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INITIAL ASSESSMENT STUDY (NEESA 13-001) ST JULIENS CREEK ANNEX CHESAPEAKE VA

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NAVY ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

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July 1981

NAVY ASSESSMENT AND CONTROL OF INSTALLATION POLLUTANTS:

Initial Assessment Study of St. Juliens Creek Annex, Norfolk Naval Shipyard, Portsmouth, VA

NEESA 13-001

NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY
Port Hueneme, California 93043

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INITIAL ASSESSMENT STUDY
of
St. Juliens Creek Annex, Norfolk Naval Shipyard,
Portsmouth, VA
UIC: 00181

April 1981

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NEPSS

Naval Environmental Protection Support Service

FOREWORD

The Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program in OPNAVNOTE 6240 ser 45/733503, 11 September 1980. The purpose of the program is to systematically identify, assess, and control contamination of the environment resulting from past hazardous materials management operations.

An Initial Assessment Study was performed at St. Juliens Creek Annex, Norfolk Naval Shipyard, by a team of specialists from the Naval Energy and Environmental Support Activity, the Ordnance Environmental Support Office, and the Army Corps of Engineers. Significant contamination does not exist at St. Juliens Creek Annex, and the need for a Confirmation Study under the NACIP program is not indicated.

Significant findings, conclusions, and recommendations are presented at the front of the report. More detailed, technical information is contained in subsequent sections of the report.

Questions concerning the NACIP program should be referred to the NACIP Program Director, Naval Energy and Environmental Support Activity (Code 20), Port Hueneme, CA 93043, AUTOVON 360-4062, FTS 799-4062, or commerical 805-982-4062. Contact the team leader, Mr. Jeff Heath, at AUTOVON 360-4821, FTS 799-4821, or commercial 805-982-4821, for further information concerning this study.

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- Pedro Cunanan, Atlantic Division, Naval Facilities Engineering Command
- William O'Brien, Management Engineering, Norfolk Naval Shipyard
- LCDR McNeill, Annex Officer, Norfolk Naval Shipyard
- LCDR Houston Hanes, Environmental Officer, Norfolk Naval Shipyard

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I. INTRODUCTION

The Chief of Naval Operations directed the Naval Energy and Environmental Support Activity (NEESA), in conjunction with the Ordnance Environmental Support Office (OESO), to conduct Initial Assessment Studies at Navy shore activities. The studies are an integral part of the Navy Assessment and Control of Installation Pollutants (NACIP) program to identify, assess, and control contamination of the environment caused by past hazardous material storage, transfer, manufacturing, and disposal operations. The first step of the NACIP program, the Initial Assessment Study, ascertains whether the potential for environmental contamination exists.

From 28 July to 1 August 1980, the on-site survey portion of the Initial Assessment Study, was performed at St. Juliens Creek Annex, Norfolk Naval Shipyard, Portsmouth, VA, by a team of specialists from the NEESA, the OESO, and the Army Corps of Engineers. Prior to performing the on-site survey, the team compiled and evaluated records from various offices, including the Naval Facilities Engineering Command, the Naval Sea Systems Command, the Navy History Office, and the National Archives, to obtain documented evidence of environmental contamination. During the on-site survey, the team reviewed activity records and maps, interviewed long-time employees and retirees of St. Juliens Creek Annex, and physically inspected the activity's facilities and environs. Survey findings and recommended actions are summarized in this report.

A recommendation for the next phase of the NACIP program, the Confirmation Study, is based on the findings of the Initial Assessment Study. A Confirmation Study will be conducted if the following conditions exist:

1. The presence of sufficient evidence to suspect contamination, <u>and</u>

2. The contamination presents a definite danger

   a. To the health of people in adjoining communities and/or within the base fenceline, <u>or</u>

   b. To the environment within and/or outside the installation.

Further studies of the activity under the NACIP program will not be recommended if these criteria are not met.

II. SIGNIFICANT FINDINGS

A. St. Juliens Creek Annex's mission included the manufacture of ammunition. Since 1898, different sizes and types of ammunition were loaded with black powder, smokeless powders, Explosive D, TNT, Composition A-3, and tetryl. Buildings in which loose ordnance materials were handled include: 12, 13, 14, 18, 29 (torn down, was adjacent to east end of M-2), 32, 32A, 33 (these three buildings were located between bldgs. 17, 38, and 39), 39, 41, 43, 46, 47, 89, 180, 184, 185, 188, 190, 193, 222 (Victory Building, located between the burning grounds and Blows Creek), 240 through 246, 256, 267, M-3, M-4, M-5, and M-5 Annex. These buildings are located south and east of the Virginia Electric and Power Company (VEPCO) power lines that bisect the activity.

B. Decontamination was performed in, around, and under ordnance handling facilities at St. Juliens Creek Annex in 1977, after ordnance operations had ceased. Visual inspections and chemical analyses since that time indicate that low concentrations of ordnance materials are present in some of these facilities but that a fire or an explosive hazard does not exist. Decontamination is discussed on page 40.

C. Ordnance wastewaters and rinsewaters were discharged into Blows Creek, into the swamp by bldgs. 257 and 130 that drains to St. Juliens Creek, and into the South Fork of the Elizabeth River. In the 1950s, most of these discharges were directed to the sanitary sewer system, but several discharges to the other areas continued until the 1970s.

D. Ordnance wastewaters and rinsewaters were discharged into the sanitary sewer system from the 1950s until the 1970s. Ordnance may be present in sewer and lift station sediments and may have absorbed into the pipe walls.

E. Contamination was not reported in the recreation area located in the northwest corner of the activity. The recreation area is to be excessed.

F. The hydrology and the geology of St. Juliens Creek Annex is conducive to pollutant migration.

G. The shallow aquifer under St. Juliens Creek Annex has a high permeability to vertical and lateral movement of water. The aquifer is not used for water supply. The shallow aquifer and the deeper aquifer are separated by thick clays.

H. The surface waters in the area are described as "poor water quality." These waters contain Kepone and are condemned to shellfishing. The Kepone does not originate from St. Juliens Creek Annex.

I. Low level concentrations of Kepone, from the EPA's past storage operation, are present in bldg. 198. Results of chemical sampling and analysis of the building are shown in figure 28 on page 48.

J. Strong evidence indicates the presence of unexploded ordnance items (such as ammunition and shells) in the sediments adjacent to the wharf area and in the sediments adjacent to bldgs. M-5 and 190 where a pier was previously located.

K. A small area of contamination exists in an open area by Cross Street and Mine Road. This contamination was caused by pesticide and herbicide tank rinsing operations. These operations ceased during the mid-1960s. Figure 25 on page 43 shows the area of contamination.

L. Known endangered species do not exist in the ecosystems at St. Juliens Creek Annex.

M. Three garbage burning dumps and one sanitary landfill (dump D) were operated at the activity. See figure 31 on page 51 for locations of the dumps.

N. Personnel reported that considerable amounts of ordnance were disposed of at the burning ground. The surface of the burning ground was decontaminated in mid-1977.

O. Contamination was not reported to exist in any magazines (except bldg. 198, Kepone); loose material was not permitted in these magazines.

III. CONCLUSIONS

A. Low level concentrations of ordnance materials exist throughout the area east and south of the VEPCO power lines. The sites where these materials exist are centered in, under, and around buildings that handled loose ordnance materials. Decontamination of these facilities lowered the concentrations of these materials. As a result, fire or explosive hazards do not exist. However, visual inspections and analytical tests performed after decontamination indicate that low concentrations of ordnance materials still exist in some buildings. Other suspected sites where residues may exist lie in the area east and south of the VEPCO power lines. These include residues under the surface of the burning ground; residues from garbage burning at the northwest edge of the base and near the swamp between bldgs. 257 and 130; residues from pesticide and herbicide rinseate disposal at Cross Street and Mine Road; and sediments of Blows Creek.

B. The sites mentioned previously in the area east and south of the VEPCO power lines do not pose a threat to human health or to the environment. None of the ordnance handling facilities are occupied by humans; they are either used for storage or they are empty. The shallow groundwater in the area is not used for human consumption. The receiving waters, into which surface drainage and groundwaters flow, are of poor quality because the activity is situated in a highly industrial location. These waters are condemned to shellfishing because of Kepone contamination (not originating from St. Juliens Creek Annex).

C. St. Juliens Creek Annex is surrounded by industrial developments. Consequently, a simple determination of who is polluting the surface waters is a difficult, if not an impossible, task, except for unique pollutants. Any indication of pollutants around the periphery of the Annex would require a hydrogeological investigation to determine if the pollutant is coming from, is coming on, or is passing through St. Juliens Creek Annex.

D. The effects of chronic human exposure to ordnance compounds present in the parts-per-million range are unknown. Whether any of the ordnance handling buildings are safe for long-term human occupancy is unknown.

E. In bldg. 198, where Kepone was stored by the EPA, low levels of Kepone are still present. A standard for chronic exposure to Kepone is not available. Therefore, a determination cannot be made whether the levels present in bldg. 198 make it unfit for human occupancy.

F. Unexploded ordnance is probably present along the wharf area and in the the sediments near bldg. M-5. The ordnance is not a hazard if the sediments are not disturbed. According to the Army Corps of Engineers, dredging the sediments would be an expensive and slow process.

IV. RECOMMENDATIONS

A. Recommend that no confirmation study be conducted at St. Juliens Creek Annex. The contamination is at low concentrations and does not pose a threat to human health or to the environment.

B. Recommend that, if any of the buildings in which loose ordnance materials (identified in section IV. A.) were handled are planned for human occupancy or are excessed, the Navy Environmental Health Center, Norfolk, VA, determine whether the buildings are fit for human occupancy or are safe to excess.

C. Recommend that real estate records for St. Juliens Creek Annex be annotated to indicate that unexploded ordnance may exist in the present wharf area and in the abandoned wharf area adjacent to bldg. M-5. If the sediments in these areas are to be disturbed, the Army Corps of Engineers and Explosive Ordnance Disposal (EOD) Group 2, Fort Story, VA, should determine how this can be accomplished safely.

D. Recommend that the activity continue its efforts to obtain certification that bldg. 198 is safe for human occupancy.

E. Other Recommendations

1. Recommend testing of a PCB transformer located in the heating plant (bldg. 283) to determine level of PCB contamination. If the PCB concentration is 500 ppm, or greater, the transformer should be labeled as a PCB transformer.

2. In recent years, bldg. 163, a magazine, was used for storing hazardous materials from the shipyard. These materials included waste PCBs, mercuric nitrate, and trichloroethylene. Visual inspection showed none of the material had spilled. Records show that incidents have not occurred. Recommend improvements to bldg. 163, such as a curbed, sealed floor and proper waste segregation, to ensure proper containment if a spill should occur. LANTNAVFACENGCOM can provide guidance on requirements for hazardous material storage facilities.

V. BACKGROUND

A. General

St. Juliens Creek Annex, Norfolk Naval Shipyard, is located within the City of Chesapeake in southeast Virginia. Figure 1 shows the general location on a 1:250,000 United States Geological Survey (USGS) topographical map. Figure 2 shows the area (labeled U.S. Naval Ammunition Depot) on a 1:24,000 USGS topographical map. Figure 3 is a map of the activity, and figure 4 is an aerial view. St. Juliens Creek Annex abuts Portsmouth City and the Norfolk and Western Railroad on the north; the Southern Branch of the Elizabeth River on the east; St. Juliens Creek on the south; and a residential section of Chesapeake City on the west. An area containing dredged material lies off the northeastern tip (industrial waste ponds on figure 2). Blows Creek arises toward the northern part of the Annex and flows east to the Southern Branch of the Elizabeth River. A VEPCO power line runs diagonally across the activity in a northeast-southwest direction, splitting the area roughly in half. Facilities northwest of the power line are predominantly storage and warehousing; facilities southeast of the power line are industrial and manufacturing, administrative, quarters, burning and disposal, and the search radar test range for the Norfolk Naval Shipyard. A rectangular area on the extreme west side, used for recreational purposes, is to be excessed (see figure 3). An aerial view is shown in figure 5.

St. Juliens Creek Annex occupies approximately 490 acres, including 407 acres of hard land, 14 acres of marsh, and 69 acres of water surface. Facilities include 244 buildings, 1,520 linear feet of wharf, 16 miles of paved roads, 17 miles of railroad tracks, a central heating plant, numerous nonoperational industrial facilities, and miscellaneous structures including a housing area.

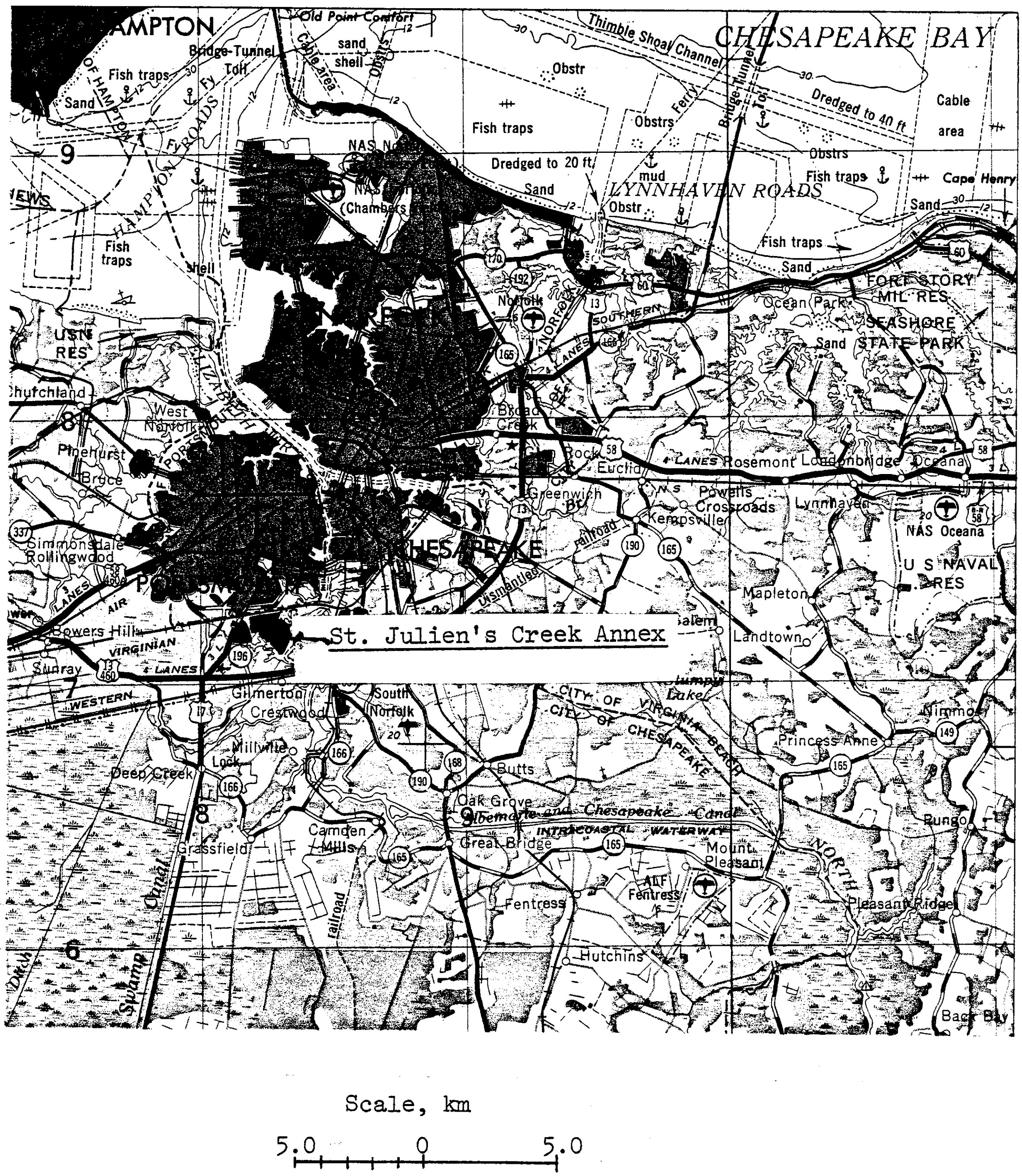


FIGURE 1. LOCATION OF ST. JULIENS CREEK ANNEX.

Scale, km

0.5 0 0.5

FIGURE 2. LOCATION MAP FOR ST. JULIENS CREEK ANNEX

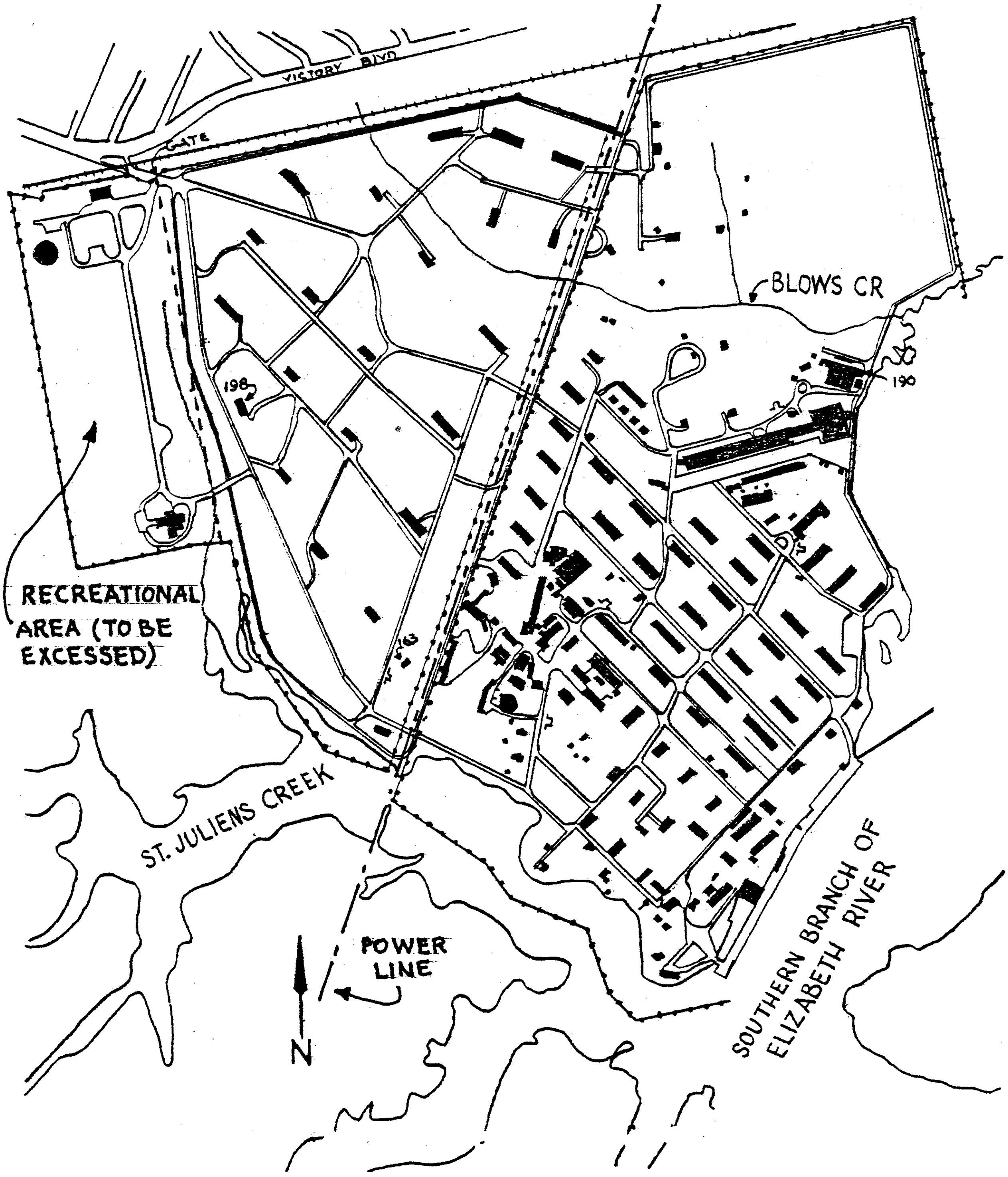


FIGURE 3. MAP OF ST. JULIENS CREEK ANNEX, NORFOLK NAVAL SHIPYARD

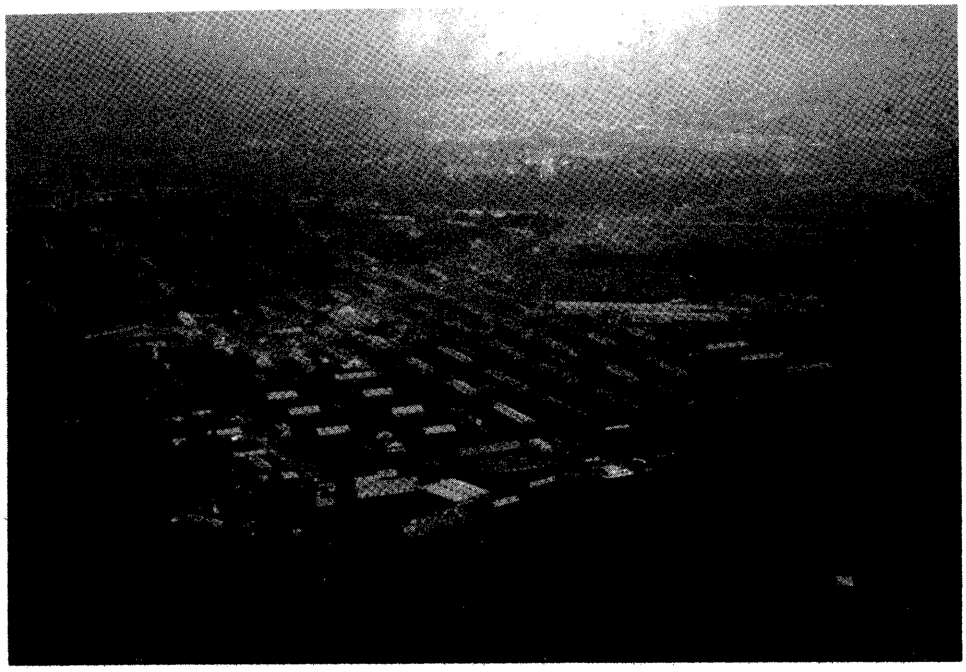


FIGURE 4. AERIAL VIEW OF ST. JULIENS CREEK ANNEX.

