ENVIRONMENTAL ASSESSMENT

FOR

THE CONSTRUCTION AND OPERATION

OF THE

ELECTRON-ION COLLIDER

BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

U.S. DEPARTMENT OF
ENERGY

Office of Science

BROOKHAVEN SITE OFFICE

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1.0 INTRODUCTION

The United States (U.S.) Department of Energy (DOE) has prepared this Environmental Assessment (EA) to evaluate the potential environmental consequences of upgrading the Brookhaven National Laboratory (BNL or Laboratory) Relativistic Heavy Ion Collider (RHIC) to accommodate the addition of electron accelerator facilities in order to create an Electron-Ion Collider (EIC). Upgrading will allow further investigation into the basic structure of the atomic nucleus and its subatomic components in order to understand the basic structures governing all matter in the universe. This project would ensure the continued operation of the RHIC complex, the development of the EIC, and future operations of the EIC.

The EIC project is a partnership between Brookhaven National Laboratory in New York and the Thomas Jefferson National Accelerator Facility (TJNAF) in Virginia. While the accelerator facility housing the experiment is located at BNL a substantial portion of the detector development, magnet construction, and other supporting work will be conducted at TJNAF. The development and review of this EA has been coordinated with TJNAF and it has been determined that the scope of the work conducted at TJNAF falls under the 2007 Environmental Assessment, Proposed Upgrade and Operation of the CEBAF and FEL Accelerators and Construction and Use of Buildings Associated with the 2005 Ten-Year Site Plan at the Thomas Jefferson National Accelerator Facility, Newport News, Virginia (DOE/EA-1534), which is incorporated into this EA by reference. Therefore, this EA will focus on work planned at BNL.

The Preferred Alternative is to design and construct an EIC using components of the existing RHIC facility and to cover all foreseen maintenance, upgrades - including new buildings, roads, electrical distribution and other enhancements within the RHIC/EIC Complex to ensure long-term operational success of the EIC. This will support the next frontier in nuclear physics fulfilling, in part, the scientific mission of the Department of Energy.

Alternatives considered are described. This EA will be used to determine whether a “Finding of No Significant Impact (FONSI)” to the environment would result from the development and construction of an Electron-Ion Collider with upgrades and enhancements to existing facilities to support operations of an electron-ion collider, or whether an Environmental Impact Statement (EIS) must be prepared.

This document complies with the National Environmental Policy Act (NEPA) of 1969, as amended (42 USC 4321-4347); the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 CFR 1500-1508); and the DOE NEPA Regulations (10 CFR 1021).

2.0 SUMMARY

BNL is a national laboratory overseen and primarily funded by the Office of Science (SC) of the DOE, and operated and managed by Brookhaven Science Associates, LLC (BSA). BSA is a limited liability company, formed between Battelle Memorial Institute and The Research Foundation of the State University of New York (SUNY) on behalf of Stony Brook University (SBU). Located 60 miles east of New York City in Upton, NY, BNL conducts research in high energy and nuclear physics, chemistry, nanotechnology, environmental sciences, energy technologies and national security (See Figures 1 and 2). Among its missions, the Laboratory is charged with conceiving, designing, constructing and operating world-class, complex, leading-edge research facilities in response to the mission needs of DOE and to a large community consisting of university, industry, government and international users (BNL 2020).

This EA analyzes the potential environmental impacts associated with:

- The No Action Alternative in which no modifications beyond sPHENIX occur to the RHIC, RHIC operates to end of planned experiments
- Development of an EIC and modifications/upgrades to existing facilities, construction of new facilities, development and construction of electron accelerators and associated detectors supporting the EIC

In the No Action Alternative, BNL would continue to operate the RHIC Complex (See Figure 3) in its current configuration and continue all activities within the current configuration including sPHENIX for the foreseeable future or until current experiments are completed.

A summary of the potential environmental impacts of the alternatives is presented in Table 1. Full analysis of these topics is covered in the Environmental Impacts section of this document.

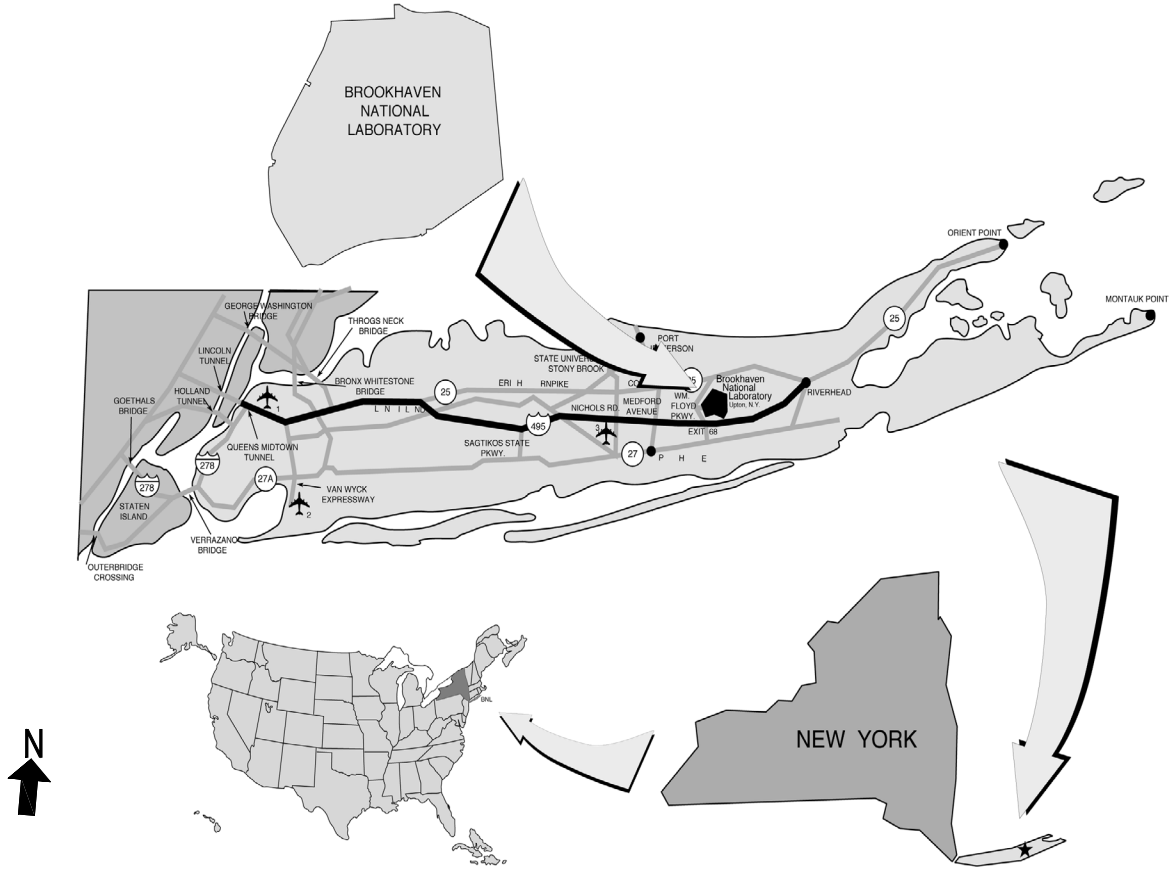


Figure 1: Regional View of Brookhaven National Laboratory Location

Figure 2: Aerial View of Brookhaven National Laboratory Core Developed Area

1. Relativistic Heavy Ion Collider
2. NASA Space Radiation Laboratory
3. Alternating Gradient Synchrotron
4. Alternating Gradient Synchrotron Booster
5. LINAC and Brookhaven LINAC Isotope Producer
6. Tandem to Booster Tunnel
7. Interdisciplinary Science Building
8. Center for Functional Nanomaterials
9. National Synchrotron Light Source II
10. Computational Science Initiative
11. Tandem Van de Graaff and Cyclotron
12. Accelerator Test Facilities
13. Medical Isotope Research Laboratories

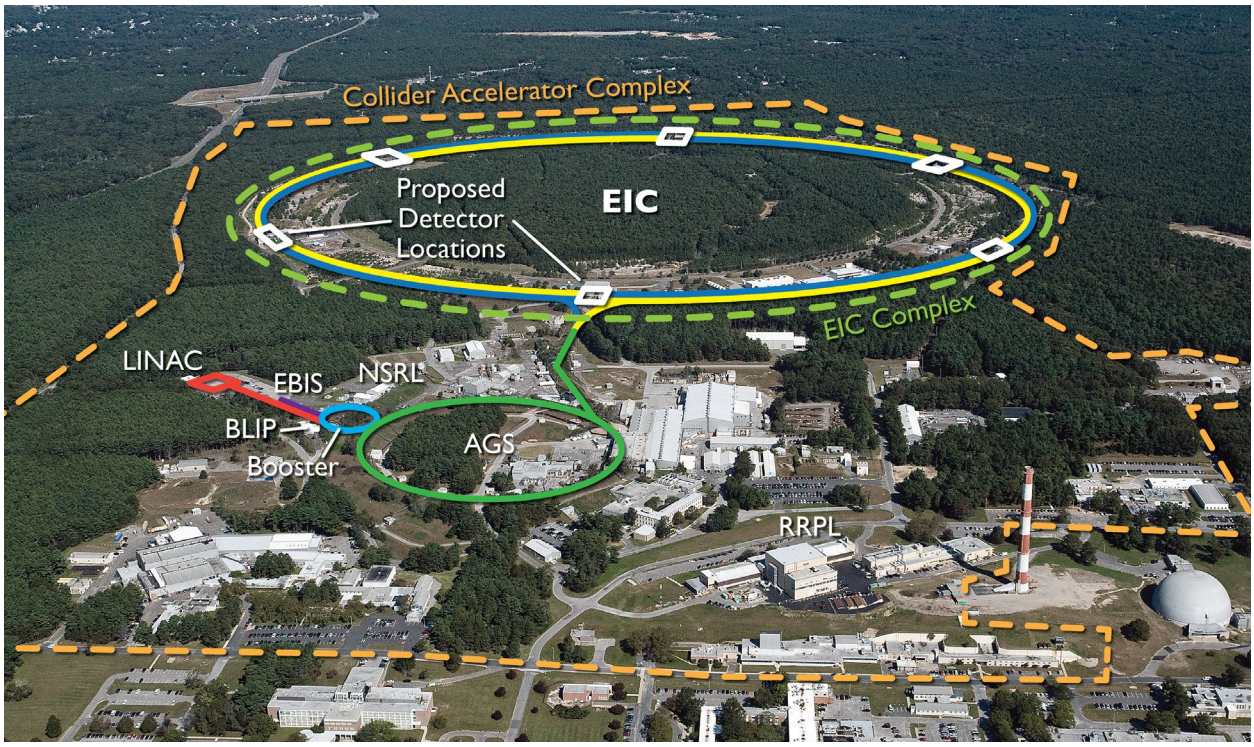


Figure 3. Collider Accelerator Complex with EIC Complex Boundaries shown.

Table 1: Summary of Potential Environmental Impacts and Controls for the No Action Alternative, and the Preferred Alternative

Comparison Factors	The No Action Alternative	Preferred Alternative
General Information	No change from the existing BNL operations.	No Change
Ecological Resources	No change from the existing BNL operations.	Approximately 10 acres could be cleared of which 3-4 acres were previously disturbed, remaining acreage cleared would be adjacent to previous disturbance. Impacts to resources expected to be minimal and no impact to threatened or endangered species would be expected.
Water Resources	No change from the existing BNL operations.	Increase in the amount of water needed for cooling using conventional cooling towers. Increased water needs for cooling towers may necessitate an additional well. Most water is returned to groundwater. Potential for violations of SPDES permit limits if alternative anti-corrosion chemicals used in cooling towers are ineffective or alternative cooling options are not possible. Water from impermeable surfaces is directed to dry wells or existing recharge basins.
Land Use, Demography, and Environmental Justice	No change from the existing BNL site conditions.	No Change
Socioeconomic Factors	No change from the existing BNL site conditions and operations.	No change.
Transportation	No change from the existing BNL site conditions.	Minor Increase over current conditions mostly during construction similar to what has been seen with other recent construction. Operational period would see minor increases from research community.
Cultural Resources	No change from the existing BNL site conditions.	No impacts to cultural resources
Air Quality	No change from the existing BNL site conditions.	Air quality would likely not change, electric purchases may be from renewable sources or offset by renewable energy credits where possible.

Table 1: Summary of Potential Environmental Impacts and Controls for the No Action Alternative, and the Preferred Alternative		
Comparison Factors	**The No Action Alternative**	**Preferred Alternative**
Climate	No change from the existing BNL site conditions.	Climate change is not likely to impact operations. Construction may result in some increase of greenhouse gasses from truck and machine operation. Operations would be expected to use energy efficiency measures and purchase of renewable energy or renewable energy credits, where possible, to offset GHG emissions. BNL's refrigerant management and recovery strives to reduce or eliminate releases.
Visual Quality	No change from the existing BNL site conditions.	New structures at the bldgs. 1002 and 1010 areas of the EIC would be visible from the adjacent Peconic River but would not be visible from the William Floyd Parkway or neighborhood to the north.
Parkland	No Change from the existing BNL site conditions.	No Change
Noise	No change from the existing BNL site conditions.	Routine construction noise would occur during the construction period, noise would return to normal levels during operational period. New compressor buildings would utilize new quieter compressors.
Industrial Safety and Occupational Health	No change from the existing BNL site conditions.	No Change
Radiological Characteristics	No change from the existing BNL site conditions.	No significant change
Natural Hazards	No change from the existing BNL site conditions.	No Change
Intentional Destructive Acts	No change from the existing BNL site conditions.	No Change
Utilities	No change from the existing BNL site conditions.	Project would result in increases in electric usage, increase in water, and increase in sanitary discharges. Water and sanitary increases are expected to be within historic ranges. New infrastructure for electric, water, and sanitary would be necessary (i.e. transmission lines, potable water lines, and sanitary lines).

Table 1: Summary of Potential Environmental Impacts and Controls for the No Action Alternative, and the Preferred Alternative		
Comparison Factors	**The No Action Alternative**	**Preferred Alternative**
Electric and Magnetic Fields (EMF)	No change from the existing BNL site conditions and operations.	New electric transmission lines would meet current standards and would be similar to existing infrastructure. EMF internal to the EIC would be managed to limit or eliminate personnel exposures.
Waste Management and Pollution Prevention (P2)	No change from the existing BNL site conditions and operations.	Minor Increase during demolition of unused RHIC components and construction of the EIC, returning to routine levels during operations. Reuse and recycling of materials would be maximized where possible.
Commitment of Resources	No change from the existing BNL site conditions.	Construction of the EIC would require steel, concrete, wood, copper, etc. to establish new accelerators and storage rings, and the associated structures needed to support the establishment of the EIC. Operation would utilize electricity, water, and helium.
Decommissioning and Restoration	No change from the existing BNL site conditions	Same as No Action, decommissioning and restoration activities would be planned to minimize impacts.

3.0 PURPOSE AND NEED

The mission of the Department of Energy's Nuclear Physics (NP) program is to discover, explore, and understand all forms of nuclear matter. NP supports experimental and theoretical research - along with the development and operation of particle accelerators and advanced technologies - to create, detect, and describe the different forms and complexities of nuclear matter that can exist in the universe, including those that are no longer found naturally.

