the survey completed in August 2005 included background. Although the measurements did include background, the estimated value of 912 pCi/g is two orders of magnitude above the referenced background. At a minimum, this indicates that the source is not naturally occurring and contamination likely is present at the Site. For example, a literature source noted that common radiation sources are radioluminescent products and that typical quantities range from µCi to mCi (IEM Tool Box). The quantity measured at the Site in August 2005 (456,090 pCi or 0.456 µCi) is near this range.

The absorbed dose reading 1.18 mR/hr would correspond to an effective dose equivalent of 1.18 mrem/hr since the Q value of gamma radiation equals 1. A dose of 1 millirem (mrem) has a biological effect similar to the dose received from an approximate one-day exposure to natural background radiation. Given that the location of the source is remote and inaccessible (enclosed by fencing), it is not expected that a park user would exceed the 10 mR/yr standard for the general public presented in the NYSDEC TAGM 4003 (NYSDEC, 1993).

4.3 Results of Cursory Risk Evaluation

The quantity of radiation measured at the Site indicates that the source is not naturally occurring but is unlikely to have resulted in health risks to the public (specifically park users). It does not appear that the measured doses at the known locations pose any immediate threat to public health. This determination is consistent with the "Health Consultation, Great Kills Park" conducted by the Agency for Toxic Substances and Disease Registry (ATSDR) provided through the USEPA on May 25, 2007. A copy of the ATSDR Health Consultation Document is provided in Appendix F. As an added precaution, however, NPS has installed fencing to isolate the five above-background detections pending further evaluation. Note that the 6000 mR estimated upper bound of radiation exposure for Sewer Line Area 1, presented in Table 3 of the ASTDR Health Consultation Document, is a very conservative estimate.

Recommendations

The ideal protection from external radiation is removal of the source. However, if this is not feasible, then exposure of individuals to external radiation may be controlled by concurrent application of one or more of the following three techniques (Cember, 1992):

- Minimizing exposure time
- Maximizing distance from the radiation source
- Shielding the radiation source

Shielding the radiation source is not a realistic option for protection from external radiation emitted from Ra-226. However, time and distance are viable tools in protecting the public and on-site workers. Therefore, limiting the amount of time working at the Site and the distance from the actual source are recommended for controlling potential exposures. Note that the five areas of background exceedance identified in the USEPA (2005) and NYCDOHMH (2006) surveys have been fenced to prevent public access.

Uncertainties

This cursory risk evaluation was conducted with limited information. As a result, there is a large amount of uncertainty associated with the evaluation. Uncertainties were encountered primarily in the following elements of the evaluation:

- Lack of comprehensive description of the Site

- Lack of detailed information of survey techniques. In order to determine accurate exposure levels, it is necessary to know how the measurement was obtained (i.e., configuration of radiation source [point or surface], distance from detector to source, type of soil sample [composite or grab], etc.)

- Inconsistent measurement units presented in various reports (1.2 µrem vs. 1.18 mR). Assumed higher measurement for evaluation

- Estimation of soil Ra-226 concentration from cpm data and assumption of instrument efficiency

- Assumption of uniform exposure to the entire body

- Inclusion of background in estimation of soil Ra-226 concentration

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the compilation and review of available literature and interviews with persons knowledgeable about the Site, the following conclusions are presented:

- Radioactive emissions have been detected at five locations at levels above background.
- The radiological contamination at the Site appears to be radium (identified as Radium-226) and the radioactive products of its decay.
- The radiological contaminants identified are not likely to pose an immediate health risk to park users.
- NPS has isolated with fencing the five suspect areas to further reduce risk of exposure.

5.2 Recommendations

Based on the results of this PA, the following actions are recommended:

- Excavate and dispose at an appropriate off-site facility the five locations of radium-contaminated soils identified by USEPA and NYCDOHMH. Soil contamination is expected to be shallow (between 6 inches and 2 feet of the existing ground surface). Upon removal, the location will be field screened to verify the reduction of radiation to background levels. This action may be undertaken as a Time Critical Removal Action (TCRA) consistent with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP).
- "Public access sites within the footprint of the old landfill, such as park ball fields, roads/fire access road, parking areas, Harbor Beach, hiking trail, Model Airplane Field and phragmities fire areas, have been screened by the USEPA, NYCDOHMH or the NYPD." In the event that

other remaining sections of the old landfill site become cleared of vegetation or are otherwise disturbed (e.g., fire or park projects), it is recommended that NPS implement a radiological screening protocol. This would be based upon and similar to actions applied during the 2007 radiological screening activities, including the 2007 phragmites fire. If additional contamination is encountered, then the removal, disposal, and confirmation process recommended above should be followed.

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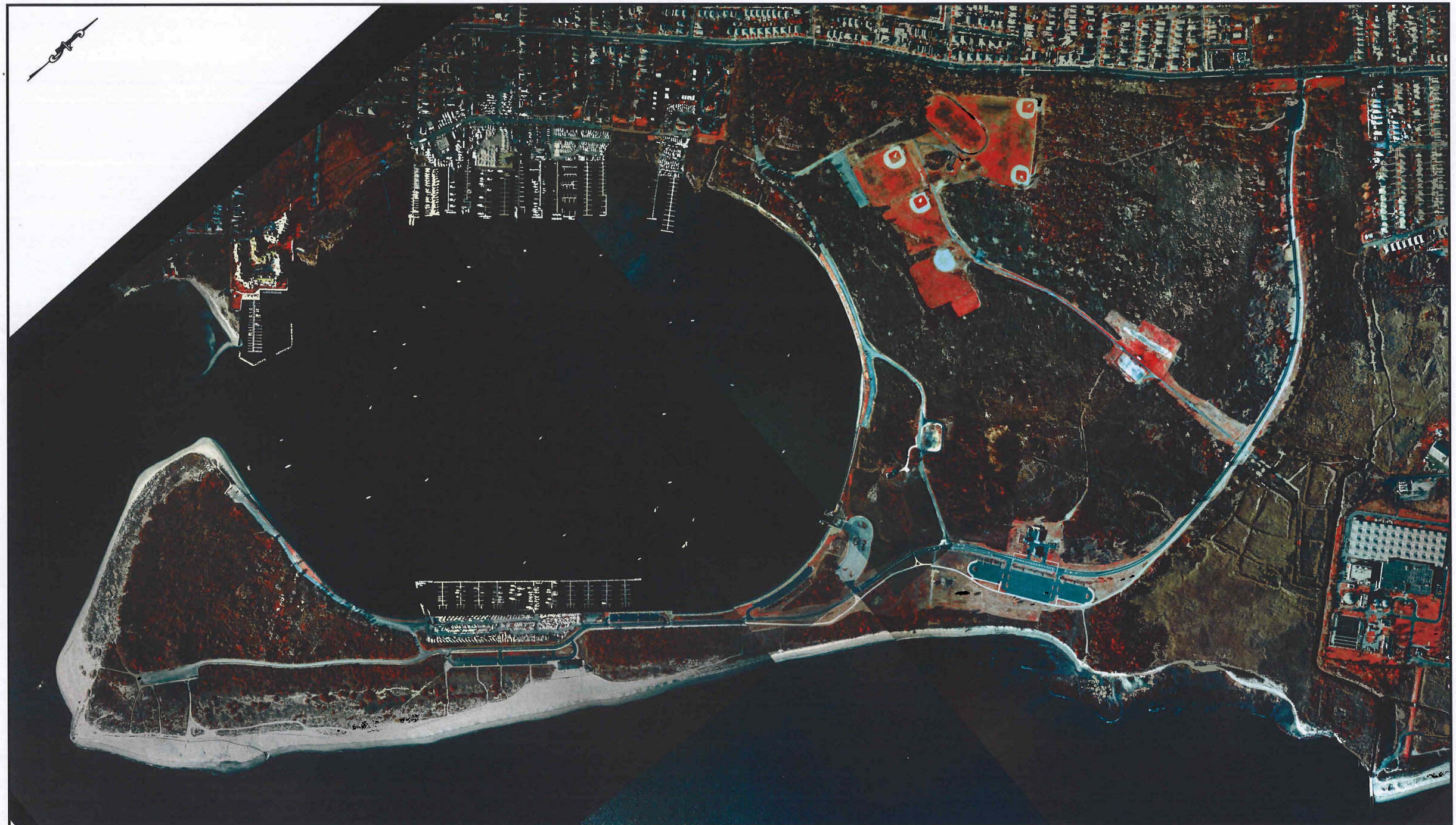
FIGURES