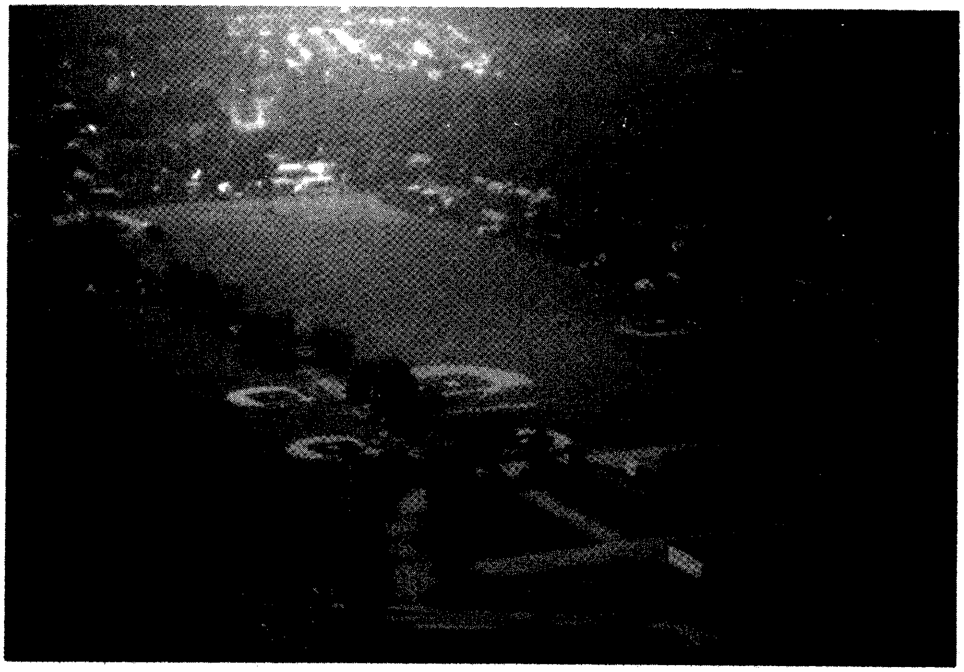


FIGURE 5. AERIAL VIEW OF LAND TO BE EXCESSED.

B. History

St. Juliens Creek Annex, Norfolk Naval Shipyard, as a naval activity, dates back to 12 September 1849. At that time, an area known as Fort Norfolk was transferred from the War Department to the Navy Department and was renamed Magazine, Fort Norfolk. The magazine's mission was storage of ordnance and materials.

From 1875 until 1898, Craney Island, located in the Elizabeth River about 7 miles north of Magazine, Fort Norfolk, was used as additional magazine space.

In 1896, 48 acres of land were purchased adjacent to Magazine, Fort Norfolk, to accommodate five magazines, two personnel quarters, an administration building, two wharfhouses, and two wharves.

By 1898, ordnance material and equipment (including presses and extractors for assembling and breaking down fixed cartridges, and dies and stands for reforming small-caliber cases) were removed from Craney Island and were installed at Magazine, Fort Norfolk. In 1898, Magazine, Fort Norfolk, was redesignated U.S. Arsenal, St. Juliens Creek. The arsenal had a work force of 25 persons.

U.S. Arsenal, St. Juliens Creek, became fully operational in time to provide critical support to the fleet during the waning months of the Spanish-American War. In 1902, the activity's name was changed to U.S. Naval Magazine, St. Juliens Creek. Prior to 1 July 1905, the activity was administered by the Inspector of Ordnance at the Norfolk Navy Yard; from 1905 to 1918, it was a separate department. A map of the activity showing facilities that exist in the early 1900s is shown in figure 6.

In 1908, U.S. Naval Magazine, St. Juliens Creek, occupied 96 acres of land enclosed by a 10-foot high, corrugated iron fence. Rainwater that fell from the roofs was directed into three cisterns. The water was used for drinking and for fire protection. A windmill pumped the water into a 90-foot-tall storage tank near bldg. 185 to maintain pressure in the distribution system. The permanent work force of the activity prior to World War I (1916) consisted of 3 officers and 65 civilians.

Until 1915 most of the ammunition work was manual labor. Projectiles were pressed into and withdrawn from cases by hand-operated machines geared to a 4-foot diameter wheel. Primers were pressed into cases, and cans were reformed using the same method. Explosive "D" was manually loaded into projectiles. Black shell powder and gun cotton were the main constituents loaded into projectiles, warheads, and mines. In 1915, machines for pressing projectiles into cases and for extracting projectiles were modernized and motor-powered.

On 1 January 1917, the activity's name was changed to Naval Ammunition Depot (NAD), St. Juliens Creek. The depot operated under the auspices of the Commandant, Fifth Naval District.

In 1917, 18 buildings and a wharf were constructed, and equipment was installed for loading MARK VI mines. Portable outside lights shining through the windows provided illumination for night work. The only source of heat during winter was a coal stove in the mess hall.

FIGURE 6. MAP OF ST. JULIENS CREEK ANNEX, EARLY 1900S.

Between World War I and World War II, the depot assumed a peacetime mission of supplying ammunition to the fleet. The civilian work force decreased from 1,800 to approximately 400 persons.

In 1941, depot personnel numbered 774. The beginning of World War II caused a rapid increase. During the peak operation period (1942-1944), depot personnel were 59 naval officers, 131 enlisted Marines, and 4,018 civilians. In addition, the present-day recreation area (see figure 3) contained barracks for 15 Navy officers and 1,253 Navy enlisted, bringing the on-board personnel count to 5,340. During World War II, additional magazines, filling houses, and other facilities, including the all-concrete wharf No. 1, were constructed.

During World War II, the depot maintained and/or operated 175 buildings. The personnel count increased to 6 officers and 600 civilian workers in the core area of the depot. The mine plant, located in the "M" buildings complex, employed 3 officers and 1,200 enlisted personnel who loaded mines 24 hours a day. During World War II, 119 additional acres of land were purchased, giving the depot a total of 215 acres. Fencing was erected to secure the new area.

NAD St. Juliens Creek's mission during World War II included loading, assembling, issuing, and receiving naval gun ammunition. All calibers from 20mm to 16-inch (with the exception of 40mm) were loaded and assembled. Shipments to the fleet alone averaged 12,500 tons per month. The depot also served as the principal experimental and test loading facility for new ammunition types for the Bureau of Ordnance. Manufacturers' samples of projectiles for flight, plate, and ballistics tests were loaded and fuzed. In an attempt to reduce fatal incidents, the Safety Department was established in 1942.

The depot again supplied ammunition to the fleet when the Korean conflict erupted. Gun ammunition (predominantly 3- and 5-inch) were loaded and assembled. Supplies of larger caliber gun ammunition, left over from World War II, were renovated. On-board personnel numbered 1,500. During the post-Korean conflict period, the depot resumed its mission of peacetime service to the fleet. The work force was once again reduced.

In 1964, the depot was the prime source of gun ammunition for Navy and Marine Corps operations in Southeast Asia. Peak production operations employed approximately 900 civilians.

In October 1969, after 50 years as an independent activity, NAD St. Juliens Creek was disestablished under Department of Defense "Project 703" and was consolidated as an annex to the Naval Weapons Station, Yorktown, Virginia.

During the early 1970s, production efforts continued to decline, commensurate with the disengagement policy and the reduced level of operations in Southeast Asia. The activity's wharf was damaged when two ships, the MV SEALORD II and the SS ELEOUSA, struck the wharf, 11 April and 23 April 1975. The wharf is still used, though it is unrepaired.

On 1 October 1977, the annex was transferred to the Norfolk Naval Shipyard.

A land-use survey was conducted by the Norfolk Naval Shipyard in 1979. The survey findings recommended that the recreation area (see figures 3 and 5), which previously contained Navy barracks, be excessed. This area was transformed into ball fields and it is currently designated a recreation area for local communities. Figure 7 shows fields and it is currently designated a recreation area for local communities. Figure 7 shows real estate acquisitions at St. Juliens Creek Annex since its establishment in 1876.

C. Physical Features

1. Climatology. St. Juliens Creek Annex is located in a humid Mesothermal Forest Climate. Mild winter temperatures average around 50°F during the day and 32°F at night. Low daily temperatures are below freezing 60 nights per year. Summers are hot with daily high temperatures in the upper 80s°F and low temperatures in the upper 60s°F. Approximately 30 days per year the maximum temperature rises above 90°F. Precipitation, which is very even year round, averages 48 inches of rain and 5 to 10 inches of snow. Thunderstorms occur approximately 40 days per year. The region is constantly humid, averaging 72% relative humidity. Annual evaporation rate for water is 40 inches; the theoretical evapotranspiration rate for this area is approximately 33 inches per year. Depth of frost penetration is shallow at 3 inches, and groundwater temperature averages 60°F. Winds, averaging 10 miles per hour, are predominantly from the southwest.

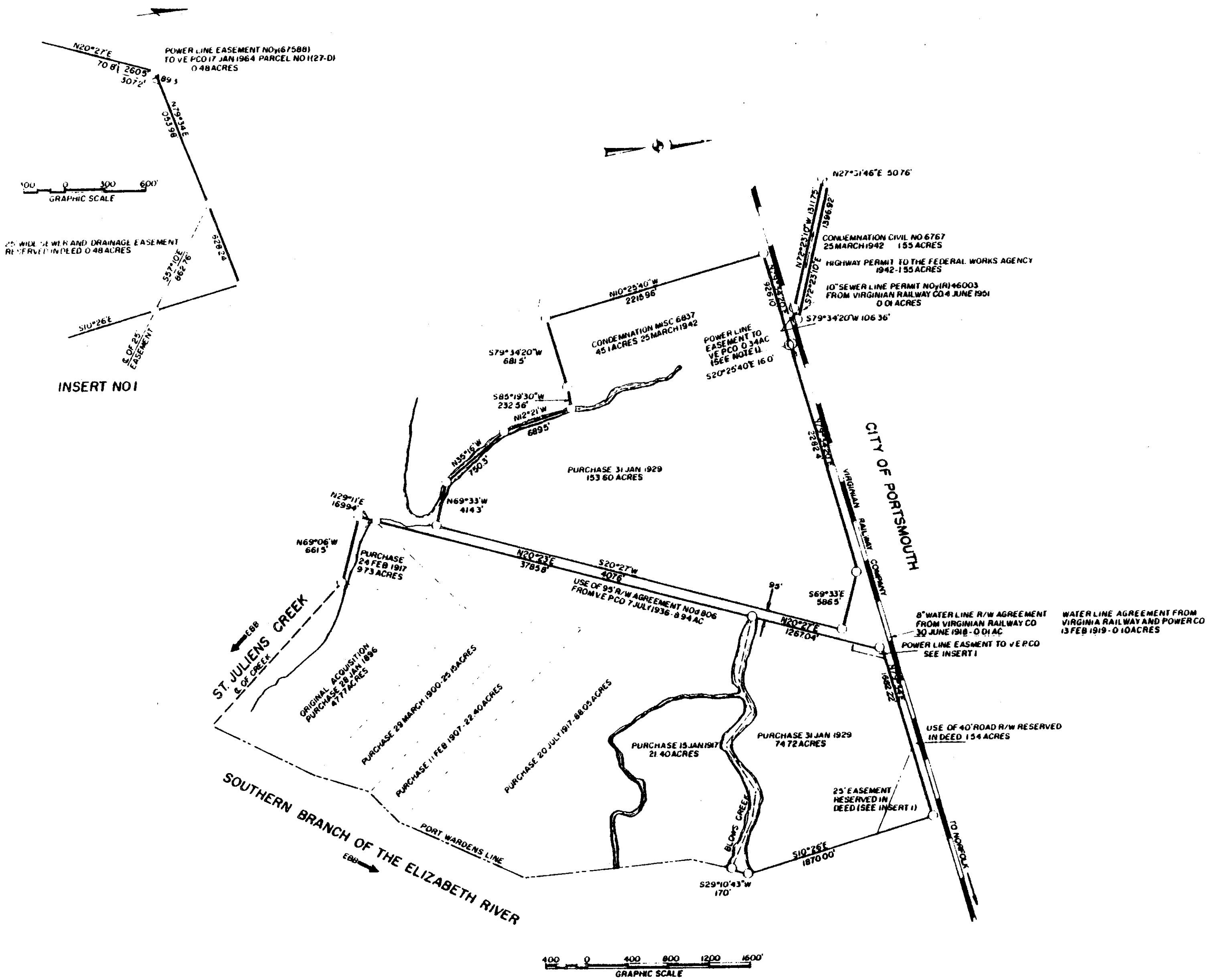
2. Topography. St. Juliens Creek Annex is a low-lying wedge of land between the Southern Branch of the Elizabeth River and St. Juliens Creek. A northwest-southeast trending ridge generally bisects the area. The ridge divides the St. Juliens Creek drainage basin from that of Blows Creek, which extends to the northeastern corner of the Annex. Topographic changes across the Annex are subtle and nearly imperceptible. Figure 8 shows the topography of the Annex.

3. Geology. St. Juliens Creek Annex is situated on the Atlantic Coastal Plain. A wedge of easterly dipping and thickening sediments contacts the basement rocks of the fall line (approximately 80 miles to the west) and extends to the Atlantic Ocean (about 20 miles to the east). The basement rocks include downfaulted Triassic strata and Paleozoic igneous and metamorphic rocks similar to the intensely fractured and sheared rocks exposed in the piedmont further west (reference a).

Marine, coastal, and alluvial cretaceous and tertiary strata overlie the basement rocks from the fall zone to beneath the continental shelf. Sediments of Pliocene or early Pleistocene age cover much of the higher portions of the coastal plain, whereas sediments of probable Pleistocene age form a thin blanket covering much of the lower, more seaward portions of the coastal plain in a series of steplike plains or "terraces" separated by east-facing scarps (reference a). Figure 9 was taken from the Virginia State Geological Map. This generalized account shows that the surface of the Annex's land is Quaternary sands and gravels.

The rock-stratigraphic units of Cretaceous through Miocene Age in the Coastal Plain of Virginia were studied, and six mappable units are defined in reference b. These units—the Patuxent, "transitional beds," Mattaponi, Nanjemoy, Calvert, and Yorktown Formations—and their characteristics are presented in figure 10.

The surficial geology of the Annex, included in reference c, shows that two facies of the Pleistocene Sand Bridge Formation and some Holocene alluvium sand, and marsh sediments outcrop on the Annex. These deposits are probably underlain by the Pleistocene Norfolk Formation. All these deposits are synonymous with the Columbia Group shown in figure 10. The eastern portion of the Annex is veneered with the clayey-sand facies of the Sand Bridge Formation. This facies ranges from clayey sand, silt, and clay to well-sorted, fine to medium sand. The facies has been interpreted as tidal channel deposits and has low to high plasticity/sensitivity, good bearing capacity, poor to



1 - CONDEMNATION MISC NO 6837 RESERVED TO VE PCO A POWER LINE R/W EASEMENT ALONG THE SOUTH R/W LINE OF VIRGINIAN RAILWAY CO THE WIDTH NOT TO EXCEED 16 FEET ALSO SUBJECT TO EXISTING DRAINAGE EASEMENTS

2 - CADASTRAL RECORDS REVEAL NO EASEMENTS ENCUMBERING THE LANDS DELINEATED, EXCEPT AS INDICATED

FIGURE 7: REAL ESTATE ACQUISITIONS AT ST. JULIENS CREEK ANNEX

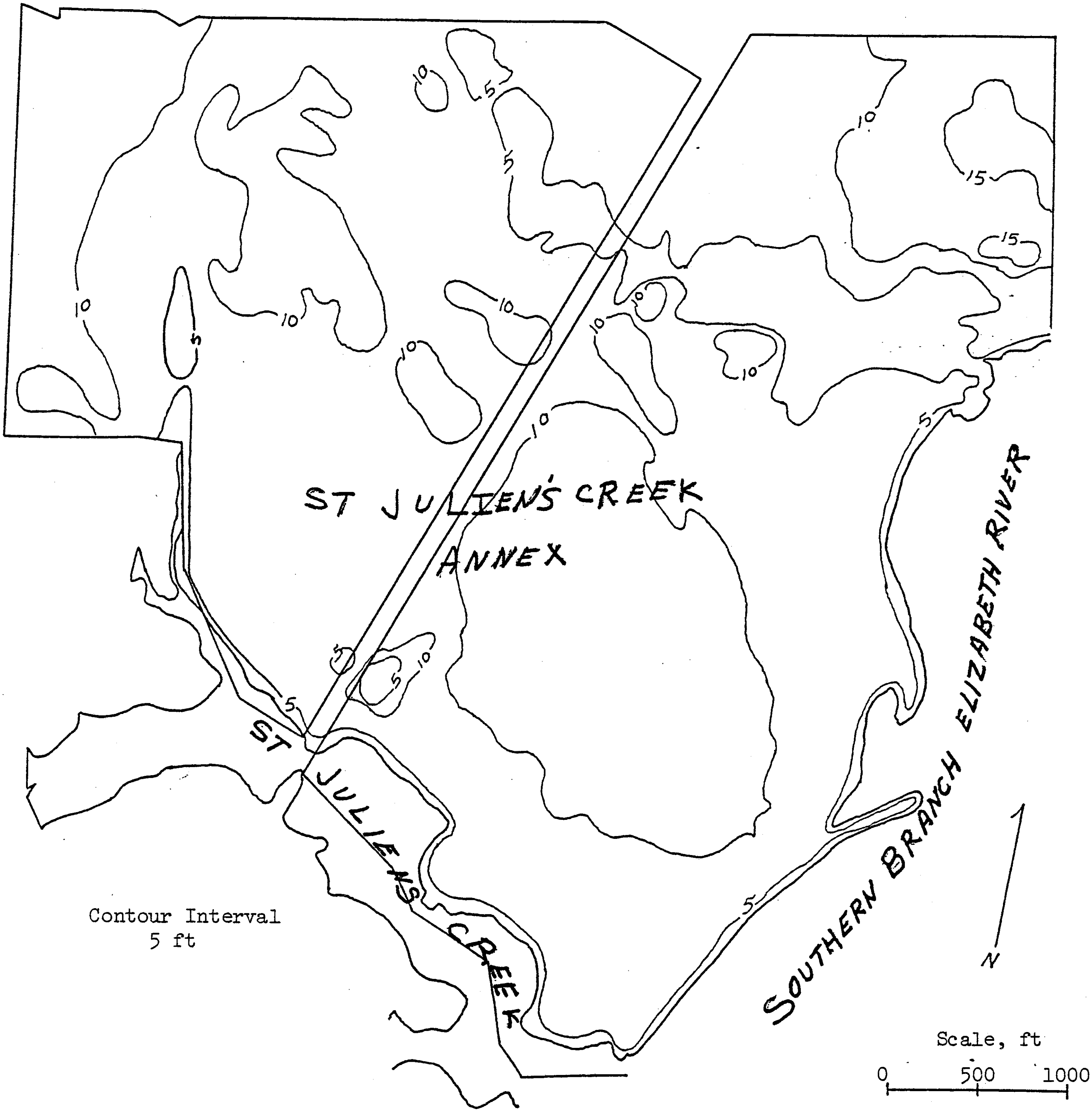


FIGURE 8. TOPOGRAPHY OF ST. JULIENS CREEK ANNEX

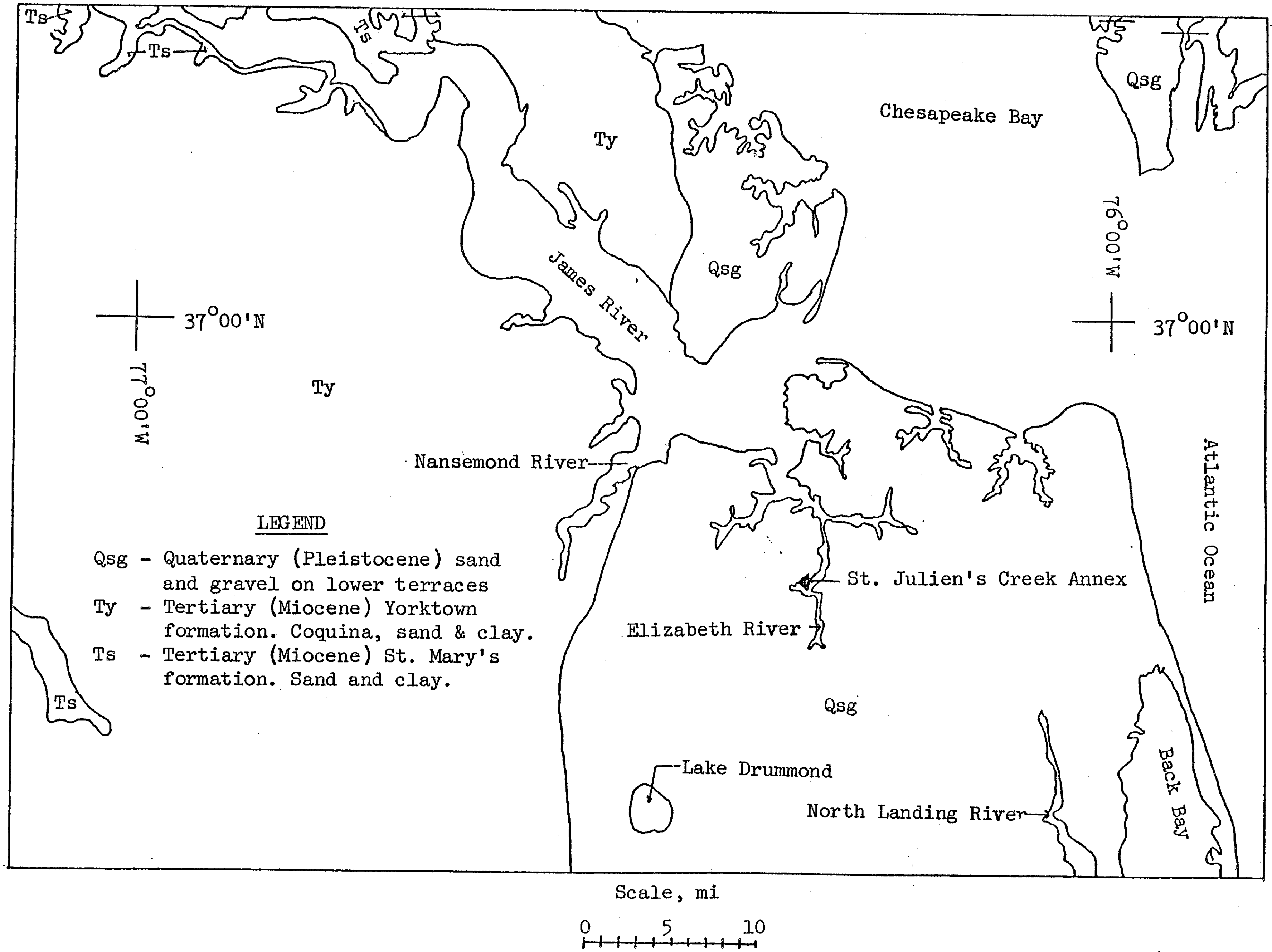


FIGURE 9. GENERAL GEOLOGY OF ST. JULIENS CREEK ANNEX AND VICINITY

	Series	Name	Lithology	Character
Quaternary	Pliocene-Holocene	Columbia Group		Light-colored oxidized deposits; mainly clays, silts, sands, and gravels; some peat.
Tertiary	—?—?—? Miocene	Yorktown Formation		Gray to bluish-gray silts, sands, shell beds; clay beds uncommon. Bioclastic sands and quartz-glauconite sands in southeastern part.
		Calvert Formation		Drab greenish-brown clays and silty clays, commonly consolidated. Plant fragments and mollusks common, locally abundant. Diatomaceous silty clays; *Siphogenerina* zone near base. Coarse basal sand—quartz-phosphorite, locally fossiliferous.
	Eocene	Nanjemoy Formation		Quartz-glauconite sands; shell beds and cavernous shell limestone fairly common. Three basal lithologies: coarse sands in eastern part; pale-gray and pale-red clays in central part; fine, silty, glauconitic beds in northwestern part.
	Paleocene	Mattaponi Formation		Drab green, gray, and brown glauconite-bearing clays; glauconite and quartz-glauconite sands; thin beds of shell and dense limestone. Glauconite mainly lobate, fissured, commonly sooty, commonly highly concentrated. Multicolored clay interbeds become increasingly common downward in eastern part; gravel marks base in western part.
—?—?—? Cretaceous (?) —?—?—	—?—?—? Upper (?)			
Cretaceous	Lower	"transitional beds"		Bright variegated fine-grained clastics; mainly nonfossiliferous. Finer and less feldspathic than Patuxent, less glauconitic than Mattaponi; feldspar and glauconite typically decomposed. Distinguishable only in south and northwest; bottom part is gray to maroon in extreme south.
		Patuxent Formation		Mainly medium- to very coarse-grained sands and fine-grained gravels; openwork deposits common. Mainly pale beds with tan, light-gray, and pale-green clay interbeds. Contains more coarse sand and gravel, and less silt and clay than "transitional beds". Potassic feldspar is diagnostic; blue quartz and pink garnet are very common.
Precambrian-Triassic		"basement"		Igneous and metomorphic rocks of Precambrian and Paleozoic age; partly consolidated sediments of Triassic (?) age.

