# Former Nansemond Ordnance Depot

*Suffolk, Virginia*

*EPA Facility ID: VAD123933426*

*Basin: Nansemond River*

*HUC: 02080208*

## Executive Summary

The Former Nansemond Ordnance Depot site was used for activities related to explosives and ammunitions and is located in Suffolk, Virginia, at the confluence of the Nansemond and James rivers. Surface water and sediment at the site contain concentrations of trace elements, PAHs, and pesticides that exceed screening guidelines. Of particular concern is substantial contamination of a beachfront disposal area. This area is subject to erosion into the James River, which provides habitat for numerous NOAA trust resources. Streeters Creek contains concentrations of PAHs in sediment that pose a risk to aquatic organisms, although information on specific NOAA trust resources in the creek was not available.

## Site Background

The Former Nansemond Ordnance Depot (FNOD) is located on a decommissioned 430 hectare (1,062 acre) U.S. military facility in Suffolk, Virginia (Figure 1). The property is bordered to the west by the Nansemond River, to the north by the James River and Hampton Roads, and to the east by Streeters Creek.

The depot was used during World Wars I and II and the intervening years for various activities related to the preparation, processing, storage, shipment, salvage, reconditioning, and disposal of ammunition. It was apparently used after World War II in demobilization, including dumping explosives, ammunition, and chemicals. Numerous areas of concern have been identified at the FNOD (Table 1 and Figure 2). The potential waste sources and affected areas that have been investigated include landfills and disposal areas, burning grounds, an impregnation kit area, on-site water bodies, and offshore areas. The FNOD property is now occupied mostly by Tidewater Community College (TCC), the General Electric (GE) Company, and Interstate 664 (Gannett Fleming 1998a).

Beachfront erosion, surface water runoff, and groundwater migration are the pathways for migration of contaminants to NOAA trust habitats. Of particular concern is the debris on the James River Beach Front Area, which is subject to continued erosion into the river. Surface water ponds and creeks are shown in Figure 2. The majority of stormwater runoff west of I-664 flows through the TCC Lake. The upper surface of the water table ranges from several feet to as much as 12 m (39 ft) or more below land surface. The permeability of the soil is moderately rapid. Information on the direction of groundwater flow was not available (Gannett Fleming 1998a).

The FNOD is currently classified as a Formerly Used Defense Site. The U.S. Army Corps of Engineers is identifying and remediating areas of concern at the site. The FNOD was placed on the National Priorities List in July 1999 (U.S. EPA 2000).