The purpose of the EIC project is to deliver a fully functional Electron-Ion Collider at Brookhaven National Laboratory including the accelerator complex and one or more detectors. The EIC is necessary to understand the basic properties or building blocks of the nuclei; and how quarks and gluons, the particles that make up neutrons and protons are held together and interact. This will allow advancement of our understanding of nature; further fundamental science and technological innovations; and advance the energy, economic, and national security of the United States.

The DOE has identified a national need for the design and construction of an Electron Ion Collider which meets the full range of the Nuclear Science Advisory Committee (NSAC) 2015 Long Range Plan parameters, including:

- Collision Luminosity of at least $1x10^{33}$ - $1x10^{34}/cm^2/s$
- Variable Center-of-Mass Energy of 20 -140 GeV
- One Interaction Region with the ability to add a second
- One Detector with the ability to add a second
- Complete the construction project in 10-15 years
- Deliver the facility within a cost range of $1.6B-$2.6B
- Consider the ability to collide polarized particles
- Maintain and operate the facility with routine improvements for the foreseeable future

The design and development of the EIC is being done under a partnership between BNL and TJNAF. The accelerator facility would be constructed and operated at BNL utilizing the existing RHIC accelerator facility and infrastructure, while substantial development and construction of magnets and detectors would occur at TJNAF. The work to be completed at TJNAF falls under the types of work historically accomplished there and a review of the proposed EIC work was evaluated and found to fall within the scope of the 2007 Environmental Assessment, Proposed Upgrade and Operation of the CEBAF and FEL Accelerators and Construction and Use of Buildings Associated with the 2005 Ten-Year Site Plan at the Thomas Jefferson National Accelerator Facility, Newport News, Virginia (DOE/EA-1534), which has been incorporated into this EA by reference.

4.0 ALTERNATIVES

4.1 Alternative 1 – (Preferred Alternative)

4.1.1 Project Location and Description

Figure 3 depicts the general layout of the RHIC (future site of the proposed Electron-Ion Collider). The RHIC Complex houses the accelerators that collide particles and will be utilized extensively for the development of the EIC facility.

Facilities addressed in this EA include:

- AGS to RHIC Transfer Line (AtR) for injection of ions into the hadron accelerator
- Existing facilities associated with the Relativistic Heavy Ion Collider (RHIC)
- Existing TJNAF facilities and operations (see DOE/EA-1534, incorporated by reference)
- New Facilities planned for EIC

Building an EIC will maintain and expand U.S. leadership in nuclear physics and accelerator science—fields of science that have impacts in health (diagnostic and therapeutic medical isotopes, accelerator advances for cancer treatment, and drug discoveries), national security (detector technologies for screening at borders, nuclear security), energy (methods to make and study computer chips, batteries, and electronics), and the development of computational tools for managing all kind of "big data" systems. The project will also serve as a training ground for numerous students (hundreds) who will apply their expertise in a range of careers that fuel the economy, provide for security, and pave the way to a healthier, brighter future for all. The project will push the state-of-the-art in particle accelerator and detector technologies, two areas with wide-ranging economic and health impacts.

The conventional facilities required for the EIC will include:

- the buildings and structures that will house the scientific equipment and utility systems
- the utility services (electric, water, sanitary, com/data) required to power, cool, occupy and communicate among the science facilities
- the site infrastructure modifications needed to provide access roads, parking and proper drainage for the EIC site and its facilities

Conventional facilities do not include the scientific apparatus and specialized equipment that accelerate particles and detect and analyze their collisions.

The new buildings proposed for the EIC will include (see Figure 4 for locations):

- four small "Alcove Buildings"
- two large Alcove Buildings
- Cryogenics Equipment Facility at RHIC 1006
- Kicker Power Supply Building at RHIC 1012
- Cryogenics Equipment Facility at RHIC 1002
- two-story Electron Injector Source Building at RHIC 1002
- Cryogenics Equipment Facility at RHIC 1010

- two-story Radiofrequency (RF) Power Facility at RHIC 1010
- two-story Kicker Power Supply Building at RHIC 1012
- An arch-plate tunnel extension of approximately 100m at the 2 o'clock location

Please see Table 2 for a summary of anticipated building needs and approximate sizes:

Table 2: Summary of new buildings for the EIC complex

Building Designations	Estimated GSQFT	Remarks
Alcove Buildings: ALC-01, ALC-03, ALC-05, ALC-11	8,000	4 @ 2,000 SF ea.
Main Alcove Buildings: ALC-07, ALC-09	10,000	2 @ 5000 SF ea.
Cryo Facility 1006	1,200	
Kicker Power Supply 1004	9,000	Two stories
Cryo Facility 1002	2,400	
eSource Building 1002	21,200	Two stories, includes SHC facility.
Cryo Facility 1010	7,200	
RF Building 1010	70,800	Two stories
Kicker Power Supply 1012	15,200	Two stories
Tunnel Extension at 2 o'clock	4,200	Buried arch - plate
TOTAL	**149,200**	**Gross SQFT**

The envisioned construction type for each building will be reinforced slab on grade with perimeter footing, structural steel frame with composite reinforced concrete slab on metal deck for upper floors, and insulated metal panel exterior. Roofing may be a combination of standing seam metal roof, built-up bitumen or membrane roof systems.

Although the building design will generally involve standard commercial design and construction techniques, there are some additional considerations due to the specific requirements of the integration required with the existing accelerator facility. Unique types of equipment will be installed and operated in these buildings. For example, RF power equipment, lasers, cryogenics, large quantities of magnets and power supplies, and vacuum chambers required to perform at an ultra-high vacuum are all planned for installation in these spaces. In addition to buildings and structure design, systems for support of the scientific and experimental equipment, power distribution and other utilities will be required:

- power and water distribution facilities, storm and sanitary drain

- Cooling tower and process water systems. The project will consider air-to-air and geothermal systems as alternatives to minimize or eliminate use of cooling tower water to minimize water consumption, chemical usage and biological growth potential.

- numerous tunnel access ports and

Special consideration will be given to the stability of the existing buried arch plate tunnel structure to eliminate instability by asymmetric unloading and loading of the tunnel during excavation and reburial. Consideration will also be made in some of the building designs to minimize sources of vibration and transmission of vibration that would impact beam stability in the accelerator and experimental beamline areas and laser spaces. There will also be specific temperature and humidity stability requirements in the accelerator, laser, cathode production and other laboratory spaces that will require HVAC system and control design that exceeds standard commercial practices. Building and tunnel designs and orientation will be such that future expansion or extension will cause minimal disruption; therefore designs will be readily extensible using standard techniques (i.e. modularity).

The EIC project scientific equipment would include:

- Addition of an electron injector consisting of a polarized, room temperature photo-electron gun and a subsequent 400 MeV S-band injector linear accelerator (linac) which will be installed in an existing straight tunnel connected to the RHIC tunnel.
- Addition of a spin transparent 400 Mev-18 GeV rapid cycling synchrotron (RCS) with normal conducting magnets and superconducting RF cavities, to be installed in the RHIC tunnel including the transport line which connect the linac to the synchrotron.
- Addition of a 5 GeV-18 GeV electron storage ring (eSR) inside the existing RHIC tunnel.
- Modifications of the hadron ring RF systems to allow for 1320 bunches including a superconducting high frequency RF holding system, modification of the injection systems and provisions for path-length changes to allow for low energy hadron operation at the high energy revolution time, removal of the DX magnets which limit presently the achievable RHIC (proton) beam energy to 255 GeV.
- An EIC interaction region with superconducting final focus magnets, crab-cavities for both hadrons and electrons and a pair of spin rotators for electrons to provide longitudinally polarized beams in collisions
- Development and construction of a detector in the interaction region. Significant input from the user community will be required before the exact design is finalized.
- A strong-hadron-cooling facility to reduce and maintain the hadron beam emittance to the level needed to operate with the anticipated luminosity. This facility consists of a high current electron source (presently estimated at 100 mA) and a 150 MeV superconducting energy recovery linac followed by 150 MeV beam transport channels to propagate the electrons together with hadron beam in two vacuum sections called “modulator” and “kicker” sections. In between these two sections is a series of electron bunch compressors and strong focusing. An additional section of beam transport will return the beam to the linac for energy recovery.
- An option to replace the existing branch tunnel at 2 o’clock with a larger tunnel section for the hadron cooling facility
- Development of an enhanced 2^{o}K liquid helium (He) cooling capacity (cryo facility),

enhanced water-cooling capacity (cooling towers and chillers) as well as air-conditioning the RHIC tunnel.

All existing RHIC facilities would be utilized under both the No Action Alternative and the Preferred Alternative. Existing RHIC Facilities include:

- AGS to RHIC transfer line
- Hadron accelerators
- RHIC tunnel
- Interaction buildings at 1006 (STAR), 1008 (sPHENIX), 1010, 1012, 1002
- Cryogenic Plant at 1005 and Helium tank farm
- Facilities at 1004
- 1005 Office and Science Building
- Cooling Towers and Electrical systems

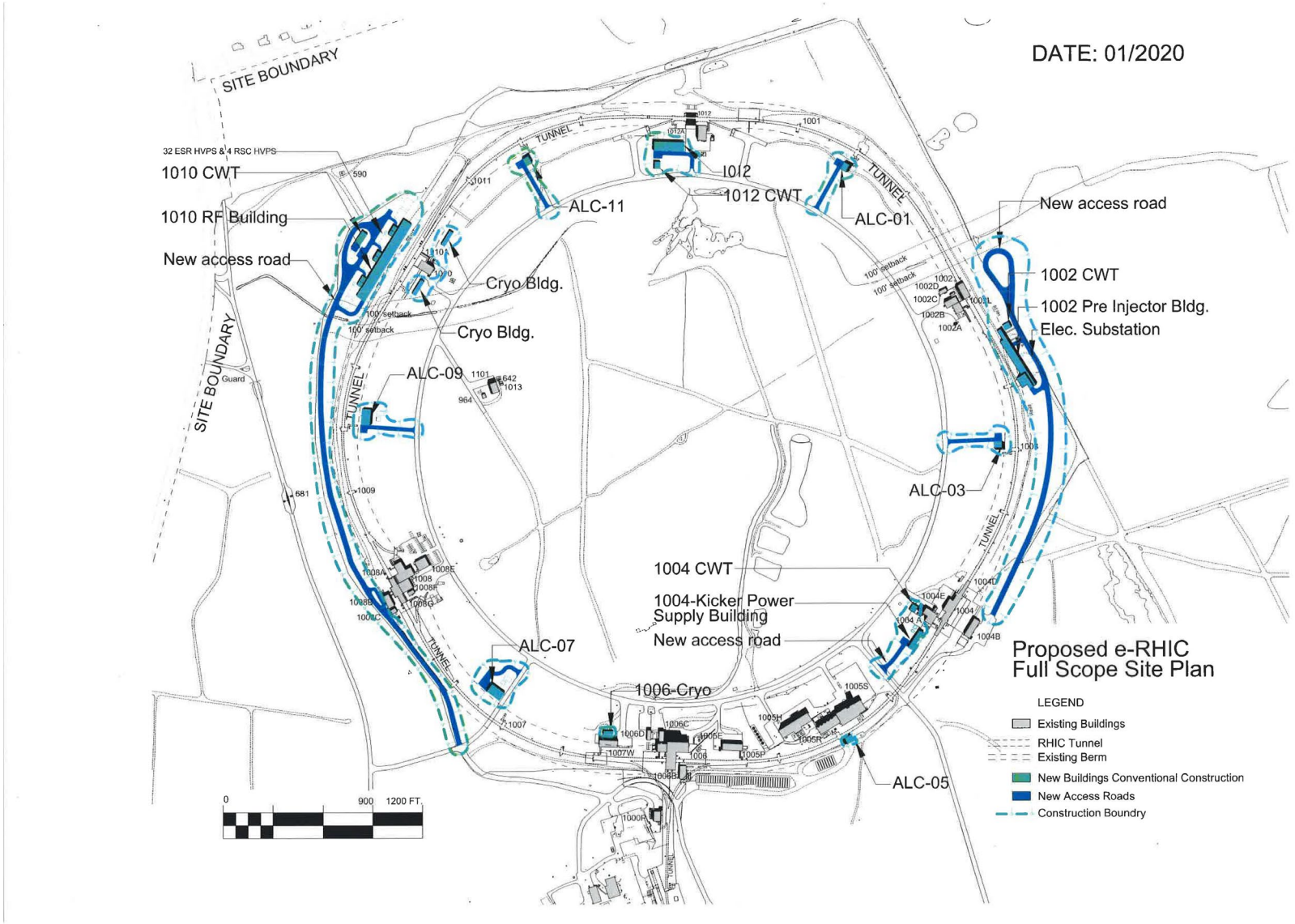


Figure 4: Geographic Layout of the EIC Complex

4.1.2 Future upgrades and maintenance

Future upgrades supporting operations for 15 to 20 years after construction ends and may include potential new detector(s) at a second interaction region. Experimental upgrades to accelerators may involve improvement of beam acceleration systems, beam control systems, beam monitoring systems, and beam extraction capabilities. These actions may also improve experimental facilities used by the experimental community, provide general environment and safety upgrades, and improve overall operations efficiency. Most of the actions typically require the installation of new or modified accelerator equipment or systems within the developed portion of the existing accelerator enclosures. These actions typically result from component failures or new scientific breakthroughs.

In order for science and technology development efforts to continue excellence in safety and environmental protection, there could be continued renovation and modernization of existing shops, offices and mechanical / electrical infrastructure in order to provide safe and efficient support facilities.

4.1.3 Decommissioning and Restoration

Decommissioning plans for each accelerator, accelerator facility, RHIC detectors (STAR, sPHENIX, etc.), EIC detectors, and support facilities would be developed near the end of their operating lifetime. In that way, plans would be in compliance with existing requirements at that time. At that point in time, the Laboratory will determine the wastes associated with decommissioning. Of the utmost importance will be to ensure the safety of the workers, protecting the public and the environment, and complying with the applicable state-, local-, and federal regulations. Key to safe decommissioning is managing the wastes from operations, or other hazardous materials that might remain in the facility after shutdown, as well as those wastes generated during decommissioning itself. Therefore, BNL will establish records during operations that identify the types and quantities of these materials. These records currently include spill reports, inventories of all chemicals, records on beam-loss events, hazardous waste records, radioactive waste records, area radiation surveys, work planning documents, and radiation work permit information.

4.2 Alternative 2 – No Action

The No Action Alternative would maintain the current conditions and operations of the RHIC complex. The RHIC mission would continue for the foreseeable future, and in addition to the routine maintenance and modifications of facilities and equipment, could include the development of the sPHENIX experiment. No additional ground disturbance would be expected under the No Action alternative.

5.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

This section describes the general environment in the area for the proposed alternatives along with specific environmental elements that may be affected. The effects of each alternative on these elements are presented within each subsection. Both alternatives have similar impacts, therefore the description of effects will be for all alternatives unless there is a variance between

alternatives. Variable effects under any specific target will be parsed out and a description of the effects will be detailed. For additional information on BNL, including detailed environmental monitoring results, please refer to BNL's annual Site Environmental Report (BNL 2020).