SCALE:	1'=2.5miles	DATE:	APRIL 2007
S.O. NO.:	109727	FILE:	109727GK01
DSN/DWN:	DMG/RRR	CHK:	RGR

Baker MICHAEL BAKER Jr., Inc.
Moon Township, pennsylvania

FIGURE 1
GATE GENERAL LOCATION MAP

GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK



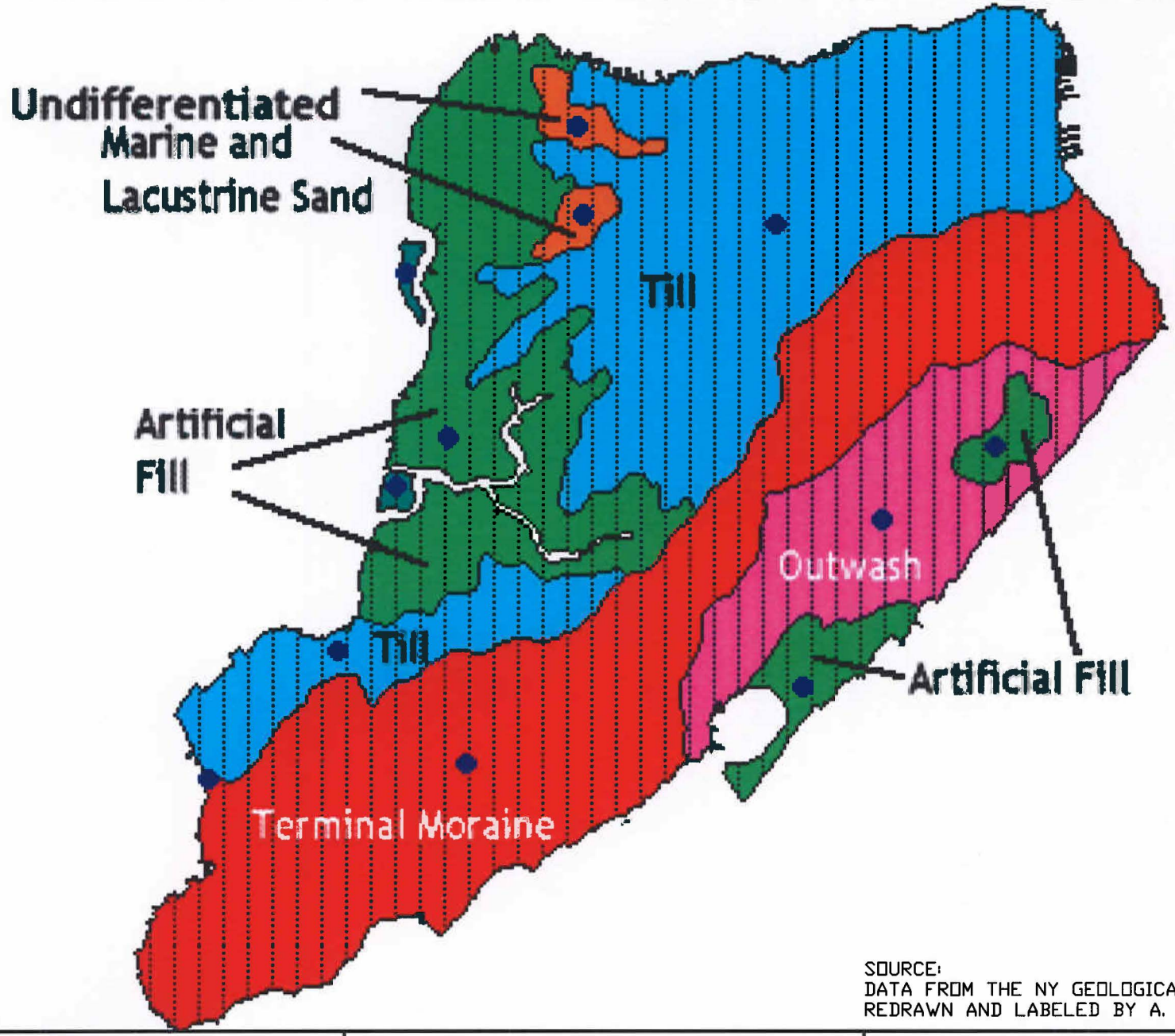
SCALE:	1'=200'	DATE:	APRIL 2007
S.O. NO.:	109727	FILE:	109727GK02
DSN/DWN:	DMG/RRR	CHK:	RGR

Baker

MICHAEL BAKER Jr., Inc.
Moon Township, pennsylvania

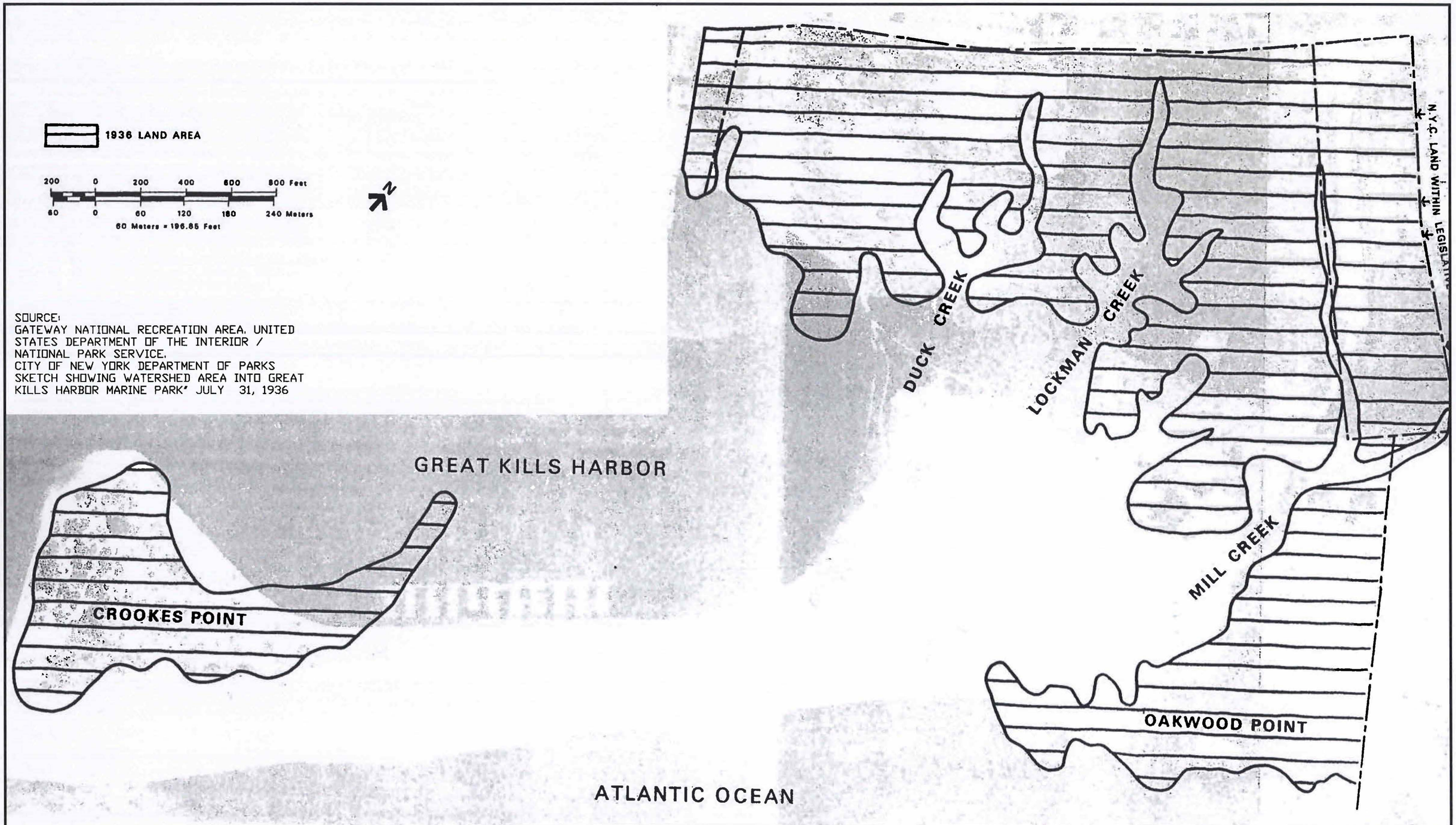
FIGURE 2
GREAT KILLS PARK GENERAL LOCATION MAP

GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK



SOURCE:
DATA FROM THE NY GEOLOGICAL SURVEY AND REDRAWN AND LABELED BY A. I. BENIMOFF.

SCALE:	NOT TO SCALE	DATE:	APRIL 2007	Baker MICHAEL BAKER Jr., Inc. Moon Township, pennsylvania	FIGURE 3 STATEN ISLAND SURFICIAL GEOLOGY GREAT KILLS PARK–GATEWAY NRA STATEN ISLAND, NEW YORK
S.O. NO.:	109727	FILE:	110727GK03		
DSN/DWN:	DMG/RRR	CHK:	RGR		