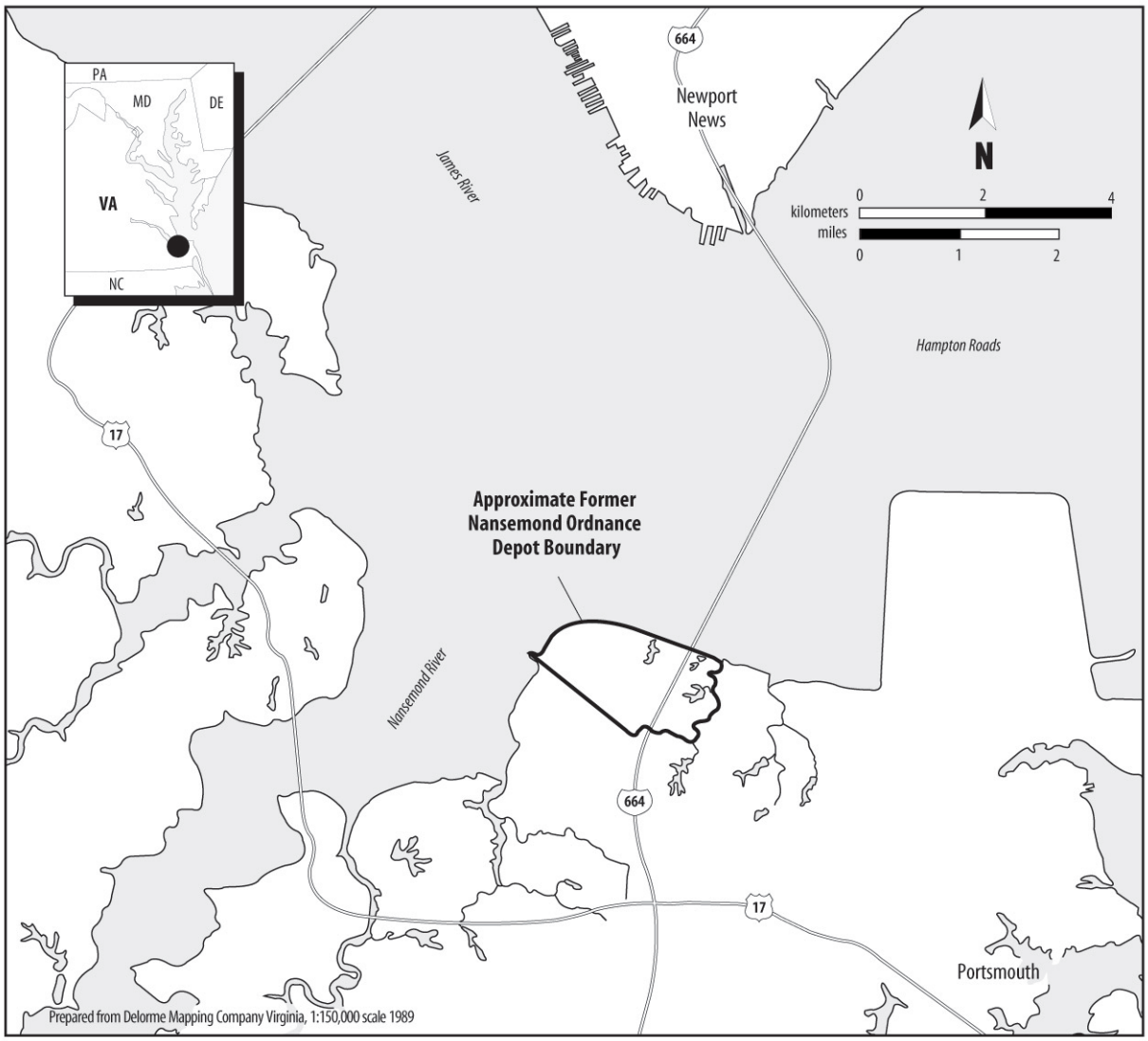


Figure 1. Location of the former Nansemond Ordnance Depot in Suffolk, Virginia.

## NOAA Trust Resources

Habitats of primary concern to NOAA are surface waters and associated bottom substrates of the Nansemond River, the James River, and Hampton Roads, both estuaries of Chesapeake Bay. Anadromous fish, estuarine fish, and invertebrates are the resources of concern within the estuaries (Table 2). Estuarine waters of this area range from shallow flats and tidal streams generally less than 2 m (6.5 ft) deep to trenches that are 13 m (43 ft) deep (USGS 1986, 1989). Salinities range from 14 to 20 parts per thousand, and sediments range from silts to sands (Majumdar et al. 1987). No resource information was available for Streeters Creek, a small tidal stream that traverses the edge of the facility (Gillingham personal communication 2000).

Trawl surveys by the Virginia Institute of Marine Science (VIMS) indicate that the estuary provides nursery and adult habitat for numerous estuarine and marine fish. Estuarine residents include bay anchovy, oyster toadfish, sheepshead minnow, killifishes, silversides, Northern pipefish, gobies, and hogchoker (VIMS 1989). All life stages of these species are spent within the estuary and several of the species are highly abundant. Species such as bluefish, mullet, pinfish, butterfish, and the sciae-