5.1 Site Description

BNL encompasses a total of 5,265 acres (2,131 hectares) with most principal facilities located near its central developed area, which occupies approximately 1,820 acres (737 hectares). The remaining 3,445 acres (1,394 hectares) of the site are largely wooded and part of the Long Island Central Pine Barrens (CPB) region. The CPB is divided into two areas 1) the compatible growth area where development is allowed but must meet minimum standards; and 2) the core preservation area where development is not allowed except under rare exceptions. The central portion of BNL is within the compatible growth area as designated by the Central Pine Barrens Joint Planning and Policy Commission (Commission), while the areas outside the central portions of the Laboratory are designated as Core Preservation Area by the Commission. The Peconic River is the major surface water feature found on the BNL site. Its headwaters start west of the BNL site, and it flows eastward through the RHIC complex leaving the site near the southeast corner of BNL. The onsite portions of the Peconic River have been designated as "Scenic" by the NYSDEC under the New York State Wild, Scenic, and Recreational Rivers Act (NYS WSRRA). Under the Act, the NYSDEC has established a 0.5-mile (0.8 km) buffer on either side of the river which limits certain activities and development that are not compatible with the designation. BNL, as a federal enclave, is not bound by NY State Environmental Conservation Law (ECL) Article 57 establishing the Central Pine Barrens or the NYS-WSRRA. However, DOE works within the spirit of these laws whenever possible by conducting review of standards and/or applying for appropriate permits. The majority of the proposed EIC complex, including likely disturbance areas, falls within the Core Preservation Area of the Central Pine Barrens and is completely within the 0.5-mile buffer of the Peconic River.

5.2 Ecology

5.2.1 Affected Environment

The Laboratory has a comprehensive understanding of the various ecological resources present on-site through multiple efforts including an extensive biological investigation conducted in the mid-1990s called the Site Wide Biological Inventory (Lawler, et. al, 1995); the Natural Resource Management Plan (NRMP) (BNL, 2016); the establishment of the Upton Ecological & Research Reserve (Upton Reserve) in 2000; and the subsequent studies conducted under both the Upton Reserve and Natural Resources Program as well as volunteer work conducted by the Foundation for Ecological Research in the Northeast (FERN), a non-profit organization. Additionally, work associated with the Peconic River remediation project provided extensive information concerning contaminants in sediments, fish, and vegetation associated with the river both before and after remediation.

Vegetation

Vegetation at BNL is for the most part typical of the Pine Barrens in which the site is situated. A 2003 aerial photo analysis of vegetation on-site identified 12 vegetation classes. Vegetation ranges from open lawns and early successional vegetation areas associated with the constructed portions of the Laboratory, to mature forests and pine plantations. Historically, much of the forested area of the BNL site has been disturbed by tree cutting for fuel (cord wood

industry 1800s) to extensive site-wide clearing of trees for the establishment of Camp Upton during World War I. The forests are in various stages of succession. More than 350 species of plants have been identified on the BNL site with thirty-three of these being identified as NY State designated threatened, endangered, rare, or exploitably vulnerable. Although some of the thirty-three plants may occur within the central portion of the RHIC complex they are not expected to be impacted by any construction or operational activities. One species that may be impacted is pink lady's slipper (*Cypripedium acaule*) which is known to grow on the tunnel berms at the 3 o'clock position.

Peconic River

What is now known as the Peconic River on the BNL site was considered swamp or wetlands prior to World War I. Starting with construction during World War I the wetlands were trenched or ditched to facilitate drainage and water flow to reduce the number of mosquitoes and related mosquito borne diseases. The on-site sections of the Peconic River and its tributaries continue to show evidence of these trenching activities with ditches ranging from 6 to 12 feet (1.8- 3.6 meters) wide and up to 4 feet (1.2 meters) deep along with side cast sediment. This ditching extends from an area west of the William Floyd Parkway, through the BNL site including the RHIC/EIC area, and past the BNL eastern boundary.

Invasive Species

The area of the proposed project contains several invasive species including Japanese Barberry (*Berberis thunbergii*), black locust (*Robinia pseudoacacia*), Asiatic bittersweet (*Celastrus orbiculatus*), Japanese stiltgrass (*Microstegium vimineum*) and phragmites (*Phragmites australis*). These species were intentionally introduced to the area as ornamentals (e.g. Japanese Barberry), inadvertently transported to Long Island and BNL by visitors, or transferred through movement by animals. The proposed project area has invasive species isolated to berms of the RHIC, within the drainage ways leading to recharge basins within the central portion of the RHIC/EIC complex, and along roadways and tunnel areas (black locust); and areas in and near recharge basins (e.g. barberry, bittersweet, and Phragmites).

Threatened, Endangered, or Species of Concern

The Northern long-eared bat (*Myotis septentrionalis*) was determined to be threatened under the federal Endangered Species Act in May 2015. This is the only federally threatened or endangered species known on the BNL property. Other federally threatened or endangered species listed for the Long Island region are located some distance away either in coastal areas or the Hempstead Plains to the west. The NY State designated endangered eastern tiger salamander (*Ambystoma t. tigrinum*) inhabits multiple wetlands on BNL including those found in the center of the RHIC/EIC complex. The RHIC/EIC Ring recharge basins have historically been documented to support tiger salamanders. The peregrine falcon (*Falco peregrinus*) is known to utilize the BNL site and has been documented nesting on the High Flux Beam Reactor Stack in 2019. This species typically hunts smaller birds and rodents and is not expected to utilize areas within the RHIC/EIC complex for nesting. Species listed by NY State as species of special concern that are present in the area of the RHIC/EIC complex include the eastern spadefoot toad (*Scaphiopus holbrookii*), eastern hognosed snake (*Heterodon platyrhinos*), spotted turtle (*Clemmys guttata*) and the eastern box turtle (*Terrapene c. carolina*). Other species of special concern that may periodically be seen in the proposed project are the Cooper's hawk (*Accipiter cooperi*), the sharp-shinned hawk (*Accipiter striatus*), red-headed woodpecker (*Melanerpes erythrocephalus*), and osprey (*Pandion haliaetus*). A full listing of threatened, endangered,

special concern species and species of greatest conservation need may be found in the annual Site Environmental Report (BNL 2020).

Migratory Birds

Under the Laboratory's Natural Resource Management Plan, bird surveys have been conducted through all of the major habitat types on site. Surveys have been conducted April through August annually since 2000, and a total of 134 species of birds have been documented. Additionally, birding has been an avid pastime for many BNL employees. Between 1948 and the present, 216 bird species have been documented on-site and approximately 85 species routinely utilize BNL for nesting. A number of migratory birds listed by the U.S. Fish & Wildlife Service as birds of conservation concern or special status are known on the BNL site including the bald eagle (*Haliaeetus leucocephalus*), black-billed cuckoo (*Coccyzus erythropthalmus*), buff-breasted sandpiper (*Calidris subruficollis*), Canada warbler (*Cardellina canadensis*), eastern whip-poor-will (*Antrostomus vociferus*), lesser yellowlegs (*Tringa flavipes*), prairie warbler (*Dendroica discolor*), red-headed woodpecker, semipalmated sandpiper (*Calidris pusilla*), and wood thrush (*Hylocichla mustelina*) may utilize the Lab site and potentially be found within the proposed project area.

Mammals

A number of mammals utilize the various habitats at BNL, including the RHIC/EIC complex. The largest mammal found at BNL is the white-tailed deer (*Odocoileus virginianus*), which is present in numbers exceeding 30 per square mile (12 per sq. kilometer). Recent implementation of deer management has significantly lowered the number of deer within the constructed portion of the BNL campus. BNL also provides habitats for small mammals such as bats, mice, squirrels, rabbits and medium-sized mammals such as raccoons (*Procyon lotor*), red fox (*Vulpes velox*), and grey fox (*Urocyon cinereoargenteus*). Virtually all known mammal species found on the BNL site may utilize the area of the RHIC/EIC complex.

Since 2011 BNL has been documenting presence of bats on the BNL site. Bat species identified include the federally threatened northern long-eared bat, little brown bat (*M. lucifugus*), eastern small-footed bat (*M. leibii*), big brown bat (*Eptisicus fuscus*), red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*). All but the small-footed bat have been confirmed through capture or observation. The small-footed bat has been documented using acoustic surveys. All of these species may utilize trees during summer and the myotids may utilize buildings during other seasons.

Reptiles and Amphibians

BNL is home to 28 species of reptiles and amphibians. The various species are distributed throughout BNL but may be localized depending on their habitat requirements. Reptiles like the eastern box turtle may be found in virtually all habitats on-site, whereas many species of snakes and other turtles are localized near wetland resources. Frogs and toads are isolated around wetlands during breeding periods but may be found moving away from wetlands to forage for food during the late spring through summer months. Several salamander species can be found in and adjacent to wetland areas on-site. These salamanders include the NY State designated endangered eastern tiger salamander, marbled salamander (*A. opacum*), red-spotted newt (*Notophthalmus viridescens*), and red-backed salamander (*Plethodon cinereus*). Additionally, four-toed salamanders (*Hemidactylium* scutatum) are known to inhabit specific habitats along

the Peconic River containing tussock sedge (*Carex stricta*) and/or sphagnum mosses (*Sphagnum sp*.).

Fish

There are six species of fish known from the Peconic River on BNL including the NY State designated threatened banded sunfish (*Enneacanthus obesus*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), creek chubsucker (*Erimyzon oblongus*), and brown bullhead catfish (*Ameiurus nebulosus*). The swamp darter (*Etheostoma fusiforme*) a NY State designated threatened species is also known to use the Peconic River but has not been confirmed within the onsite stretch of the river. These species of fish utilize a variety of habitats within the river from slow moving backwater areas to deep open water pools. During high flow period's fish have been documented as far upstream as the ponds within the RHIC/EIC complex. In these rare cases fish had to overcome multiple barriers to fish passage. In general fish can only move up and downstream during extreme high water and flow periods which typically occur every 10 to 15 years.

5.2.2 Effects of Alternatives on Ecological Resources

Projected power and water requirements, and disturbance areas associated with the proposed EIC will not have impacts on ecological resources as new power transmission will be routed through previously disturbed areas and water discharges will be to existing basins, new dry wells, or the Sewage Treatment Plant which has a capacity of 2.3 mgd. Increases/decreases in radiological emissions are expected to be roughly equivalent to current conditions and existing or new shielding will ensure ALARA principles are met. Waste generation will be identified as specifically as possible and follow approved procedures to prevent ecological impacts.

Effects on Threatened, Endangered, or Species of Concern

The recharge basins and ponds that serve the RHIC and proposed EIC are known tiger salamander habitat. Discharges of storm water from the northern portions of the AGS complex and southern area of the RHIC including cooling tower blowdown are routed to recharge basins in the southern portion of the RHIC Ring (interior to Renaissance Rd.) where the northern most basin provides marginal habitat for tiger salamanders. The ponds associated with the Peconic River in the northern most area of the RHIC/EIC Complex provide habitat for tiger salamanders. In wet years and/or during heavy precipitation events water flows in the upper Peconic from west of the William Floyd Parkway under the accelerator tunnel at the building 1010 area. Monitoring of water has found no contaminants from existing operations that would cause impact to protected species. Tiger salamanders are known to move in an area extending more than 1000 ft. from wetland habitats and have been found in sumps, manholes, and other structures that may retain water. When they are found they are moved to appropriate habitat. Surveys within the RHIC wetlands have documented a healthy, reproducing population. Construction and operation under the Preferred Alternative are not expected to alter existing habitat of tiger salamanders. Furthermore, cooling tower discharges to basins have not impacted tiger salamanders or their habitat.

The northern long-eared bat (federally threatened) primarily utilizes trees for roosting during summer months. Winter hibernacula are suspected to occur somewhere on Long Island and possibly at BNL. This bat has been documented on the BNL site as early as March suggesting that there may be a small population of this bat overwintering either on or in the vicinity of BNL.

Bats in the genus *Myotis* are known to enter and utilize buildings for roosts and on rare occasions bats have been seen or captured in buildings of the RHIC complex. For buildings that may undergo demolition, BNL conducts multiple surveys using either acoustic monitoring or visual searches to ensure that no bats are impacted. In existing buildings, when bats are found or reported as nuisance animals, they are captured when possible, and released without harm. Under the Preferred Alternative a small amount of clearing would remove trees near the building 1010 area that had been previously cleared during construction of RHIC and at the building 1002 area. Neither clearing would be significant enough to reduce forest habitat supportive of summer roosting bats.

Effects on Migratory Birds

Radiation exposures from operations will be as low as reasonably achievable (ALARA) to all life and much less than DOE, EPA or other regulatory limits. The current RHIC program has not had any documented impacts on migratory birds and therefore the No Action Alternative is not expected to have impact.

Under the Preferred Alternative, clearing of trees at building 1010 and building 1002 areas may result in minor loss of nesting habitat but are not expected to have impacts on concerned species like black-billed cuckoo (*Coccyzus erythropthalmus*) that are found throughout the BNL site. Based on experience with other construction projects, cleared areas and construction sites may be attractive to Killdeer (*Charadrius vociferous*), a ground-nesting shorebird. Should this happen, nests are protected by symbolic fencing (stakes and flagging) and birds allowed to raise chicks. In instances where nests cannot be protected removals are carried out by individuals that possess appropriate permits. Since neither alternative will result in disturbance to wetlands within the center of the RHIC/EIC complex impacts to shorebirds are not expected. New buildings are not expected to have large expanses of glass that would result in bird strikes. Increased water use associated with cooling towers would result in increased amounts of water diverted to either recharge basins or sanitary which ultimately gets recharged to one of four basins after treatment. The basins are routinely used by shorebirds and increase flows would expand the available area for use.

Effects on Mammals

Radiation exposures will be ALARA to all life and much less than DOE, EPA or other regulatory limits. Larger animals, like deer, may enter bermed areas covering accelerator facilities, but do not receive significant radiological dose due to ALARA practices. BNL manages nuisance animals through the Natural Resource Management Plan. Nuisance animals such as rodents, raccoons, skunks, and opossums are occasionally reported as getting into buildings. When this happens, larger animals are trapped using live traps and appropriately released. Extensive efforts are made to identify where animals can enter buildings and the openings are sealed.

Effects on Reptiles and Amphibians

Radiation exposures will follow ALARA practices to minimize effects on all life and much less than DOE, EPA or other regulatory limits. There will be no significant changes to liquid effluents with any of the alternatives. The project will follow current practices and will only return secondary non-activated process cooling-water to the local groundwater. Cooling tower blow-down, if used, will be to the same outfalls currently used at RHIC or will be diverted to sanitary. The use of cooling towers, chillers, or geothermal systems will be determined as the project progresses. Anti-corrosion chemicals that may cause periodic permit excursions do not appear

to impact amphibians. Use of chilled water or geothermal systems would eliminate discharges to basins. Recharge basins receiving discharges, either storm water or cooling water, will continue to provide limited habitat for both reptiles and amphibians.