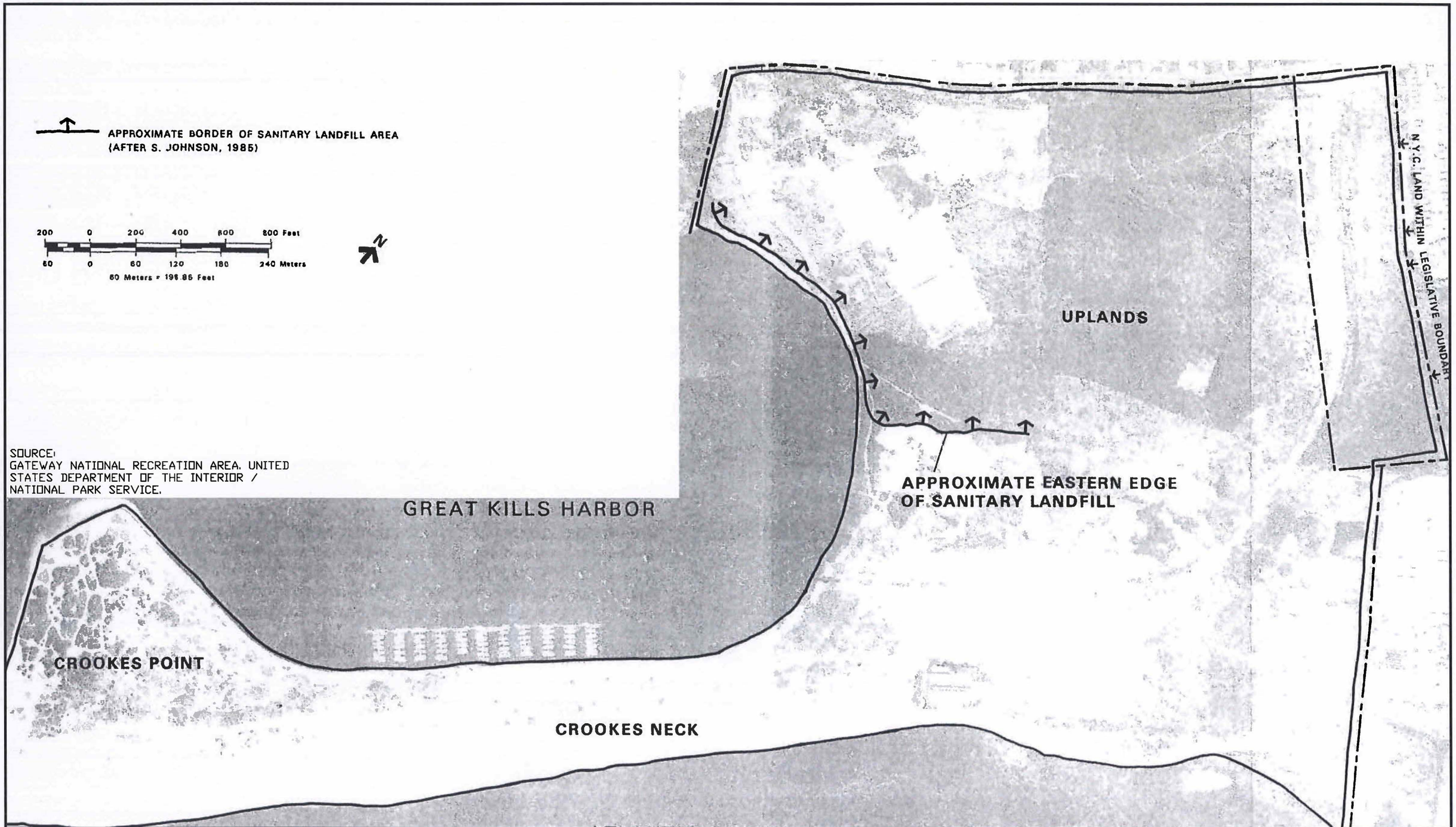


SCALE:	1'=400'	DATE:	APRIL 2007
S.O. NO.:	109727	FILE:	110727GK04
DSN/DWN:	DMG/RRR	CHK:	RGR

Baker MICHAEL BAKER Jr., Inc.
Moon Township, pennsylvania

FIGURE 4
GREAT KILLS PARK – PRELANDFILL CONDITIONS

GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK



SCALE:	1'=400'	DATE:	APRIL 2007
S.O. NO.:	109727	FILE:	110727GK05
DSN/DWN:	DMG/RRR	CHK:	RGR

Baker MICHAEL BAKER Jr., Inc.
Moon Township, pennsylvania

FIGURE 5
GREAT KILLS PARK – PARK AREAS AND SANITARY LANDFILL LOCATION

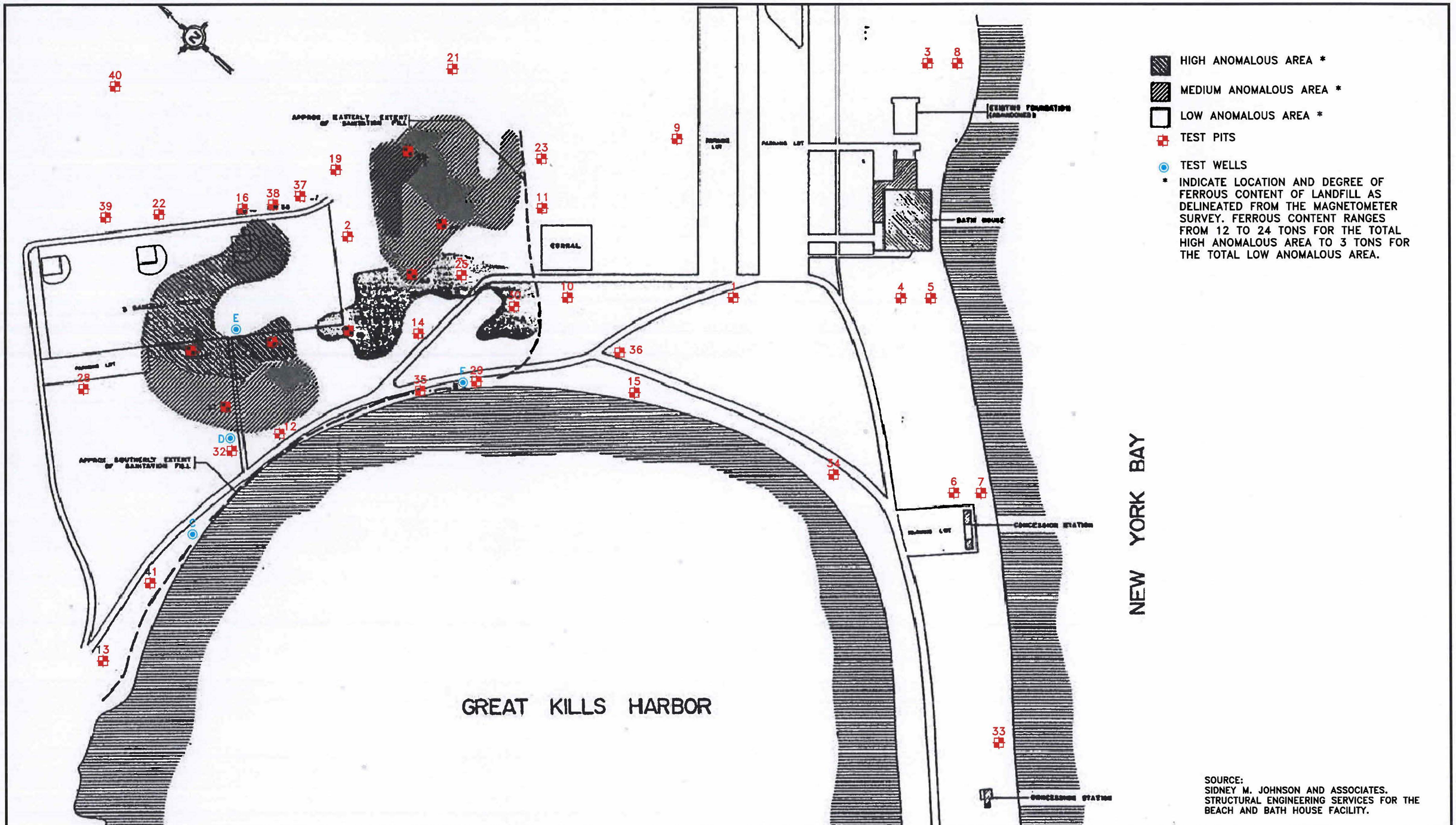
GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK

"The Greatkills series consists of very deep to bedrock, well drained soils where an abandoned household landfill of 5 feet or more in thickness has been capped withi a thin layer of loamy fill up to 24 inches thick."

"The Gravesend series consists of very deep to bedrock, well drained soils where an abandoned household landfill of 5 feet or more in thickness has been capped with a thin layer of sandy materials up to 24 inches thick."

SOURCE: USDA NRCS GATEWAY SOIL SURVEY MANUSCRIPT.

Baker	MICHAEL BAKER Jr., Inc. Moon Township, pennsylvania	FIGURE 6 EXTENT OF LANDFILL SOIL – 2000 NRCS GATE SOIL SURVEY GREAT KILLS PARK–GATEWAY NRA STATEN ISLAND, NEW YORK
DATE: APRIL 2007	S.O. NO.: 110727	FILE: 110727GK06



SCALE:	1'=600'	DATE:	APRIL 2007
S.O. NO.:	109727	FILE:	109727GK07
DSN/DWN:	DMG/RRR	CHK:	RGR

Baker MICHAEL BAKER Jr., Inc.
Moon Township, pennsylvania

FIGURE 7
TEST TRENCH AND GROUNDWATER SAMPLE LOCATION MAP 1985 STUDY

GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK

FIGURE 8
LOCATION MAP OF RADIOLOGICAL MEASUREMENTS
GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK

SCALE:	1'=200'	DATE:	APRIL 2007	Baker MICHAEL BAKER JR., INC. MOON TOWNSHIP, PENNSYLVANIA
S.O. NO.:	109727	FILE:	109727GK08	
DSN/DWN:	RGR/RRR	CHK:	RGR	

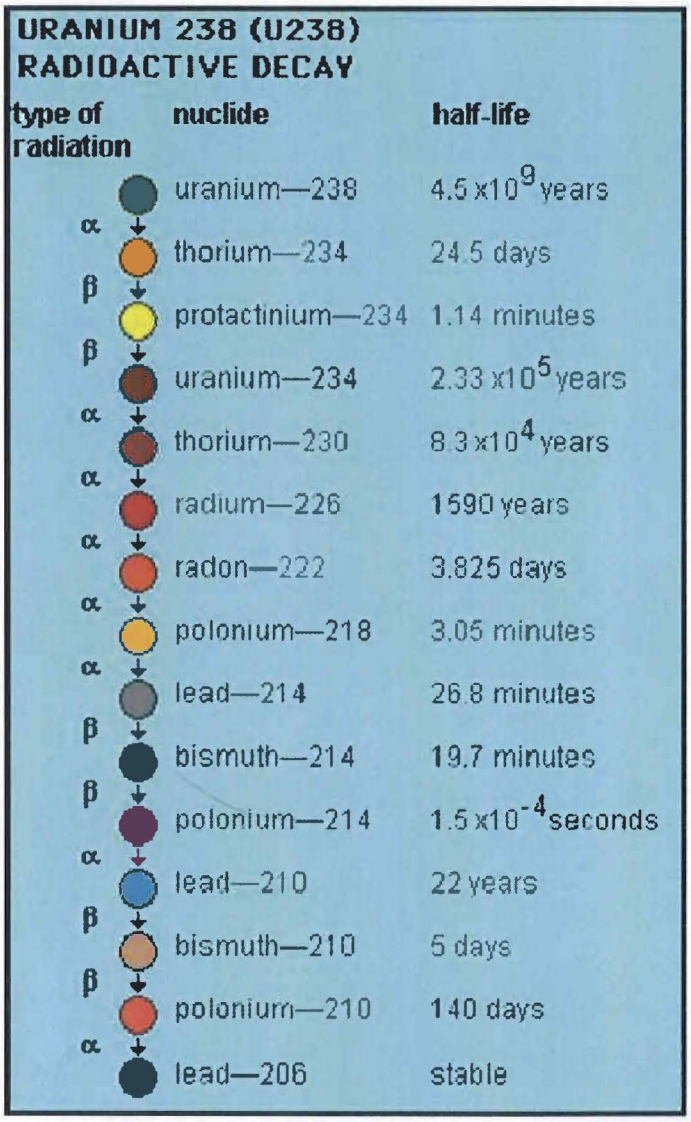


FIGURE 9
URANIUM 238 RADIOACTIVE CHAIN
GREAT KILLS PARK–GATEWAY NRA
STATEN ISLAND, NEW YORK

SCALE:	NOT TO SCALE	DATE:	APRIL 2007	Baker MICHAEL BAKER JR., INC. MOON TOWNSHIP, PENNSYLVANIA
S.O. NO.:	109727	FILE:	109727GK09	
DSN/DWN:	RGR/RRR	CHK:	RGR	