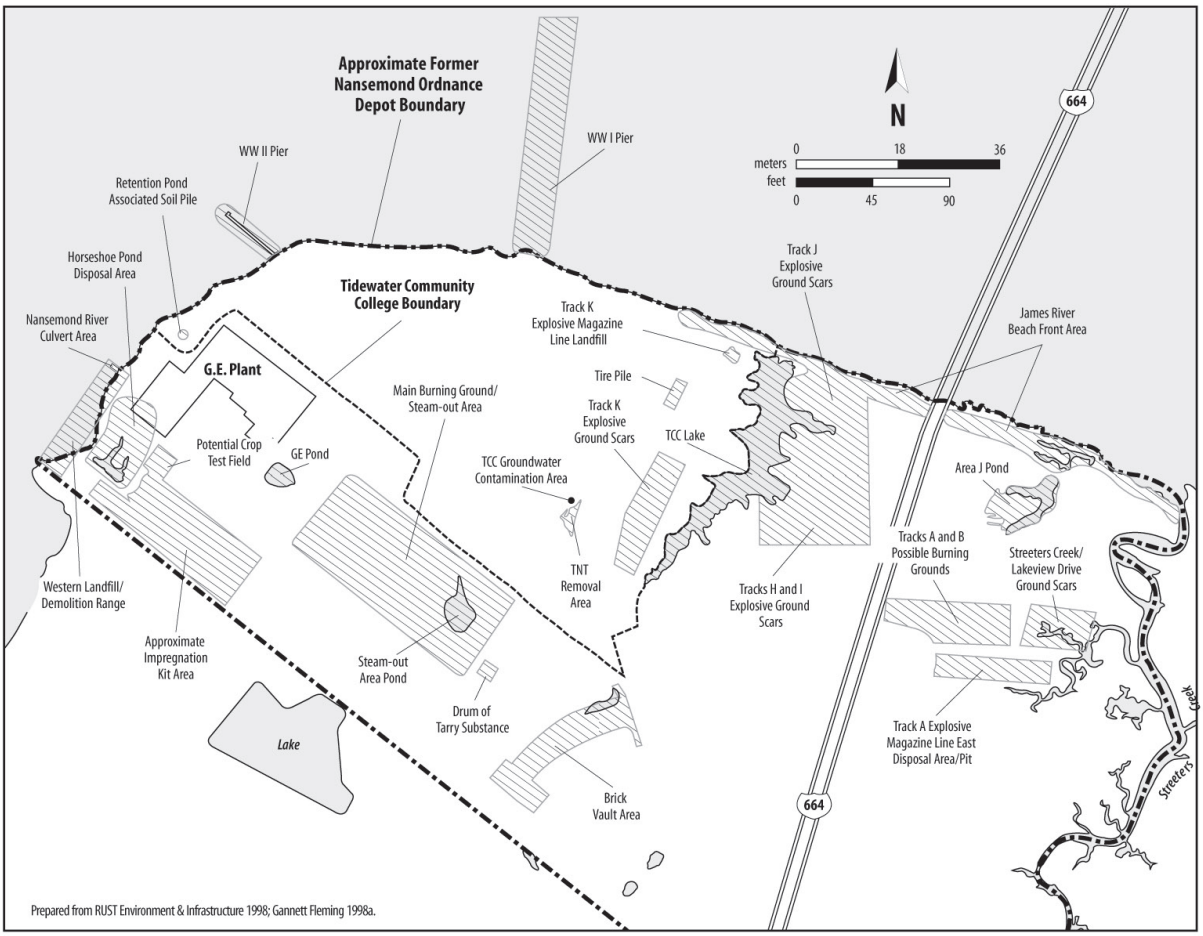


Figure 2. Detail of the Former Nansemond Ordnance Depot Property.

nids (croaker, weakfish, spotted seatrout, spot, drum) are coastal spawners; eggs and larval stages drift offshore and juvenile stages migrate to the estuary. Because many of these species are long-lived, juveniles may spend several years in the estuary. Adults of several of the species also can be found within the estuary seasonally. Bluefish, spot, and Atlantic croaker are particularly abundant in the area (Stone et al. 1994).