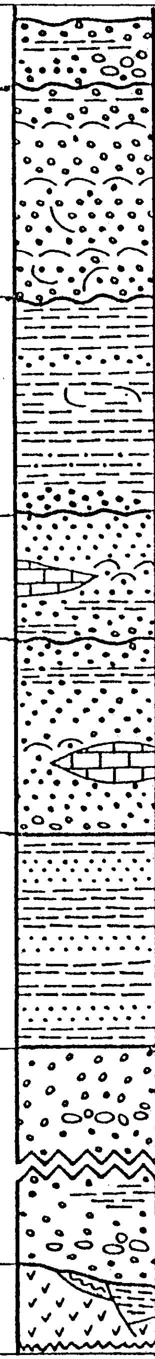


FIGURE 10. GEOLOGIC FORMATIONS IN THE COASTAL PLAIN OF VIRGINIA

good permeability, good erosion resistance, fair slope stability, and fair to good aquifer recharge. This recharge capability permits the vertical migration of contaminants from the ground surface to the water table.

The western portion of St. Juliens Creek Annex is veneered with the silty sand facies of the Sand Bridge Formation. This facies is a clean, homogeneous, fine to medium sand with silt concentrations of 10 percent to 35 percent. The average thickness is 12 to 14 feet. The facies has been interpreted to represent river-influenced lagoonal deposits. The silty sand facies has a low to moderate plasticity/sensitivity; poor to good bearing capacity; good permeability, erosion resistance, and slope stability; and fair aquifer recharge. The facies offers good paths for both the vertical and horizontal migration of pollutants.

The Holocene alluvium, sand, and marsh sediments occur along both Blows Creek and St. Juliens Creek. The sediments can range from low energy organic silt to higher energy clean sand, but the sediments are limited to low energy deposits on St. Juliens Creek Annex. The Annex's deposits have a high plasticity/sensitivity; low bearing capacity, permeability, and erosion resistance; poor slope stability; and poor aquifer recharge.

Figure 11 is a portion of the geologic map covering St. Juliens Creek Annex. Figure 12 is a portion of the cross section along Interstate 64 from U.S. Highway 17 on the west to the Southern Branch of the Elizabeth River. Figure 13 is the log-book entry for a boring north of the Annex.

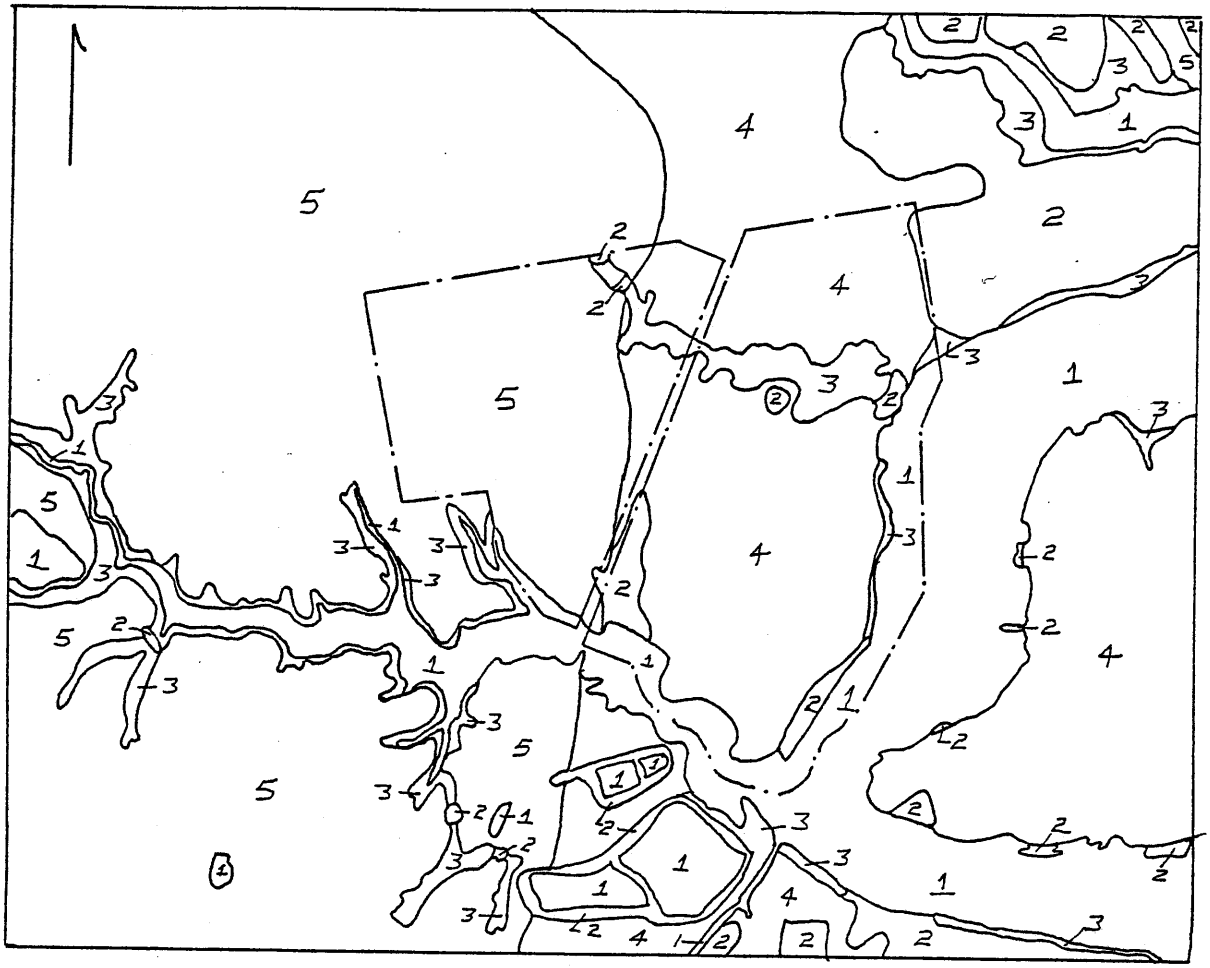
Boring logs, ranging from 1946 to 1978, were examined. Although some of the logs indicated a silty or clayey soil at the surface, most logs exhibited a sandy material for the surface. These findings substantiate the geological maps and reinforce the possibility for vertical migration of pollutants. Figure 14 shows the locations of these borings, and appendix A contains the boring logs.

4. Hydrology.

a. Surface Water. Both Blows Creek and St. Juliens Creek capture most of the surface runoff from St. Juliens Creek Annex. Both creeks empty into the Southern Branch of the Elizabeth River. Most of the runoff from the storage area (northwest of the Virginia Electric Power Company) is carried overland either to Blows Creek or to St. Juliens Creek. The remainder of the Annex is served by storm drains which empty either into St. Juliens Creek or into the Southern Branch of the Elizabeth River. Some surface water from off-base enters the upper end of Blows Creek. A very small amount of the Annex's surface water may exit the western boundary. However, in general, surface water does not enter or leave the activity except via St. Juliens Creek or via the Southern Branch of the Elizabeth River. Figure 15 shows the Annex's surface drainage. Figure 16 is an aerial view of Blows Creek.

The Southern Branch of the Elizabeth River flows through a highly industrialized area, which includes oil storage facilities, fertilizer plants, and creosol industries. The river, part of the intercoastal waterway, is used by many small boats during summer and by larger commercial and naval craft year round.

The State of Virginia has classified the water courses in this area as IIB. This classification results from the water being contaminated by Kepone and by sediments from manufacturing activities of a private firm located several miles from St. Juliens Creek Annex. Taking shellfish from IIB waters is prohibited, but bathing and fishing are



Scale, ft

0 2000 4000

LEGEND

1 Water

2 Fill

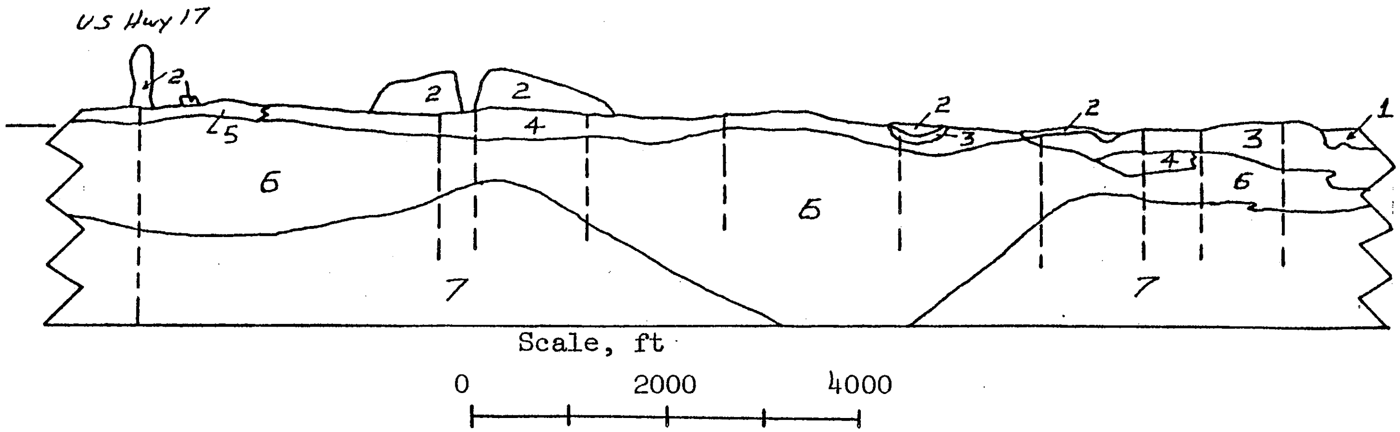
3 Quaternary (Holocene) alluvium, sand, and marsh sediment. Estuarine-beach, tidal marsh, and fluvial silt, sand, and clay with organic material (peat) abundant in tidal marshes.

Quaternary (Pleistocene) Sand Bridge Formation

4 Tidal channel facies; clayey sand

5 Shoal lagoonal facies; silty sand

FIGURE 11. GEOLOGICAL MAP OF ST. JULIENS CREEK ANNEX AND VICINITY



LEGEND

1 Water

2 Fill

3 Quaternary (Holocene) alluvium sand, and marsh sediment. Estuarine-beach, tidal marsh, and fluvial silt, sand, and clay with organic material (peat) abundant in tidal marshes.

Quaternary (Pleistocene) Sand Bridge Formation

Upper Member

4 Tidal channel facies; clayey sand

5 Shoal lagoonal facies; silty sand

Lower Member

Tan to light gray, fine to medium sand with a small amount of pebbles. Included with Upper Member.

6 Quaternary (Pleistocene) Norfolk Formation

Upper Member

Brackish marine silty sand and fluvial-estuarine silty sand.

Lower Member

Clean quartz sand and fine gravel. Included with Upper Member.

7 Tertiary (Pliocene) Yorktown Formation

Nearshore marine fossiliferous, silty, coarse sand and coquina.

FIGURE 12. GEOLOGICAL CROSS SECTION SOUTH OF ST. JULIENS CREEK ANNEX

Test boring B—1, job no. 74-458, Herbert and Associates, Ltd., 3850 Elm Avenue, Portsmouth; adjacent to U. S. Naval Shipyard, approximately 1,000 feet (305 m) west of the intersection of Elm Avenue and the Norfolk and Portsmouth Belt Line Railway. Elevation at top of boring is 9 feet (3 m).

	Thickness	
	Feet	*(Meters)*
Fill, rubble, and orangish-brown, silty to clayey, fine to coarse, subangular sand and rounded gravel	1.0	(0.3)
Sand Bridge Formation		
Clayey sand facies		
Sand, gray, mottled yellowish-brown to orange, mottled light-gray, clayey to silty, fine to medium, medium plastic	10.0	(3.0)
Sand, grayish-orange, clayey to silty, fine to medium, moist, soft	2.5	(0.8)
Norfolk Formation		
Clayey silty sand facies		
Sand, brownish-gray mottled light bluish, gray, fine-grained, silty to slightly clayey, moist, very soft to loose	5.5	(1.7)
Sand, gray, mottled bluish-gray, fine, fossiliferous, trace of coarse sand to fine gravel	3.0	(0.9)

FIGURE 13. BORING LOG, NORTH OF ST. JULIENS CREEK ANNEX

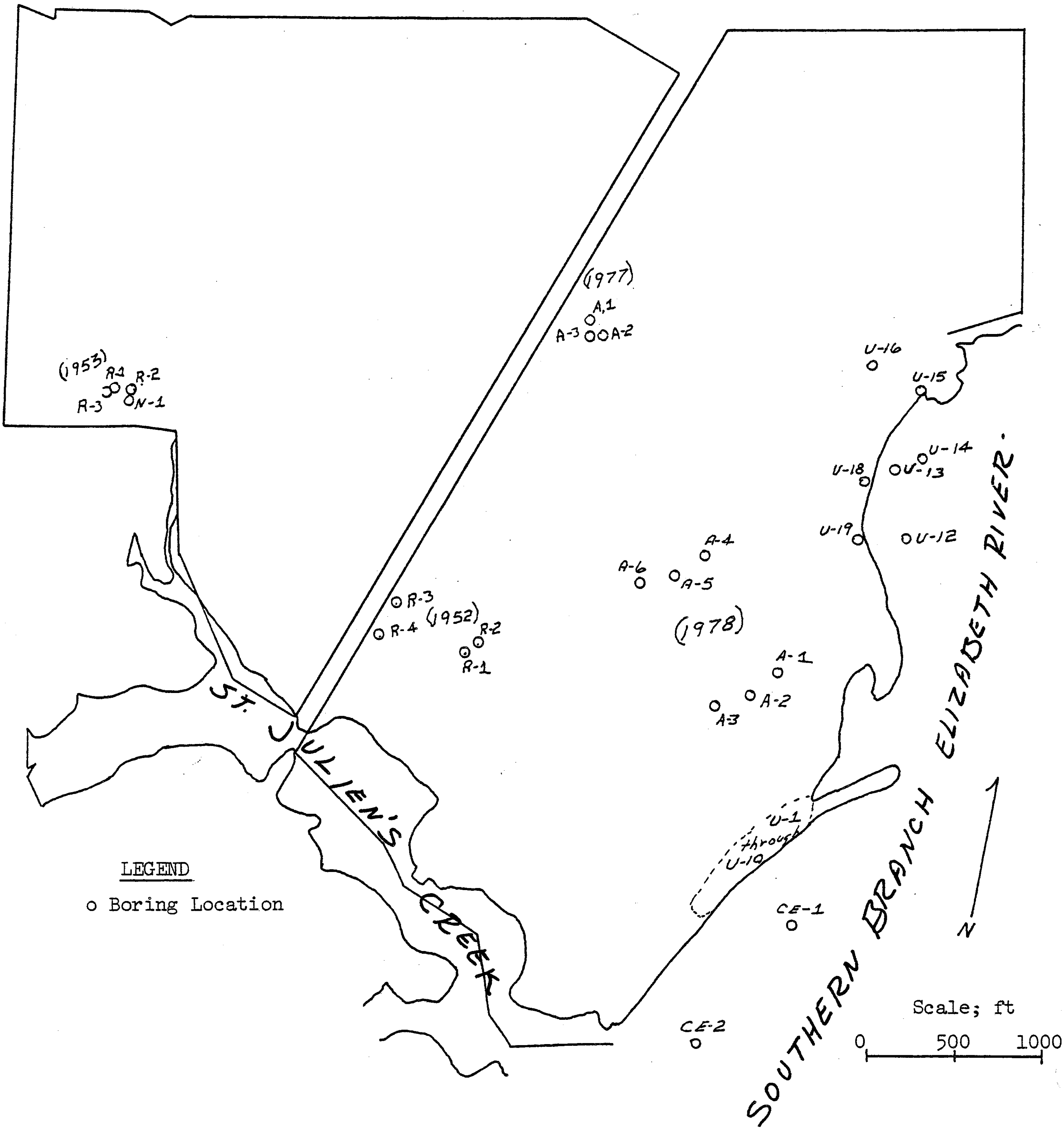


FIGURE 14. LOCATIONS OF BORINGS AT ST. JULIENS CREEK ANNEX

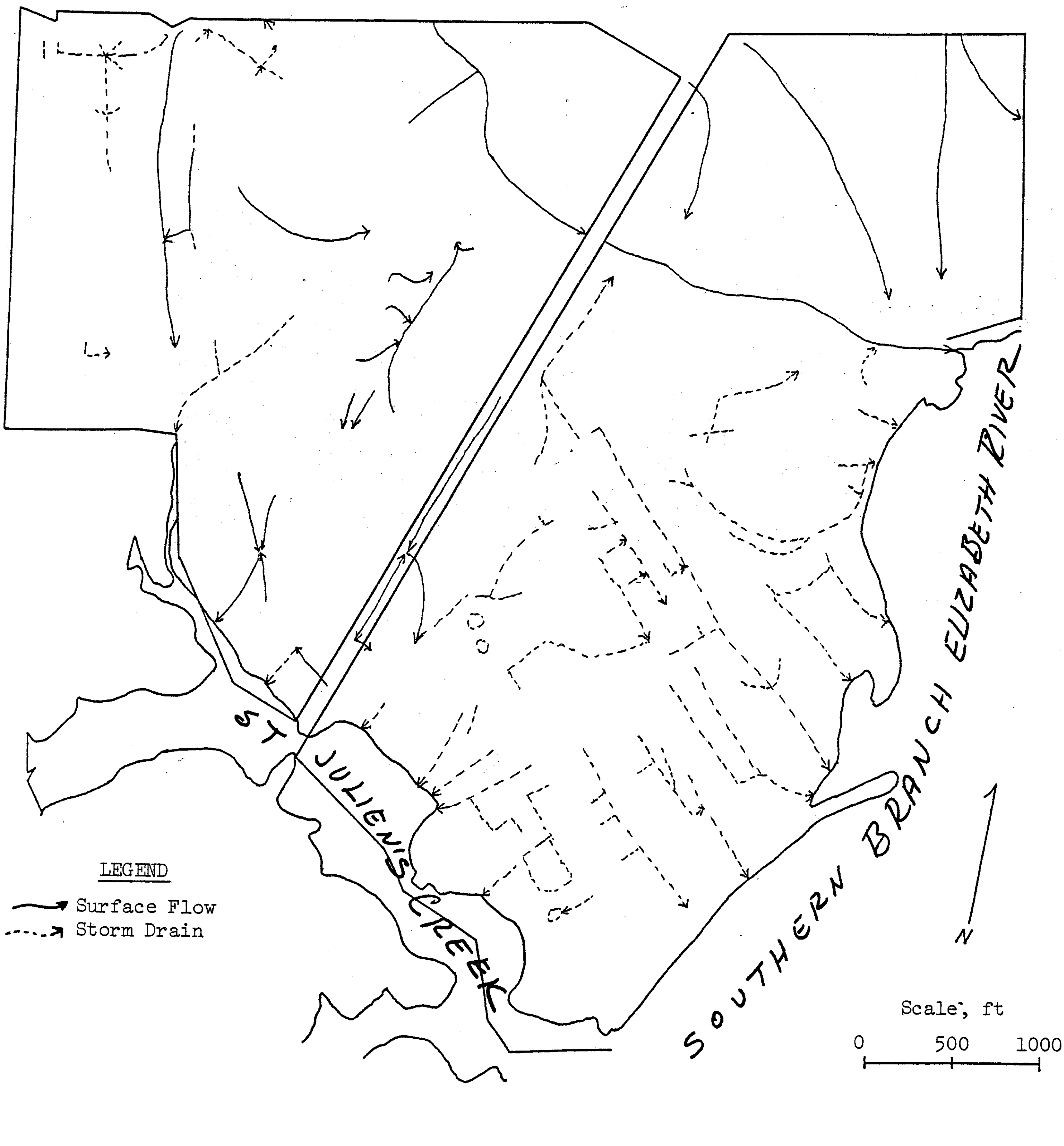


FIGURE 15. SURFACE DRAINAGE AT ST. JULIENS CREEK ANNEX

FIGURE 16. AERIAL VIEW OF BLOWS CREEK.
SOUTHERN BRANCH OF THE ELIZABETH RIVER
IS IN THE BACKGROUND.

permitted. The fecal coliform bacteria count in IIB areas should not exceed the geometric mean of 200 colonies per 100 milliliters. Classification IIB indicates that tidal water should have a dissolved oxygen content of not less than 4.0 milligrams per liter and should have a pH range of 6.0 to 8.5. In past years, the State of Virginia has noted that the concentrations of oil and grease, heavy metals, and coliform bacteria in these waters has increased. A state water quality person described the area as "poor water quality."

b. Groundwater. The high permeability of the soil and the proximity of much surface water (approximately 50 percent of the Annex's perimeter is bounded by water) cause a high water table. During dry seasons, the average depth to the water table is 4 feet beneath ground surface; during wet seasons, the average depth is 1 foot (reference d). The data extracted from the boring logs indicate that the water table is at a depth of 5 feet or less. However, the timespread over which these borings were made does not permit reliable estimates of seasonal or long-term fluctuations. In addition, the locations of borings do not allow estimates of the groundwater flow directions (see figure 17). However, the nature of groundwater flow and the topography of the activity indicate that the northwest-southeast trending ridge divides groundwater flow between Blows Creek and St. Juliens Creek. A component should also be flowing to the Southern Branch of the Elizabeth River.