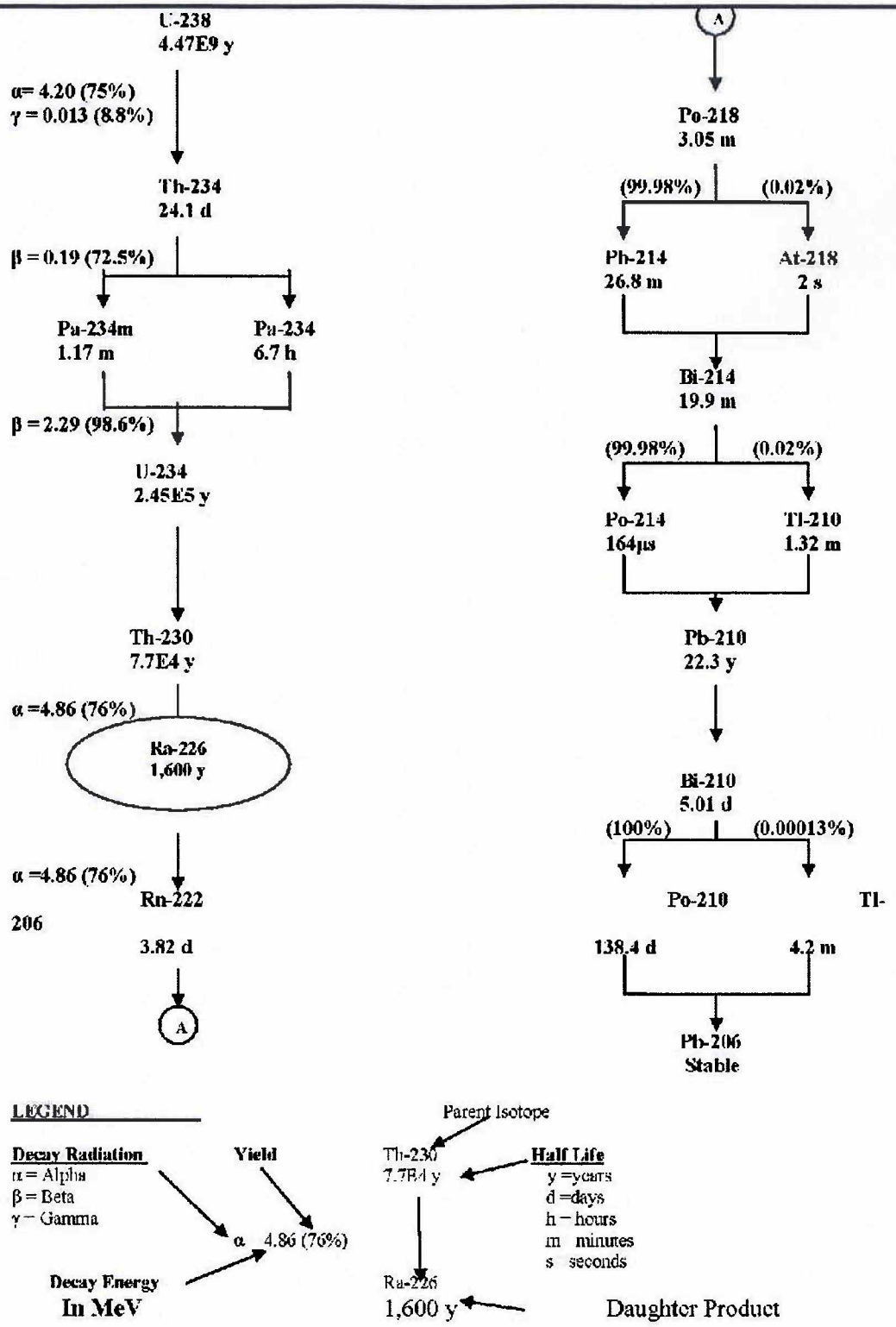


FIGURE 10
RADIOACTIVE DECAY FOR RADIUM-226
GREAT KILLS PARK-GATEWAY NRA
STATEN ISLAND, NEW YORK

SCALE:	NOT TO SCALE	DATE:	APRIL 2007	Baker MICHAEL BAKER JR., INC. MOON TOWNSHIP, PENNSYLVANIA
S.O. NO.:	109727	FILE:	109727GK10	
DSN/DWN:	RGR/RRR	CHK:	RGR	

APPENDIX A

Historical Topographic Maps

EDR Historical Topographic Map Report

Great Kills Park
Buffalo Street
Staten Island, NY 10306

Inquiry Number: 1885401.1

March 23, 2007

EDR® Environmental Data Resources Inc

The Standard in Environmental Risk Management Information

440 Wheelers Farms Rd
Milford, Connecticut 06461

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

EDR Historical Topographic Map Report

Environmental Data Resources, Inc.s (EDR) Historical Topographic Map Report is designed to assist professionals in evaluating potential liability on a target property resulting from past activities. EDRs Historical Topographic Map Report includes a search of a collection of public and private color historical topographic maps, dating back to the early 1900s.

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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Historical Topographic Map

N ↑	TARGET QUAD NAME: PASSAIC MAP YEAR: 1900 SERIES: 30 SCALE: 1:125000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

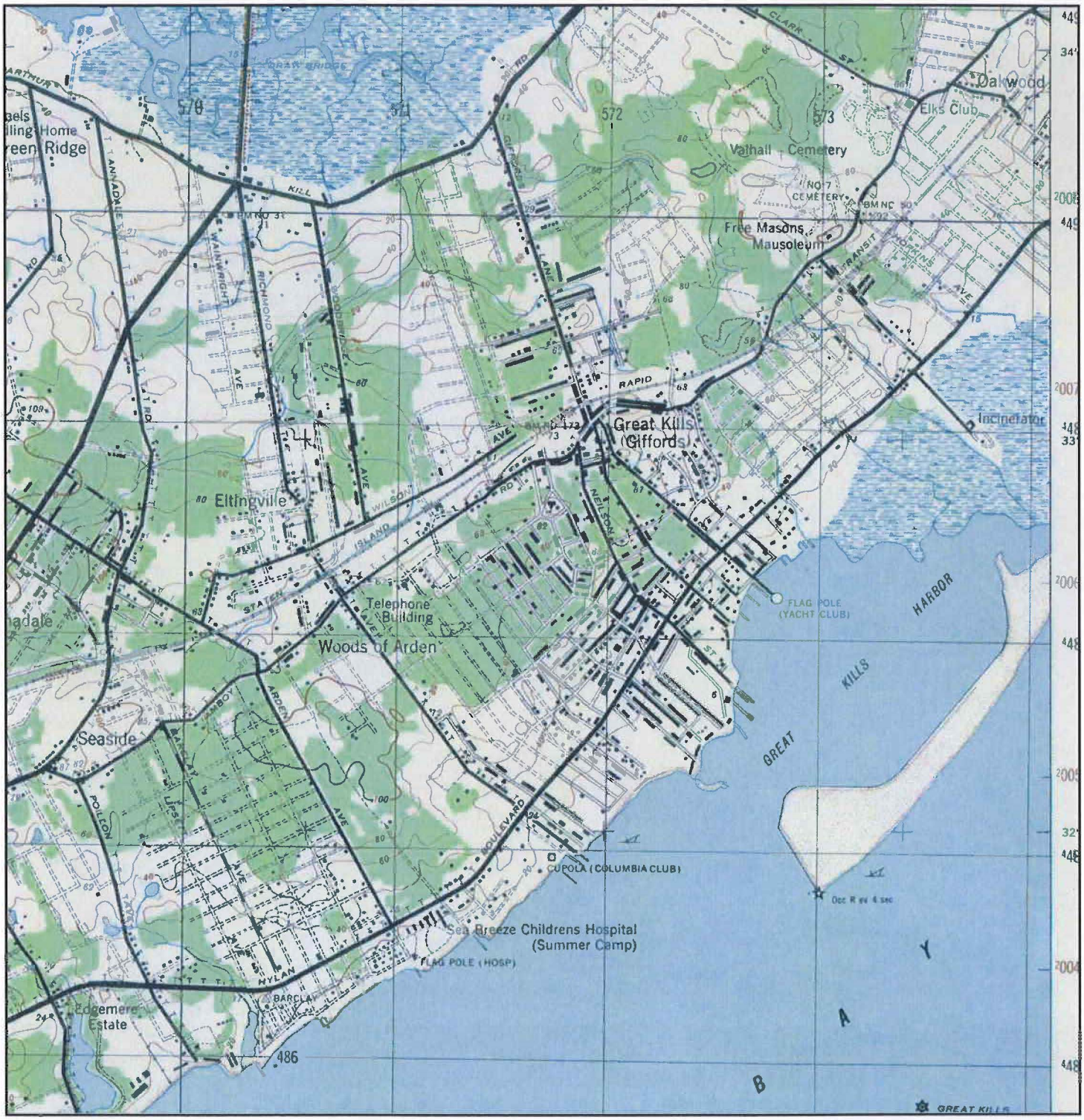
Historical Topographic Map

N	TARGET QUAD NAME: STATEN ISLAND MAP YEAR: 1900 SERIES: 15 SCALE: 1:62500	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map

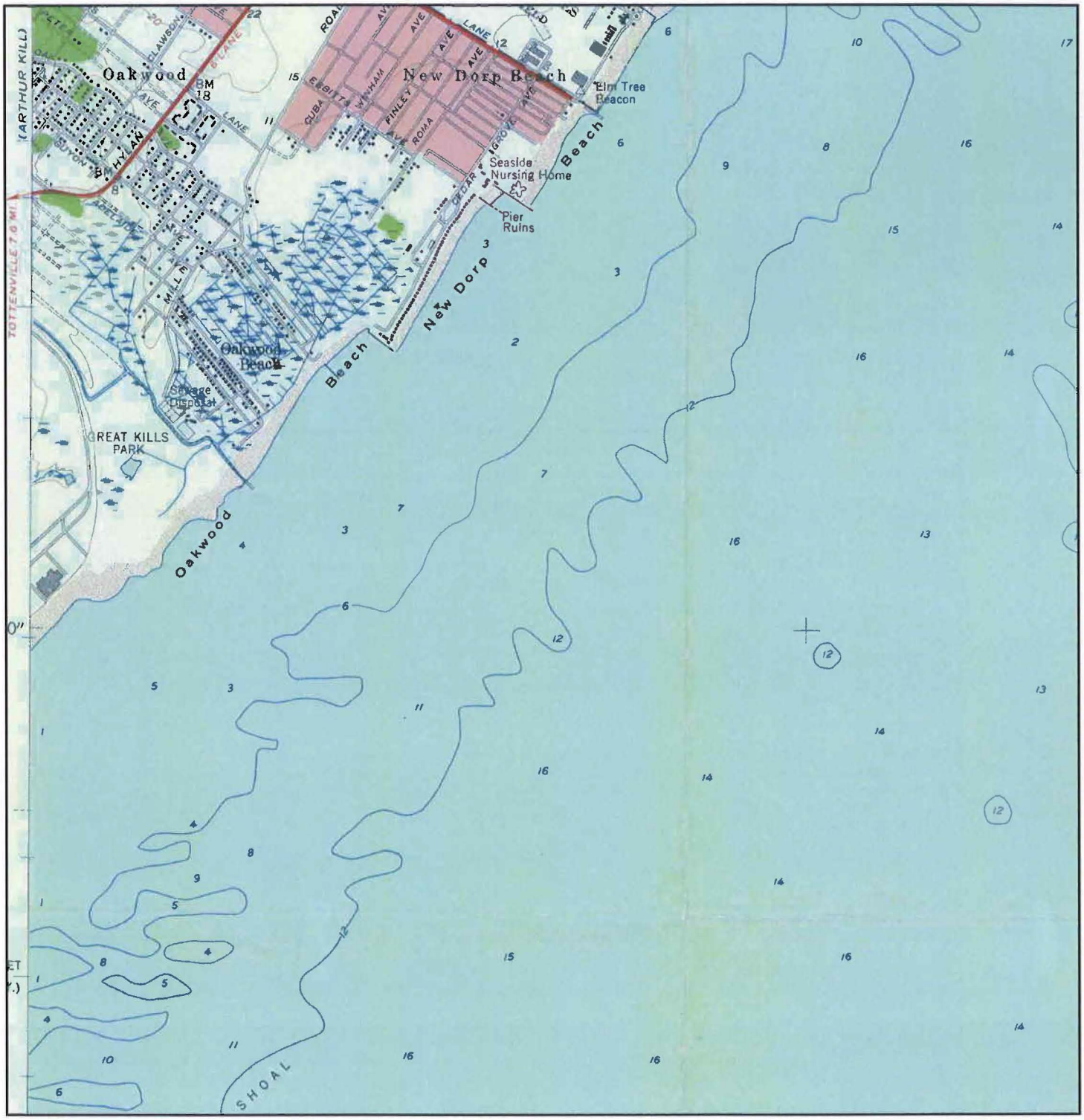
N	TARGET QUAD NAME: PASSAIC MAP YEAR: 1905 SERIES: 30 SCALE: 1:125000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map