Effects on the Pine Barrens

The RHIC/EIC Complex is wholly within the core preservation area of the Central Pine Barrens. New construction of buildings at building 1002 and 1010 areas and roads leading to these two areas would total less than 10 acres of which approximately 4 acres had been previously disturbed. Clearing will be minimized where possible. Radiation exposures will be ALARA to all life and much less than DOE, EPA or other regulatory limits. Direct radiation exposures from operation of the EIC are not expected to be greater than the current RHIC operations which are roughly equivalent to background.

5.3 Water

5.3.1 Affected Environment

Water resources associated with BNL include both surface waters and groundwater.

Surface Water

BNL lies within the headwater region of the Peconic River watershed. The Peconic River is a groundwater fed stream. Standing and flowing water is observed during periods of high precipitation and high water table conditions. During extended periods of low precipitation, the Peconic River and its associated wetlands can be completely dry. Starting in late 2014 all discharges to the Peconic River from the sewage treatment plant were diverted to groundwater recharge basins. As a result, the Peconic River has reverted to a naturally functioning stream. Coastal plain ponds and ephemeral wetlands are also found throughout the site and provide habitat for a number of wildlife species including tiger salamanders. The Peconic River and its associated wetlands are the key wetland features on BNL. Several recharge basins are also found within the developed portion of the BNL site with some providing habitat to various wetland dependent species and are further discussed under impact to ecological resources in Section 5.2.2 above.

Scenic River Corridor

The onsite portions of the Peconic River have been designated as “Scenic” by the NYSDEC under the *New York State Wild, Scenic, and Recreational Rivers Act*. Under the Act, the NYSDEC has established a 0.5-mile (0.8 km) buffer on either side of the river which limits certain activities and development that are not compatible with the designation. The entire RHIC/EIC Complex are within the boundaries of the Scenic River Corridor. Any actions causing disturbance within the river channel or within 100 ft. (30 m) of a designated wetland would require a freshwater wetlands permit and/or a Wild, Scenic, and Recreational Rivers Act permit from the NYSDEC.

Groundwater

BNL is situated over a U.S. Environmental Protection Agency (EPA)-designated sole-source aquifer system that is the primary regional source of drinking water. The underlying groundwater

is further classified by New York State as Class GA groundwater, which is defined as a source of potable water. Federal drinking water standards, NYS drinking water standards as well as NYS ambient water quality standards (AWQS) for class GA groundwater are used as goals for groundwater protection and remediation.

Groundwater flow directions across the BNL site are influenced by natural drainage systems: eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River. Pumping from on-site supply wells and recharge basins affect the direction and speed of groundwater flow, especially in the central, developed areas of the site. The main groundwater divide on Long Island is aligned generally east– west and lies approximately one-half mile north of the Laboratory. Groundwater north of the divide flows northward and ultimately discharges to the Long Island Sound. Groundwater south of the divide flows east and south, discharging to the Peconic River, Peconic Bay, south shore streams, Great South Bay, and Atlantic Ocean.

BNL has an extensive groundwater monitoring and protection program with more than 700 permanent monitoring wells. All major facilities with potential for impacts to groundwater have monitoring wells including an extensive network of monitoring wells for the RHIC/EIC complex. Within the RHIC complex, impervious caps have been installed over beam stop and collimator areas where activation of soil shielding may occur. Groundwater monitoring is conducted to verify that the caps are effective in preventing the infiltration of precipitation which could leach soil activation products such as Na-22 or tritium into the groundwater. Results of groundwater monitoring are published annually in the Site Environmental Report (BNL, 2020).

BNL utilizes its own wells and distribution system for potable and process water. Groundwater is currently pumped from 5 wells that produce approximately 1,352.9 million liters (357.4 million gallons) of water for use as potable water, in cooling towers, and once through cooling water.

5.3.2 Effects of Alternatives on Water Resources

Effects on Surface Waters – Preferred Alternative

Under the Preferred Alternative the range of effects will depend on the method to supply and recharge water needed for cooling to minimize any impacts. Cooling towers will result in significant pumping of water (783 gpm at peak) to make up for evaporative losses. This volume is equivalent of the production from one of BNL's current production wells. Even at this rate significant pumping is not expected to result in draw down of surface waters as wells are located significant distances from ponds and wetlands. Use of cooling towers would result in additional cooling tower blowdown water that would typically be released to recharge basins potentially keeping them wet for longer periods. Chemical use associated with cooling towers is currently being evaluated to identify alternatives that would reduce or eliminate permit excursions related to anti-corrosive chemicals. These reductions would improve water quality going to both stormwater and STP recharge basins. Should water chillers be selected they would significantly reduce the need for pumping water and therefore not have impact on surface waters. Under a scenario using geothermal systems, water would be pumped from one or more wells and returned back to groundwater, through multiple recharge wells, with little to no loss and would not likely impact surface waters.

New construction at the building 1002 and 1010 areas of the EIC would be just outside of the 100-foot wetland boundary of the Peconic River. Since, construction would be within the scenic corridor a Wetlands/Scenic River permitting would be submitted to the NYSDEC. Construction

would utilize the NYSDEC General Construction Stormwater Permits and would require a Notice of Intent and submittal of a Construction Stormwater Pollution Prevention Plan. Implementing a CSPPP would eliminate or minimize any impact to wetlands.

New buildings would be connected to the sanitary system for collection of sanitary discharges and potentially cooling tower discharges. Water would be processed by the STP and released to onsite recharge basins. Stormwater from the increased in impervious surfaces from new roadways and buildings would be directed to recharge basins or dry wells.

Effects on Surface Waters – No Action

The buildings associated with the No Action presently exist and no changes to those buildings will be made. There will be no changes to liquid effluents with the No Action Alternative. RHIC will only return secondary non-activated process cooling-water to the local groundwater through the current recharge basins. Cooling tower blow-down under the No Action Alternative will be to the same outfalls currently used. The current water treatment chemical program for cooling towers is being evaluated to identify potential alternatives for chemicals that would reduce or eliminate permit excursions related to anti-corrosive chemicals. These reductions would improve water quality going to both stormwater and STP recharge basins.

Since no new construction is expected under the No Action Alternative wetland permits would not be necessary.

Effects on Peconic River Scenic Corridor – Preferred Alternative

New construction would be within the scenic river corridor and construction at the building 1002 and 1010 areas of the EIC would be visible from the river. Therefore, permits under the New York Wild, Scenic, and Recreational Rivers Act would be submitted.

Effects on Peconic River Scenic Corridor – No Action Alternative

No construction will occur under the No Action Alternative therefore there would be no impacts to the Peconic River Scenic Corridor.

Effects on Groundwater – Preferred Alternative

Although BNL is situated above a sole source aquifer, construction and operation of the EIC should not affect groundwater quality. The BNL Standards Based Management System Subject Areas "Liquid Effluents" and "Accelerator Safety" provide rules related to discharges and protection of groundwater. EIC would follow these rules to ensure contaminated effluents do not make their way into the groundwater. Activated soil shielding or caps would be maintained and would be managed through any future decommissioning (i.e., allowed to decay in place or physically removed for disposal). The extensive groundwater monitoring well network and program provide significant data to track potential contamination. If groundwater contamination is detected, immediate actions occur to prevent degradation of groundwater resources. Results of groundwater monitoring are reported annually in Chapter 7 and Volume II of the annual Site Environmental Report (BNL 2020). To date no impacts to groundwater have been detected resulting from RHIC operations.

Potable water used by BNL and surrounding communities comes from the underlying EPA designated sole source aquifer system. Protection of the aquifer requires scrutiny of all

operational programs on water consumption and potential contamination. It is estimated that the total water consumption of the EIC in cooling systems could increase over current use by as much as 2,953 lpm (780 gpm) due to make-up for evaporative losses if cooling towers are utilized. BNL usage at all existing/proposed facilities, would require up to 2,109 lpm (557 gpm) for process and 4,370 lpm (1,154 gpm) for air conditioning. Water pumping from the aquifer for the operation of EIC would represent a total increase in BNL pumpage of 626.1 million liters (165.4 million gallons) actual increase in annual water usage which is an approximate 50% increase over current annual pumpage. This increase would be within historic volumes from current supply wells but may warrant the need to establish an additional well to ensure capacity. Most of the water would be returned via the STP or nearby recharge basins. Establishment of appropriate operational controls would minimize potential drawdown impacts in well capture zones or recharge impacts at basins. If chillers or open loop geothermal systems are utilized the amount of water used would be considerably less as both would utilize closed loop systems and heat exchangers. Geothermal systems would return all water back to the aquifer

Electric usage increase and energy requirements will result in the need for several new emergency generators to ensure no loss of power during a grid outage. These generators have fuel oil tanks that could leak. However, the likelihood of impact to surface or groundwater is low due to requirements for double walled tanks, spill containment, and routine inspections.

5.4 Land Use, Demography, and Environmental Justice

5.4.1 Affected Environment

Land Use

The current BNL site was established in 1947 specifically to develop and construct large-scale scientific facilities. Figure 5 “Land Use Within 1-mile of BNL Border” presents a 2020 aerial photograph of the Laboratory site and surrounding areas. Land use to the east, within one mile (1.6 kilometers) of the Laboratory, consists of preserved open space, public and private land dedicated to public recreation, and low-density residential areas of one dwelling or less per acre. To the north is a mixture of residential properties, commercial retail and service properties, and public utility services. Schools and churches, open space, and low-to-medium density residential areas are found to the west. To the south are commercial and industrial properties, vacant land, and medium-to-high density residential areas of two or more dwellings per acre. On-site land use consists of open space, scientific, industrial and commercial, and residential areas. The onsite brownfield areas are designated for industrial use within established controls.

Demography

Based on the 2010 U.S. Census and subsequent population estimates for 2019, approximately 60,773 persons live in communities surrounding the Laboratory. Figure 6 shows BNL boundary and 1-mile extent superimposed over a map of the U.S. Census blocks, along with the 2018 population estimate.

The Laboratory’s on-site population includes approximately 2,500 employees and more than 5,075 guest researchers who visit each year. On a daily basis an average of 184 people live in temporary on-site housing and during the summer months an average of 120 additional guest scientists and students who visit the Laboratory stay in the dormitories.

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies.

Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the adverse environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies. Federal agencies must identify and address disproportionately high and adverse effects of federal projects on the health or environment on minority and low-income populations (Executive Order 12898). An environmental justice population is defined as a population being at least half minority status or at least half low-income status, or this status is meaningfully greater than the general population. A minority is defined as Black or African-American, Hispanic or Latino, Asian, American Indian and Alaskan Native, Native Hawaiian and other Pacific Islander.

BNL is situated within the Town of Brookhaven which has a population of 480,763 persons, based on the 2019 U.S. Census data. According to the 2019 U.S. Census data, 14.8 percent of Brookhaven Town's population consisted of minorities. Using the same U.S. Census data, within one mile of the Laboratory's boundary the percentage of minority population is estimated to be approximately 15.9 percent. While the percentage of minorities is slightly higher than that of the Brookhaven Town, the 1.1 percent difference would not constitute a percentage that is meaningfully greater than the general population. Therefore, the population living within one mile of the Laboratory border would not be defined as an environmental justice population based on minority status.

In regard to low-income status, no data was available to evaluate the income level of the discrete population living within one mile of the Laboratory's boundary or corresponding to the same geographic blocks used for the population data. Income data for the year 2018 was available for the Town of Brookhaven from the U.S. Census Bureau. It must be noted that the Town of Brookhaven is the largest of the 10 towns in Suffolk County, NY, and is composed of many communities with variable average incomes. The 2018 median income for households in Brookhaven was $92,569. Approximately 7.6% of individuals in the Town of Brookhaven are below the poverty level. In the four communities bordering the BNL site 7.9% of individuals in Manorville, 7.6% of individuals in Ridge, 4.2% of individuals in Yaphank, and 12.9% of individuals in Shirley are below the poverty level (Table 3).

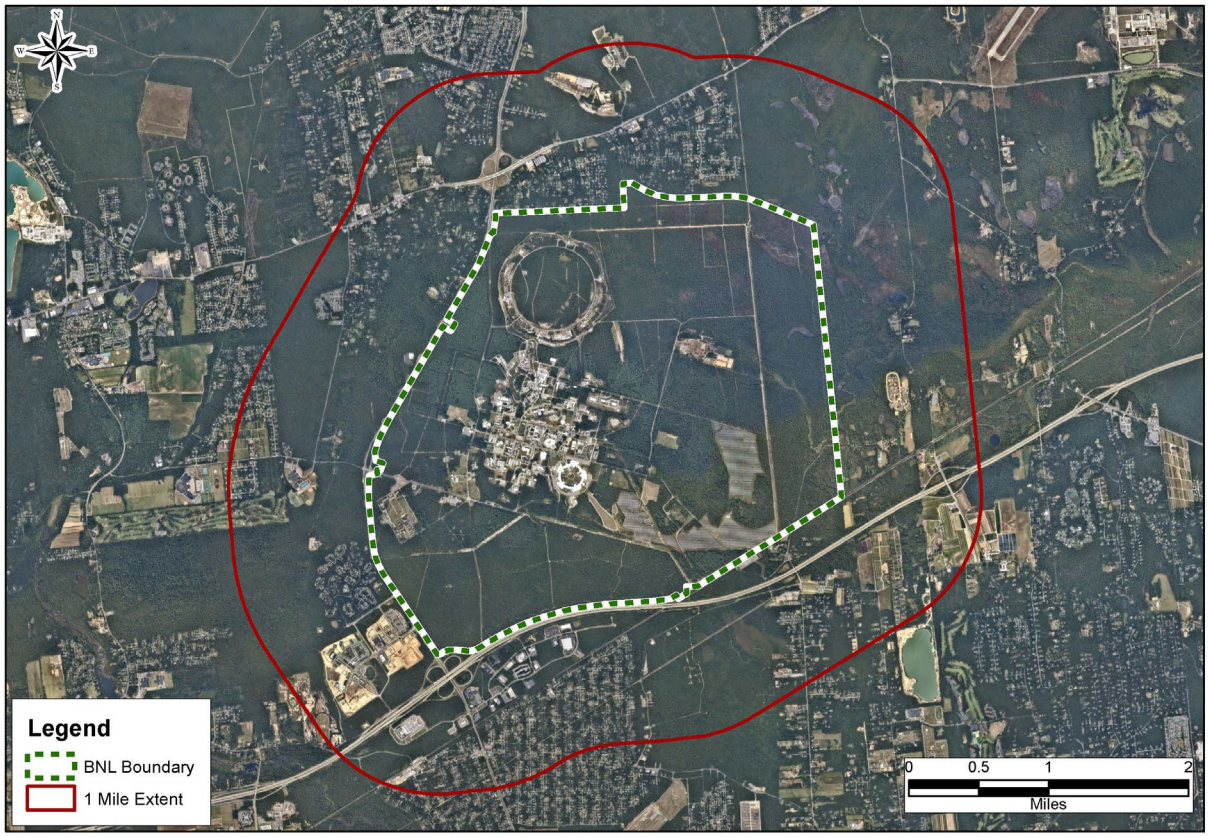


Figure 5: Land Use within 1 mile of the BNL border.