The Miocene, the Eocene, and the Cretaceous aquifers furnish most of the water for the developed water supplies of the Coastal Plain of Virginia. These aquifers outcrop west of St. Juliens Creek Annex. The Miocene aquifer, which has the closest outcrop, lies approximately 25 to 30 feet below the surface at the Annex. The Eocene aquifers are 500 to 600 feet below the surface of the Annex, and the tertiary aquifers are some 600 to 700 feet below the surface of the Annex. Figure 18 shows the characteristics of these aquifers and the groundwater quality.

c. Migration Potential

(1) The hydrology of St. Juliens Creek Annex is conducive to pollutant migration. The geological descriptions (section V-C-3 of this report) and the boring logs (appendix A) both show a predominance of coarse-grained materials which have a high capacity for infiltration and good permeabilities for horizontal migration. The high rainfall and shallow water table should increase the potential pollutant migration. Conversely, the extensive storm drainage system and the nearness of St. Juliens Creek and the Southern Branch of the Elizabeth River would probably mitigate any deep penetration of pollutants.

Water supplies (industrial and domestic) do not exist in the shallow Quaternary deposits, so the potential for problems is not great. In addition, the deeper aquifers of the Eocene and Cretaceous are separated from the Annex's surface by thick clays of the Miocene and Eocene (see figure 18).

Surface migration is a definite possibility. All pollutants in St. Juliens Creek and in the Southern Branch of the Elizabeth River must be identified before a determination can be made of the Annex's contributions to these pollutants. If pollutants are on the land surface at St. Juliens Creek Annex, they are probably entering these streams from the Annex.

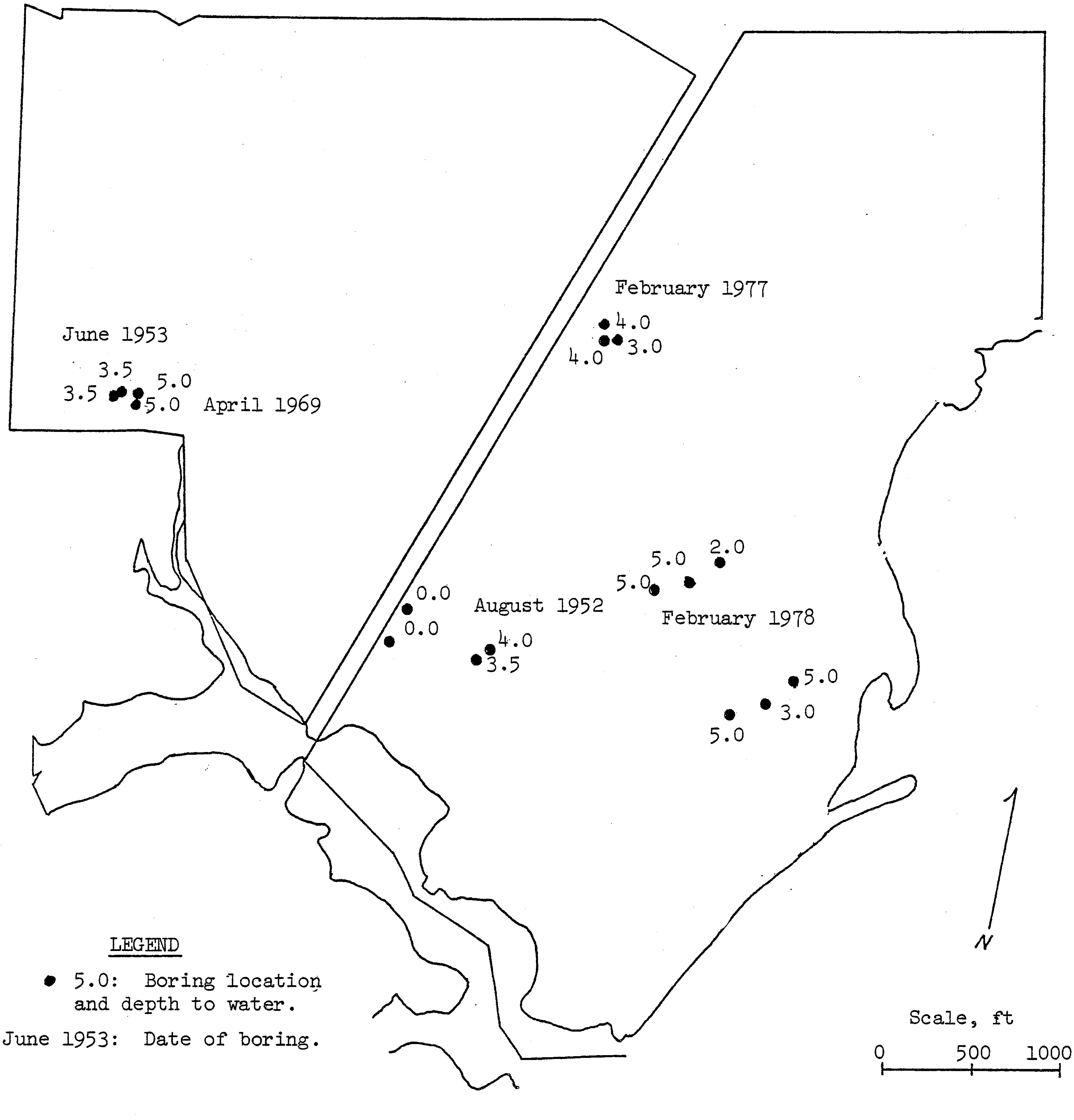


FIGURE 17. DEPTH TO GROUNDWATER AT ST. JULIENS CREEK ANNEX

System	Series	Formation		Approximate thickness (feet)		Physical character	Hydrologic comments
				out-crop	sub-surface		
Quaternary	Recent and Pleistocene			0 - 100	0	Unconsolidated gravels, sand, loam, partly of fluvial and partly of marine origin.	Good aquifers for domestic and small industrial supplies when sources are located some distance from surface saline waters.
Tertiary	Miocene	Chesapeake Group	Yorktown St. Marys Choptank Calvert	125 180 50 200	0 to 600+	Blue and gray sandy diatomaceous shales, shell marls, and minor amounts of sand.	In eastern peninsular area sands yield moderate supplies subject to salt-water encroachment when pumping is heavy near marine estuaries.
Tertiary	Eocene	Chickahominy (subsurface)		—	0 to 1,000	Blue, gray, and brown pyritic and glauconitic clay.	Aquiclude
Tertiary	Eocene	Pamunkey Group	Nanjemoy	125	0 to 1,000	Gray marls and fine quartz and glauconitic sands.	Quartz and glauconitic sands furnish water to some screened wells.
Tertiary	Eocene	Pamunkey Group	Aquia	100	0 to 1,000	Gray marls and fine quartz and glauconitic sands.	Quartz and glauconitic sands furnish water to some screened wells.
Tertiary	Paleocene	Mattaponi (subsurface)		—	0 to 100+	Mottled clay, glauconitic sands and marls with thick quartz basal sand.	A very good water-bearing formation in central part of Coastal Plain. East of Williamsburg the formation yields brackish water.
Cretaceous	Upper Cretaceous	Mattaponi (subsurface)		—	0 to 100+	Mottled clay, glauconitic sands and marls with thick quartz basal sand.	A very good water-bearing formation in central part of Coastal Plain. East of Williamsburg the formation yields brackish water.
Cretaceous	Upper Cretaceous	Potomac Group[1]	Patapsco	150	Up to 4,500	Mottled clay, glauconitic sands and marls with thick quartz basal sand.	A very good water-bearing formation in central part of Coastal Plain. East of Williamsburg the formation yields brackish water.
Cretaceous	Lower Cretaceous	Potomac Group[1]	Patuxent	250–300	Up to 4,500	Lenticular sands and clays underlying the entire Coastal Plain of Virginia.	Some of the sands are excellent aquifers and furnish large supplies to wells. Down dip to the east these same deposits contain water too brackish for use.
Pre-Cretaceous		Basement complex				Large thick crystalline masses of granites, gneiss, schist and other metamorphic type rocks.	Good aquifers where overlain by permeable soils adjacent to the Fall Line, down dip water quality becomes poor.

[1] Not recognized in outcrop

FIGURE 18. GEOLOGIC UNITS IN THE COASTAL PLAIN PROVINCE OF VIRGINIA

(2) Use of Adjacent Areas. The industrial developments around St. Juliens Creek Annex make a simple determination of who is polluting the streams a difficult, if not an impossible, task, except for unique pollutants. If any indication of pollution is found in the periphery of the Annex, a hydrogeological investigation would be necessary to determine if the pollutants were coming from, were coming on, or were passing through the Annex.

D. Biological Features

1. General. This section of the report is a summary of ecological conditions presented in "Construction of Naval Family Housing, NAD St. Juliens Creek Annex," prepared by NAVFACENGCOM, Atlantic Division. Definitive biological and/or ecological studies have not been conducted at the activity.

During the last 300 years, the activities of man have extensively modified the ecosystems in the vicinity of St. Juliens Creek Annex. Only a fraction of the original forest remains, and a majority of the tidal marsh has been filled. Exotic trees, shrubs, and herbs are common throughout the area. Some native pines are planted in evenly spaced rows amid the numerous buildings. Exotic grasses and introduced weedy species dominate most of the area. The recognizable and the functional ecosystems are discussed below. Recognizable ecosystems include a loblolly-hardwood forest, an urban grassland, and a tidal salt marsh.

2. Terrestrial Ecosystems

a. Forest and Urban Grassland and Ecosystems. The St. Juliens Creek Annex site, excluding the salt marsh areas, was vegetated with dense forests prior to the arrival of Europeans in the region. The Southern Evergreen Forest region is a recognized Coastal Plain forest formation extending from southern Virginia to Texas. The forest type within this region characteristically contains numerous broad-leaved evergreen species and represents a transition between this Coastal Plain region and the adjacent oak-pine forest region of the piedmont. The present forest is a loblolly pine-hardwood forest type; however, man-induced disturbances have altered the structure and the species composition. Loblolly pine, which is scattered throughout the forest stand at the Annex, was more predominant before selective cutting reduced its proportion in this forest. The dominant species represented in the forest composition today are oaks (willow, water, southern red, post, and white). Disturbances have tended to favor an abundance of sweetgum in the present forest. Other, less common, species observed include red maple, poplar, sassafras, holly, persimmon, red cedar, locust, white mulberry, dogwood, and alder. Green ash, beech, hickories, swamp white oak, red oak, chestnut oak, swamp red oak, and sourgum may also be present.

The age and growth character of the large isolated oaks suggest development in the absence of competition. This area, with the exception of these few scattered oaks, was probably cleared in the early part of this century. Varying age and size classes of existing trees indicate two or three stages of intense reseeding. Forest canopy height, in general, ranges from 60 to 70 feet. The larger, older oaks are 2 to 3 feet in diameter; the younger trees have varying diameter sizes, depending on their ages.

Understory vegetation is sparse in the areas where canopy opening permits light to reach the forest floor. Many "shrub-type" forest trees, such as dogwood, sassafras, alder, white mulberry, and holly, form intermediate strata throughout the forest. Other understory species, possibly present, include fetter brush, waxmyrtle, huckleberry, smilax, gallberry, sweetbay, prickle ash, sourwood, yaupon, blueberry, blackberry, wild grape vines, and honeysuckle. The dense canopy and heavy cover of deciduous leaves and pine needles tend to exclude the development of herbaceous plants. Ferns, however, occur in the moist shaded areas.

Loblolly pine, as well as most of the observed forest species, are producing viable seedlings. The climax forest would probably be dominated by the oaks, but may contain a greater abundance of loblolly pine. Furthermore, the competition for light and nutrients, which increases with maturity, may result in a thinning of the tree density.

One stand of forest vegetation, about midway along the Annex's northern boundary, has a park-like character. The understory shrubs and herbs were replaced by exotic grasses, which are regularly clipped. This forest stand is older and is less dense than the previously described forest.

In 1961 and 1962, the area around the munitions buildings was seeded with 1-year-old loblolly pine creating a monocultural system. Today, many of these pines are 25 to 30 feet tall.

A 36-acre grassland habitat is located west of the large forest stand. Numerous species of endemic and exotic grasses are represented in the mosaic of wet and dry habitats that occur there.

b. Forest and Urban Grassland Wildlife. The forests, the grassy areas, and the many man-induced disturbed areas have a reduced potential for sustaining wildlife populations. The interaction of physical factors precludes a diverse and abundant wildlife community. Dense, urban areas surrounding the Annex, segregate wildlife populations. Physical development at the Annex has limited and disturbed the natural habitats. The habitats lack the diversity necessary to provide functional niches for species. The lack of a fresh water source excludes many wildlife species.

Definitive studies to determine the presence, the abundance, and the distribution of wildlife at the Annex have not been conducted. Information on wildlife populations was collected during field visits, during interviews with a local biologist, and during studies of specific and generalized publications.

Reptiles and amphibians are probably limited in the terrestrial habitats because fresh water is not available. Fresh water is essential to many reptilian species and to most amphibians, especially for reproduction. The greater siren, the red-spotted newt, the marbled salamander, and the slimy salamander may exist on the Annex because they are not restricted to fresh water habitat. The eastern box turtle may possibly occur in the forest, but the general lack of rotting logs may exclude this species. Most lizards, however, are well adapted to a variety of terrestrial niches. The green anolis, the northern fence lizard, the ground skink, the five-lined skink, the broad-headed skink, the southern five-lined skink, and the six-lined race runner are all potentially present at the Annex. A diversity of snakes may not be present because of the lack of suitable food; those species depending on amphibians would be excluded. Species likely to be present include the red-bellied snake, the northern brown snake, the eastern garter snake, the eastern mud snake, the eastern worm snake, the northern black racer, the black rat snake, the scarlet snake, the Coastal Plain milk snake, the mole snake, and the southern copperheads. Fowler's toad may be the only toad present in this area. Frogs potentially present include the spring peeper, the squirrel tree frog, the upland chorus frog, the pickerel frog, and the southern leopard frog.

provide niches for avian species. Niches available to bird species were found in the dense stratified forest and its extensive edge, in the park-like distribution of many woody species, in the fence row vegetation, in the many grassy areas, and in the disturbed areas. However, the lack of fresh water and the urbanized and disturbed nature of the habitats exclude many avian species. Figure 19 lists the common avian forest species likely to occur in this area.

The habitat characteristics discussed previously have relevance to the mammal populations potentially present on the Annex. Factors limiting the presence and abundance of other vertebrate species are the same factors that limit the presence and abundance of mammalian species of the area. Figure 20 lists the potentially present mammalian species.

3. Tidal Salt Marsh Ecosystem

a. Plant Ecosystem. Evidence throughout the site indicates the extent to which human encroachment has limited the area of the original marsh along Blows Creek. Service roads block dendritic tidal extremities, railroads sever functional marsh units, and heaps of rubble-fill encroach upon the natural flood plain of the tidal stream. The marsh has adjusted to these encroachments and remains a viable, functioning unit. However, oil film is visible on portions of the marsh.

Ecological studies describing the flora, the fauna, and the intricate functional relationships of this marsh do not exist. However, field observations yielded evidence sufficient to classify this marsh according to a known type.

Twice daily, the saline waters of the Southern Branch of the Elizabeth River enter Blows Creek, a small tidal stream, on the alluvial plain of the Annex. These saline waters inundate the surrounding grassy vegetation (figure 16).

The surface salinity of the Southern Branch of the Elizabeth River, from which this tidal stream receives its water, ranges from about 25 parts per thousand near the mouth to approximately 5 to 10 parts per thousand in the vicinity of the Great Bridge Locks. St. Juliens Creek Annex is located approximately 6 miles from each of these points.

The dominance of cord grass, Spartina alterniflora, in the intertidal zone, an area of regular flooding, suggests that the marsh is classified as type 18 (reference e). Cane grass, phragmites communis, the dominant emergent species, is present near the shore, and is particularly dense in areas recently disturbed by fills. An extensive vegetative survey would probably reveal the presence of Chairmaker's rush, (Scirpus americanus), salt marsh bulrush (Scirpus maritimus), salt hay (Spartina patens), spike grass (Distichlis spicata), and smartweed (Polyonum sp.). Cattails (Typha sp.) are prevalent in the moist drainage channels (remnants of the once-extensive flood network) that are dissected from the tidal flood system. The exposed banks of the tidal creek support a dense population of mud algae, such as diatoms and dinoflagellates, which is photosynthetically active all year.

mourning dove	white warbler
common nighthawk	parula warbler
chimney swift	yellow warbler
yellow-shafted flicker	myrtle warbler
downy woodpecker	black-throated green warbler
eastern kingbird	pine warbler
eastern wood pewee	palm warbler
blue jay	ovenbird
common crow	yellowthroat
tufted titmouse	American redstart
house wren	house sparrow
catbird	red-winged blackbird
robin	common grackle
wood thrush	brown-headed cowbird
golden-crowned kinglet	cardinal
ruby-crowned kinglet	American goldfinch
starling	rufous-sided towhee
red-eyed vireo	white-throated sparrow
black warbler	song sparrow

Figure 19. Potential Avian Populations at St. Juliens Creek Annex

opposum	southern flying squirrel
southern shrew	eastern harvest mouse
shorttail shrew	white footed mouse
eastern mole	golden mouse
keen myotis	river rat
big brown bat	meadow vole
silver-haired bat	muskrat
red bat	meadow jumping mouse
hoary bat	marsh rabbit
Seminole bat	raccoon
evening bat	longtail weasel
eastern yellow bat	mink
eastern big-eared bat	red fox
eastern chipmunk	gray fox
eastern gray squirrel	woodchuck
eastern fox squirrel	

Figure 20. Potential Mammalian Populations at St. Juliens Creek Annex

b. Tidal Salt Marsh Wildlife. The salt marsh provides suitable habitat for numerous species of wildlife. However, only a dozen or so animals spend their entire lives in the marsh ecosystem. Invertebrate species likely to be found in this marsh and the surrounding estuarine waters of the Southern Branch of the Elizabeth River include barnacles; fiddler, hermit, and blue crabs; oysters; soft-shell, Carolina march, and hard-shell clams; several mussel species (Modiolus, Volsella, etc.); salt marsh periwinkles; and mud snails. The behavior of many marsh filter feeders results in the concentration of nutrient-rich organic matter. Of the above mentioned shellfish, which occur in waters encircled by the marsh, only the blue crab, the oyster, and possibly the hard-shell clam are commercially significant. Maximum blue crab catches on the river may approach 125 bushels per day. However, the entire Elizabeth River system is condemned for commercial shellfishing purposes. Despite the condemnation, shellfish, especially crabs, are taken for both private and commercial purposes.

Representative fish fauna potentially present in Blows Creek are the striped killifish, the Atlantic silversides, the mummichog, the top minnow, and the sheepshead minnow.

Blows Creek is a potential nursery for the following marine species: Atlantic menhaden, croaker, spot, striped bass, sea bass, weakfish, bluefish, anchovy, and flounder. However, in recent years, the water quality has deteriorated in the Norfolk Harbor and in the Southern Branch of the Elizabeth River. The deterioration may discourage many of these marine species from migrating to the area. Local fishermen report occasional catches of croaker, spot, striped bass, and bluefish in the Southern Branch of the Elizabeth River. The American eel, a species that may feed in the marsh, was also reported in the Southern Branch.

All the above mentioned marine fish species are important to commercial and sport fishing.

Reptiles and amphibians have adapted to the varying environmental parameters, such as fluctuating salinity, of the tidal marsh. The brown water snake, the mud, loggerhead, musk, and painted turtles, and the diamondback terrapin are species potentially present in this marsh.

Some avian species nest in salt marshes; other avian species utilize the habitat of the salt marsh during winter migrations. The Annex's salt marshes provide breeding habitat for the king rail, the clapper rail, the Virginia rail, and the long-billed marsh wrens. Shore birds that use the marsh for feeding include the little blue heron, the black-crowned night heron, the tricolored heron, the American egret, the snowy egret, the American bittern, the Eastern least bittern, and the double-crested cormorant. Ducks potentially present that would winter in the area include the mallard, the wood duck, the black duck, the teal, the diving duck, the redhead, the canvasback, the scaup, the ruddy duck, the merganser, and the brant.

Gulls and terns common to this area include the laughing gull, the Foster's and common tern, and the herring gull. The redwing blackbird may also be present.

Few mammals have adapted to the restraining environmental parameters of the marsh. Species potentially present include the muskrat, the meadow vole, and the black and Norway rats. Swamp rabbits, mink, and raccoon may occasionally wander into salt marshes to feed.

4. Scarce, Rare, or Endangered Species. known scarce, rare, or endangered species of flora and/or fauna do not exist in the ecosystems of St. Juliens Creek Annex.

E. Legal Action

Legal action has never been filed against St. Juliens Creek Annex for environmental contamination or for migration of contamination.

VI. ACTIVITY FINDINGS

A. Operations, Ordnance

1. General. High explosives, smokeless powders, and pyrotechnics were used in ordnance operations at St. Juliens Creek Annex to manufacture and process finished ammunition for the fleet. During World War II, at the peak of production, shipments of ammunition and explosives to the fleet averaged 12,500 tons per month. Operations tapered off during the 1970s. Ordnance operations were terminated or transferred in October 1977. Ordnance-handling buildings, equipment, magazines, and burning grounds were then decontaminated.

The facts presented in this section are the best reconstruction of the operations performed at St. Juliens Creek Annex. Information and records covering the time prior to World War II are sketchy or non-existent. Appendix B is a glossary of chemicals and compounds used at the Annex.