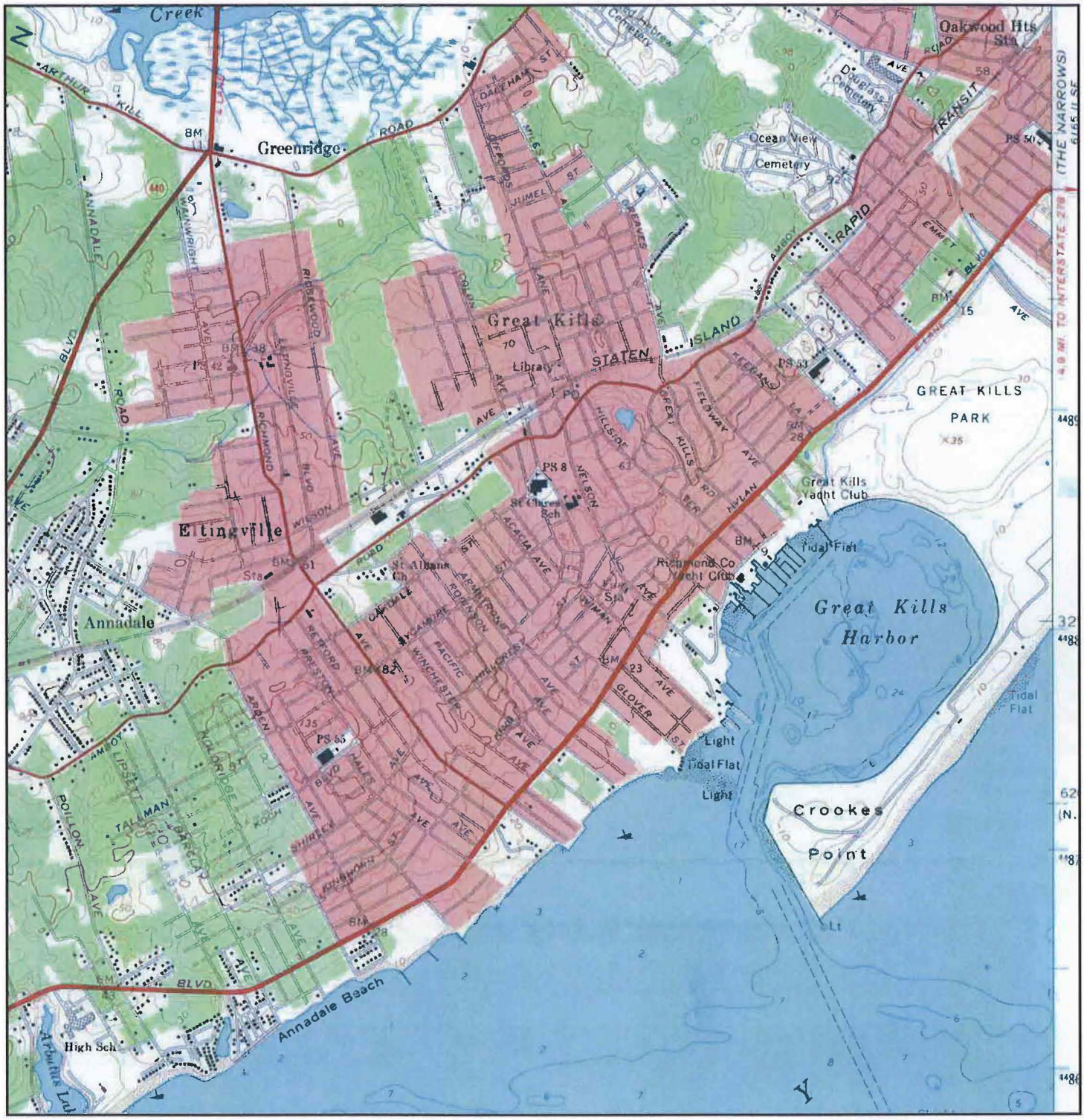
N	TARGET QUAD NAME: ARTHUR KILL MAP YEAR: 1947 SERIES: 7.5 SCALE: 1:25000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map



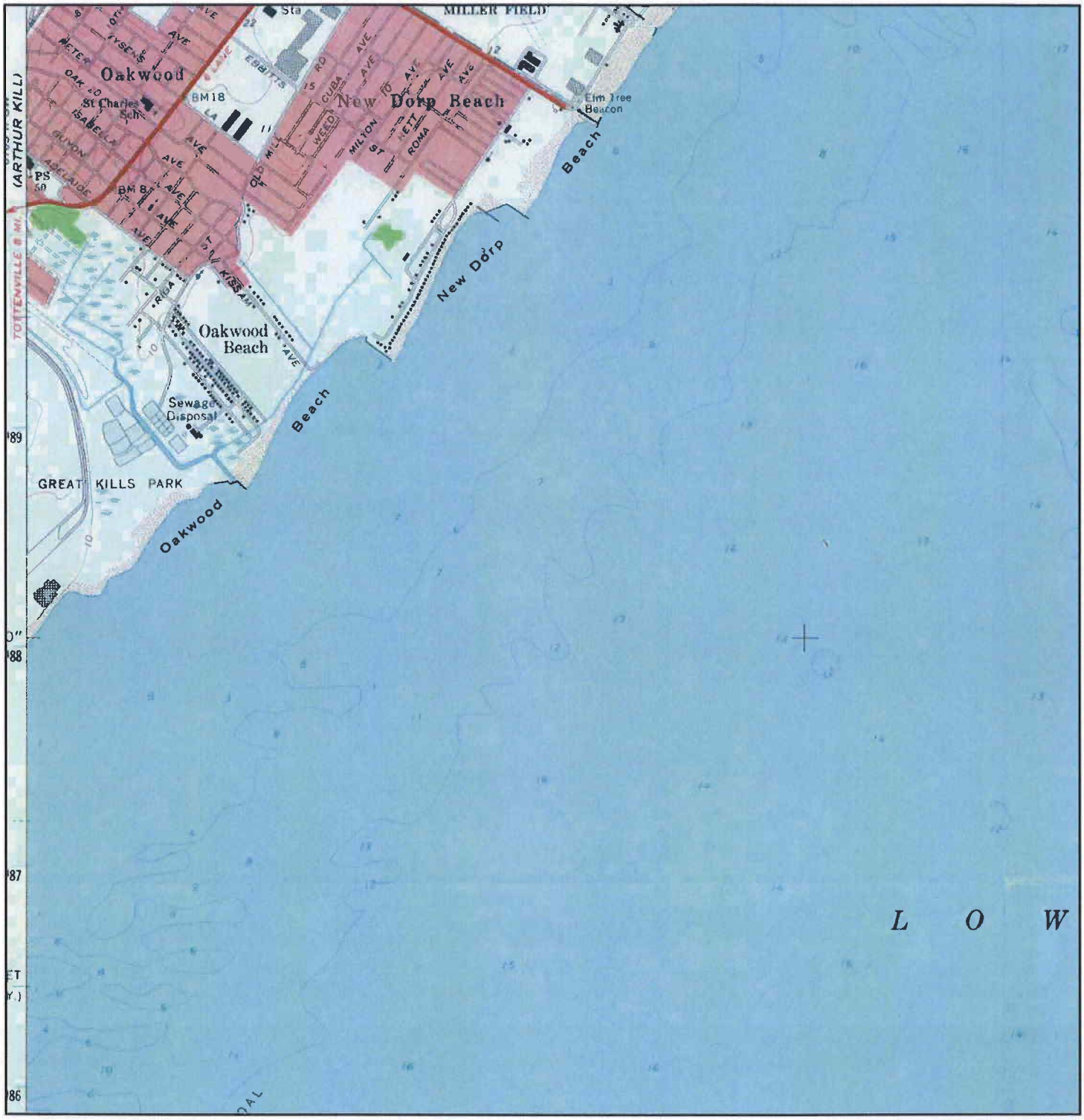
N	TARGET QUAD NAME: THE NARROWS MAP YEAR: 1955 SERIES: 7.5 SCALE: 1:24000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map



N	TARGET QUAD NAME: ARTHUR KILL MAP YEAR: 1966 SERIES: 7.5 SCALE: 1:24000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map