Several anadromous fish use the estuaries as a migratory corridor, juvenile nursery, and adult habitat. Juvenile and adult white perch are abundant; the adults spawn in the Nansemond River upstream of the site. Striped bass, particularly juvenile stages, are common in the estuary. Adults may spend time in the area as well, but many move seaward. Blueback herring and alewife also are present in the estuaries, spawning in upper portions of the Nansemond River, upstream of the site. The catadromous American eel is found throughout the Chesapeake basin, with juvenile life stages near the site (Stone et al. 1994).

Several invertebrates are present in the estuary including blue crab, grass shrimp, eastern oyster, and northern quahog. Juvenile and adult blue crab are abundant; mating and larval stages also are observed in the estuary although females usually migrate to coastal waters to brood and release eggs. Grass shrimp, oyster, and quahog spend all life stages in the estuary (Stone et al. 1994).

Substantial commercial and recreational fisheries are present in the Hampton Roads portion of Chesapeake Bay. Popular species include bluefish, croaker, spot, weakfish, flounder, blue crab,

Table 1. Areas of concern at the Former Nansemond Ordnance Depot (Rust Environment & Infrastructure 1998; Gannett Fleming 1998a).

| Area of Concern | Description[a] | Available Data[b] |
|---|---|---|
| James River Beach Front Area | Used as a disposal area during WW II. Approximately 6 ha (15 acres) of the beach front is littered with miscellaneous debris, including metal machinery parts and German artillery shells. | 15 soil samples |
| TNT Removal Area | Approximately 0.8 to 1.2 ha (2 to 3 acres) used as a disposal and maintenance area for ordnance-related waste, bulk explosives, propellants, small arms ammunition, and scrap metal from about 1917 to 1950. A removal action for contaminated soils was conducted in 1992. | 7 soil samples (after the removal action) |
| Main Burning Ground/Steam-out Area | Used to detonate explosives and clean out TNT from shells during and after WW I and WW II. | 4 soil samples |
| Impregnation Kit Area | Used as a disposal area for WW I impregnation kits and other debris. | 23 soil samples |
| Horseshoe Pond Disposal Area | Used as a disposal and burning area for solid waste and ordnance. | 2 soil samples, 5 sediment samples, 5 surface water samples |
| Western Landfill/ Demolition Range | Area is littered with miscellaneous debris. The activities conducted are not known. | One sediment sample, one surface water sample |
| Retention Pond-Associated Soil Pile | Ordnance and explosive materials were found while excavating a retention basin on the TCC Campus. | No data were available |
| TCC Lake | Ammunition magazines, a smokeless powder magazine, a primer/ fuse magazine, a powder exchange, and a tetryl platform once operated around the lake. | 6 sediment samples, 6 surface water samples |
| Area J Pond | The site contains three former smokeless powder magazines and ground scars exist along the edge of the pond. | 3 sediment samples, 3 surface water samples |
| Potential Crop Test Field | Identified as a ground scar and may possibly be a defoliant or biological testing area. | No data were available |
| Tire Pile | Contains large amounts of stockpiled tires and the area is possibly a former solid waste dump. | One soil sample |
| Tracks A & B Possible Burning Grounds | TNT and ordnance are suspected to have been burned in this area. | One soil sample |
| Tracks H, I, J, K Explosive Ground Scars | Mounding and ground scars have been observed around the former explosive magazines. | No data were available |
| Streeters Creek/ Lakeview Drive Ground Scars | Used for dumping of solid wastes and construction debris. | 4 soil samples, 3 sediment samples, 4 surface water samples |
| Track K Explosive Magazine Line Landfill | Evidence of solid waste has been reported in the area. | No data were available |
| Track A Explosive Magazine Line East Disposal Area/Pit | The site is believed to have been a solid waste disposal area, and mounding and ground scars have been observed. | No data were available |
| WW I- and WW II-Era Piers | Used for loading and unloading munitions and engineering materials. | One sediment sample |
| Brick Vault Area | Contains up to 30 vaults that may have been used for irrigation of crops, steam-out of TNT, and management of waste water generated in the burning ground. | Approx. 48 soil samples, 6 groundwater samples, 4 sediment samples, and 2 surface water samples |
| GE Pond | Several areas of concern surround the pond. | One sediment sample, one surface water sample |
| TCC Groundwater Contamination | Groundwater near the TNT disposal area contains explosives and trace elements. | 102 soil samples, 16 groundwater samples |
| Nansemond River Culvert Area | Stormwater runoff flowing through the culvert may be contaminated from soil and groundwater in the area. | One sediment sample, one surface water sample |
| Drum of Tarry Substance | A drum filled with a black tarry substance of unknown origin. | One soil sample |