2. Black Powder Operations. Black powder, a mixture of charcoal, nitrate, and sulfur, ignites other explosives or smokeless powders. Black powder was used at St. Juliens Creek Annex to produce torpedo impulse cartridges and other similar small cartridges and primers. Black powder was usually shipped in 25-pound kegs and was stored in magazines until used. Reports indicate that the powder was used in two buildings, bldgs. 18 and 184. In bldg. 18, built in 1905, the black powder was poured into the cartridges and primers. In bldg. 184, built in 1942, the black powder was quilted (sewn) into the end of a powder bag. The remainder of the powder bag was filled with the propellent, smokeless powder (discussed later); the black powder ignited the bag when the bag was loaded into the gun. The empty powder kegs were reportedly returned to the powder manufacturer for reuse. Loose powder from the filling operations was usually swept up and sent to the burning grounds for disposal.

3. Smokeless Powder Operations. Three types of smokeless powder propellents were loaded into ammunition at St. Juliens Creek Annex: single base (nitrocellulose (NC)), double base (NC and nitroglycerine (NG)), and triple base (NC, NG, and nitroquamidine (NQ)). The smokeless powder was shipped to the Annex in cans, which were stored in magazines until used.

Personnel in various buildings loaded smokeless powder into cartridges. These buildings included bldgs. 185, 46, 39, 41, 32, 32A, and 33. In bldg. 185, silk bags were filled with smokeless powder for use as propellent charge in large-caliber bag guns during World War II. Operations ceased during the next 20 years. The line was reopened in 1968 to produce more bag charges. It operated until the 1970s. Recorded information does not indicate whether bag charges were produced at the Annex prior to World War II.

Various sizes of small- and medium-caliber cartridges were loaded in bldgs. 39, 41, and 46. These buildings were constructed around 1913 and were used until the present time. Bldgs. 32, 32A, and 33 (located between bldgs. 17, 39, and 38), which were used for loading smokeless powder into cartridges, were torn down immediately after World War II. (Figure 21 shows exact locations). Reports indicate that, in the mid-1930s, smokeless powder (probably single base) was loaded into tank cars adjacent to bldg. 44. The amount of spillage from this operation is unknown. Dust from smokeless powder operations was usually swept up and sent to the burning grounds for disposal. Powder cans were washed in bldgs. 13 and 47 and then returned to the manufacturer. The rinseate from both buildings most probably went into the swale that runs under bldg. 13 and drains into St. Juliens Creek.

4. Projectile Loading Operations. Three types of explosives were loaded into projectiles at St. Juliens Creek Annex: Explosive D, Composition A-3 (RDX and wax), and tetryl. Explosive D was used at the activity from 1908 to present time. The use of tetryl started sometime between World Wars I and II. The use of Composition A-3 started during World War II. These explosives were not produced at the Annex. They were usually received in lined boxes from the manufacturer. The explosives were pressed into the projectiles. The empty boxes were sent to the burning ground for disposal. Explosive D handling and loading operations produced more dust than that produced by other operations at the Annex because of the fine powdery nature of the explosive. Dust was either swept up and sent to the burning grounds for disposal, or was washed into the nearest floor drain. Figure 22 is a summary of the buildings that used these explosives, including reported dates of use and other relevant comments. Magazines are not included in figure 22 because loose material was not permitted or was not reported in these areas.

5. Mine Loading. From 1912 to 1917, Mark VI mines were loaded with TNT in bldgs. M-3, M-4, and M-5 for the North Sea minefield. The TNT, shipped to St. Juliens Creek Annex in lined boxes, was melted and then poured into mine cases where it solidified. Existing records do not indicate how wastes from this operation, including empty TNT boxes and sweepings, were disposed of. Most probably, the wastes were burned, primarily for safety reasons. Wash-down water was probably discharged into both the Southern Branch of the Elizabeth River and Blows Creek. A photo of the "M" buildings is included as figure 23.

6. Tracer Mixtures. Tracers are slow-burning pyrotechnic compositions that produce a colored flame. Less than 1 gram of tracer, usually a strontium nitrate composition (a salt), is placed in the base of the projectile. After ignition, the tracer burns, emitting light to show the path of the projectile. Other salts used in tracer mixtures include sodium, barium, and copper salts.

Tracer mixtures were reportedly used throughout St. Juliens Creek Annex's history in bldgs. 188 and 29. Bldg. 29, torn down after World War II, was located adjacent to the east end of bldg. M-2.

7. Demilitarization

a. Fuze drillout. From the 1940s until the 1970s, fuze drillout operations were conducted in bldgs. 244, 245, and 246. The fuzes, containing tetryl, were drilled out; the shavings were caught and then sent, along with the dust sweepings, to the burning ground for disposal. Some dust may have washed into the floor drains.

b. Ammunition Breakdown. Ammunition breakdown was performed throughout St. Juliens Creek Annex's history. During ammunition breakdown, the projectile is pulled loose and the primer is unscrewed from the cartridge. The spacer and the wad are picked from the cartridge and are either kept for reuse or disposed of as

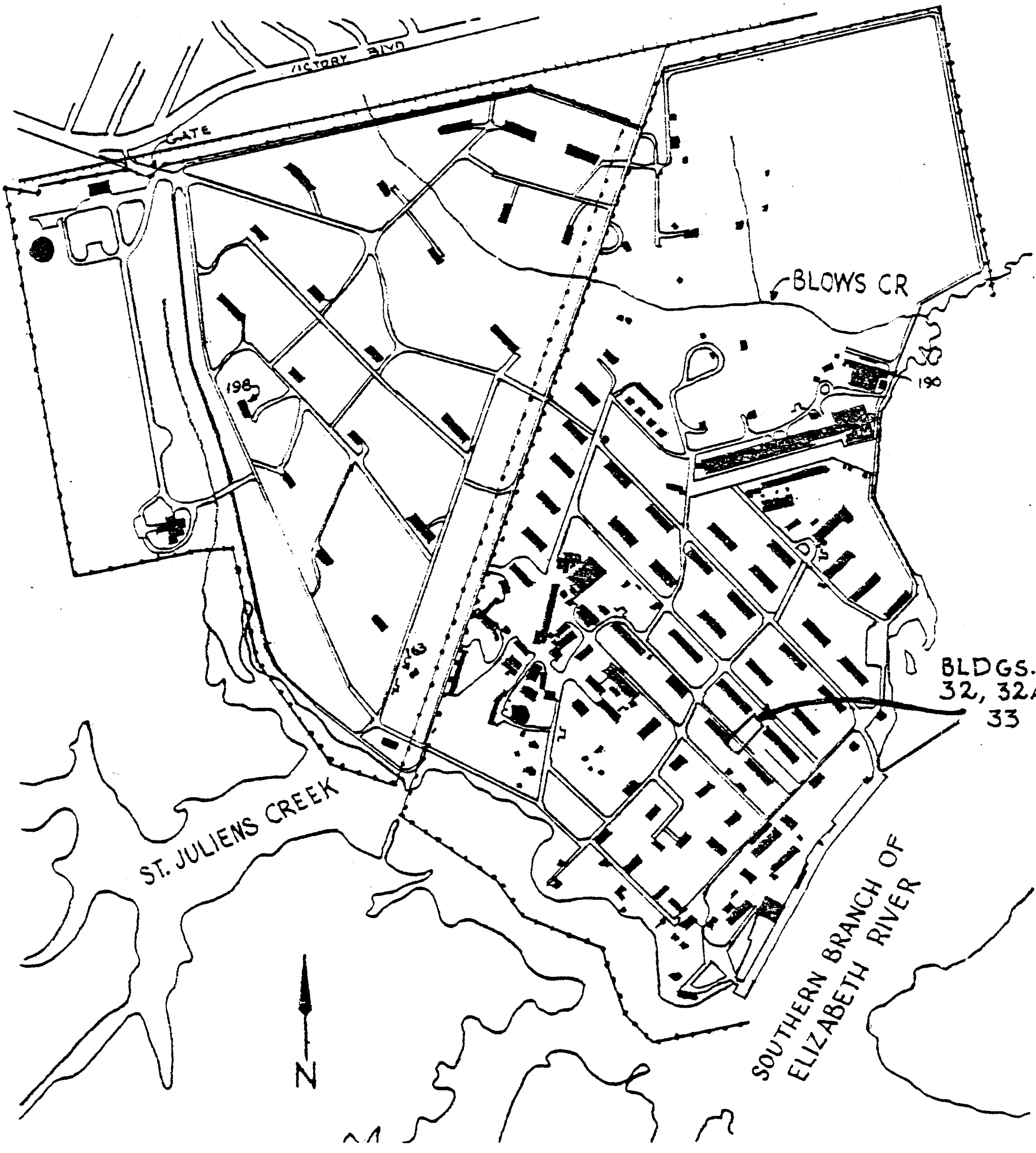


FIGURE 21. LOCATION OF BLDGS. 32, 32A, AND 33
AT NORFOLK NAVAL SHIPYARD, ST. JULIENS CREEK ANNEX.
THESE BUILDINGS WERE USED FOR SMOKELESS POWDER LOADING
PRIOR TO THEIR REMOVAL AFTER WORLD WAR II.

Bldgs. 12, 14:	Explosive D (1900s to late 1930s) These buildings originally had wooden or dirt floors. The concrete slab flooring was probably installed about 1940. Whether contamination is still present under these buildings is unknown.
Bldg. 43:	Explosive D (1908 to 1970s), Compound A-3 (1940s to 1970s). This building originally had wooden or dirt floors. The concrete slab was probably installed about 1940.
Bldg. 89:	Explosive D (1920s to 1970s), Tetryl (1930s to 1970s). This building was heavily used for loading explosives into ammunition.
Bldg. 188:	Composition A-3 (1940s to 1970s), Tetryl (1940s to 1970s) Ammunition loading.
Bldg. 190:	Explosive D (1940s to 1970s), Composition A-3 (1940s to 1970s). This building was heavily used for loading explosives into ammunition.
Bldg. 193:	Explosive D (1900s to late 1930s) This building was torn down and was replaced with a new building in 1942. Whether any contamination is present under the building is unknown.
Bldg. 240:	Explosive D (1945 to 1970s) Explosive-sifting building.
Bldgs. 241, 242, 243:	Composition A-3 (1940s to 1970s), Tetryl (1940s to 1970s) Vacuum systems for bldg. 188.
Bldg. 256:	Explosive D (1940s to 1970s), Composition A-3 (1940s to 1970s) Vacuum systems for bldg. 190.
Bldg 267:	Explosive D (1940s to 1970s), Tetryl (1940s to 1970s) Vacuum system for bldg. 89.

Figure 22. Summary of Buildings Where Explosives Were Used

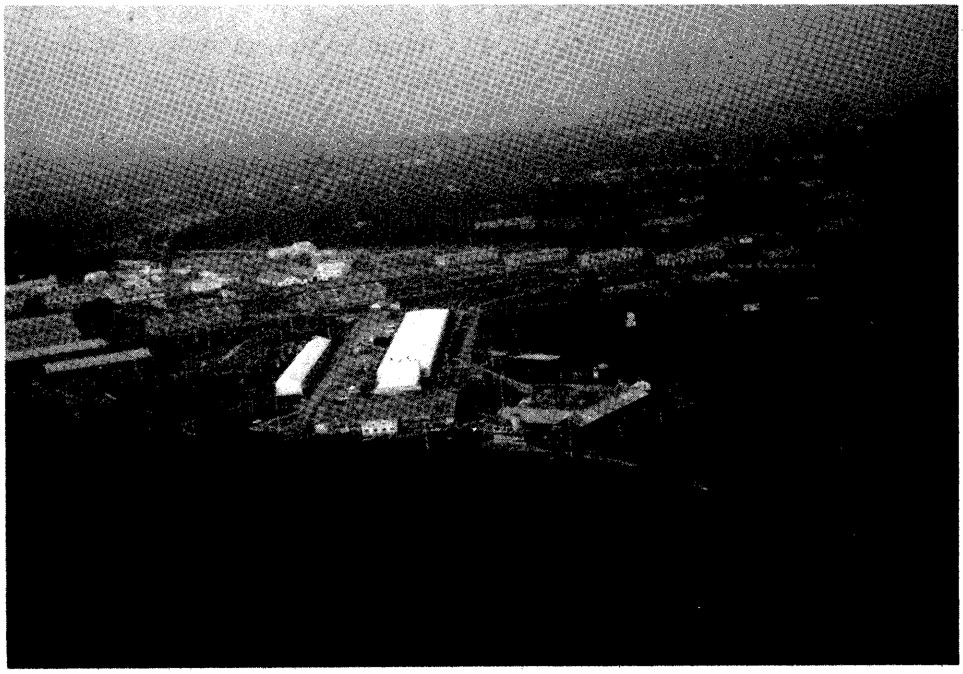


FIGURE 23. AERIAL VIEW OF "M" BUILDINGS AREA. BLDGS. M-3, M-4, AND M-5 ARE IN FOREGROUND. BLOWS CREEK (RIGHT) FLOWS INTO THE SOUTH FORK OF THE ELIZABETH RIVER.

garbage. The smokeless powder is emptied out of the cartridge and either packaged and sent back to the manufacturer for reprocessing or sent to the burning ground for disposal. These operations were performed in bldgs. 39, 46, and 185. Also, cartridges were filled with smokeless powder in these buildings. Primers were renovated in bldgs. 18 and 184. The black powder was removed from the primer and was either reused or sent to the burning grounds for disposal. Projectiles that were removed from the cartridges were either demilitarized or reused. As in other black powder and smokeless powder operations, dust and spillage either was swept up and sent to the burning ground for disposal or was washed into the floor drains.

c. Steamout. Steamout operations were performed in three buildings: M-5, M-5 annex, and 222 (Victory building, see figure 24). The steamout process used steam to clean explosive residues, such as TNT and Explosive D, out of projectiles. The condensed steam, containing explosives, was captured and then discharged into a series of two cooling and settling tanks. There, the explosive cooled, recrystallized, and settled to the bottom of the tank. The explosive was then removed from the tank. TNT either was packaged and sent to the manufacturer for reprocessing or, like explosive D, was sent to the burning grounds for disposal. The overflow from the final settling tank usually contained from 0.01 to 10 parts per million (ppm) of explosive, but could have contained as much as 100 ppm.

Reports indicate that during the 1960s a steamout operation for TNT was performed in bldg. M-5 for approximately 6 months. The overflow from this operation went either into the sanitary sewer system or (more probably) into the Southern Branch of the Elizabeth River.

An Explosive D steamout operation was conducted in bldg. M-5 annex from the mid 1950s to about 1970. Overflow from this operation, which initially discharged into the Southern Branch of the Elizabeth River, may have been routed to the sanitary sewer system during the 1960s.

During World War II, an Explosive D steamout operation was conducted in bldg. 222, the Victory building. Overflow from the operation discharged into Blows Creek about 1,200 feet west of the creek mouth.

A probability exists that steamout operations were also performed periodically at the Annex prior to World War II. Where these operations were conducted is not documented; but the most likely location is in the M-buildings complex area.

8. Degreasing (ordnance). Cartridge cases were cleaned and degreased, in preparation for explosive loading.

Prior to World War II, cartridge cases were degreased with carbon tetrachloride in bldg. 47. The waste solvent was most likely taken to the burning grounds for disposal, but this action was not confirmed. Black-powder shell-case cleaning was also performed throughout the activity's history. The cleaning operation consisted of a series of washing tubs or vats in this order: (1) lye, (2) water rinse, (3) 10% sulfuric acid, (4) rinse, (5) optional chromic acid wash, and (6) final rinse. The waste from this operation was dumped into the storm drain system, which empties, via a swampy area, into St. Juliens Creek. About 14 tubs, each containing 400 to 500 gallons of liquid, were used in this operation.

The operation performed in the tank overhaul plant, bldg. 13, was similar to the operation performed in bldg. 47, but on a smaller scale. From prior to

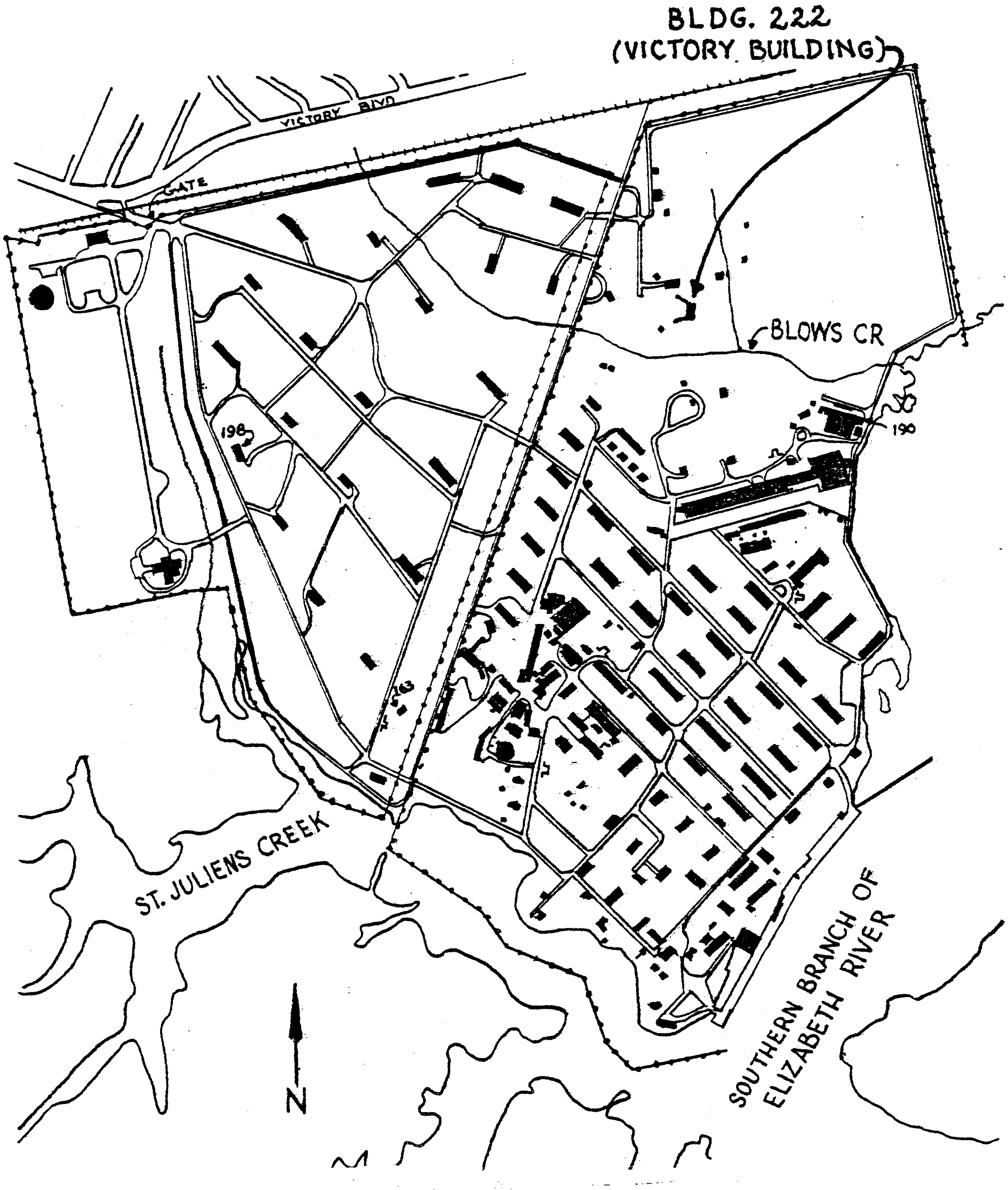


FIGURE 24. LOCATION OF VICTORY BUILDING
AT NORFOLK NAVAL SHIPYARD, ST. JULIENS CREEK ANNEX

1940 to the 1970s, approximately 15 pounds of alodine, a caustic detergent, were used each day in the hardware cleaning tanks. In addition, about 2 gallons per day of methyl ethyl ketone (MEK) and acetone were used in the building. The waste was usually dumped along the adjacent railroad tracks.

From the 1940s to the 1970s, trichloroethylene was used in bldgs. 190 and 227 to degrease ordnance hardware. The spent solvent was disposed of at the burning grounds.

9. Wharf Operations. The waterfront areas of the base include about 6,000 feet of shoreline on the Elizabeth River and 4,200 feet of shoreline on St. Juliens Creek. The status of the pier area (now present only as rubble off the M-5 area) during early production is unknown. Explosive Ordnance Disposal Team divers searched the area and reported some metal and deep silt. The area of the new pier, along the river in the southeast corner of the property, was also searched. Many metallic objects and deep silt were reported. A reasonable assumption is that various ordnance items were dropped during loading operations. Similiar items were exhumed from a similar pier at the Jackson Park Annex near Bremerton, Washington. The number of objects remaining is unknown.

According to U.S. Army Corps of Engineers personnel, if the pier area is ever dredged the process would be extremely slow and expensive, because ordnance items may be present in the silt.

10. Testing Operations. Destructive testing of ordnance items was performed throughout St. Juliens Creek Annex's history. Manufacturers' samples and ordnance loaded at the activity were tested near bldgs. 23 and 282, and at the 40-foot drop tower, bldg. 354. Fuzes and other ignition devices were tested in the drop tower. The Explosive Ordnance Disposal Team, stationed at the Annex until 1969, performed occasional tests and used explosives during training exercises at the burning grounds.

11. Decontamination Operations. Ordnance operations at the Annex were terminated in the 1970s. An effort was then made to decontaminate all ordnance-handling buildings, equipment, magazines, and burning grounds. Prior to the decontamination effort, the Naval Ammunition Production Engineering Center (NAPEC) visually inspected in, under, and around the facilities, and collected samples for chemical analyses. The results of the inspections and the analyses were used to develop appropriate step-by-step decontamination procedures for each building (reference f).

In mid-1977, the following procedures (explained in reference f) were implemented. Buildings were flushed with chemical solutions and water. Equipment was removed, filled with oil and straw, and was either ignited at the burning grounds or flashed in 550°F ovens. The burning ground was then covered with oil and straw and was burned. Then, the top 6 inches of soil were disced. The soil was again covered with oil and straw, and was burned. Decontamination solutions and rinse waters were directed to the sanitary sewer system. Magazines were swept, water-washed, and reswept. At the conclusion of this process, NAPEC visually reinspected each building, all equipment, and the burning grounds; collected samples for chemical analyses; and certified that the facilities were decontaminated. This certification (along with a list of the facilities decontaminated) appears in appendix C. However, the level of decontamination was not specified. Regardless of how thoroughly the decontamination operation was conducted, residues of ordnance materials will remain. The effects of long-term human exposure to these levels have not been determined.

In July 1978, representatives of the Ordnance Environmental Support Office (OESO) and NAPEC reinspected bldgs. 89 and 240 for Explosive D contamination. Results of the inspection indicate that levels of Explosive D (less than 10 ppm) still remain in portions of these buildings, and that further decontamination is required before these buildings can be used for non-ordnance operations (reference g).

During the on-site survey, when the NACIP team visually inspected bldgs. 240 and M-5 Annex, Explosive D was observed seeping from the lower portions of walls in several areas of the buildings.