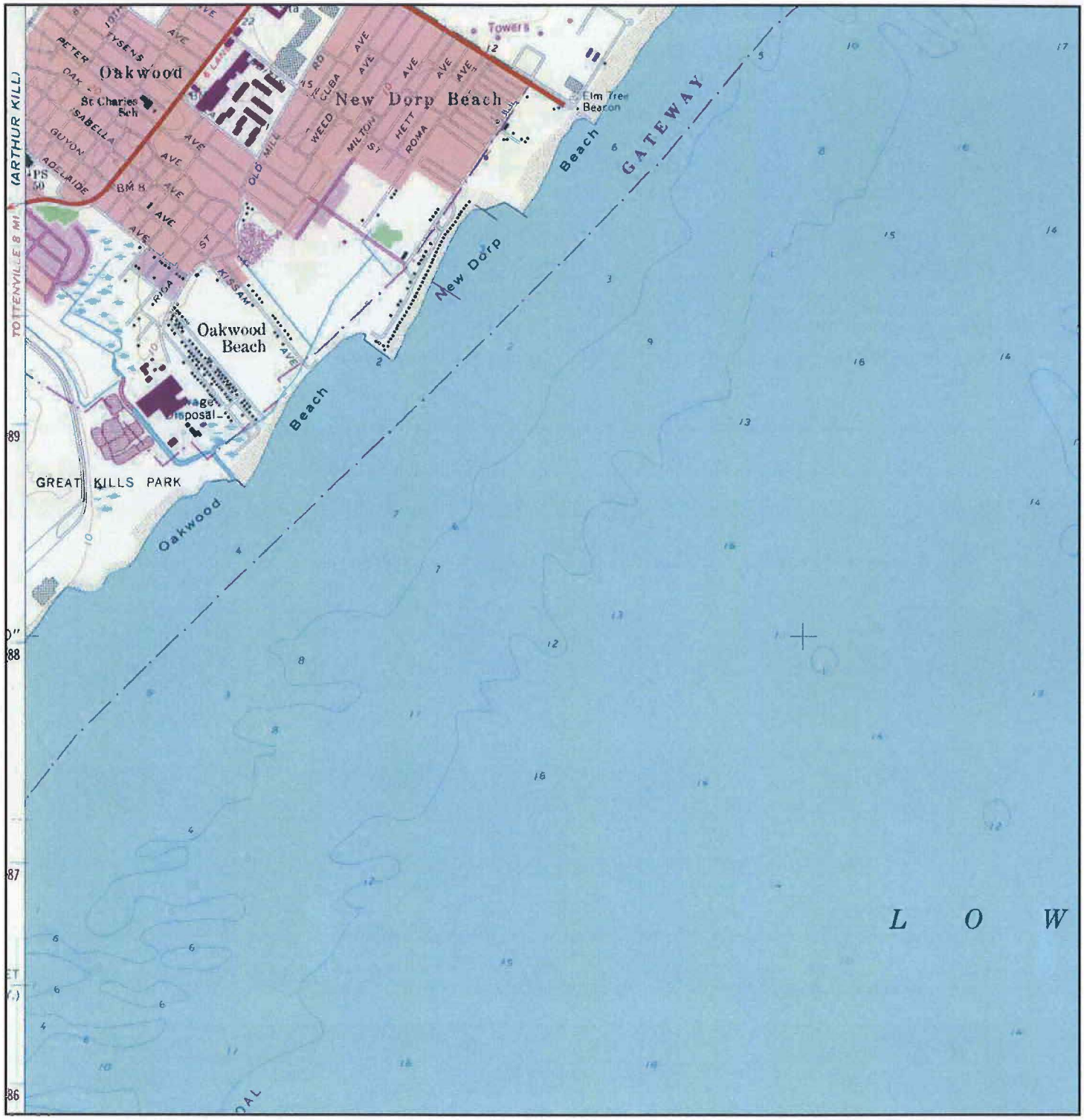


N	TARGET QUAD NAME: THE NARROWS MAP YEAR: 1966 SERIES: 7.5 SCALE: 1:24000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map

N	TARGET QUAD NAME: ARTHUR KILL MAP YEAR: 1981 PHOTOREVISED FROM:1966 SERIES: 7.5 SCALE: 1:24000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map



N	TARGET QUAD NAME: THE NARROWS MAP YEAR: 1981 PHOTOREVISED FROM:1966 SERIES: 7.5 SCALE: 1:24000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

Historical Topographic Map

N	TARGET QUAD NAME: THE NARROWS MAP YEAR: 1998 SERIES: 7.5 SCALE: 1:24000	SITE NAME: Great Kills Park ADDRESS: Buffalo Street Staten Island, NY 10306 LAT/LONG: 40.5447 / 74.125	CLIENT: Michael Baker Jr., Inc. CONTACT: Robert Roselius INQUIRY#: 1885401.1 RESEARCH DATE: 03/23/2007

APPENDIX B

Historical Aerial Photographs

The EDR Aerial Photo Decade Package

Great Kills Park
Buffalo Street
Staten Island, NY 10306

Inquiry Number: 1885401.2

March 26, 2007

EDR® Environmental Data Resources Inc

The Standard in Environmental Risk Management Information

440 Wheelers Farms Road
Milford, Connecticut 06461

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EDR Aerial Photo Decade Package

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Date EDR Searched Historical Sources:

Aerial Photography March 26, 2007

Target Property:

Buffalo Street

Staten Island, NY 10306

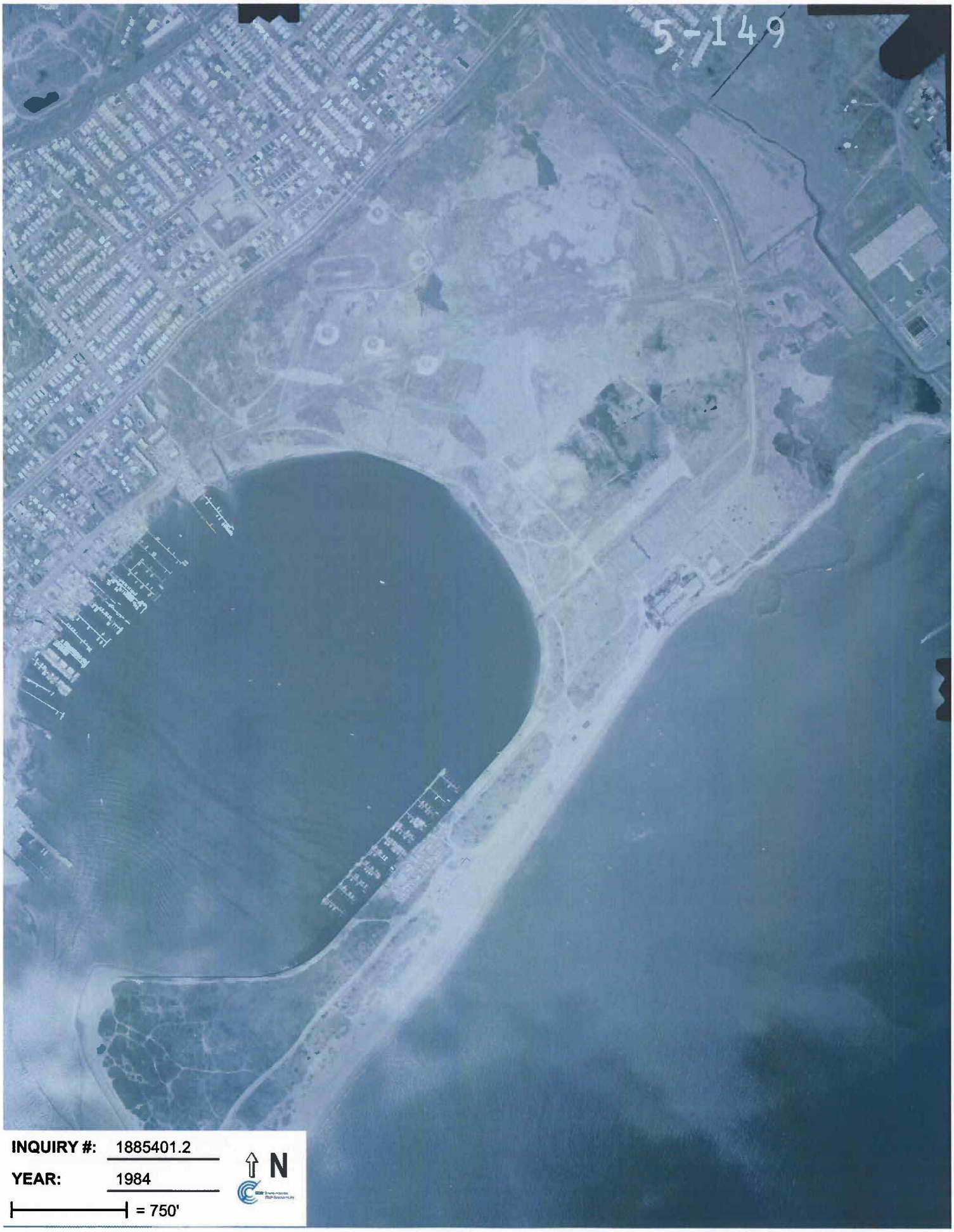
Year	***Scale***	***Details***	***Source***
1949	Aerial Photograph. Scale: 1"=750'	Panel #: 2440074-E2/Flight Date: April 28, 1949	EDR
1954	Aerial Photograph. Scale: 1"=750'	Panel #: 2440074-E2/Flight Date: January 04, 1954	EDR
1966	Aerial Photograph. Scale: 1"=750'	Panel #: 2440074-E2/Flight Date: February 22, 1966	EDR
1975	Aerial Photograph. Scale: 1"=750'	Panel #: 2440074-E2/Flight Date: April 01, 1975	EDR
1984	Aerial Photograph. Scale: 1"=750'	Panel #: 2440074-E2/Flight Date: April 27, 1984	EDR
1995	Aerial Photograph. Scale: 1"=833'	Panel #: 2440074-E2/Flight Date: March 29, 1995	EDR

INQUIRY #: 1885401.2
YEAR: 1949
= 750'
N

6 21
GS VE
INQUIRY #: 1885401.2
YEAR: 1954
= 750'
N

INQUIRY #: 1885401.2
YEAR: 1966
= 750'
N

4-1-75
INQUIRY #: 1885401.2
YEAR: 1975
= 750'
N


5-149
INQUIRY #: 1885401.2
YEAR: 1984
= 750'
N

INQUIRY #: 1885401.2
YEAR: 1995
= 833'
N

APPENDIX C

1985 Test Trenching Photographs

PHOTO NO. 5 ELECTRICAL CONDUIT LYING ON UNDERMINED BEACH AREA - A RESULT OF BROKEN HANGARS.

PHOTO NO. 6 SAND STRATA OVERLYING BLACK GARBAGE FILL AT TEST WELL A

PHOTO NO. 7 BROWN GARBAGE FILL AT TEST PIT NO. 31

PHOTO NO. 8 BLACK GARBAGE FILL AT TEST PIT NO. 31

APPENDIX D

EPA Radiation Response Investigation Report - August 2005

USEPA Region 02 Bullet - Great Kills Park Radiation Response Investigation

Cause of Action

At around 2000 hour of August 2, 2005, EPA Region 2's Office of Radiation and Indoor Air (ORIA) received a telephone call from Lieutenant Steven M. Donahoo, New York Police Department (NYPD), requesting ORIA assistance on the elevated gamma radiation levels that were identified in Great Kills Park, Staten Island, NY. ORIA notified the Regional Response Center in Edison, NJ, and requested their assistance in responding to this radiological incident in Great Kills Park.

Site History

The park is a former landfill located on Federal land owned by the National Park Service. According to NYPD, the maximum radiation reading was 1.5 mR/hr located within a 1 square foot surface area near a parking lot. The source was tentatively identified as radium-226.