a: Size of site and dates of operation provided only if the information was available from the documents reviewed.
b: Data from Gannett Fleming (1998a and 1998b).

Table 2. NOAA trust resources in the vicinity of the Former Nansemond Ordnance Depot (Stone et al. 1994; VIMS 1989).

| Species | | Habitat Use | | | Fisheries | |
|---|---|---|---|---|---|---|
| Common Name | Scientific Name | Spawning Ground | Nursery Ground | Adult Forage | Comm. Fishery | Recr. Fishery |
| **ANADROMOUS/CATADROMOUS** | | | | | | |
| Alewife | *Alosa pseudoharengus* | | ◆ | | | |
| American eel | *Anguilla rostrata* | | ◆ | | ◆ | |
| Blueback herring | *Alosa aestivalis* | | ◆ | | | |
| Striped bass | *Morone saxatilis* | | ◆ | ◆ | ◆ | |
| White perch | *Morone americana* | | ◆ | ◆ | | |
| **MARINE/ESTUARINE FISH SPECIES** | | | | | | |
| Atlantic croaker | *Micropogonias undulatus* | | ◆ | ◆ | | ◆ |
| Atlantic herring | *Clupea harengus* | | ◆ | ◆ | | |
| Atlantic menhaden | *Brevoortia tyrannus* | | ◆ | ◆ | | |
| Bay anchovy | *Anchoa mitchilli* | | ◆ | ◆ | | |
| Black drum | *Pogonias cromis* | | ◆ | ◆ | | |
| Black sea bass | *Centropristis striata* | | ◆ | ◆ | | |
| Bluefish | *Pomatomus saltatrix* | | ◆ | ◆ | | ◆ |
| Butterfish | *Peprilus triacanthus* | | ◆ | ◆ | | |
| Cownose ray | *Rhinoptera bonasus* | | ◆ | ◆ | | |
| Gobies | *Gobiosama spp.* | ◆ | ◆ | ◆ | | |
| Hogchoker | *Trinectes maculatus* | ◆ | ◆ | ◆ | | |
| Killifish | *Fundulus spp.* | ◆ | ◆ | ◆ | | |
| Mullets | *Mugil spp.* | | ◆ | | | |
| Northern pipefish | *Syngnathus fuscus* | ◆ | ◆ | ◆ | | |
| Northern searobin | *Prionotus carolinus* | | ◆ | | | |
| Pinfish | *Lagodon rhomboides* | | ◆ | ◆ | | |
| Red drum | *Sciaenops ocellatus* | | ◆ | ◆ | | ◆ |
| Red hake | *Urophycis chuss* | | ◆ | | | |
| Oyster toadfish | *Opsanus tau* | ◆ | ◆ | ◆ | | |
| Scup | *Stenotomus chrysops* | | ◆ | | | |
| Spotted seatrout | *Cynoscion nebulosus* | | ◆ | ◆ | | ◆ |
| Sheepshead minnow | *Cyprinodon variegatus* | ◆ | ◆ | ◆ | | |
| Silversides | *Menidia spp* | ◆ | ◆ | ◆ | | |
| Skates | *Raja spp.* | | ◆ | ◆ | | |
| Spot | *Leiostomus xanthurus* | | ◆ | ◆ | | ◆ |
| Summer flounder | *Paralichthys dentatus* | | ◆ | ◆ | | ◆ |
| Tautog | *Tautoga onitis* | | ◆ | ◆ | | |
| Weakfish | *Cynoscion regalis* | | ◆ | ◆ | | |
| Windowpane flounder | *Scophthalmus aquosus* | | ◆ | ◆ | | |
| **INVERTEBRATE SPECIES** | | | | | | |
| Bay shrimp | *Crangon septemspinosa* | ◆ | ◆ | ◆ | | |
| Blue crab | *Callinectes sapidus* | ◆ | ◆ | ◆ | ◆ | ◆ |
| Blue mussel | *Mytilis edulis* | ◆ | ◆ | ◆ | | |
| Eastern oyster | *Crassostrea virginica* | ◆ | ◆ | ◆ | | ◆ |
| Grass shrimp | *Palaemonetes pugio* | ◆ | ◆ | ◆ | | |
| Northern quahog | *Mercenaria mercenaria* | ◆ | ◆ | ◆ | | ◆ |