B. Operations, Non-Ordnance

1. Metal Plating. Records searches and personnel interviews indicate that metal plating was not conducted at the Annex. Metal plating, as needed, was accomplished at the nearby Norfolk Naval Shipyard.

2. Degreasing (non-ordnance). Solvents were readily available at the Annex. They were used for general degreasing. The common method of disposal was to dump small amounts (less than 2 gallons) of waste solvents on the railroad tracks next to buildings.

3. Paint Shops. Ordnance containers, after they were cleaned, were painted in a spray paint booth located in the overhaul building, bldg. 13. During normal daily operations, 15 to 20 gallons of paint were used. Waste paint sludge that accumulated in the water curtain was removed and was placed in 55-gallon barrels for disposal. The paint sludge may also have been dumped at the burning grounds area.

4. Machine Shop. A salvable cutting oil is used in the machine shop, bldg. 68, for machining metal. Approximately 5 gallons are used every 6 months. Waste oil is poured down the storm drain.

Machine shop personnel are responsible for maintaining the hydraulic pumps and the equipment in bldgs. 190, 228, 191, 43, 185, 39, 46, 47, and 201. The hydraulic fluid is changed every 6 months. About two to three 55-gallon drums of waste is generated. Past disposal practices included pouring the waste hydraulic oil along the fence line for weed control and on the roads for dust control. The present disposal practice is to deliver the waste to Craney Island for disposal.

5. Vehicle and Locomotive Maintenance Shops. St. Juliens Creek Annex has vehicle maintenance operations in bldgs. 101, 109, 107, 201, and 239. Locomotive maintenance operations are located in bldgs. 187, 247, and 248. In previous years, some waste oils and waste solvents were used for dust control around the station. Presently, waste oils and waste solvents are usually drummed for disposal off-station. The area around the locomotive shed, bldg. 187, is saturated with oil. This is a common condition for maintenance and repair facilities that have been in operation for some time.

6. Pest Control Shop. The pesticide shop, bldg. 249, houses the Annex's supply of pesticides. This supply includes Abate, rodent baits, Bromacil, Carbaryl, Chlordane, Dalapon, Diazinon, Diquat, Gardona, Malathion, Naled, Tandex, and other combinations of chemicals. The chemicals are mixed at the pesticide shop and are applied according to label directions.

From the early 1950s to the mid 1960s, only one mobile 150-to-250-gallon spray tank was available at the Annex. Both herbicides and insecticides were sprayed from the same spray tank. The tank was thoroughly cleaned when tank usage changed from herbicides to insecticides and vice-versa. One hundred to three hundred gallons of rinsewater was used in each cleaning operation. The waste rinsewater was discharged to an open area by Cross Street near bldgs. M1 and 212. Figure 25 is a photograph of this area. The spray tank was generally used each day. An additional spray tank was purchased in the mid-sixties. Daily cleaning of the tanks was not necessary. Rinsewater discharges ceased. The rinseate disposal area is devoid of vegetation, though the area has not been used for rinseate disposal since the mid-sixties. Soil samples were not taken at this area.

Other possible areas of contamination from pesticide and herbicide operations include the burning grounds area where pesticides were buried "a long time ago," and the wash pad near bldgs. 249 and 266 where spray tanks were washed.

7. Battery Shop. The battery shop was located in bldg. 102 until the building was torn down in 1954. Lead-acid battery maintenance operations were moved to bldg. 279. According to station battery-maintenance personnel, waste-acid electrolyte, which was collected in containers, was hauled off-station for disposal.

8. Print Shop. A printing shop was located in bldg. 69, until the late seventies. Chemical usage or disposal practices were never reported.

9. Electrical Shop, Bldg. 53. The Annex purchases electrical power from VEPCO. The only power generated on-station is generated by emergency generators located in bldgs. 90, 283, 233, and 234. The majority of the transformers are in the 75-to-300 KVA range. Only one transformer on-station is known to contain polychlorinated biphenyls (PCB); all others contain oil dielectric.

The PCB transformer, which is located in the heating plant, bldg. 283, once developed a leak. A New Jersey firm was contracted to pump out the PCB dielectric, flush the transformer, and refill it with a silicon dielectric in 1979. This transformer is probably contaminated with PCB. It should be tested to determine PCB concentration. If the concentration of PCB is about 500 ppm or greater, the transformer should be labeled as a PCB transformer.

The station electricians used about 5 gallons per month of trichloroethylene for cleaning and degreasing. Most of this solvent evaporated. The remainder was poured beside the building or on the railroad track bed.

The electricians replace an average of about 10 fluorescent ballasts per month. The old ballasts, which normally contain PCB, are disposed of in the dumpster, along with the station's solid waste. Approximately two boxes (40 total) of fluorescent light tubes, which contain traces of mercury, are also thrown into the dumpsters each month. Occasionally, two or three lead-acid batteries have been placed in the station's dump.

10. Boiler Plant. The main boiler plant, bldg. 283, has two boilers. Internal chemical treatment is accomplished by feeding phosphate and sulfite, and by softening the water with sodium zeolite softeners. The backwash enters the sanitary sewer along with the boiler blowdown. About 50,000 gallons of makeup water is used daily because the station has no condensate return. Other boilers are located in bldgs. 271, 277, and 285. A boiler was operated in bldg. 272, until about 1977. At that time, the boiler was

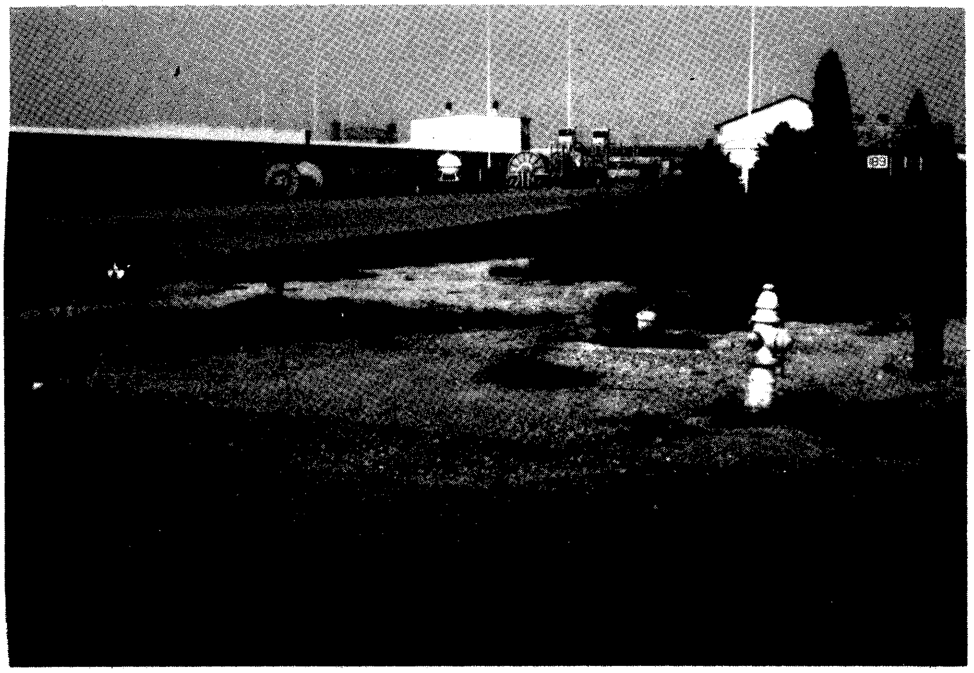


FIGURE 25. PESTICIDE RINSEATE DISPOSAL AREA. THE AREA PICTURED IS ADJACENT TO CROSS STREET; BLDG. M-1 IS IN THE BACKGROUND. NOTE THAT THE AREA HAS PATCHES DEVOID OF VEGETATION.

taken out of service and the asbestos walls of the building were removed by Norfolk Naval Shipyard personnel. The asbestos from the ripout was sent to an unknown location. The best guess is that it was sent to an off-base location.

The boilers are acid cleaned, about every 5 to 6 years, with approximately 15 barrels of Formula 990, a chemical manufactured by Penetone of New Jersey. The waste from the cleanout enters the sanitary sewer.

11. Washrack. Vehicles and equipment are washed and steam cleaned in the washrack, bldg. 266 (figure 26). The washrack's concrete pad is bermed. A deck-drain directs wastewater flows to the sanitary sewer. Prior to 1976, the effluent from the washrack discharged into a storm drain that emptied into a swampy area, which drained into St. Juliens Creek. A chemical cleaner, Penetone (trade name), is used for equipment cleaning.

12. Potable Water. St. Juliens Creek Annex does not have waterwells. Potable water is supplied by the City of Portsmouth, Virginia. Preventive medicine units conduct regular checks on the water quality. A 1-million-gallon reservoir, bldg. 263, is used to store water for the Annex.

13. Salt Water Fire Protection System. The Annex has a salt water system for fire protection. Pumps, located in bldg. 113, withdraw water from the Southern Branch of the Elizabeth River at the southeast corner of the Annex and pump the water into the 150,000-gallon elevated salt water tank, structure 286, which maintains pressure throughout the system. The salt water system and the potable water system are not cross-connected.

14. Radiological Materials. Radiological materials have not been reported as being used at St. Juliens Creek Annex.

C. Materials Storage

1. Oil Storage. The boiler plant, bldg. 283, burns heavy fuel oil. The fuel oil is stored in two 2,500-gallon tanks and two 1,500-gallon tanks. The raised tanks are adjacent to bldg. 283. In 1975 or 1976, up to 500 gallons of oil leaked from one of the tanks. The oil spill was cleaned up. Further incidents were not noted.

2. Ordnance Materials. Incoming ordnance materials were stored in their shipping boxes in various magazines, by classification. Loaded goods were also stored in magazines, by classification. Unpadded, loose ordnance materials were not allowed to be stored on base. The activity has not reported any significant spills or other incidents that could cause contamination.

3. Non-Ordnance Chemical Storage

a. Kepone. In March 1976, EPA Region III and the Naval Weapons Station, Yorktown, negotiated a consent agreement to temporarily store 96 drums (55 gallons each) of technical Kepone in bldg. 198 at St. Juliens Creek Annex. The Kepone contaminated bldg. 198. This Kepone, originally removed by EPA from Life Sciences Products, Incorporated, of Hopewell, Virginia, had been initially stored in a privately owned warehouse. When insurance problems precipitated removal of the Kepone from the private warehouse, the EPA negotiated the agreement with the Navy.

FIGURE 26. VIEW OF WASHRACK, BLDG. 266. PENETONE IS USED TO CLEAN VEHICLES. EFFLUENT FROM THE WASHRACK DRAINS TO THE BACK OF THE PHOTOGRAPH TOWARDS A SWAMPY AREA OFF TO THE LEFT.

The Kepone was delivered, under the direction of an EPA Region III representative, to the Annex, 12 March 1976. Three Navy civilian employees offloaded the material. These employees wore protective clothing and/or apparatus during the 1-hour operation. A permanent log was improvised to record the names and identification numbers of personnel who made physical contact with Kepone storage containers and storage pallets.

Bldg. 198 is an above-ground, poured-concrete structure with a raised concrete platform and a metal-ribbed, peaked roof. (See figure 27.) The building does not have utilities. It is ventilated by three squirrel ventilators and by several windows and doors. The Kepone was stored in metal drums lined with plastic bags. Apparently, pallets used for handling the drums, rather than the drums themselves, caused the contamination of bldg. 198. A new consent agreement was negotiated with EPA, in 1977, when cognizance of St. Juliens Creek Annex was transferred from the Naval Weapons Station, Yorktown, to the Norfolk Naval Shipyard.

During October and November 1978, Allied Chemical employees removed the Kepone and the pallets from bldg. 198. The contaminated materials were shipped, via a container ship, to salt mines in West Germany. Allied Chemical personnel decontaminated bldg. 198, which was still leased to EPA.

On 5 October 1978, an extensive swipe survey was performed, before decontamination efforts commenced, to determine levels of Kepone contamination. On 1 November 1980, a second swipe survey was performed to check levels of Kepone contamination after decontamination. Results of the surveys are shown in figure 28. Allied Chemical related the results of the swipe survey to EPA in a 27 November 1978 letter. Allied Chemical stated that all swipes taken after decontamination efforts were less than the 10-microgram-per-square-foot guidelines established for other decontamination efforts. Allied Chemical recommended that bldg. 198 be released for use as a warehouse facility.

In March 1979, the Norfolk Naval Shipyard needed the space in bldg. 198 to store electronic systems. The Shipyard requested EPA to issue a "Free From Kepone Contamination Certificate" for bldg. 198. A letter from the Deputy Assistant Administrator for Pesticide Programs for EPA outlined restrictions that should be imposed on the utilization of bldg. 198. EPA did not mention a contaminant-free certificate.

In July 1980, the Norfolk Naval Shipyard indicated to EPA that restrictive use of the facilities was not acceptable. The Shipyard once again requested EPA to issue a contaminant-free certification. As of this date, EPA has not responded.

During the Initial Assessment Study, team members made an on-site inspection of the decontaminated bldg. 198. The building is kept secure. Stringent control is maintained on access to the interior of the building. Team members noticed a white residue in several areas on the floor of the building (see figures 29 and 30). However, after examination of the Allied Chemical swipe survey results, team members were in agreement that the white residue was the result of solutions used during decontamination, and that the residue did not pose a threat. The team could not visually determine if Kepone residuals remained.

b. <u>Other</u>. In recent years, the Shipyard stored hazardous materials in a magazine, bldg. 163. Stored materials include waste PCBs, mercuric nitrate, and trichloroethylene. Incidents have not occured. Visual evidence of spills was not present. Improvements such as a curbed, sealed floor and proper waste segregation, should be made to ensure future spill containment.

FIGURE 27. BUILDING 198.
THIS MAGAZINE WAS USED TO TEMPORARILY STORE
KEPONE FOR THE ENVIRONMENTAL PROTECTION AGENCY.

A. Kepone Levels Before Decontamination

Sample Date - 10/5/78

Sample No.	Microgram kepone/ft^2
1	94
2	296
3	148
4	186
5	149
6	194
7	43
8	31
9	152
10	27
11	20
12	49
13	152
14	39
15	48
16	62

Samples were all 1 ft^2 swipes of floor areas throughtout the building.

B. Kepone Levels After Decontamiantion

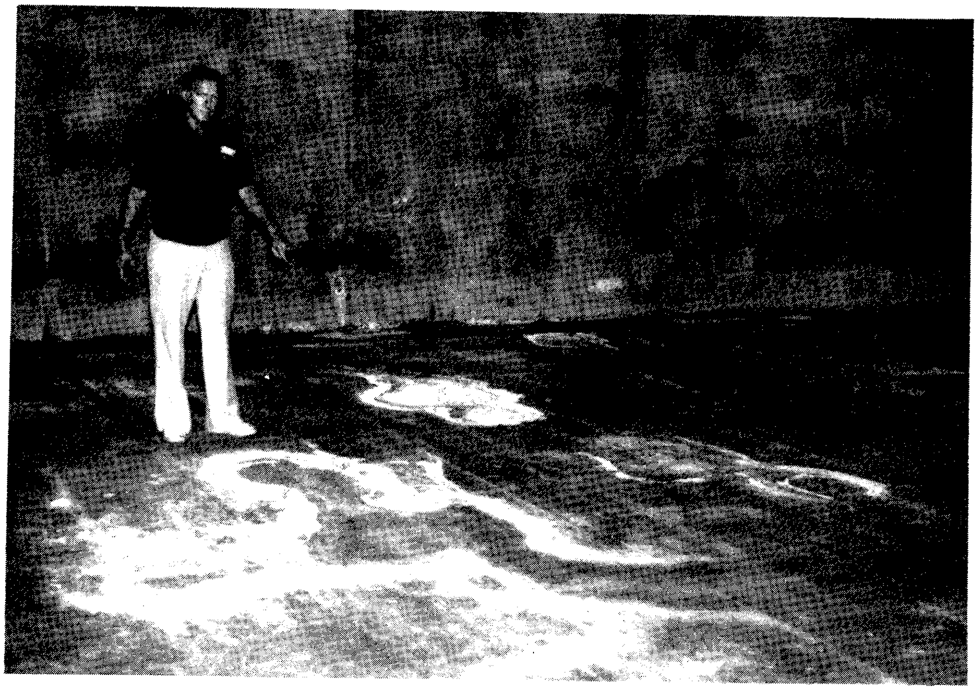
Sample Date - 11/3/78

Sample No.	Microgram Kepone/ft^2	Sample No.	Microgram Kepone/ft^2
1	1.386	24	.044
2	1.427	25	.111
3	.304	26	.401
4	.478	27	.145
5	5.382	28	.122
6	.798	29	.233
7	.754	30	.085
8	1.140	31	.567
9	.648	32	.134
10	.300	33	.170
11	.386	34	.007
12	.386	35	.010
13	.797	36	.072
14	.634	37	nd
15	.159	38	nd
16	.194	39	nd
17	.409	40	nd
18	.014	41	.017
19	.118	42	.017
20	.235	43	.021
21	.118	44	.079
22	.195	45	1.159
23	.454		

Samples 1 through 33 are 1 ft^2 swipes of floor areas throughout the building. Samples 34 through 45 are 1 ft^2 swipes of walls throughout the building.

nd = not detectable
ug = 1×10^{-6} grams

Figure 28. Kepone Swipe Test Results



FIGURES 29 & 30. INTERIOR OF BLDG. 198.
WHITE RESIDUES SHOWN ARE THE RESULT
OF DECONTAMINATION SOLUTIONS.

4. Disaster Preparedness Chemicals (NBC Agents). Two hundred eighty-one chemical indicator kits were stored in bldg. 163. The kits contained materials listed in references h and i. The kits are used to detect various chemical warfare agents, including arsenicals and G and H series chemical agents. Refill kits contain anticholinesterase agents (V and G agents). In September 1977, as part of the SETCON ONE operation to remove all such kits from naval activities, the kits were airlifted to Marine Corps Air Station, Quantico, VA. Reports do not indicate that any incidents resulted from the storage or the removal of the kits.

D. Waste Disposal Operations

1. Sewage Collection and Treatment. Prior to the late fifties, the sewage collected at the Annex was discharged, through four outfalls, into surrounding watercourses. Two outfalls discharged into St. Juliens Creek; one was located under the VEPCO power lines, the other was near the elevated saltwater tank (bldg. 286). The other two outfalls discharged into the Southern Branch of the Elizabeth River; one discharged near south wharf (bldg. 289) and the junction of St. Juliens Creek; the other discharged near the manufacturing area (M bldg. complex) south of Blows Creek. In addition, numerous small industrial discharges were reportedly located throughout the Annex.

In the late fifties, the sewage collection system was connected, via a force main, to the City of Portsmouth's system. The sewage discharges, mentioned in the previous paragraph, were discontinued. Many of the industrial discharges, mostly through floor drains, to surrounding watercourses, reportedly continued into the 1970s. In addition, from 1942 to 1947, a small sewage treatment plant (bldg. 318) treated wastewater from the barracks. The barracks were torn down in 1947, and use of the plant was discontinued.

2. Landfilling Operations or Garbage/Refuse Operations. Information on garbage disposal methods, prior to 1921, was not recorded. Probably, garbage would not have been buried at the annex, during this period, because that practice was uncommon and because cover material was not available at the Annex. Garbage and trash were probably burned at a designated area on base. Another possibility is that garbage was sold to farmers as feed for hogs, and trash was burned.

From 1921 until the present time, records and other information indicate four garbage/trash dumps. These dumps are shown in figure 31.

Dump A, initiated about 1921, was operated for less than 3 years. Garbage and/or trash was most likely burned there. The ash was probably used as fill. Visual examination of the location did not reveal any indication of environmental contamination.

From about 1921 until the mid-1940s, Dump B was the primary garbage and trash disposal site. Trash and garbage were open-burned there; the ash was used to fill this former low, swampy area. Records indicate that, from 1942 to 1947, an incinerator operated at this location. During that time, a barracks existed on the far northwestern portion of the base, and the base generated its greatest amount of garbage. Physical examination of the area revealed broken glass, cinder, ash, deteriorated metal, and other rubbish—typical residues of garbage-burning operations (see figures 32, 33, and 34).

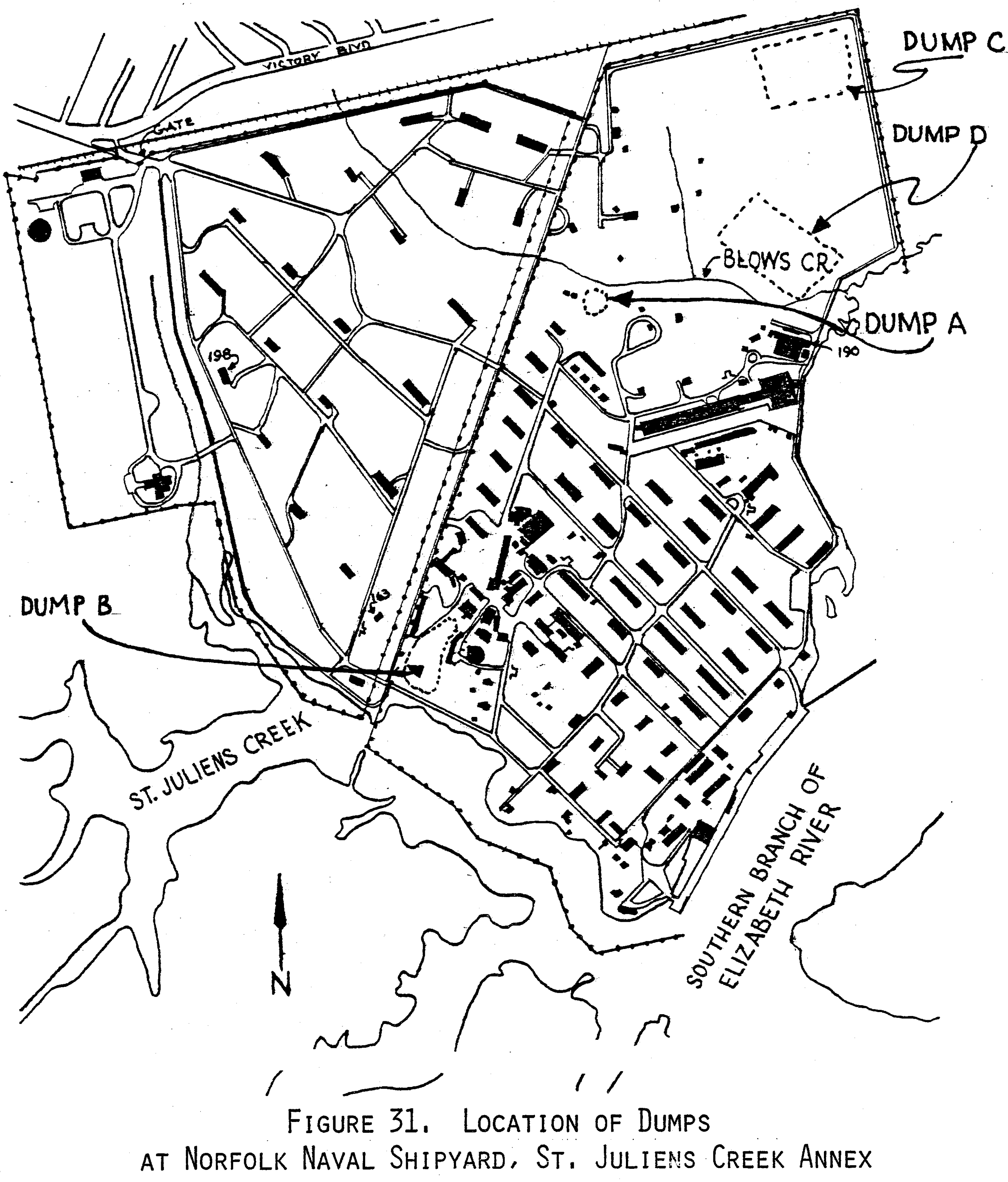


FIGURE 31. LOCATION OF DUMPS
AT NORFOLK NAVAL SHIPYARD, ST. JULIENS CREEK ANNEX

FIGURE 32. AERIAL VIEW OF DUMP B. DUMP IS PICTURED ABOVE THE SWAMPY AREA AND IS OVERGROWN WITH VEGETATION.