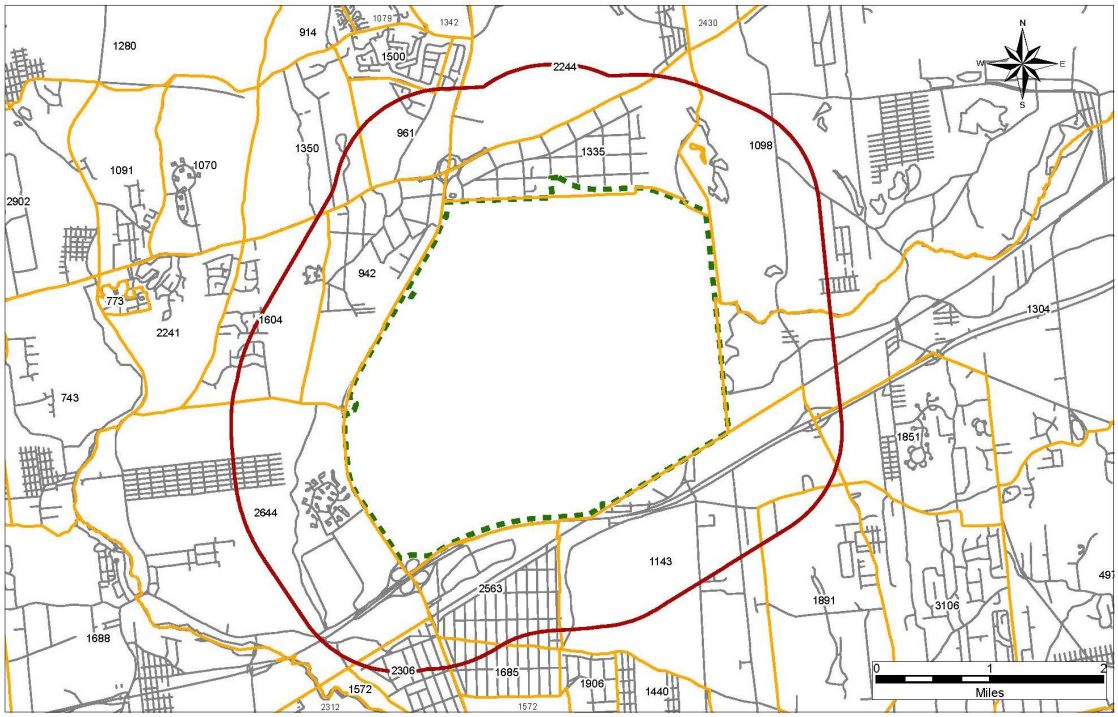


Figure 6: Population within 1 mile of the BNL border.

Table 3: **Low Income Status in Communities Adjacent to BNL Site**

Town or Community	Population (2019)	Poverty Status in 2019 – Individuals*	Population in Poverty Status
Brookhaven Town	480,763	7.6 %	36,538
Ridge	13,189	7.6 %	1,002
Shirley	27,547	12.9%	3,554
Manorville	14,157	7.9 %	1,118
Yaphank	5,880	4.2 %	247
Combined total (Communities Only)	60,773	9.7 %	5,921

*The U.S. Census Bureau defined the average poverty threshold as a maximum annual income of $25,701 or less for a family of four for the year 2019 (U.S. Census, 2019).

The percentage of low-income families is lower for the combined populations of the four communities bordering BNL than that of Brookhaven Town, the 2.5 percent difference is indicative of the variability of economic status found within the Town of Brookhaven. The population living within one mile of the Laboratory border would not be defined as an environmental justice population based on low-income status.

5.4.2 Effects of All Alternatives on Land Use and Demography

Under all of the alternatives there would be no change from the existing conditions related to land use, demographics, or environmental justice.

5.5 Socioeconomic Factors

Socioeconomic factors describe the local economy and employment that may be influenced by the Proposed Action.

5.5.1 Affected Environment

The Laboratory employs approximately 2,500 full and part-time personnel and has over 5,075 visiting scientific researchers annually, and a fiscal year 2019 budget of $681 million, the Lab has a significant economic impact on New York State. An additional 40,000 members of the public visit the Laboratory site each year as part of educational and group tours, conferences and events. In 2019, Lab employee salaries, wages, and fringe benefits accounted for approximately $384 million, or 56 percent of its total budget. Supporting local and state businesses whenever possible, the Lab spent more than $108 million in 2019 on goods and services in New York State alone, $87 million of that with Long Island companies.

5.5.2 Effects of All Alternatives on Socioeconomic Factors

Under all alternatives the Laboratory will continue to employ approximately 2,500 full and part-time personnel, and visiting scientific researchers annually will increase due to user facilities like

National Synchrotron Light Source II (NSLS-II), Center for Functional Nanomaterials (CFN), RHIC, etc. Public visits to the Laboratory site each year will continue as part of educational and group tours, conferences, and events. Direct spending by BNL will increase as will total output of goods and services to the region during construction. EIC construction would employ several thousand individuals both locally and at other institutions. Once construction is completed, jobs for operations may increase slightly over current employment at the Laboratory as the experimental mission ramps up. Spending from both construction and operational jobs will generate secondary employment opportunities in Long Island communities.

5.6 Transportation Conditions

5.6.1 Affected Environment

A 2017 traffic study for determining the traffic pattern for the Front Entrance to BNL measured peak morning volume at 630 vehicles entering the Lab and the peak afternoon volume of 434 vehicles exiting the Lab. The Lab utilizes the Front Gate and North Gate for entry to the Lab each morning and the Front, North, and South gates to expedite departures in the afternoon. Local traffic to and from the BNL site utilize the Long Island Expressway, William Floyd Parkway, Longwood Road, and Middle Country Road (Rte. 25).

5.6.2 Effects of Alternatives on Transportation Conditions

Effects on Transportation Conditions – Preferred Alternative

The Laboratory has experienced large construction projects over the past 15 years including the construction of the Long Island Solar Farm and the NSLS-II. Both of these projects did not cause undue increase in traffic delays on the roadways surrounding the Laboratory. During the construction of the EIC traffic is expected to increase to levels similar to that seen during other construction projects due to deliveries of materials and construction workers arriving/departing. At the same time BNL expects gradual increases in traffic as build out of NSLS-II beamlines continue resulting in a gradual increase of users. The level of traffic is expected to decline to levels indicative of normal BNL operations as construction is completed.

Effects on Transportation Conditions – No Action Alternative

Under the No Action Alternative traffic is expected to be similar to current conditions with gradual increases over time as planned due to the continued build out of NSLS-II beamlines and increased use of other user facilities resulting in increased numbers of users.

5.7 Cultural Resources

5.7.1 Affected Environment

The *Cultural Resource Management Plan for BNL* (CRMP) (BNL 2013) identifies the Laboratory's historic and cultural resources, and describes the strategies developed to manage them in accordance with applicable laws and regulations.

The RHIC/EIC complex does contain trench features associated with WW I Camp Upton that were identified during archeological surveys carried out in the 1970s for the development of the ISABELLE project (Johannemann and Schroeder 1977 and 1978). These features are located within the central wooded portion of the area central to Renaissance Circle.

5.7.2 Effects of Alternatives on Cultural Resources

BNL performs cultural resources analyses pursuant to Section 106 of the National Historic Preservation Act. Integrated into the BNL CRMP are recommendations by the Institute for Long Island Archaeology (ILIA) that address the potential for land disturbance/development within the footprint of the former World War I-era Camp Upton (Bernstein, et. al 2001). The RHIC/EIC Complex is less than 50 years of age and therefore does not contain structures requiring evaluation under Section 106 of the NHPA. Buildings associated with the AGS complex are eligible for listing on the National Register of Historic Places but are not being modified under this project.

World War I features within the central portion of the RHIC/EIC complex will not be affected by construction activities. Ground disturbance on the outside of the ring at the building 1010 area will be within previously disturbed areas, and disturbance at the building 1002 area is expected to be minimal with no features present.

5.8 Air Quality

5.8.1 Affected Environment

The overall regional air quality is affected by a mix of maritime and continental influences. This results in the region, and BNL, being very well ventilated by winds from all directions.

The local air quality management in the New Jersey-NY-Connecticut Interstate Air Quality Control Region, which includes Suffolk County and BNL, is in attainment with most National Ambient Air Quality Standards (NAAQS) for criteria pollutants, which include sulfur dioxide, nitrogen oxides, and particulate matter less than 10 microns in diameter (PM_{10}), lead, and carbon monoxide (CO). The region is considered a moderate non-attainment area for the 2015 8-hour ozone standard and a serious non-attainment area for the 2008 8-hour ozone standard. While ozone is a regulated pollutant, it is not emitted directly from sources but is formed by a combination of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) reacting with sunlight in the atmosphere. The New Jersey – New York – Connecticut Interstate Air Quality Control Region is classified as a maintenance area for the 24-hour PM 2.5 standard.

5.8.2 Effects of Alternatives on Air Quality

Under the Preferred Alternative, because Suffolk County is a serious non-attainment area for the 2008 8-hour ozone standard and a maintenance area for the 24-hour PM 2.5 standard, a conformity review of emissions associated with the construction and operation of the EIC will be performed in accordance with 40 CFR 93 Subpart B following Guidance on Clean Air Act General Conformity Requirements and the National Environmental Policy Act Process issued by DOE's Office of NEPA Policy and Assistance in April 2000. The conformity review must demonstrate and document that the combined total of direct and indirect emissions of NOx or VOCs associated with the construction and operation of the EIC is less than 50 tons/yr; while the direct and indirect emissions of PM 2.5, SO2, NOx, VOCs, and ammonia are less than 100 tons/yr. Emissions from purchased electricity generation, stationary sources, construction phase emissions, and mobile sources during construction will be considered.

5.9 Climate

5.9.1 Affected Environment

Climate can influence several environmental parameters including regional and local air quality, storm water drainage, surface waters, and natural hazards.

The climate at the Laboratory can be characterized as breezy and well-ventilated, like most of the eastern seaboard. The Long Island Sound, the Atlantic Ocean, and associated bays influence wind directions and humidity and provide a moderating influence on extreme summer and winter temperatures. The prevailing ground-level winds are from the southwest during the summer, from the northwest during the winter, and about equal from these two directions during the spring and fall (Nagle, 1975; 1978).

BNL has been recording local weather data since August 1948. The average yearly precipitation is 48.75 inches (123.8 centimeters) and the average yearly snowfall is 33 inches (83.82 centimeters). The average monthly temperature is 50.2˚ Fahrenheit (10.1˚ Celsius). (Additional historical meteorological data are available from the BNL Meteorology Services webpage.)

Climate Change

In recent years, climate change has evolved into a matter of global concern because it is expected to have widespread, adverse effects on natural resources and systems. A growing body of evidence points to anthropogenic (manmade) sources of greenhouse gases (GHG), such as carbon dioxide (CO_2), as major contributors to climate change. Additional greenhouse gases include methane (CH_4), nitrous oxide (N_2O), halocarbons, and fluorinated compounds. Climate is usually defined as the average weather, over a period ranging from months to many years. Climate change refers to a change in the state of the climate, which is identifiable through changes in the mean and/or the variability of its properties (e.g., temperature or precipitation) over an extended period, typically decades or longer (DOE 2009b). Ongoing climate change research was summarized in reports by the United Nations Intergovernmental Panel on Climate Change (IPCC), *US Climate Change Science Program's Science Synthesis and Assessment Products*, and the *US Global Change Research Program*. These reports concluded that the climate is already changing; that the change would accelerate; and that man-made GHG emissions, primarily CO_2, are the main source of accelerated climate change (DOE 2009a). Terrestrial carbon sequestration is the process through which CO_2 from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, branches, foliage and roots) and soils. Forests and soils have a large influence on atmospheric levels of CO_2, essentially helping to mitigate man-made CO_2 emissions (EPA 2006).

Various GHGs differ in their potential contribution to global warming. The global warming potential (GWP) compares the relative ability of each GHG to trap heat in the atmosphere over a certain period. According to guidelines, CO_2 is the reference gas with a GWP of 1. Based on a period of 100-years, the GWP of methane is 21, implying that a ton of methane is 21 times more effective in trapping heat than a ton of CO_2. The GWP for N_2O is 310. Carbon dioxide equivalent is a measure that expresses, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same GWP (Hailey 2008).

5.9.2 Effects of Alternatives on Climate

The Preferred Alternative would result in constructing and operating the EIC with requirements for conventional cooling, air conditioning, increased use of energy, and potential release of greenhouse gasses (CFCs, SF6, etc.) BNL has processes in place to recover CFC and SF6 from equipment before retiring equipment that might be retired, or during maintenance operations. The Laboratory also works to purchase green energy or offset energy purchases with renewable energy credits.

Relative to an indirect increase in GHGs, electrical power use under the Preferred Alternative would increase by a fraction since the baseline load due to existing newer more efficient equipment and energy efficiency upgrades overtime throughout the RHIC/EIC complex.

There would be no additional GHGs added to the environment directly as a result of the No Action Alternative. However, the No Action Alternative would result in the continued use of operating equipment that was less efficient with increased potential for failure and release of GHGs.

5.10 Visual Quality

5.10.1 Affected Environment

Large scientific facilities and structures have been constructed and operated at BNL since the late 1940s. Such structures have included research reactors with a 310-foot (94.5 meter) exhaust stack located on the highest point of the BNL site and a 280-foot (85 meter) tall meteorological tower. Current visual features of the proposed project area consist primarily of a Pine Barrens habitat that surrounds the RHIC/EIC complex and the scenic river corridor of the Peconic River.

5.10.2 Effects of Alternatives on Visual Quality

Under the No Action Alternative, visual quality would not be affected.

Under the Preferred Alternative, new construction at the building 1002 and 1010 areas of the EIC would consist of new structures up to two stories tall or roughly the height of the existing berm covering the accelerator tunnel. New buildings would not be readily visible from either the William Floyd Parkway (1,000 ft/305 m distant) or the community of Ridge (1200 ft/366 m) immediately north of the Lab but, would be visible from the Peconic River as the river is immediately adjacent to these two areas. Other new structures built around the EIC complex would be less likely to be seen from the Peconic River due to distance and tree cover that exists near the river.

5.11 Parkland

5.11.1 Affected Environment

Brookhaven National Laboratory is in close proximity to town (Smith Estate), county (Hubbard County Park and Open Space), and New York State parklands (Brookhaven State Park). Federal parklands are located to the south and include the William Floyd Estate and Fire Island National Seashore and wilderness area.

The Smith Estate is located approximately 0.25 miles (0.4 kilometers) west of the Laboratory's west boundary and is surrounded by pine barrens habitat. County park land and open space is located along the entire east boundary and much of the north boundary of the Laboratory. Brookhaven State Park is located approximately 2 miles (3.2 kilometers) north of BNL and access is off of the William Floyd Parkway. This park was established in the early 1970s through a donation of land from the federal government to New York State. Prior to the donation the land was part of BNL and its predecessor Camp Upton. The William Floyd Estate and Fire Island National Seashore are located 7 to 8 miles (11.2 to 12.8 kilometers) south of BNL.

5.12.1 Effects of Alternatives on Parklands

Under both alternatives no impacts to parkland would occur.