oyster, and quahog (Majumdar et al. 1987). Commercial fisheries also occur with the majority of the harvest consisting of blue crab. The Virginia Marine Resources Commission did not have any information on Streeters Creek; however, the tidal stream is not actively managed and fisheries are likely to be limited (Gillingham personal communication 2000). Bivalve harvests are restricted surrounding the FNOD facility because of industrial runoff (Wright personal communication 2000).

## Site-Related Contamination

Numerous investigations involving sampling of soils, groundwater, sediment, and surface water have been conducted throughout the site (Gannett Fleming 1998a). The number of samples collected, and the type of matrix sampled is presented in Table 1. Maximum concentrations of contaminants detected at the FNOD, compiled from data in Gannett Fleming (1998a and 1998b) are presented in Table 3. Trace elements, polynuclear aromatic hydrocarbons (PAHs), and pesticides have been detected at concentrations greatly exceeding screening guidelines (Table 3). Ordnance compounds also have been detected, but screening guidelines are not available for these contaminants (Table 4).

The greatest concentrations of arsenic, cadmium, copper, lead, and PAHs found in soil were collected from the James River Beach Front Area, which is subject to erosion into the river. Concentrations of trace elements exceeded average U.S. concentrations by two to three orders of magnitude. Screening guidelines for PAHs in soil are not available, but the PAH concentration exceeded the sediment ERL by two orders of magnitude. The highest concentration of zinc was found in soil from the Impregnation Kit Area. Pesticides and ordnance compounds were detected throughout the FNOD. Maximum concentrations of trinitrotoluene (TNT) and dinitrotoluene (DNT) were found in the vicinity of the TNT Removal Area.

Groundwater samples were collected at the TCC Groundwater Contamination Area and the Brick Vault Area. Numerous ordnance compounds were detected, primarily at the TCC Groundwater Contamination Area. Copper detected in groundwater was an order of magnitude greater than the ambient water quality criteria (AWQC).

Sediment and surface water samples were collected from freshwater ponds and creeks on the FNOD property, including Horseshoe Pond, TCC Lake, Area J Pond, Streeters Creek, the Steam-out Area Pond, a water body near the Brick Vault Area, and a culvert on the western edge of the site draining into the Nansemond River. In addition, four offshore sediment samples have been collected in the James River adjacent to the FNOD.

The maximum sediment concentrations of copper and lead were in samples collected from the Nansemond River Culvert Area. Sediment from Streeters Creek contained total PAH concentrations that substantially exceeded the ERL guideline. Elevated dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE) concentrations were found in sediment from Horseshoe Pond. Surface water samples collected from Horseshoe Pond contained the greatest concentrations of cadmium, nickel, silver, and zinc. Concentrations of lead in surface water from the Brick Vault Area exceeded the AWQC by four orders of magnitude. In the offshore areas, sediment from one location near the James River Beach Front Area had concentrations of copper, lead, and zinc that slightly exceeded their respective screening guidelines.