FIGURE 33. GROUND VIEW OF DUMP B, PICTURED IN FOREGROUND. SWAMPY AREA IS TO TOP AND LEFT.

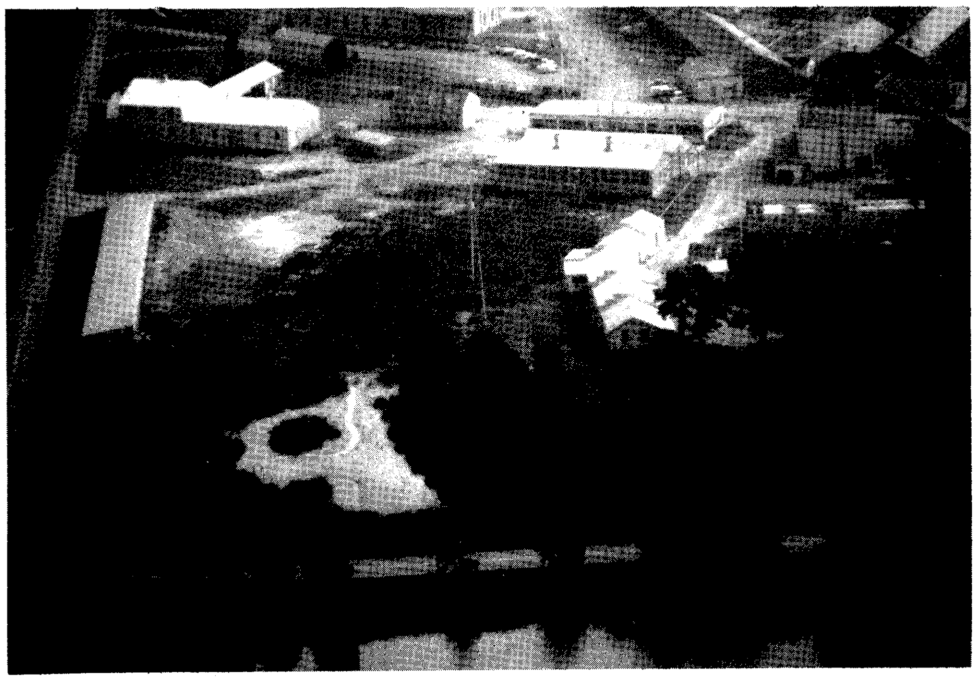


FIGURE 34. VIEW OF DUMP B.
CLOSE-UP VIEW OF GLASS, METAL, AND ASH RESIDUALS.

Starting about 1940, and continuing until about 1970, refuse was burned at Dump C. A 1953 study (reference j) indicates that this former low-lying area and the mud flats were being reclaimed with noncombustible rubbish and ashes. Refuse was burned and then extinguished daily, using water from a fire hose. Most of the refuse consisted of dry, easily burned materials. Occasionally small quantities of wet refuse was included. Salvageable materials were removed daily from the site. Once every two weeks a bulldozer compacted and leveled the site. In 1952 and 1953, approximately 35,000 cubic yards per year of refuse were disposed of at this site. From 1963 to 1966, approximately 11,500 cubic yards per year of trash and semi-wet garbage were burned at this site on a weekly basis (reference k).

Two pits were also reported as available at this site for the disposal of waste oils and oil sludges that were not accepted by Naval Supply Center, Craney Island. Periodically, the oil was burned in the pits.

About 1970, the activity ceased burning garbage and trash and started a sanitary landfill operation at Dump D in the marshes of Blows Creek. The operation was continued until 1976. Initially, a trench was dug parallel to Blows Creek. The trench was located approximately 500 feet north of the creek. This 1,000-foot-long trench stretched from near the eastern boundary of the activity westward. As this trench was filled, a parallel trench was dug. The soil was used to cover the first trench. Primarily, trash and some wet garbage were disposed of at this location. Figures 35 and 36 show how this area looks today.

Since 1976, trash and garbage have been hauled to the Salvage Fuel Boiler at the Norfolk Naval Shipyard for disposal. Inert material is disposed of at site D.

3. Ordnance Disposal Operations. Starting in the 1930s, waste ordnance materials were disposed of by open burning at the burning grounds (see figure 37). Reports indicate that, prior to the 1930s, ordnance was disposed of with garbage at Dump B (see section III. D. 2., figures 32-34).

Three main pads were located at the burning grounds for the disposal of ordnance materials, including black powder, smokeless powder, Explosive D, Composition A-3, and materials containing or contaminated by these compounds. The amount of ordnance disposed of varied over the years; 427 short tons of ordnance items were disposed of at the burning grounds in 1974. Reports state that, in the 1970s, the burning ground spontaneously caught fire several times prior to the decontamination effort mentioned earlier. A pit with a cage over it was located just west of bldg. 23. Small items, such as igniters and fuzes, were burned in the pit (see figure 37). The pit was filled in during recent years.

Visual examination of the burning grounds revealed ordnance residue, such as old cartridge ends and spacers, as well as non-ordnance residue, such as broken glass (see figures 38 and 39). The presence of broken glass indicates that non-ordnance items were burned along with the ordnance materials, at least occasionally - a typical mode of operation at other locations.

As stated in Section IV. A. 11, the surface of the burning grounds was decontaminated in mid-1977.

FIGURE 35. AERIAL VIEW OF DUMP D (CENTER).
BLOWS CREEK BORDERS THE DUMP ON LEFT.

FIGURE 36. GROUND VIEW OF DUMP D. DEBRIS AND RUBBLE
IS SCATTERED AROUND SITE.

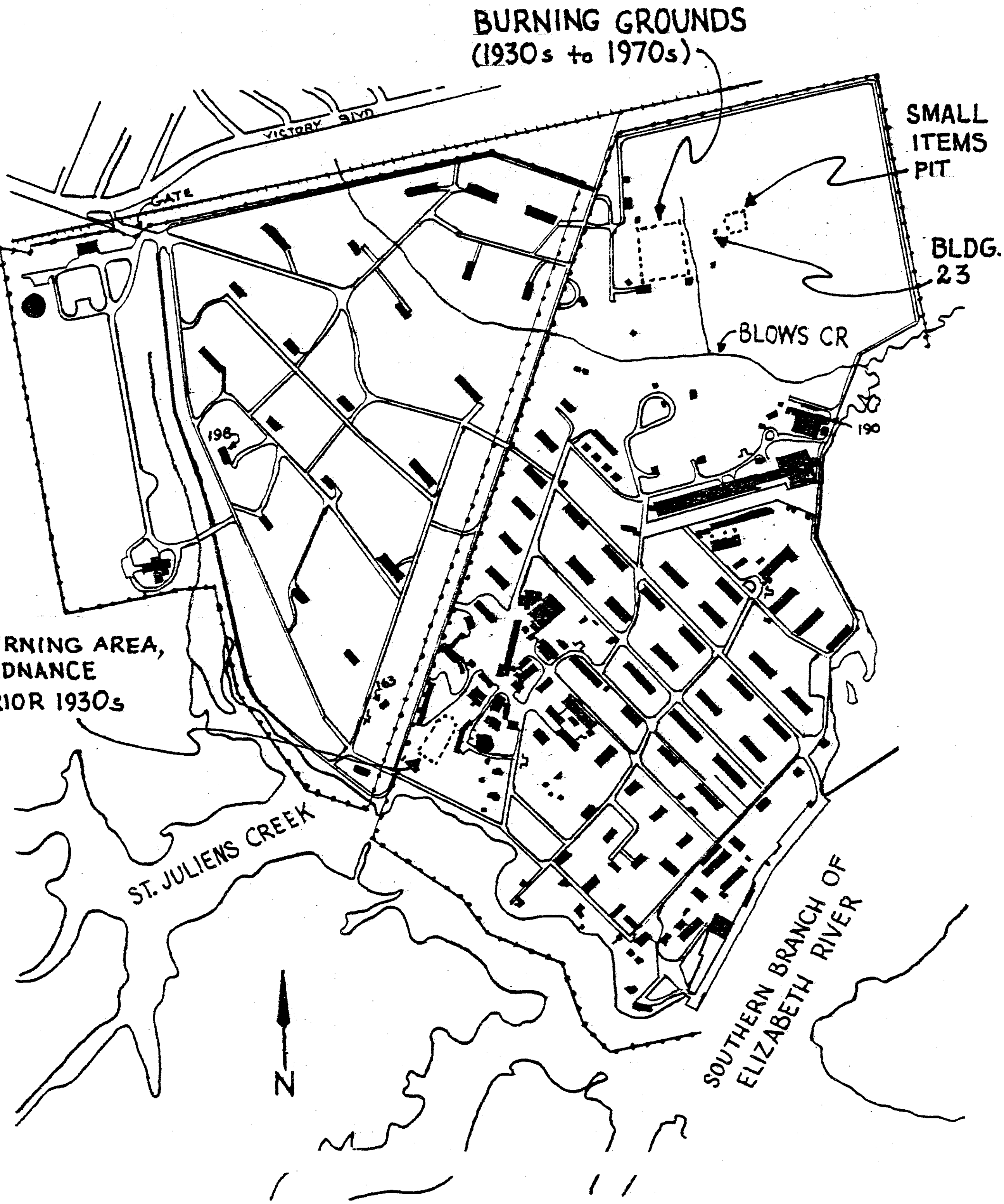
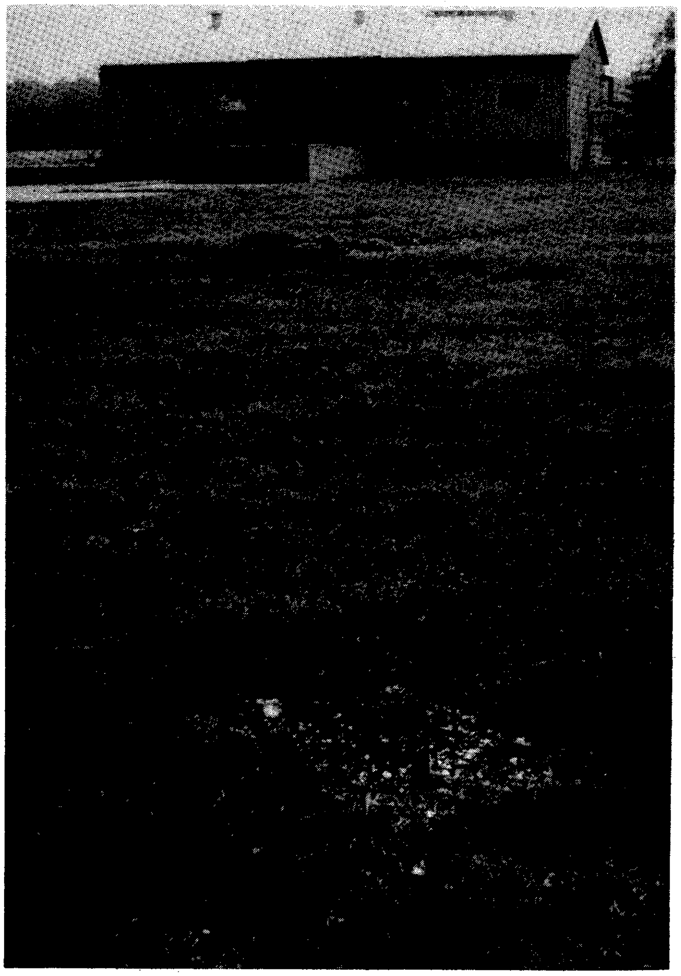


Figure 37. Location of Burning Grounds at Norfolk Naval Shipyard, St. Juliens Creek Annex



◄ FIGURE 38. VIEW OF ORDNANCE RESIDUES AT BURNING GROUNDS.

▼ FIGURE 39. CLOSE-UP VIEW OF RESIDUES AT BURNING GROUNDS.

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Appendix A

Boring Logs

Boring A-1 (1977)

Depth, ft	Description
0- 0.5	Topsoil.
0.5- 3.0	Brown, moist, medium stiff silty clay.
3.0- 6.0	Brown, saturated, soft, sandy clay.
6.0- 8.0	Brown, very moist, loose, silty fine to medium sand.
8.0-14.5	Brown, saturated, loose fine to medium sand.
14.5-17.5	Gray, very moist, soft sandy clay.
17.5-22.0	Gray, very moist, very loose fine to medium sand.
22.0-34.0	Gray, very moist, very soft silty clay.
34.0-39.5	Gray, very moist, very soft silty clay with little sand and marine shell fragments.
39.5-48.0	Gray, saturated, loose to very dense, fine to medium sand with trace of marine shell fragments.
48.0-52.0	Gray, saturated, medium dense, silty fine sand.
52.0-72.0	Light gray, very moist, loose to dense, silty fine sand with marine shell fragments.
72.0-80.0	Gray, very moist, medium stiff, sandy silt.

Groundwater at 4.0 ft at completion.
Hole caved in at 5.0 ft.

Boring A-2 (1977)

Depth, ft	Description
0.0- 1.0	Topsoil.
1.0- 3.5	Brown, moist, medium stiff, silty clay.
3.5-13.0	Brown, very moist, loose, silty fine sand.
13.0-27.5	Gray, very moist, very soft to medium stiff, silty clay with trace of sand at 15 ft.
27.5-37.5	Gray, very moist, very soft, sandy clay.
37.5-42.0	Gray, saturated, medium dense, silty fine sand.
42.0-45.5	Light gray, saturated, medium dense, fine to medium sand.
45.5-52.5	Gray, saturated, loose, fine sand.
52.5-64.0	Gray, saturated, loose, fine to coarse sand with traces of fine gravel and marine shell fragments.
64.0-80.0	Gray, saturated, medium dense to dense, silty fine to medium sand and marine shell fragments with traces of clay.

Groundwater at 3.0 ft at completion.
Hole caved in at 4.0 ft.

Boring A-3 (1977)

Elevation Interval	Description
0.0- 1.5	Brown, moist, soft, sandy clay with traces of brick fragments (Fill).
1.5- 4.0	Brown, moist, soft, sandy clay.
4.0-12.5	Brown, very moist to saturated, loose, silty fine to medium sand.
12.5-19.0	Gray, moist, very soft, silty clay.
19.0-21.5	Gray, very moist, softy, sandy clay.
21.5-29.0	Gray, very moist, very soft, silty clay.
29.0-34.5	Gray, very moist, soft, silty clay with traces of sand.
34.5-37.0	Gray, very moist, very loose, clayey sand.
37.0-42.5	Gray, very moist, medium dense, fine to medium sand.
42.5-52.5	Gray, saturated, very dense medium sand.
52.5-54.0	Gray, saturated, medium dense, silty fine to coarse sand.
54.0-56.5	Gray, very moist, very stiff, silty clay with little marine shell fragments.
56.0-68.0	Light gray, very moist, very dense, silty fine sand and marine shell fragments.
68.0-80.0	Gray, very moist, medium stiff to very stiff, silty clay. Trace to some cemented sand and marine shell fragments.

Groundwater at 4.0 ft.
Hole caved in at 6.0 ft.

Boring A-1 (1978)

Depth, ft	Description
0.0- 0.5	Topsoil.
0.5- 4.0	Dark brown to brown, moist, loose to medium, dense clayey fine sand (SC) with trace organic material. (Possible fill to 2.0').
4.0-14.0	Brown, saturated, very loose to loose silty fine sand (SM-SP).
14.0-17.5	Gray, saturated, loose, silty fine to medium sand (SM).
17.5-22.0	Dark brown, moist, very soft, clayey silt (ML) with trace organic material.
22.0-34.0	Gray, very moist, very soft to soft, silty clay (CL-CH).
34.0-37.0	Brown, saturated, loose, silty fine to medium sand (SM).
37.0-40.0	Gray, moist, medium stiff, fine sandy clay (CL-SC).

Note: Water on rods at 7.0 ft; Water depth at completion 5.0 ft; Hole caved in at 6.0 ft.

Boring A-2 (1978)

Depth, ft	Description
0.0- 0.3	Topsoil.
0.3- 7.5	Brown, very moist, loose, clayey fine sand (SC).
7.5-12.0	Brown, saturated, loose, silty fine sand (SM-SP).
12.0-19.0	Gray, saturated, very loose, clayey fine to medium sand.
19.0-27.0	Gray, saturated, very soft, clayey silt (ML).
27.0-32.0	Gray, saturated, loose, silty fine to medium sand (SM).
32.0-50.0	Gray, saturated, dense to very dense, medium sand (SP).

Note: Water on rods at 6.0 ft; Water depth at completion 3.0 ft; Hole caved in at 6.5 ft.

Boring A-3 (1978)

Depth, ft	Description
0.0- 0.5	Topsoil.
0.5- 3.0	Brown, moist, loose, silty fine to medium sand (SM). (Possible Fill).
3.0- 7.5	Gray, saturated, very soft, fine sandy clay (CL) with trace organic material.
7.5-12.0	Gray, very moist, medium dense, silty fine sand (SM) with trace clay.
12.0-17.0	Gray, saturated, very loose, silty fine to medium sand (SM) with trace clay.
17.0-32.5	Gray, saturated, very soft, fine sandy clay (CL).
32.5-40.0	Gray, moist, medium dense to very dense, silty fine sand (SM-SP) with trace sand.

Note: Water on rods at 4.5 ft; Water depth at completion 5.0 ft; Hole caved in at 14.0 ft.

Boring A-4 (1978)

Depth, ft	Description
0.0- 0.5	Topsoil.
0.5- 7.0	Brown, moist, very loose to medium dense, clayey fine sand (SC).
7.0-12.0	Yellowish brown, saturated, medium dense, silty fine sand (SM).
12.0-27.0	Gray, very moist, very soft, clayey silt (ML) with trace fine sand lenses.
27.0-32.0	Gray, moist, medium dense, clayey fine sand (SC).
32.0-40.0	Gray, saturated, medium dense, medium sand (SP).

Note: Water on rods at 5.0 ft; Water depth at completion 2.0 ft; Hole caved in at 11.0 ft.

Boring A-5 (1978)

Depth, ft	Description
0.0- 0.5	Topsoil.
0.5- 4.0	Brown, very moist, soft, fine sandy clay (CL).
4.0- 7.5	Brown, very moist, loose, silty, fine to medium sand (SM) with trace clay.
7.5-12.0	Brown, saturated medium dense, clayey fine to medium sand (SC).
12.0-17.0	Gray, saturated, very loose, clayey fine to medium sand (SC).
17.0-27.0	Gray, very moist, very soft to soft, clayey silt (ML) with trace organic material.
27.0-32.0	Gray, saturated, medium dense, clayey fine to medium sand (SC).
32.0-50.0	Gray, saturated, very dense to medium dense medium sand (SP) with trace silt.

Note: Water on rods at 6 ft; Water depth at completion 5.0 ft; Hole caved in at 25.0 ft

Boring A-6 (1978)

Depth, ft	Description
0.0- 0.5	Topsoil.
0.5- 4.0	Brown, moist, loose clayey fine sand (SC-CL).
4.0- 7.0	Brown, very moist, medium dense, clayey fine to medium sand (SC).
7.0-12.0	Brown, saturated, loose, fine sand (SP).
12.0-17.0	Gray, saturated, very loose, clayey fine sand (SC-CL).
17.0-27.0	Gray, very moist, very soft, clayey silt (ML-MH).
27.0-32.0	Gray, saturated, loose, clayey, fine to medium sand (SC).
32.0-37.0	Gray, moist, soft, silty clay (CL) with trace organic material.
37.0-40.0	Gray, saturated, very dense medium sand (SP).

Note: Water on rods at 6.0 ft; Water depth at completion 5.0 ft; Hole caved in at 28.0 ft.

Boring CE-1 (1946)

Elevation Interval	Description
0 - (-)23	Water
(-)23 - (-)30	Soft mud
(-)30 - (-)36	Sand

Boring CE-2 (1946)

0 - (-) 7.8	Water
(-) 7.8 - (-)11.6	Sand (30%) and Mud
(-)11.6 - (-)25.8	Sand
(-)25.8 - (-)35.5	Sand (80%) and Mud

Boring N-1 (1969)

0.0-3.0	Silt and gravel
3.0-4.0	Silt, trace of clay
4.0-7.0	Fine sand, trace of clay

No surface elevation given.
Water depth after 24 hrs = 5.0 ft.

Boring R-1 (1952)

Depth, ft	Description
0.0- 3.5	Brown sandy clay.
3.5- 9.0	Medium gray-brown sand.
9.0- 13.5	Fine brown sand.
13.5- 16.0	Soft gray silt, some sand.
16.0- 19.5	Soft brown silt, some sand and organic matter.
19.5- 24.0	Soft gray silt and organic matter.
24.0- 28.5	Soft gray silt, some shells and organic matter.
28.5- 31.0	Fine gray silty sand, some organic matter.
31.0- 36.0	Fine gray sand, some clay.
36.0- 39.5	Fine to coarse gray sand, some clay.
39.5- 45.6	Fine gray silty sand.
45.6- 51.0	Medium gray sand, some clay.
51.0- 68.0	Fine white-brown sand and shells, some clay.
68.0-100.0	Fine gray sand and shells, some clay.

Elevation of top of hole 102 ft (Floor Bldg 134).
Water level after 3 hrs = 3.5 ft.