The U.S. Department of Energy's (DOE) Radiological Assistance Program (RAP) team has done some additional assessment and determined that there are additional sporadic areas of radiological contamination. The alpha surface reading over the 1.5 mR/h hot spot is 4,000 cpm. Historically, the park was an active landfill from the early 1900's until the 1939. Although landfill operations ceased in 1939, illegal dumping was reported to have occurred from 1939 to 1974.

EPA Response Action and Findings

On August 3, 2005, EPA OSCs Anderson and Daly responded with Nidal Azzam of ORIA to perform an emergency assessment for the National Park Service. The EPA response team arrived at the park at 12:30 pm and met with Mr. O'Connell of the National Park Service and Mr. Waite of the US Park Police. The National Park and US Park Police had provided security to prevent public access to the area of concern. Other NYC agencies like the NYPD- Emergency Services HazMat and Counter Terrorist Team were present during the meeting, but played a support role for the Park agencies. The EPA response team was tasked to identify the perimeter, trace or identify the source's location, and confirm the radionuclide was radium-226. To perform this task, the EPA team began an assessment with several radiation instruments. EPA used the SAM 935, Exploranium, Ludlum 19, Bicron, and a 2x2- sodium iodide detector.

EPA initiated a phase 1 surface gamma scan and flagged the areas where instrument readings were higher than background readings. This activity confirmed the DOE RAP team's findings and identified additional areas exhibiting anomalous gamma radiation levels. The locations exhibiting radiological contamination can be broken into two areas. Area 1 is approximately 10 feet by 20 feet where EPA took three surface gamma and exposure rate measurements (Points A, B, and C). Area 2 is approximately 20 feet by 150 feet and there are several hot spots (Points D through K) with point D exhibiting the

highest radiation level. EPA investigated this spot which measured 1.5 mR/hr on contact to determine if the source of contamination is an orphan source or contaminated material commingled with soil. The investigation comprised digging a 6-inch deep hole over the hot spot where the contaminated area was reached. It appears that the source of the elevated reading may be buried since higher readings were found 6 inches below the surface. A soil sample (D-1) was taken and was sent to the EPA laboratory (NAREL) for analysis. Elevated measurements were noted on corroded metal pieces found on the surface of the ground and the collected soil sample. The pieces varied in size and were extremely corroded. The DOE RAP team's equipment, as well as EPA's SAM 935, confirmed that the radioactive material was radium-226 and its decay products. The corroded radium-contaminated metal may have originated from radium extraction, use, storage, or any combination of the three.

At 1530, EPA completed field activities. Both EPA screening/sampling personnel were screened with a pancake probe upon exiting the area of concern. This survey indicated no removable radiological contamination.

The Park Department will conduct an internal meeting today to consider clean-up options and EPA will continue to provide technical support.

USEPA REGION 02-RADIOLOGICAL SCREENING RESULTS FOR GREAT KILLS PARK INVESTIGATION

2"x2" Sodium Iodide coupled with a Ludlum 2221 Scaler/Ratemeter (Rate)

Location	Ground level in Counts per Minute (cpm) Values include background	Size of the area	Comments
Parking Lot	3603	50' x100'	Background
Flag-A Flag- B Flag- C	58603 65516 63603	A, B, C area size ~ 10' x20	Adjacent to the parking lot
Flag-D	202504	2' x2'	soil sample take in this area Located on dirt path
Flag-E	79014	Corroded metal present	Police tape placed here Located on dirt path
Flag-F	57804	Corroded metal present	30' from the Police tape Located on dirt path
Flag-G	33615	Corroded metal present	Located on dirt path
Flag-H	31313	Corroded metal present	Located on dirt path
Flag-I	18914	Corroded metal present	Located on dirt path
Flag-J	19354	Corroded metal present	Located on dirt path
Flag-K	26298	Corroded metal present	Located on dirt path

USEPA REGION 02-RADIOLOGICAL SCREENING RESULTS FOR GREAT KILLS PARK INVESTIGATION

Exploranium GR 135 (Exposure Rate)

Location	Ground Level. Values include background	Size of the area	Comments
Parking lot	7 μR/h	50' x100'	Background
Flag-A Flag-B Flag-C	75 μR/h 79 μR/h 88 μR/h	A, B, C area size ~ 10' x20	Adjacent to parking lot
Flag-D	**1.18 mR/h**	2' x2'	soil sample take in this area Located on dirt path
Flag-E	17 μR/h	Corroded metal present	Police tape placed here Located on dirt path
Flag-F	65 μR/h	Corroded metal present	30' from the Police tape Located on dirt path
Flag-G	35 μR/h	Corroded metal present	Located on dirt path
Flag-H	36 μR/h	Corroded metal present	Located on dirt path
Flag-I	31 μR/h	Corroded metal present	Located on dirt path
Flag-J	27 μR/h	Corroded metal present	Located on dirt path
Flag-K	30 μR/h	Corroded metal present	Located on dirt path

C 63603 cpm
B 65516 cpm
D 202504 cpm
A 58603 cpm
K 26298 cpm
J 19354 cpm
I 18914 cpm
G 33615 cpm
H 31313 cpm
F 57804 cpm
0 50 100 200
Feet
Great Kills Sites, 10 August, 2005

APPENDIX E

NYC Department of Health and Mental Hygiene March 22, 2007 Summary Letter

THE CITY OF NEW YORK

DEPARTMENT OF HEALTH AND MENTAL HYGIENE

Michael R. Bloomberg
Mayor

Thomas R. Frieden, M.D., M.P.H.
Commissioner

nyc.gov/health

March 22, 2007

To Dave Avrin, National Parks Service

On March 21, 2007, DOHMH employees doing a survey in a section of Great Kills, came across a hot spot just off the road leading to the model airplane field. Readings at contact on the grass were 10 mR/hr and 0.5mR/hr at 1 meter over the spot. Natural background readings for the area are normally 0.01 mR/hr.

DOHMH requires its radioactive materials licensees and registrants to limit exposures to members of the public to 2 mR/hr and 100 mR /year. We use the same criteria for exposure limits to unlicensed sources of radiation in public areas within the City. In other words we would limit access to an area if readings above 2 mR/hr were detected.

Two members of DOHMH's Office or Radiological Health will be at Great Kills this afternoon to confirm yesterdays readings in the same area cited above. Any questions concerning this matter may be put to them or feel free to contact me @ (347) 865-5704.

Gene Miskin, Director
Office of Radiological Health

APPENDIX F

ATSDR Health Consultation Document

Health Consultation

Great Kills Park

Richmond County

Gateway National Recreation Area

National Park Service

Staten Island, New York

Prepared by

Site and Radiological Assessment Branch

Division of Health Assessment and Consultation

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Summary and Statement of Issues

The US Environmental Protection Agency (EPA), Region II office contacted the Agency for Toxic Substances and Disease Registry (ATSDR) Region II office requesting assistance in addressing radiological data collected in the Great Kills Park, Staten Island, New York. The EPA request to ATSDR was to develop a public health statement based on the existing limited data so that park users would be aware of their potential public health consequences. Great Kills Park is in the Staten Island unit of the Gateway National Recreation Area operated by the National Park Service. In 2005, a flyover radiation survey for New York City identified an elevated radiation reading within the park. Additional area surveys located additional elevated readings.

Background

Site Description and History

Great Kills Park in Richmond County, Staten Island, New York, is bounded on the northwest by Hylan Boulevard. The towns of Great Kills, Great Kills Harbor, and Crookes Point are on the west side of the park. Raritan Bay is on the southeast, where the boundary continues along the bay to Oakwood Beach. The northeast boundary of the park is slightly northeast of Emmet Avenue, the entrance to the park (1). The park apparently was the result of a planned operation to reclaim the area from the surrounding marshy areas and waters. Historical documentation indicates that fill operations began in the 1940 ultimately resulting in the deposition of approximately 15 million cubic yards of fill materials. From 1955 to 1959, clay and sludge were added to form the topsoil for the park (1). Later, the US Government purchased the land and formed the national recreation area which is now part of the National Park Service. The area contains baseball fields, soccer facilities, a model airplane recreational area consisting of a runway and associated activities.

During a 2005 radiation flyover by the New York Police Department, a radiation hotspot was found near the model airplane field. A flyover is typically performed to determine background levels of radiation over a large area or to assist in the location of radioactive sources. Following a brush fire in the park in 2007, a National Park Service Ranger equipped with an alarming radiation monitor located another hotspot in the fire area. As a result, the New York City Department of Health and Mental Hygiene (DOHMH) performed additional radiation surveys and located additional areas of elevated radioactivity. The survey site is shown in Figure 1 and the reported results are shown in Table 1.

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1 Wrenn TP (1975). General History, Gateway National Recreation Area, New York, NY Jamaica Bay, Breezy Point, and Staten Island Units. Prepared for the National Park Service (Order Number: PX 1600-5-0353).

Figure 1. Great Kills Park and survey areas

The park is open during daylight hours daily. The official sport season is from the third week in April through November for baseball, softball, and soccer. These activities are at the athletic field complex. The sport activities are usually over by August for baseball and softball; soccer typically ends in November.

Demographics

Staten Island, one of the boroughs comprising New York City, is the third-largest borough of New York City (with an area of 60 square miles). It is the least populated of the five boroughs[2]. The US Census estimates the population at 464,573 with 51.4% of the population comprised of females[3]. The number of housing units is estimated at 173,954. ATSDR estimates the demographic composition of a population within one mile of an area. In the case of Great Kills, the estimated total population is 39,900 individuals with 3600 children under the age of 6. The number of women of childbearing age (15 to 44 years of age) is estimated at 8,281. Additional details are given in Figure 2.

[2] New York Public Library (http://www.nypl.org/branch/staten/) accessed on April 25, 2007.

[3] US Census Bureau web site (http://quickfacts.census.gov/qfd/states/36/36085.html) accessed on April 25, 2007.