5.12 Noise

5.12.1 Affected Environment

Noise is defined as unwanted sound that interferes with normal activities, or in some way reduces the quality of the environment. Response to noise varies according to its type, perceived importance, appropriateness in the setting and time of day, and the sensitivity of the individual receptor. The EPA developed an index (threshold) to assess noise impacts from a variety of sources using residential receptors. If daytime noise values exceed 65 decibels (dBA), residential development is not recommended (EPA 1974). Noise sensitive receptors are defined as the occupants of a facility or a location where a state of quietness is a basis for use or where excessive noise interferes with the normal use of the facility or location. Typical noise sensitive receptors include schools, hospitals, churches, libraries, homes, parks, and wilderness areas.

Table 4: **Common Noise Exposures**

Sound Source	Pressure Decibels dBA
Large rocket engine (nearby)	180
Jet takeoff (nearby)	150
Pneumatic riveter	130
Jet takeoff (200 feet)	120
Construction noise (10 feet)	110
Subway train (100 feet)	100
Heavy truck (50 feet)	90
Average factory	80

Sound Source	Pressure Decibels dBA
Normal conversation (3 feet)	60
Quiet office	50
Library	40
Soft whisper (16 feet)	30
Rustling leaves	20
Normal breathing	10
Hearing threshold	0

New York Department of Environmental Conservation (NYDEC) Guidance "Assessing and Mitigating Noise Impacts" (DEP-00-1, Issuance Date: October 6, 2000 Revised: February 2, 2001) states that:

"Increases ranging from 0-3 dBA should have no appreciable effect on receptors. Increases from 3-6 dBA may have potential for adverse noise impact only in cases where the most

sensitive of receptors are present. Sound pressure increases of more than 6 dBA may require a closer analysis of impact potential depending on existing Sound Pressure Level (SPLs) and the character of surrounding land use and receptors."

The existing 1005H RHIC compressor building will be re-used in the EIC complex. Noise levels immediately surrounding the building during operation range from 85 – 91 dBA depending on whether the doors are open or closed. However, this level drops off quickly to less than 65 dBA at the nearest roadway or building and is indistinguishable from background at the nearest residential area.

5.12.2 Effects of Alternatives on Noise

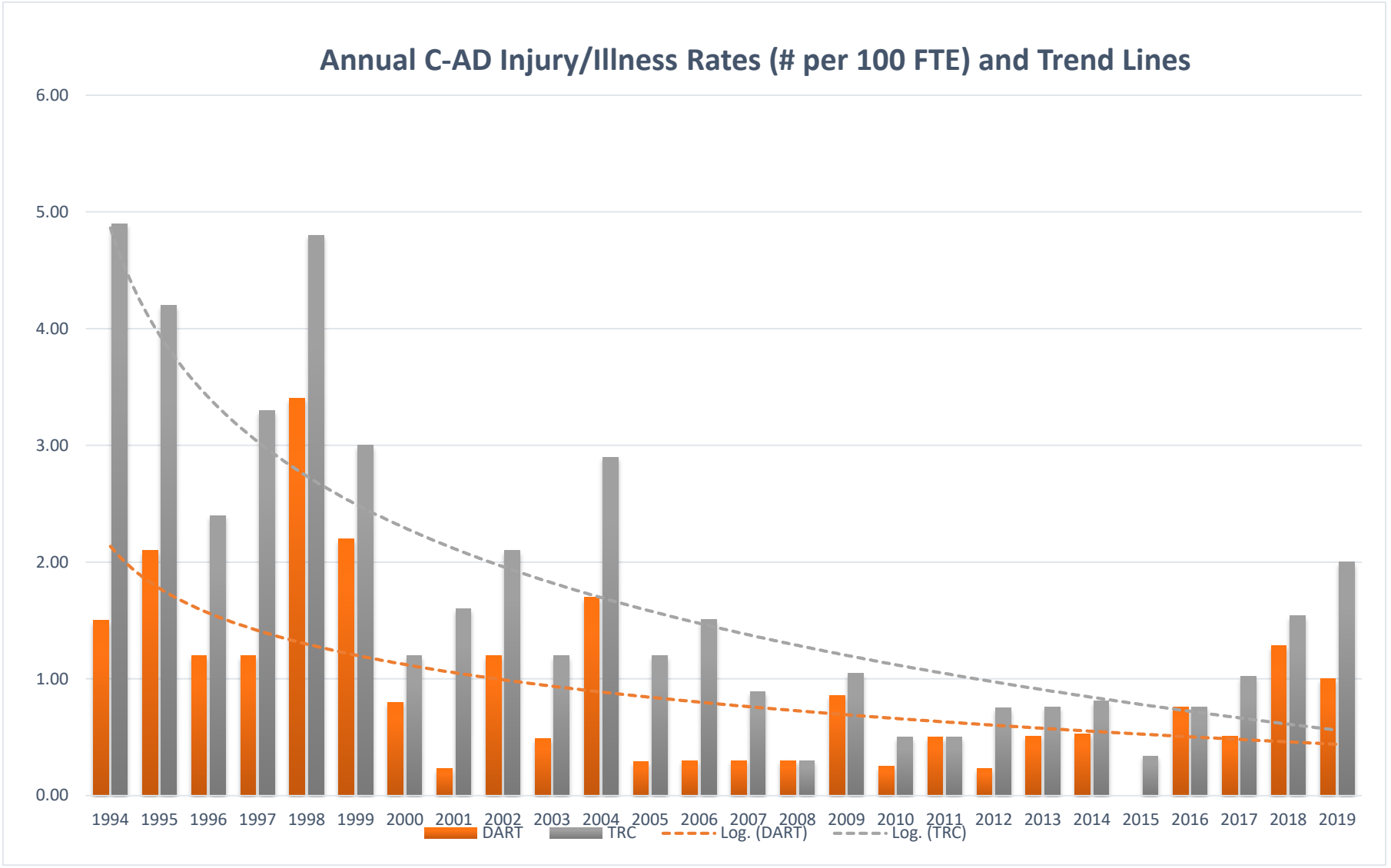
Under the No Action Alternative the level of noise would remain similar to current levels as no new construction or equipment would result in a greater level of noise above existing conditions.

Under the Preferred Alternative a new compressor facility is planned for the 1010 region and would include noise generation equipment similar to other new facilities on site. A measurement outside the latest helium compressor building showed 73 dBA immediately outside the building, and 64 dBA within 3 meters of the open door. The new facility would not result in any increased noise to the residential areas that are approximately 1,510 ft (460 m) away. It is normal to get a sound level drop of 6 dB per doubling of distance.

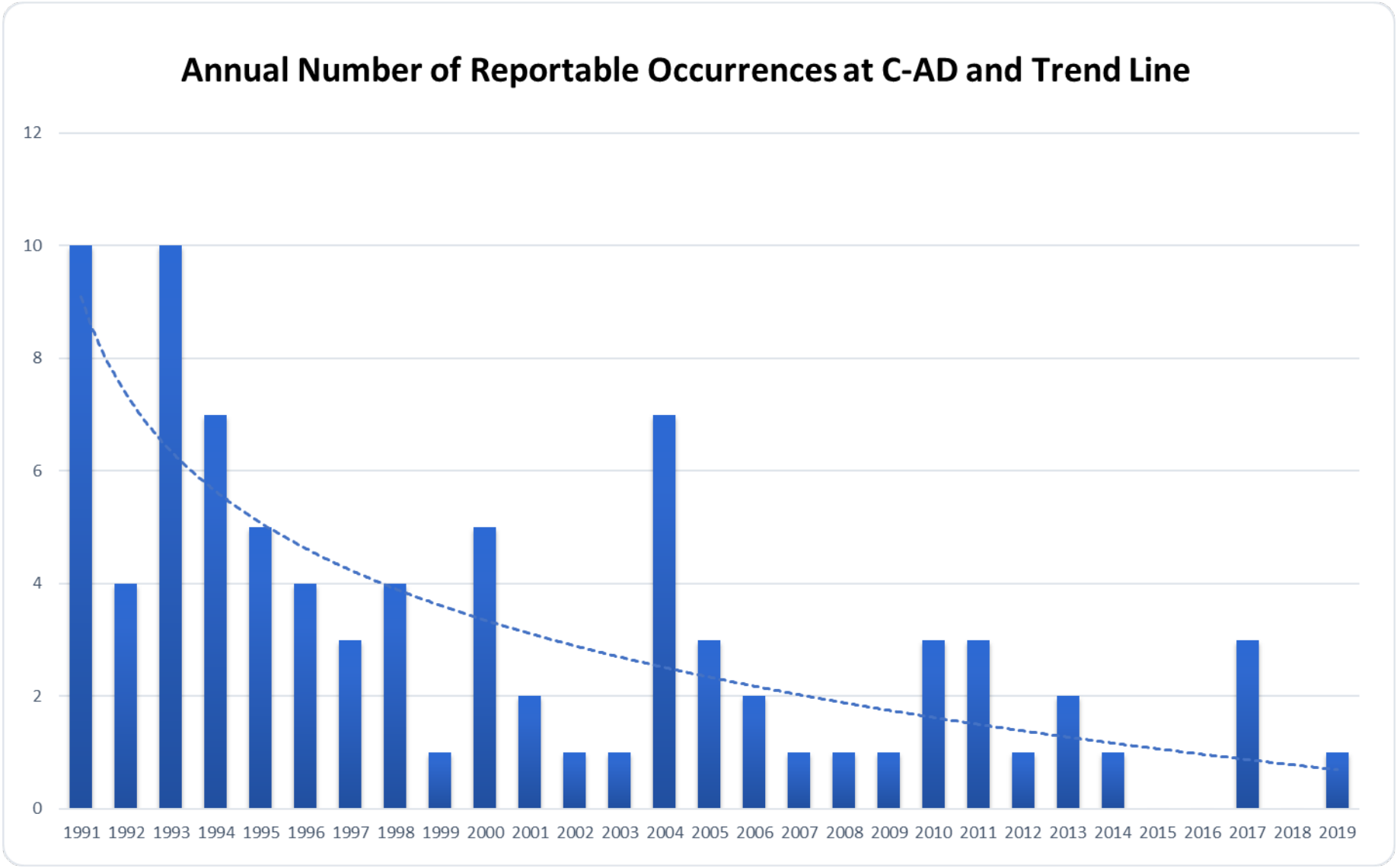
5.13 Industrial Safety and Occupational Health

5.13.1 Affected Environment

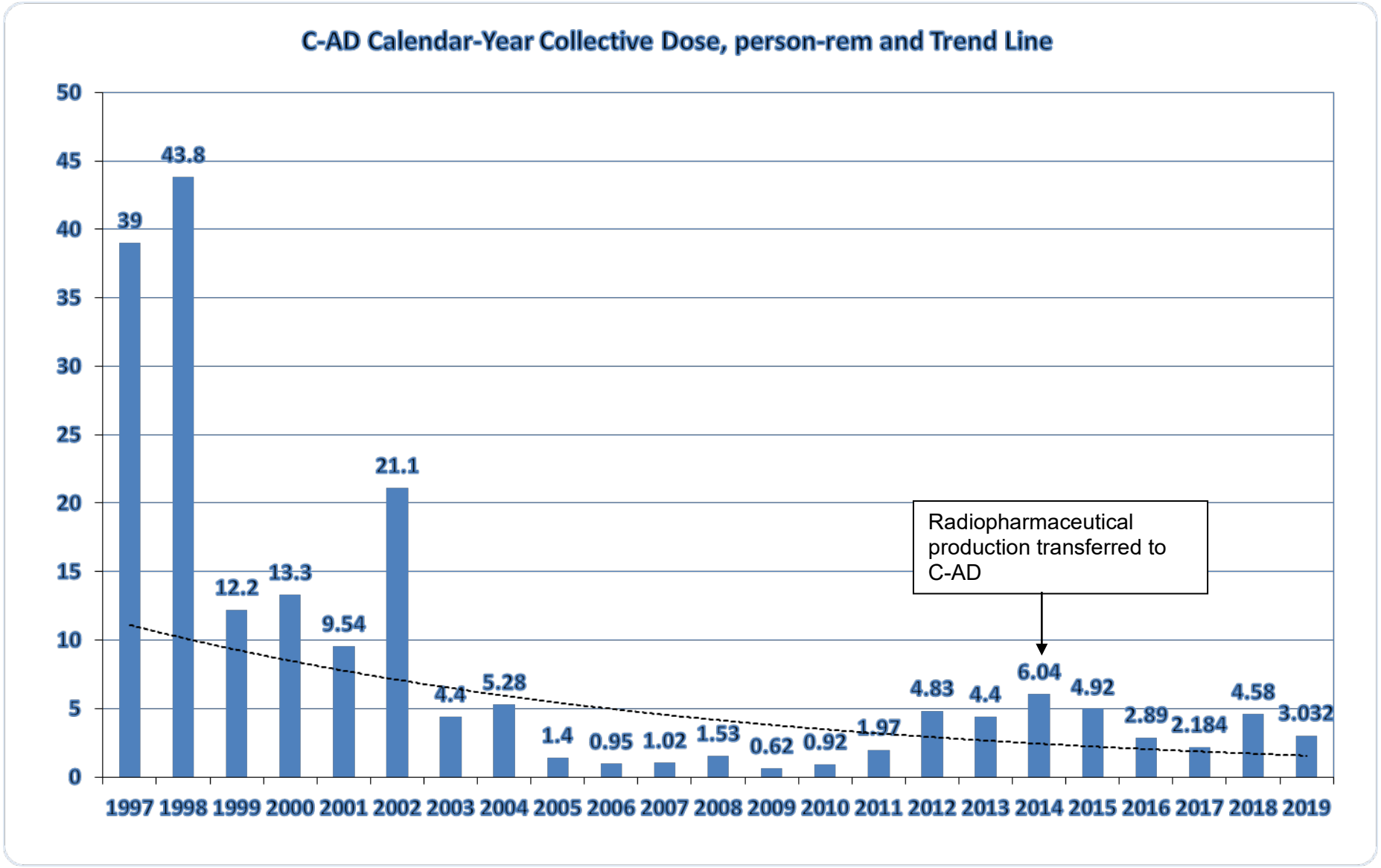
The graphed results that follow occurred during a period when many new facilities and modifications were added to the Collider Accelerator Division facilities and affected the on-site dose, inventory of radioactive cooling water, injuries and DOE reportable occurrences. The RHIC complex is historically associated with C-AD and therefore the provided information is appropriate for comparison and discussion with regard to the EIC complex. The number of incidents continues to be low, and improvements in facilities and practices have kept the collective dose low even while adding new facilities.



DART = Days Away or Restricted Work due to injury at C-AD; TRC = Total OSHA recordable injury rate at C-AD



Long Term Occurrence Decline at C-AD, Number per Year


C-AD Calendar-Year Collective Dose, person-rem and Trend Line
50
45
40
35
30
25
20
15
10
5
0
39
43.8
12.2
13.3
9.54
21.1
4.4
5.28
1.4
0.95
1.02
1.53
0.62
0.92
1.97
4.83
4.4
6.04
4.92
2.89
2.184
4.58
3.032
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Radiopharmaceutical production transferred to C-AD

5.13.2 Effects of Alternatives on Industrial Safety and Occupational Health

The No-Action Alternative would provide for no construction, while continued use of facilities which do not provide the proper energies, particles or beam currents would seriously affect program, there would be no effect on Industrial Safety and Occupational Health programs.