Boring R-2 (1952)

Depth, ft	Description
0.0- 1.0	Ballast and asphalt.
1.0- 4.0	Brown sandy clay.
4.0- 9.0	Medium brown sand.
9.0- 13.5	Fine brown sand.
13.5- 19.0	Soft gray-brown silt, some sand.
19.0- 27.5	Soft gray silt, some organic matter.
27.5- 31.0	Soft gray-brown silt, some shells and organic matter.
31.0- 34.5	Fine gray silty sand.
34.5- 38.0	Medium gray sand, some clay.
38.0- 41.5	Coarse gray sand, some gravel.
41.5- 46.5	Soft gray-brown silt, some sand and organic matter.
46.5- 53.0	Fine gray sand, some clay.
53.0- 56.0	Coarse gray-brown sand and gravel.
56.0- 63.0	Fine white-brown sand and shells, some clay.
63.0- 68.0	Fine brown sand and shells, some clay.
68.0-100.0	Fine gray sand and shells, some clay.

Elevation of top of hole = 102.5 ft.
Water level at 4.0 ft after 1 hr.

Boring R-3 (1952)

Depth, ft	Description
0.0- 2.5	Sand fill.
2.5- 15.5	Soft gray silt and organic matter.
15.5- 22.0	Medium gray silty sand, some gravel and organic matter.
22.0- 35.5	Soft gray silt, some sand.
35.5- 58.5	Fine white sand and shells, some clay.
58.5- 63.5	White shells, some sand and clay.
63.5- 70.0	White-brown shells, some sand and clay.
70.0-100.0	Fine gray sand and shells, some clay.

Boring inundated at time of completion.
Surface elevation 96.5 ft.

Boring R-4 (1952)

Depth, ft	Description
0.0- 3.0	Semi-liquid silt.
3.0- 12.5	Soft gray silt.
12.5- 20.0	Soft gray silt and organic matter.
20.0- 28.0	Fine gray silt-sand and organic matter.
28.0- 33.0	Soft gray silt, trace fine sand.
33.0- 50.5	Soft gray silt, trace organic matter.
50.5- 58.0	Fine gray silty sand.
58.0- 72.0	Fine to coarse gray sand, some shells.
72.0-100.0	Medium gray sand and shells, some clay.

Boring inundated at time of completion.
Surface elevation 94.5 ft.

Boring R-1 (1953)

Depth, ft	Description
0.0- 1.0	Brown sandy loam.
1.0- 3.5	Medium gray sand.
3.5- 5.5	Medium brown gray sand, trace clay.
5.5-10.5	Medium brown sand.
10.5-14.5	Medium gray silty sand.
14.5-22.5	Gray silt, trace sand and organic matter.
22.5-27.5	Medium gray sand and silt, trace of gravel.
27.5-34.5	Gray silt, trace sand and organic matter.
34.5-38.0	Coarse gray sand and silt, trace of gravel.

Surface elevation 102.9 ft.
Water level at 3.5 ft 1 hr. after bailing.

Boring R-2 (1953)

Depth, ft	Description
0.0- 1.0	Brown sandy loam.
1.0- 3.6	Medium gray brown sand, trace clay.
3.5-11.0	Medium brown-gray sand.
11.0-14.0	Medium gray silty sand.
14.0-22.0	Gray silt, trace sand and organic matter.
22.0-24.5	Medium gray sand, trace silt.
24.5-35.5	Gray silt, trace sand and organic matter.
35.5-38.0	Fine gray green sand, trace gravel and silt.
38.0-42.0	Fine gray sand, shells, trace gravel and silt.
42.0-42.5	Soft strata, probably silt, no sample.
42.5-54.0	Fine gray sand and shells, trace of silt.

Surface elevation 102.3.
Water level at 5.0 ft 1 hr. after bailing.

Boring R-3 (1953)

Depth, ft	Description
0.0- 1.0	Brown sandy loam.
1.0- 4.0	Medium brown sand.
4.0- 6.0	Medium brown gray sand.
6.0-10.5	Medium brown gray sand, trace clay.
10.5-13.5	Medium brown sand.
13.5-25.5	Gray silt, trace sand and organic matter.
25.5-28.0	Coarse gray sand, trace silt.
28.0-35.5	Gray silt, trace sand and organic matter.
35.5-38.5	Coarse gray sand, trace silt and shells.
38.6-60.0	Fine gray sand and shells, trace silt.

Surface elevation = 102.8 F.
Water level at 3.5 ft 1 hr. after bailing.

Boring U-1

Elevation Interval*	Description
101 -92.5	Clean light yellowish sand.
92.5-87.5	Clean yellowish sand.
87.5-82.5	Plastic (soft) blue (dark gray) clay.
82.5-77.5	Plastic blue clay, some shells.
77.5-67.5	Gray and yellow sand, some fines (clay).
67.5-57.5	Coarse sand, cohesionless, gray and yellow.
57.5-52.5	Blue sandy clay, compact, rubbery, cohesive.
52.5-50	Blue sandy clay, compact, rubbery, cohesive, with more sand.

Boring U-2

Elevation Interval*	Description
101 -97.5	Clean white sand.
97.5-92.5	Gray sand and clay, some rotted vegetation.
92.5-87.5	Coarse yellow quartz sand.
87.5-79.0	Plastic blue (dark gray) clay.
79.0-52.5	Coarse yellow and gray sand, cohesionless, some mica.
52.5-49.0	Blue clay.
49.0-47.5	Clean gray sand.
47.5-40	Coarse sand and gravel, compact, cohesionless, some shell and marl.

Boring U-3

Elevation Interval*	Description
94.0-91.0	Sand.
91.0-82.5	Plastic (soft), blue (dark gray) clay.
82.5-77.5	Sand and blue clay, some shells.
77.5-67.5	Yellow sand, some gravel and shells.
67.5-62.5	Coarse sand and gravel.
62.5-57.5	Gray and yellow sand, some clay.
57.5-50.0	Sand, clay, gravel, shells, fairly dry, compact.

*Mean sea level = 93.84 ft.

Boring U-4

Elevation Interval*	Description
94 -87.5	Coarse yellowish sand.
87.5-82.5	Plastic blue (dark gray) clay.
82.5-77.5	Plastic cohesive sandy clay, yellowish.
77.5-67.5	Yellow sand, cohesionless.
67.5-62.5	Light gray soft clay, some fine yellow sand.
62.5-57.5	Sand, cohesionless.
57.5-52.5	Compact varved sand and fairly dry clay.
52.5-47.5	Compact sand and clay.
47.5-42.5	Compact sand, gravel, shells, and ground up shells with marl binder.
42.5-30.0	Ground up shells, shells, marl, and sand with some fines.

Boring U-5

95 -92.5	Beach sand.
92.5-87.5	Sand.
87.5-82.5	Sandy silt.
82.5-77.5	Soft to medium soft silty clay.
77.5-72.5	Silty clay and yellow sand.
72.5-62.5	Coarse yellow sand, cohesionless.
62.5-57.5	Coarse brown sand, cohesionless.
57.5-52.5	Coarse yellow sand, cohesionless.
52.5-47.5	Fairly stiff blue (dark gray) clay.
47.5-37.5	Coarse yellow and gray sand and gravel.
37.5-32.5	Sand and shell.
32.5-30	Coarse sand and shell, some fines.

Boring U-6

95 -87.5	Sand.
87.5-82.5	Plastic clay.
82.5-57.5	Medium blue clay.
57.5-47.5	Gray fine cohesive sand, compact clay binder.
47.5-37.5	Sand, shell, and gravel.

* Mean sea level = 93.84 ft.

Boring U-7

Elevation Interval*	Description
97 -87.5	Beach sand.
87.5-82.5	Soft blue clay.
82.5-77.5	Plastic blue clay.
77.5-72.5	Medium blue clay.
72.5-57.5	Medium stiff blue clay.
57.5-52.5	Stiff sandy clay.
52.5-42.0	Sand, shell, and gravel.

Boring U-8

90 -74.5	Soft clay.
74.5-69.5	Medium clay.
69.5-59.5	Medium stiff clay.
59.5-57.0	Gray clay, some sand.

Boring U-9

90.0-76.5	Soft blue clay.
76.5-61.5	Medium clay.
61.5-59.0	Fine gray sand, cohesionless.

Boring U-10

90 -79.5	Soft clay.
79.5-56.0	Sand, clean, yellow, cohesionless.

Boring U-12

94-92	Tidewater.
92-83	Soft Mud.
83-55	Soft clay, lumps washed out.
55-50	Clean gray sand.

Boring U-13

94-92	Tidewater.
92-83	Soft mud.
83-55	Soft clay, lumps washed out.
55-50	Clean gray sand.

* Mean sea level = 93.84 ft.

Boring U-14

Elevation Interval*	Description
92-82	Soft mud.
82-52	Very soft clay, lumps washed out. Vegetation at the bottom.
52-47	Clean gray sand.

Boring U-15

Elevation Interval*	Description
95-75	Soft clay.
75-70	Soft blue clay.
70-60	Medium blue clay.
60-55	Medium stiff blue clay.
55-50	Medium stiff sandy clay.
50-45	Silty gray sand.
45-40	Clean gray sand.

Boring U-16

Elevation Interval*	Description
95.5-85	Soft clay.
85 -78	Yellow sand, pieces of wood and small lumps of clay in wash.
78 -73	Yellow and gray sand, silt, and clay. Lump of compacted sand in wash.
73 -68	Medium blue clay.
68 -58	Gray cohesive sand, some silt, sandy clay gravel in wash.
58 -53	Gray cohesive sand, silt in wash.
53 -50	Clean gray sand.

Boring U-18

Elevation Interval*	Description
97-90	Muddy yellow sand.
90-83	Yellow sand and silt.
83-78	Yellow sand with clay.
78-73	Medium stiff sandy clay, clay, sand, and stones.
73-71	Coarse sand with sandy clay.
71-68	Cohesive sand with silt and clay.
68-63	Medium sandy clay.
63-60	Fine gray sand.
60-55	Clean gray sand.

* Mean sea level = 93.84 ft.

Boring U-19

Elevation Interval*	Description
95.5-75	Soft clay.
75 -70	Gray sand, wood, and lumps of clays in wash.
70 -65	Sand and clay lenses.
65 -60	Gray sand and shells.
60 -55	Gray sand.

* Mean sea level = 93.84 ft.

Appendix B

Glossary of Chemicals

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BLACK POWDER: A mechanical mixture of 75-percent potassium nitrate (saltpeter), 10 percent sulfur, and 15 percent charcoal.

COMPOSITION A-3: Pressed charges made of phlegmatized RDX and wax. RDX (also known as Hexogen, cyclonite, and cyclo-1,3,5-trimethylene-2,4,6-trinitramine) is practically insoluble in water and is reported as chronically toxic.

EXPLOSIVE D: Also known as Ammonium Picrate, ammonium-2,4,6-trinitrophenolate, and yellow D. Exhibits acute and chronic toxicity properties; recommended safe drinking water limits is 0.05 ppm. Animal toxicity value is reported as 200 ppm.

KEPONE: Chemical Formula $C_{10}\ Cl_{10}O_1$ is an acutely and chronically toxic compound that is persistent for long periods in soil and water. It accumulates in animal tissue and is a suspected carcinogen. The material is extremely toxic when ingested or inhaled. Probable human lethal dose is between 1 teaspoon and 1 ounce.

PCB: Polychlorinated biphenyl. LD_{50} for mammals reported at 0.250MG/KG. Rapidly accumulates in food chain. Chronically toxic with inhalation or skin absorption.

SMOKELESS POWDER: Three types commonly used: Single base (nitrocellulose (NC)), double base (NC and nitroglycerine (NG)), and triple base (NC, NG, and nitroquamidine (NQ)). Smokeless powder is insoluble in cold water. NQ is soluble in hot water.

TETRYL: Trinitro-2,4,6-phenylmethylnitramine. Reported to be poisonous. Practically insoluble in water.

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Appendix C

Decontamination Inspection of Facilities and Equipment at St. Juliens Creek Annex

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
NAVAL AMMUNITION PRODUCTION ENGINEERING CENTER
NAVAL WEAPONS SUPPORT CENTER
CRANE, INDIANA 47522

CO

IN REPLY REFER TO:
SEA-04J2511B/MJC:kjh
8026

19 JUL 1977

From: Commander, Naval Sea Systems Command
To: Commanding Officer, Naval Weapons Station Yorktown, St. Juliens Creek Annex, Portsmouth, Virginia 23702

Subj: Decontamination inspection of facilities and equipment at St. Juliens Creek Annex

Ref: (a) NAVSEA ltr SEA-992611B/SES:jmm 8026 of 21 Dec 1976
(b) NAVSEA ltr SEA-04J2511B/SES:kjh 8026 of 20 Jan 1977
(c) NAVSEA ltr SEA-04J2511B/SES:kjh 8026 of 4 Feb 1977
(d) NAVSEA ltr SEA-04J2511B/SES:kjh 8026 Ser 1 of 4 Mar 1977
(e) NAVSEA ltr SEA-04J2511B/SES:kjh 8026 Ser 2 of 4 Mar 1977
(f) NAVSEA ltr SEA-04J2511B/SES:kjh 8026 Ser 3 of 4 Mar 1977
(g) NAVSEA ltr SEA-04J2511B/SES:kjh 8026 of 18 Mar 1977
(h) NAVSEA spdltr SEA-04J2511B/MJC:kjh 8026 of 3 Jun 1977

Encl: (1) Procedures to Test for TNT, RDX, Tetryl and Explosive D
(2) List of Buildings Inspected/Tested
(3) EODGRUTWO ltr EODGRUTWO/00/IS 8026 Ser 637 of 14 Jun 1977

1. An inspection to determine completion of and compliance with the requirements set forth in references (a) through (g) was performed 21 through 30 June 1977 by SEA-04J25 (NAPEC) representative (Mr. Merrill Crouch) accompanied by WPNSTA Yorktown representative (Mr. Jerry Parker) and St. Juliens Creek Annex representatives (Mr. A. G. Bryant and Mr. C. Bell).

2. All buildings addressed in references (a) through (g) were inspected for explosive contamination. In addition to visual inspection of all potential explosive contaminated areas in, under and around each building, extensive testing was conducted in accordance with the procedures delineated in enclosure (1). The visual examination revealed no trace of explosive in any of the buildings and the tests verified the visual findings. Therefore, the facilities listed in references (a) through (g) are certified to be decontaminated. In addition to these facilities other buildings (primarily magazines) where decontamination efforts were expended in the form of cleanup/sweep and water wash of the walls and floors were visually inspected. Enclosure (2) is a list of all buildings inspected and certified as being decontaminated. Buildings not listed in enclosure (2) are considered inert and do not require decontamination or still contain material and have not been cleaned/washed.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Subj: Decontamination inspection of facilities and equipment at St. Juliens Creek Annex

3. The procedures delineated in reference (h) were discussed with EOD Group Two representatives. It was the contention of the EOD Group Two representatives, as indicated in enclosure (3), that a search of the pier area as described in reference (h) would be meaningless because of the condition (comparable to chocolate pudding) and amount of silt in the area to be searched. The amount of silt is such that a diver cannot probe to solid bottom; also, the metal detector indicates that the bottom (beneath the silt) is covered with metal. The amount and mass of metal cannot be determined from the signal. The method of sample searching one deep scoop of the bottom as recommended in enclosure (3) was also discussed. This sample size is too small and would not be conclusive.

4. As a result of the above discussion two alternatives were established. One alternative would be for divers to search only the area where hard bottom exists, find the hard bottom in other areas, and mark so that the contour of the bottom can be determined (areas to be marked would be determined by St. Juliens Creek personnel). St. Juliens Creek personnel would then scoop the bottom in those areas marked, place the material on the pier, wash the silt back into the area from whence it was removed and analyze the residue. The amount of scooping required is approximately ten percent of the total length of pier remaining after that area searched by divers is subtracted. For example, if 1,400 linear feet of pier remains after divers search the area where hard bottom exists, then 140 linear feet of the pier should be scooped. (Details for scooping would be established by St. Juliens Creek personnel assisted by NAPEC.) The ten percent sample would be a representative sample size upon which certification could be based; however, according to calculations, as many as seven pieces of ordnance could remain in the area undetected. Other drawbacks to this alternative are that before the bottom of the river can be disturbed approval/authorization is required from the Army Corps of Engineers and NAVFAC Atlantic Division. Approval and subsequent completion of the sampling is not possible in the allotted time frame. Also, if a piece of ordnance is found, either complete dredging (at tremendous cost) would be required or the pier would be certified at the single X level of decontamination. Certification at this level can be made without further decontamination and is the other alternative discussed.

5. As noted above, the second alternative is to do nothing to the pier area and base decontamination certification on past records, which indicate no ordnance has been dropped into the river and not retrieved, and the fact that the river has been dredged three times (the last time in 1974) since 1969 and nothing has been found. Decontamination certification by this alternative would be at the single X level. NAPEC recommends this alternative since St. Juliens Creek Annex will remain in government (DOD) ownership. NAVSEA (SEA-04H) concurs with this recommendation.

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6. The ingenuity, thoroughness and overall quality of workmanship exhibited by St. Juliens Creek personnel during the decontamination operations were extremely evident. It was a well coordinated and implemented effort.

James F. Weller
JAMES F. WELLER
By direction

Copy to:
WPNSTA Yorktown

PROCEDURES TO TEST FOR TNT, RDX, TETRYL AND EXPLOSIVE D

Spot Test For TNT

Dissolve five milligrams of the unknown in a 4 ml. test tube with 2 ml. of acetone. Add one drop of cyclohexylamine. A red to deep purple color denotes TNT.

Run a TNT known and a reagent blank.

Before using the cyclohexylamine, take some in an eye dropper and note the color. A dark brown color indicates that the cyclohexylamine has decomposed and should not be used. A clear to light amber color indicates the cyclohexylamine is suitable for use in the spot test.

Cyclohexylamine $CH_2(CH_2)_4$ M.W. 99.18

Spot Test for Explosive D

Dissolve .1 gram of material in about 5 milligrams of acetone, add 2 ml. of 10% Sodium Hydroxide solution. A deep orange color indicates Explosive D.

Spot Test for RDX and Tetryl

Place one milligram of the unknown on a white porcelain spot test plate. Add one milligram of thymol and mix thoroughly. Add three drops of concentrated sulfuric acid and stir. Wait exactly one minute and add two drops of 95% ethanol and stir. A pink or rose color denotes RDX and Tetryl.

Run an RDX and Tetryl known and a reagent blank at the same time.

Cotton Swab Test

Swab test or Diphenylamine test is the indicator for RDX, Tetryl and TNT on a swab. Black, blue or violet color on the swab indicates the presence of one of the above.

Enclosure (1)

LIST OF BUILDINGS INSPECTED/TESTED

Building Number	Contaminants Present	Decontamination Method	Method of Inspection	Conclusion
43	Expl D, RDX	Chemical wash - 4 water rinses	Visual + 4 tests	No cont. present
188	RDX, Tetryl	Chemical wash - 2 water rinses	Visual + 13 tests	No cont. present
241	RDX, Tetryl	Chemical wash - 2 water rinses	Visual + 1 test	No cont. present
242	RDX, Tetryl	Chemical wash - 2 water rinses	Visual	No cont. present
243	RDX, Tetryl	Chemical wash - 2 water rinses	Visual	No cont. present
244	Expl D, RDX	Chemical wash - 3 water rinses	Visual + 6 tests	No cont. present
245	Expl D, RDX	Chemical wash - 3 water rinses	Visual + 4 tests	No cont. present
246	Expl D, RDX	Chemical wash - 3 water rinses	Visual	No cont. present
M-3	TNT, RDX	Chemical wash - 2 water rinses	Visual + 10 tests	No cont. present
18	Black Powder	Water wash	Visual	No cont. present
39	Smokeless Powder	Water wash	Visual	No cont. present
41	Smokeless Powder	Water wash	Visual	No cont. present
89	Expl D, Tetryl	Chemical wash - 4 water rinses	Visual + 20 tests	No cont. present
267	Expl D	2 Chemical washes - 5 water rinses	Visual + 4 tests	No cont. present
M5 Annex	Expl D	2 Chemical washes - 5 water rinses	Visual + 2 tests	No cont. present
240	Expl D	2 Chemical washes - 5 water rinses	Visual	No cont. present
184	Black Powder	Water wash (3 times)	Visual	No cont. present
190	RDX, Expl D	Chemical Wash - 3 water rinses	Visual + 35 tests	No cont. present
256	RDX, Expl D	Chemical Wash - 3 water rinses	Visual + 3 tests	No cont. present
46	Smokeless Powder	Water wash	Visual	No cont. present
185	Smokeless Powder	Water wash	Visual	No cont. present

NOTE: Test areas are shown on attached drawings.

Enclosure (2)

Magazines Inspected	Method of Decontamination	Method of Inspection	Conclusion
6, 7, 8	Swept - water washed - reswept	Visual	OK
11, 16, 17, 18	Swept - water washed - reswept	Visual	OK
38	Swept - water washed - reswept	Visual	OK
40	Swept - water washed - reswept	Visual	OK
83	Swept - water washed - reswept	Visual	OK
62, 64, 65, 66, 67	Swept - water washed - reswept	Visual	OK
237, 238 (igloo type)	Swept - water washed - reswept	Visual	OK
218, 219, 220 (igloo type)	Swept - water washed - reswept	Visual	OK
57 Temporary Bldg.	Swept - water washed - reswept	Visual	OK
56 Temporary Bldg.	Swept - water washed - reswept	Visual	OK
59, 60, 61, 70, 71, 72	Swept - water washed - reswept	Visual	OK
73, 74, 75, 76, 77	Swept - water washed - reswept	Visual	OK
78, 79, 80, 81	Swept - water washed - reswept	Visual	OK
84	Swept - water washed - reswept	Visual	OK
86, 87, 88	Swept - water washed - reswept	Visual	OK
161, 162 (igloo type)	Swept - water washed - reswept	Visual	OK
M-2	Swept - water washed - reswept	Visual	OK
207 (igloo type)	Swept - water washed - reswept	Visual	OK
159, 160, 164	Swept - water washed - reswept	Visual	OK
28, 24	Swept - water washed - reswept	Visual	OK
251, 141 (igloo type)	Swept - water washed - reswept	Visual	OK
146	Swept - water washed - reswept	Visual	OK
165, 166, 167, 168	Swept - water washed - reswept	Visual	OK
169, 170, 171, 172, 173	Swept - water washed - reswept	Visual	OK
174, 175, 176, 177, 178 179, 180	Swept - water washed - reswept	Visual	OK
198, 277, 358	Swept - water washed - reswept	Visual	OK
Plus 120 rail cars	Water washed - swept		

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