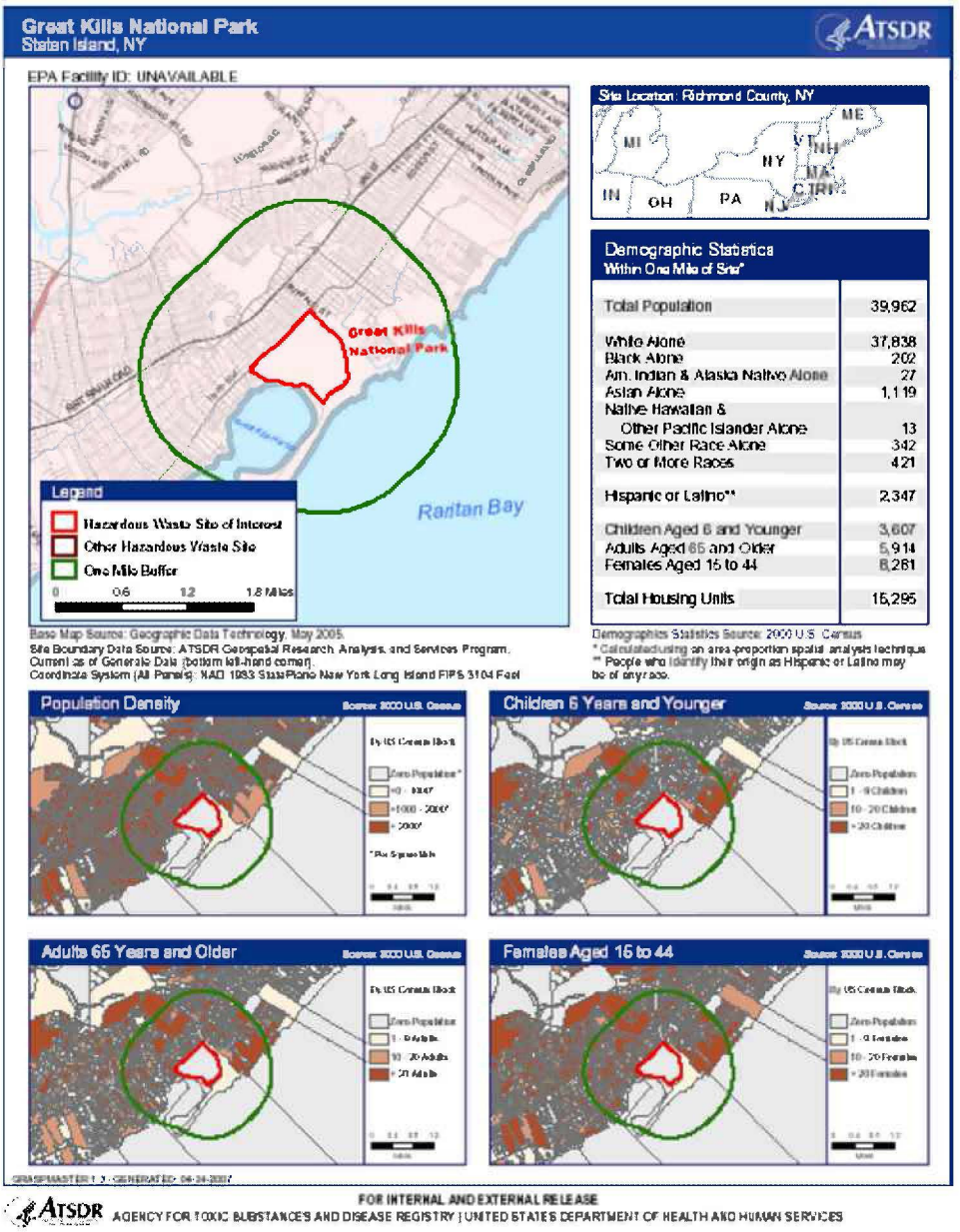

Figure 2. Demographic analysis for Great Kills Park

Community Health Concerns

The public health concern associated with this site is the impact of external radiation exposure in the park during recreational activities.

Discussion

The information supplied to ATSDR is narrow in scope. The readings, shown in Table 1, indicate the locations of the areas of contamination; moreover, these data are external radiation readings only and no indications of the total area of contamination are given. Estimation of radiation dose can be made based on these data; however, one must be aware that the estimates are limited in nature and apply only to a maximum distance of 3 feet from the discovered contamination. Therefore, these results should only be used for informational purposes and not to determine the adequacy of regulatory compliance.

For the evaluation of radiological dose that one might receive using the specific areas of Great Kills Park, ATSDR used the following parameters. 1) Park hours of operation – 10 hours per day; 2) length of soccer and baseball and softball season of 229 days and 138 days, respectively; and 3) the exposure rate varying over the range of the reported values. That is, any exposures were possible from the contact rate out to a distance of 3 feet. Table 1 gives the exposure data supplied to ATSDR.

Because of the uncertainty in these exposure parameters (time and distance), ATSDR performed an uncertainty analysis using commercially available software. Realizing that an individual would not necessarily use the park for 10 hours per day nor continuously occupy the 3 foot diameter area around the elevated readings, ATSDR selected a normal distribution with the average time in the contaminated area of 3 hours per day. For the possible maximum exposures, ATSDR also selected a triangular distribution with the most probable exposure rate being the geometric mean of the measurements. The reasoning is that for an individual to receive the contact exposure rate, they would have to remain on that exact location during their time in the park. The parameters used are supplied in Table 2.

The estimated average radiation exposures and the estimated upper boundary of the radiation exposures are given in Table 3. The assessment of radiation exposure on children requires special considerations as the activities of children, even those of different ages, vary significantly from that of adults. For example, the outdoor activities of children typically exceed those of adults or even adults who maintain active lifestyles. Children may engage in hand-to-mouth behaviors that increase their exposure potential to contaminated soils or water and their rates of respiration can differ from adults. Other factors that require children-specific evaluation include body mass, age, height, and weight. For some radiological contaminants special consideration must also be given for specific organs as many radioactive substances concentrate in one particular organ.

Table 3The average exposure is what ATSDR believes a maximum user of the park will receive and the upper bound estimates that 97.5% of all users would receive a radiation exposure less than the value given in the table.

Table 1. Radiation exposure data for Great Kills Park*

Hotspot Location	*Ground Contact*	*1 foot elevation*	*3 foot elevation*	*Area Background*
Ballfield 1	3.2	0.90	0.40	0.009 to 0.025
Brush Fire	0.42	0.14	0.07	
Sewer Line 1	10.5	3.0	1.04	
Sewer Line 2	2.37	0.73	0.32	

* The exposure data are given in milliroentgens per hour (mR/h).

Table 2. Activity use parameters for Great Kills Park

Location	*Time in park*	*Days of Activity per year**
Baseball Field 1	3 hours per day with 95% of the population there 7 hours per day	For soccer, 229 days For baseball, 138 days
Brush Fire Area		
Sewer Line Area 1		
Sewer Line Area 1		

* The activity presumes the typical park user is in the park playing either soccer or baseball everyday.

Child Health Considerations

The assessment of radiation exposure on children requires special considerations as the activities of children, even those of different ages, vary significantly from that of adults. For example, the outdoor activities of children typically exceed those of adults or even adults who maintain active lifestyles. Children may engage in hand-to-mouth behaviors that increase their exposure potential to contaminated soils or water and their rates of respiration can differ from adults. Other factors that require children-specific evaluation include body mass, age, height, and weight. For some radiological contaminants special consideration must also be given for specific organs as many radioactive substances concentrate in one particular organ.

Table 3. Estimated Annual Radiation Exposures in Great Kills Park*

Park Location	*Activity*	*Average annual estimated radiation exposure (mR)*	*Upper bound of radiation exposure (mR)*
Ball field 1	Soccer	1065	3000
	Baseball	640	
Brush fire area	Soccer	150	245
	Baseball	90	
Sewer Line area 1	Soccer	3360	6000
	Baseball	2035	
Sewer Line area 2	Soccer	875	2500
	Baseball	530	

*** The estimated radiation exposures are given in units of milliroentgens (mR)**

Because several of the areas of the park are not in the typical use areas, ATSDR also estimated the radiation dose an individual might receive while walking through the contaminated areas. These times ranged from a maximum of approximately 1 minute and an average of 36 seconds. The calculated doses from this estimation are given in Table 4.

Table 4. Estimated radiation doses from walking near the contaminated areas.

Park Location	*Average annual estimated radiation exposure (mR) from walking near areas*	*Upper bound of radiation exposure (mR)*
Ball field 1	18	48
Brush fire area	2.5	6.5
Sewer Line area 1	56	157
Sewer Line area 2	15	37

Conclusions

ATSDR has reviewed limited radiological exposure data for Great Kills Park, Staten Island, New York. Because the data for this site was very limited in scope, ATSDR determined that an uncertainty analysis would be necessary in an attempt to characterize the potential impact on those individuals using the park in recreational activities. These activities were limited to soccer and baseball in those specific areas of the park where the radiation readings were determined to be above regional background levels that ranged as high as 0.025 mR/h or about 150 mR per year. Also included in the evaluation was an individual walking near the contaminated areas. Including all sources of radiation, the annual background radiation in the United States is about twice this value. The total background would include radiation from soils, water, food, cosmic rays, nuclear fallout from atmospheric tests, Chernobyl, and other man-made radiation generating devices such as medical examinations[4].

The ATSDR conclusions are based on the limited information supplied and analyses of this information. The request from the EPA was to evaluate exposures that have occurred in the past for these areas of concern. **Based on this information, ATSDR considers the known contaminated areas to be an Indeterminant Public Health Hazard**. Nonetheless, ATSDR believes the hazards to public health from past exposures are not expected to be a health hazard for the following reasons.

1) The currently available limited data indicate the contamination detected thusfar, is only in 4 distinct areas;
2) The radiation exposure measurements at these locations indicate significant attenuation at a distance of 3 feet;
3) The brush fire area and sewer line areas do not appear to be locations where significant amounts of activities occur;
4) The baseball field contamination appears to be limited to an area outside the typical base paths;
5) It is very unlikely that an individual would remain in the exact 3 foot radius of where the contamination was detected for 3 hours or more; and
6) The most likely scenario is one of an individual walking briefly through the contaminated areas.

Recommendation

ATSDR believes there is currently insufficient data to fully characterize the extent of the potential contamination in Great Kills Park. As such, the following recommendations are put forth for consideration by the EPA, the US Park Service, and the City of New York.

1. Perform historical archive search to evaluate the types of radiological and/or chemical materials that may have been in the fill used during park construction in order to determine the type of sampling and analyses needed to characterize the park
2. Based on the historical analysis, perform a complete characterization of the park to include at a minimum surface radiological readings, soil borings; and

[4] ATSDR (1999). Toxicological Profile for Ionizing Radiation. Atlanta: US Department of Human Services

3. Perform detailed characterizations of the current elevated radiation areas and any additional areas that might be located using appropriate analyses such alpha spectroscopy, beta analyses, and gamma spectroscopy.

Public Health Action Plan

1. The areas of currently detected contamination have been restricted from use by the National Park Service.
2. ATSDR will be available to the EPA and partners through interactions with the ATSDR Region II office as needed.
3. ATSDR will review additional data as it becomes available to determine if this documents needs to be revised.

Authors, Technical Advisors

Paul A. Charp, Ph.D.
Senior Health Physicist
Site and Radiological Assessment Branch