Under the Preferred Alternative, the research programs would continue and improve; The following would be expected under both construction and operation.

Construction

Industrial hazards associated with the construction phase of the Proposed Action would be typical of those experienced at any general mid- to large-scale construction activity; these would include electrical, mechanical, elevated work, noise and lifting hazards. Prior to the start of construction, the selected contractor would establish a Health and Safety Plan with BNL. The contractor would be required to comply with applicable BNL ESH Standards, DOE Orders and regulatory requirements. The contractor would establish an Accident Prevention Program as well as an Environmental Protection Program that would include:

- Use of containment for spill intervention
- Proper storage and handling of hazardous materials
- Proper documentation of operations, maintenance and repair of equipment
- Retention systems for leaking and loose fluids, and
- Overnight storage of vehicles on concrete or asphalt

In addition, a review would be performed to identify all pertinent ESH issues that must be addressed during construction and would include:

• Environmental review
• Industrial hygiene issues
• Industrial safety review
• Operational requirements
• Facility issues
• Operational readiness evaluation
• Waste management

Operation

Industrial and experimental hazards associated with the EIC operations would include: fire, electrical, non-ionizing radiation and ionizing radiation, magnetic fields, noise, lasers, confined spaces, material handling, oxygen deficiency, gases and chemicals, toxic metals such as lead and beryllium, and cryogens. Integrated Safety Management (ISM) or its equivalent at the time of EIC operations would provide the structure for work planning conducted at the EIC. Work would be defined, the hazards to the workers/environment/equipment would be identified, the resulting risks for injury would be assessed, the controls to minimize or mitigate these hazards and reduce the risks would be developed, the work would be conducted within the scope of the controls, and feedback and improvement for the next cycle would be provided. Analysis by industrial hygienists would be used to assess a worker's exposure to a particular hazard and would allow a choice of substituting a less hazardous condition, an engineered control, an

administrative control or personal protective equipment to bring the risk to the worker to a minimal level.

5.14 Radiological Characteristics

5.14.1 Affected Environment

The radiological characteristics of laboratory operations are determined through routine DOE required surveillance and permit-based monitoring efforts. Water discharged from the STP is routinely monitored at the plant's outfall. In 2019, all effluents were found to be less than the Safe Drinking Water Act (SDWA) limits of 4 millirem annual dose limit for gross beta, 15 picocuries per liter (pCi/L) for average gross alpha activity, and 20,000 pCi/L average tritium concentration (BNL 2020).

BNL uses 10 recharge basins permitted under SPDES to discharge once-through cooling water, cooling tower blow-down, and storm water runoff. Routine monitoring of these basins indicated that the average concentrations of gross alpha and beta activity were within typical background ranges, and that there were no Laboratory related gamma-emitting radionuclides detected. All samples taken from discharges to recharge basins were below the SDWA standards (BNL 2020).

BNL is subject to the requirements of 40 CFR Part 61, Subpart H National Emission Standards for Hazardous Air Pollutants (NESHAP). The U.S. EPA established a national policy on the airborne emission of radionuclides, and a dose limit to the public of 10millirem/yr for the airborne pathway. The effective dose equivalent from all air emission sources at BNL for 2019 was calculated to be 1.28 millirem, far below the allowable limit (BNL 2020). The Brookhaven Linac Isotope Producer produces 99% of the short-lived radionuclides responsible for the effective dose equivalent from BNL facilities. The RHIC operated for 24 weeks in 2019 with no detectable emissions.

5.14.2 Effects of Preferred Alternative on Radiological Characteristics

The EIC would not have facilities with fume hoods or stacks or other single radioactive airborne emission points.

The radiological effects for the Preferred Alternative are presented in the following sections.

Direct Radiation for Preferred Alternative

Although the laboratory site is considered to be a limited access facility, service personnel from offsite and BNL non-radiation workers may work or visit near the RHIC/EIC Complex. Laboratory policy for such personnel is to restrict the annual dose to less than 25 mrem in one year. This goal would be accomplished through shielding design.

To measure direct radiation from all Laboratory operations, 60 environmental thermo-luminescent dosimeters (TLDs) were deployed by BNL, of which 10 were placed in known radiation areas and 17 off-site areas in 2019. An additional 30 TLDs were placed in a lead-shielded container for use as reference and control TLDs for comparison purposes. The average dose of all TLDs showed there was no additional contribution above the natural background radiation to on-and off-site locations from BNL operations. The annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was estimated as 66 ± 11 mrem and

the annual off-site external dose was estimated as 64 ± 10 mrem. Average dose from RHIC was 64±13 mrem. Because of local shielding, the Preferred Alternative will not change annual on-site or off-site external dose and is much less than 25 mrem in one year when one considers 64 mrem as natural background (BNL 2020).

Soil Activation and Ground Water Effects for Preferred Alternative

Localized areas of the soil beneath or overlying a beam collimator or dump areas or other planned beam loss locations can become activated by interactions with secondary particles (primarily neutrons) produced at these beam loss areas. The primary radionuclides of concern produced in the activated soil are tritium and sodium-22. Tritium is easily leached from activated soil and is highly mobile, whereas sodium-22 is less leachable and migrates at a slower rate. Activated soils are controlled to prevent human exposure and the leaching of radionuclides into the groundwater. The design practices for engineering controls that minimize beam loss and mitigate the potential for rainwater infiltration into activated soil shielding are described in the BNL SBMS Accelerator Safety Subject Area.

The standard control to prevent leaching of the tritium from the soils is an impermeable cap or other engineered structure such as a building floor that extends over the activated soil.

Operations procedures contain loss limits, and response by operators to alarms is written in procedures. Loss problems are corrected within minutes; otherwise operators must reduce the beam intensity to the affected area. By procedure, accelerator operations staff must determine whether there will be a negative impact on the environment, safety or health of workers, a negative impact on the physics program, or a negative impact on accelerator equipment if prolonged high-loss operation is permitted. Authorization for prolonged high-loss operation, with an alarm present, must come from the EIC Chair and be documented. Responsibility for maintaining loss-monitor systems is assigned to trained and qualified accelerator operations staff, and beam current transformers and loss monitors used to monitor losses undergo periodic calibration. Residual radiation surveys on new accelerator components and structures are made after the first operational running period in order to confirm loss assumptions. Finally, soil coupons (i.e., small containers filled with locally obtained sand) are placed at known loss areas and are periodically analyzed to confirm beam loss and soil activation assumptions.

Storm water runoff for the Preferred Alternative and adjacent paved areas is either conveyed to BNL's storm water system or allowed to infiltrate the ground in an area sufficiently away from the activation area. Construction details of these systems are reviewed in advance of routinely performed physical inspections intended to verify the integrity of caps. New caps would be placed over areas where soil activation may occur to prevent precipitation from infiltrating. There is a low probability of storm water infiltration into activated soil areas.

BNL has a comprehensive groundwater surveillance program that provides a means of verifying that the operational and engineered controls at beam loss areas are effective in protecting groundwater quality. BNL maintains a network of groundwater monitoring wells in the RHIC Complex to verify the effectiveness of the engineered controls. The final design for the EIC will determine the need for additional monitoring wells.

Emission of Airborne Radioactivity for the Preferred Alternative

As mentioned above The RHIC complex has no radiological air emissions based on annual NESHAPs reports. As designs are finalized and evaluations made air emission calculations will be made. The closest comparable facility containing electron accelerators is the NSLS-II. This facility has no radiological air emissions. The EIC is currently expected to not have radiological air emissions.

5.15 Natural Hazards

5.15.1 Affected Environment

Natural phenomena, which could lead to operational emergencies at BNL, include hurricanes, tornadoes, wildfires, thunderstorms, snowstorms, and ice storms. Hurricanes occasionally hit Long Island, and the high wind speeds associated with them may potentially damage structures. Record high winds for BNL were recorded during Hurricane Carol in September 1954 (Hoey 1994). Tornadoes and hailstorms are rare on Long Island. Thunderstorms, snowstorms, and ice storms do occasionally occur and have the potential to cause damage to facilities.

Earthquakes centered on Long Island are extremely rare, but do occur within 50 miles of the island, and no active earthquake-producing faults are known in the immediate Long Island area (Hoey 1994). Long Island lies in a zone 2, or moderate damage seismic probability area, and it is assumed that an earthquake of 3.0 magnitude could occur. A recent history of earthquakes within approximately 50 miles of the central Long Island area is presented below. The likelihood of a serious earthquake in the BNL area is slight and seismologists would not expect significant earthquakes to occur (Petersen, et. Al. 2019).

Table 5: Recent History of Earthquakes within approximately 50 miles of Long Island (USGS 2020)

Year	Date	Magnitude
1976	Apr 13	3.1
1978	Jun 30	2.9
1978	Sep 3	2.8
1979	Mar 9	3.1
1979	Dec 30	2.5
1980	Jan 17	2.9
1980	Oct 24	3.1
1981	Oct 21	3.8
1982	Jun 17	3.0
1985	Oct 19	3.6
1986	Apr 22	2.7
1991	Apr 12	2.7
1991	Oct 28	3.0
1992	Jan 15	2.5
2000	Aug 22	2.6
2001	Oct 27	2.6
2009	Feb 2	3.0
2014	Aug 14	2.7
2015	Aug 14	2.6
2019	Apr 9	3.0

The Central Pine Barrens and community types within BNL are fire dependent systems that experience periodic wildfire events either natural or from arson. Wildfires, direct flame and smoke could affect BNL operations. An arson set wildland fire burned approximately 300 acres in the northeast portion of the BNL site in 2012, and an additional 700-800 acres offsite. Approximately 95 acres of the same area were burned in 2020 from an arson set fire. The BNL Wildland Fire Management Plan (WFMP) includes recommendations for periodic mechanical fuels management and prescribed fire (controlled burns) to reduce potential fuel loading and the effects of unanticipated wildfire ignitions (BNL 2009). Prescribed burns, totaling about 53 acres (21.4 hectares), have been performed since 2004. The WFMP also recommends that a cleared area of at least 30 feet (9 meters) be maintained between buildings and the nearest treed area. The BNL on-site fire department is manned 24-hours a day to respond to all fire emergencies and maintains mutual aid agreements with local fire departments.

5.15.2 Effects of Natural Hazards on Alternatives

All alternatives under consideration would likely be affected by natural hazards the same.

The RHIC/EIC Complex has been constructed over a period of years. During this construction, techniques were used to assure compliance with building codes, while considering seismic hazards and wind damage. New construction would meet all current construction code requirements and fire protection is incorporated in design requirements.

DOE Order 420.1, DOE Standard 1022-94, and DOE Standard 1023-95 provide for natural hazard categorization of structures, systems and components of the built environment. Commensurate with a graded approach to the facility, a Performance Category of PC-1 would be sufficient to describe the design criteria for the structures, systems and components built at BNL.

Adherence to the building codes at BNL (equivalent to New York Uniform Building Codes) during construction, being constructed of good-quality materials, and having structural parts securely tied together and anchored to the foundation, provides appropriate seismic hazard mitigation to comply with the criteria of PC-1.

For above ground facilities, the Long Island area basic wind speed (3-second gust) is 120 MPH based on Factory Mutual Data Sheet 1-28 and BCNYS figure 1609.4. The ground roughness exposure category for the area is 'Exposure B." Based on the calculations, above ground buildings would have roof assemblies classified as "Class 90" rated assemblies

Flooding from precipitation events is not likely to occur within the area of the RHIC/EIC complex. The Peconic River floodplain is narrow, and no base flood has been determined for the area. FEMA flood risk maps indicate that a 100-year flood would be retained within the wetland area inside Renaissance Circle, or between the bermed area and Renaissance Circle at the building 1002 and 1010 areas.

5.16 Intentional Destructive Acts

5.16.1 Affected Environment

BNL has not historically been subject to significant intentional destructive acts. The Laboratory maintains a 24 hour a day protective security force and Fire/Rescue group to protect both personnel and property. The Security force routinely patrols the BNL campus including its more remote areas. The Fire/Rescue group's response time to alarms is typically less than 3 minutes to most locations on BNL.

The Laboratory does experience trespass situations along the north and east boundaries of the site from individuals riding all-terrain vehicles, horses, bicycles, or just walking. These have resulted in little if any vandalism on the site. The RHIC/EIC complex is isolated with an eight-foot-high security fence that extends around the west, north, and east boundaries of the complex.

5.16.2 Intentional Destructive Acts, Effects on Alternatives

It is not expected that the Preferred Alternative would be affected by intentional destructive acts.

RHIC/EIC operates 365/24/7 with a minimum of 2 trained staff members monitoring the RHIC/EIC buildings each shift. Locked doors are required and they are routinely checked by the Watch in addition to the site security force checks. Additionally, security cameras and card or code access are required to access the buildings or structures.

5.17 Utilities

5.17.1 Affected Environment

Current peak electrical demand by BNL is about 60 MW. Peak electric use at BNL for FY 2019 from BNL's Energy Management Group ranges from a low of 31 MW in December 2018 to a peak of 47 MW in June 2019. The switchover from NSLS-I to NSLS-II account for these figures. Operating the RHIC Complex itself was metered to be about 25 MW.

The Laboratory pumped approximately 368.5 million gallons of water in 2019. That water included potable use, steam generation, cooling tower use and blowdown, and once through cooling water. The majority of this water is used in the potable water system, (0.98 MGD) of which 0.03 MGD is used for steam generation, 0.03 MGD is returned to a recharge basin during iron removal, 0.01 MGD is lost to evaporation, 0.44 MGD is used for cooling by the AGS/RHIC complex, 0.23 MGD is used for general cooling, and 0.23 MGD is released to the Sewage Treatment Plant recharge beds.

5.17.2 Effects of Preferred Alternative on Utilities

The EIC will be connected to BNL's medium voltage power distribution system, sanitary system, potable water system, tele-communication and data system, sitewide fire alarm system and storm drainage system.

Electricity

The Preferred Alternative is expected to require approximately double the current electric load (see table below). The existing electric infrastructure is believed to be sufficient to handle the increased delivery to substations. The new infrastructure within the EIC complex would distribute electricity to locations needing additional power. The Laboratory is investigating the need to establish an additional substation and an additional feeder line to support Laboratory operations (see connected actions).

Operating Condition	Existing Loads at B-631 & B-638 on Tie Line MW	Additional EIC Power Required MW	Real Power load on Tie-line MW	Apparent Power Load on Tie Line (pf~0.8) MVA	Tie-line Capacity MVA	Tie line operating margin MVA	Total Apparent Power EIC, including AGS and all CAD loa
Scope 1, 10 GeV	28	27.4	39	48.75	77	28.25	55.4
Scope 2, 18 GeV, Lumi = 1 x 10E33	28	27.4	39	48.75	77	28.25	55.4
Scope 3, 18 GeV Lumi = .44 x 10E34	28	27.4	39	48.75	77	28.25	55.4
Scope 4, 18 GeV, Full Luminosity, 1 x 10E34	28	37	49	61.25	77	15.75	65
Scope 4, as above, one detector	28	43.5	55.5	69.375	77	7.625	71.5
Scope 4, as above, two detectors	28	50	62	77.5	77	-0.5	78

Water

Water usage - Cooling Tower installations currently planned for approximately 13,055 tons (45,900 kW) capacity. For a makeup rate of 0.06 GPM/ ton (0.0646 LPM/kW), maximum water consumption is 783.3 GPM (2965 LPM). Exploration is planned of alternative dry air-cooling technologies to minimize water consumption, bacteriological growth potential in cooling towers and chemical treatment systems usage.

Increased water needs for cooling systems is expected to fall within current supply capabilities under a scenario where cooling towers are used to provide conventional cooling. The peak increase in makeup water for cooling towers would be approximately 1 MGD (3.79 MLD) on the highest evaporative days. Discharge waters from cooling towers can be handled by existing outfalls including the Sewage Treatment Plant which has a designed capacity of 2.3 million gallons per day (8.71 MLD). Corrosion control chemicals could cause permit exceedances at outfalls if chemicals containing tolyltriazole (TTA) are used. The Laboratory is currently investigating the use of alternate chemicals free of TTA for corrosion control. Should chillers be selected for use, the potential impacts of cooling tower discharges would be greatly reduced and supplied water would remain similar to current levels. In a scenario using geothermal cooling, water would be pumped from new supply wells, used for cooling (heat exchangers), then injected to the groundwater at a higher temperature than the water extracted. The placement of extraction and injection wells would require careful consideration to not interfere with production wells for drinking water supplies or impact known contaminant plumes.

5.17.3 Effects of No Action Alternative on Utilities

The No Action Alternative would not have any effect on water use or power.

5.18 Electric and Magnetic Fields (EMF)

There are no Federal standards limiting residential or occupational exposure to the common-utility magnetic or electric fields found in the United States. The applicable electric field strength standards established by the New York State Public Service Commission (PSC) are set forth in the Opinion No. 78-13, issued June 19, 1978. The magnetic field standards are set forth in the PSC's Interim Policy Statement on Magnetic Fields, issued September 11, 1990.

Opinion 78-13 established an electric field strength interim standard of 0.5 kilovolts per foot (1.6 kilovolts per meter (kV/m)) for electric transmission lines, at the edge of the right-of-way, 3.3 feet (1 meter) above ground level, with the line at the rated voltage. The Interim Policy established a magnetic field strength interim standard of 200 milligauss (mG), measured at 3.3 feet (1 meter) above ground grade, at the edge of the right-of-way, at the point of lowest conductor sag (Caithness 2005).

5.18.1 Affected Environment

The local transmission lines into the BNL site operate at 13,800 V. National Electrical Safety Code requires vertical clearance to be 18.5 feet from the ground for transmission lines with this voltage. The oscillating magnetic field at ground level from AC current transmission has been reported to be about 0.5 to 10 mG at 60Hz.[1]

[1] Biological Effects of Power Frequency Electric and Magnetic Fields, Congress of the United States, Office of Technology Assessment, NTIS # PB89-209985, 1989.

5.18.2 Effects of Alternatives on EMF

The Preferred Alternative would require additional power beyond what is currently provided to the BNL site. While the additional power and potentially additional power transmission lines may be necessary the EMF from these lines would be similar to those currently present and electric service to the EIC would fall withing transmission specifications. The potential connected action of extending an additional 69 kV line into the Lab to serve the EIC would have EMF characteristics similar to the existing power distribution system.

5.19 Waste Management and Pollution Prevention

5.19.1 Affected Environment

The Laboratory has implemented extensive and active pollution prevention (P2) and recycling programs that reflect the national and DOE P2 goals and policies. The Laboratory's Environmental Protection Division (EPD) is staffed with subject matter experts responsible for evaluating and implementing regulatory requirements and P2 programs. The EPD operates the Waste Management Facility (Buildings 855 and 865) where waste generated at BNL is processed and prepared for off-site shipment and disposal. Additional details of the P2 and recycling programs are described in Chapter 2 of the Site Environmental Report (BNL 2020).

The beam stop and beam dump areas of RHIC are very well delineated as is the potential for soil activation in these areas. To ensure that potential soil activation products are not leached into the local groundwater impermeable caps have been placed over these areas to prevent precipitation from infiltrating. Additionally, areas where soil activation might occur are monitored with permanent groundwater monitoring wells. Discharges from cooling towers to licensed outfalls are monitored and programs are in place to prevent or minimize potential releases.

5.19.2 Effects of Preferred Alternative on Waste Management and Pollution Prevention

Much of the RHIC accelerator complex will be repurposed for use by the EIC including both hadron colliders, RHIC tunnel, interaction areas, and support structures. Where dismantlement is necessary equipment and shielding will be repurposed when possible. Materials not repurposed will be disposed of following standard practices that meet all regulatory requirements. The construction of the EIC will result in the building of several new structures totaling roughly 150,000 sq. ft. using conventional building techniques and materials. Where possible recycling of excess materials will take place and structures will strive to comply with the principles of high performance sustainable buildings.

5.19.3 Effects of the No Action Alternative on Waste Management and Pollution Prevention

There would be no effect on standard industrial/universal waste or low-level radioactive waste from the RHIC Complex. RHIC plans to continue shipping large non-reusable radioactive components as waste, to licensed disposal facilities, when funding allows and, continue disassembling and re-using legacy program equipment where practicable.

5.20 Commitment of Resources

5.20.1 Commitment of Resources under the Preferred Alternative

Construction of the EIC will require land clearing, excavation and grading for the installation of new utilities and services, extension of existing utilities and services and construction of new facilities. The new facilities will be designed to house accelerator equipment such as power supplies, radio-frequency amplifiers, magnets, controls systems components and network and data systems. Construction adjacent to the existing tunnel and that required for a proposed new tunnel section will require steel sheet pile for slope stabilization and poured concrete for retaining walls and shielding. A certain amount of heavy, high density concrete will be required for shielding. This will be mixed at a local concrete plant, transported to the site and poured in-place. Additional concrete shielding block, if required, will be sourced from existing inventory.

The new buildings will be constructed of concrete slab on-grade with footings and conventional steel frame or concrete masonry unit construction, depending on the most economical approach required to fulfill the design requirement.

Electrical distribution will require overhead transmission lines to distribute power to and around the site with branch takeoffs to areas needing electric service. Locations will be fitted with transformer and substation yards to provide appropriate voltage and power to each area. Water cooling systems, where required, will consist of open evaporative cooling towers mounted on structural footings and fitted with appropriate distribution piping, pumping and distribution systems. They will be equipped with chemical monitoring and dosing stations to ensure that required operating parameters are met. Makeup water will be drawn for the BNL Site potable water distribution system.

Accelerator components will be manufactured off-site, then delivered, assembled, tested and installed in a combination of existing facilities, including the existing RHIC tunnel and new facilities and tunnel as described above. An important project goal is to leverage and utilize the maximum amount of existing facility square footage and utility capacity as possible in order to minimize new construction. To that end, the Rapid Cycling Synchrotron, and Electron storage Ring will both be located in the existing RHIC tunnel, while the Electron Linac and supporting facilities will be housed in new structures as described above.

Several new satellite cryogenics facilities will be located in key support areas as listed. These will house cryogenics compressors, cold boxes and support auxiliaries and be constructed conventionally.

Various piping and cabling systems will need to be installed between the new facilities and the tunnel areas. These paths will be created by installing pipe “ports” through the tunnel berm and into the tunnel from the adjacent service building with minimally invasive jacking or excavating techniques. Disturbed soil will be fully restored upon completion of all port installations.

5.20.2 Commitment of Resources under the No Action Alternative

The No Action Alternative would not have an effect on commitment of resources.

5.21 Sustainability

5.21.1 Affected Environment

Brookhaven National Laboratory has established a Site Sustainability Plan that is used to implement and track sustainability measures. The plan, actions, and tracking measures can be found at: https://www.bnl.gov/about/sustainability/.

5.21.2 Effects of Alternatives on Sustainability

All alternatives would include actions that improve sustainability including taking advantage of energy savings, water savings, pollution prevention, reuse, and recycling. The Laboratory consistently works to reuse accelerator components from other accelerators both at BNL and elsewhere within the DOE complex. As building and facilities are upgraded, energy efficiency is often built in, paint is low/no VOC, and materials are typically of recycled content. Thus, providing improvement on sustainability. Also see section 5.9.2 concerning green house gasses.

Effects of Preferred Alternative on Sustainability

Construction of the EIC provides opportunities for sustainability. The project will utilize the existing hadron accelerators and the Electron Storage Ring and Rapid Cycling Synchrotron will be placed within the existing tunnel eliminating the need for new tunnel construction. The use of concrete containing fly-ash or other sustainable materials may be incorporated where possible. Where practical to do so, highly sustainable building concepts may be used in design and construction for the conventional buildings.

5.23 Decommissioning and Restoration

The EIC is expected to operate for 10 or more years after construction. As the program nears the end of operations decommissioning plans would be developed. At that time, the Laboratory will determine the hazards and risks associated with decommissioning, and the activities required for completing it. Environmental reviews, including NEPA, would be completed as part of the decommissioning plans. Of the utmost importance in formulating these plans is ensuring the safety of the workers, protecting the public and the environment, and complying with the applicable state-, local-, and federal-regulations.

5.24 Cumulative Impacts

Besides the activities outlined under this document, recent and planned projects include:

- Sewage treatment plant upgrades with discharge to groundwater (completed 2014)
- Construction and operation of the 200-acre Long Island Solar Farm, 145 acres of clearing (completed 2011)
- National Synchrotron Light Source II, 15 acres cleared (completed 2014)
- Science User Support Center at Upton Square – 20-acre development near Lab entrance, construction started in 2020

The current project along with recent (since 2009) and planned projects will impact a proximately 290 acres of the BNL site with approximately 180 acres requiring clearing of natural areas. Each project has been or will be reviewed under the requirements of NEPA to assess impacts. Cumulative impacts are not expected to result in significant negative impact to the environment.

Connected Action – New Electric Substation and Electric Feed

The EIC will result in increased power needs for the Laboratory. In order to meet these and other future needs the Laboratory is exploring the need for an additional 138 kV feeder from the grid distribution running along the eastern firebreak. The new electric substation would be located at a point along the main electric line on the east fire break at the intersection with East Fifth Avenue or slightly to the west of the east firebreak along East Fifth Avenue. The new 138 kV feeder would extend along East Fifth Avenue toward the center of the Laboratory connecting to Substation 9 feeding the RHIC/EIC complex. The new feeder would pass over wetlands and would utilize either the existing poles or new poles placed nearby. The project would require wetland permits and potentially some tree cutting along the route.

Connected Action – Helium Recovery and Production Facility

The EIC will continue to require the use of helium to maintain cryogenic temperatures for the hadron storage rings. Additionally, use of helium for cryogenic systems exist within the Collider Accelerator Department, NSLS-II, Center for Functional Nanomaterials, Chemistry, and the Integrated Science Building. To support the multiple need for helium the Laboratory may develop a new Helium Recovery and Production Facility that would include parking for two tube trailers, an ~15,000 sq. ft. superconducting magnet facility, an ~22,500 sq. ft. cryo plant, a ~6,000 sq. ft. cooling tower, and possible re-utilization of building 974 as part of the new facility. The project would also include the removal of the existing facility once the new facilities are in operation. The new facility would most likely be placed within the current disturbance footprint of the RHIC and may require limited clearing for placement of piping between RHIC and bldg. 974. The scenic river corridor for the Peconic River extends to just south of building 974, therefore the clearing may require a Scenic River Permit from the NYSDEC.

6.0 ACRONYMS, INITIALS, AND ABBREVIATIONS

ALARA	As Low As Reasonable Achievable
AWQS	Ambient Water Quality Standards
BER	Brookhaven Executive Roundtable
BHSO	Brookhaven Site Office (DOE)
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates, LLC
CAC	Community Advisory Council
CCC	Civilian Conservation Corps
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGA	Compatible Growth Area
CO	Carbon monoxide
CPA	Core Preservation Area
CPB	Central Pine Barrens Joint Planning & Policy Commission
CRMP	Cultural Resource Management Plan
dBA	Decibel
DOE	Department of Energy
EA	Environmental Assessment
ECL	Environmental Conservation Law
EIC	Electron-Ion Collider
EIS	Environmental Impact Statement
EMF	Electric and Magnetic Fields
EPA	Environmental Protection Agency
EPD	Environmental Protection Division
FEMA	Federal Emergency Management Agency
FERN	Foundation for Ecological Research in the Northeast
FONSI	Finding of No Significant Impact
GHG	Greenhouse Gas
GWP	Global Warming Potential
ILIA	Institute of Long Island Archaeology
IPCC	United Nations Intergovernmental Panel on Climate Change
ISB	Integrated Science Building
LIPA	Long Island Power Authority
LISF	Long Island Solar Farm
MEI	Maximally Exposed Individual
MeV	Milli-[thousandth] electron Volt
mG	milligauss
MGD	Million gallons per day
MLD	Million liters per day
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOx	Nitrogen Oxides
NRMP	National Resource Management Plan
NSLS-II	National Synchrotron Light Source-II
NY	New York
NYCRR	New York Codes, Rules, and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation

OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
PM	Particulate Matter
PSC	Public Service Commission
pCi/l	Pico-[trillionths] Curies per liter [Curie = basic unit used to describe the intensity of radioactivity in a sample of material]
RHIC	Relativistic Heavy Ion Collider
SC	Suffolk County
SER	Site Environmental Report
SEQRA	New York State Environmental Quality Review Act
SHPO	State Historic Preservation Officer
SPDES	State Pollutant Discharge Elimination System
SPL	Sound Pressure Level
STP	Sewage Treatment Plant
T&E	Threatened and Endangered
U.S.	United States
USGS	Untied States Geological Survey
VOC	Volatile Organic Compound
WFMP	Wildland Fire Management Plan
WWI	World War I
WWII	World War II
WSRRA	Wild, Scenic, and Recreational Rivers Act

7.0 LIST OF AGENCIES CONTACTED AND PRESENTATIONS TO STAKEHOLDERS

7.1 Agencies Contacted

DOE NEPA regulations, found in 10 CFR 1021.301, require that the host state be provided the opportunity to review and comment on the EA document prior to DOE's approval of the EA.

Copies of the draft EA were distributed to the following New York State offices:

New York State Governor's Office – Albany, NY

New York State Department of Environmental Conservation – Stony Brook, NY

New York State Office of Parks, Recreation and Historic Preservation – State Historic Preservation Officer

7.2 Stakeholder Presentations

Presentations on the EIC and the EA were provided to the following groups:

BNL Community Advisory Council (CAC)

The CAC consists of approximately 27-member organizations representing business, civic, education, employee, environment and health organizations. Members meet monthly, set their own agenda, and work to reach consensus recommendations on issues of concern to them. Meetings are open to the public; each meeting has a comment period during which community members may voice their opinions and concerns [http://www.bnl.gov/community/CAC.asp]. Presentations about the EIC were provided to the CAC on September 10, 2020.

Brookhaven Executive Roundtable (BER)

The BER consists of elected officials or their representatives from town, county, state and federal levels as well as officials from governmental organizations like the NYSDEC, US Fish & Wildlife Service, and the Central Pine Barrens Joint Planning and Policy Commission. A presentation to the BER about the EIC EA was provided on Sept. 16, 2020.

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