Table 3. Maximum concentrations of trace elements, PCBs, PAHs, and pesticides detected in samples collected from the Former Nansemond Ordnance Depot (Gannett Fleming 1998a and 1998b).

| | Soil (mg/kg) | | Water (µg/L) | | | Sediment (mg/kg) | |
|---|---|---|---|---|---|---|---|
| Contaminant | On-site Soils | Mean U.S.[a] | Ground-water | Surface water | AWQC[b] | Sediment | ERL or TEL[c] |
| **TRACE ELEMENTS** | | | | | | | |
| Arsenic | 700 | 5.2 | 11 | 23 | 36 | 18 | 5.9 |
| Cadmium | 21 | 0.06 | <5 | 5.1 | 2.2[d] | 1.4 | 0.596 |
| Chromium | 120 | 37 | 40 | 49 | 11 | 47 | 37.3 |
| Copper | 20,000 | 17 | 230 | 49 | 3.1 | 320 | 34 |
| Lead | 4,300 | 16 | 37 | 57,000 | 2.5[d] | 400 | 46.7 |
| Mercury | 1.0 | 0.058 | <0.4 | 0.52 | 0.77 | 0.52 | 0.15 |
| Nickel | 40 | 13 | 40 | 220 | 8.2 | 32 | 18 |
| Silver | 4.9 | 0.05 | <5 | 3.3 | 0.12 | 2.7 | 1.0 |
| Zinc | 11,000 | 48 | 120 | 1,900 | 81 | 270 | 123.1 |
| **SVOCs** | | | | | | | |
| PCBs | 0.48 | NA | NA | ND | 0.014 | ND | 0.0227 |
| Total PAHs | 750 | NA | NA | ND | 300[e,f] | 150 | 4.022 |
| **PESTICIDES** | | | | | | | |
| Alpha chlordane | 0.0012 | NA | N/A | ND | 0.002[g,h] | 0.031 | 0.0005 |
| DDD | 0.14 | NA | N/A | ND | 0.6[e,f] | 0.12 | 0.002 |
| DDE | 0.079 | NA | N/A | ND | 14[e,f] | 0.73 | 0.00142 |
| DDT | 0.50 | NA | N/A | ND | 0.0005[h] | 4.1 | 0.001 |
| Dieldrin | 1.3 | NA | N/A | ND | 0.00095[h] | 0.0005 | 0.00002 |
| Alpha-BHC | 0.0013 | NA | N/A | 0.024 | 0.08[i] | 0.12 | 0.00094[i] |
| Methoxychlor | 0.0075 | NA | NA | 0.075 | 0.03 | ND | NA |

NA: Screening guidelines not available.
N/A: Not analyzed.
ND: Not detected; detection limit not available.
a: Shacklette and Boerngen (1984), except for cadmium and silver, which represent average concentrations in the earth's crust from Lindsay (1979).
b: Ambient water quality criteria for the protection of aquatic organisms (USEPA 1999). Lower of the marine or freshwater chronic criteria presented unless otherwise noted.
c: The lower of the two guidelines, the marine Effects Range-Low (ERL) or the freshwater Threshold Effects Level (TEL), was chosen. The ERL represents the 10th percentile for the dataset in which effects were observed or predicted in studies compiled by Long et al. (1995; 1998). The TEL is the geometric mean of the 15th percentile of the effects data and the 50th percentile of the no-effects data, and is intended to represent the concentration below which adverse biological effects rarely occurred (Smith et al. 1996).
d: Criterion expressed as a function of total hardness; concentrations shown correspond to hardness of 100 mg/L $CaCO_3$.
e: Lowest observable effect level.
f: Marine acute value presented.
g: Value for chlordane.
h: Value has been halved to be comparable to criteria derived by 1985 guidelines.
i: Value for gamma BHC (lindane).

Table 4. Maximum concentrations of ordnance compounds detected at the Former Nansemond Ordnance Depot. There are no screening guidelines for ordnance compounds (Gannett Fleming 1998a and 1998b).

| Organic Compounds | Soil (mg/kg) | Groundwater (ug/L) | Surface Water (ug/L) | Sediment (mg/kg) |
|---|---|---|---|---|
| Dinitrobenzene | 0.49 | 1.8 | ND | ND |
| 1,3 Dinitrobenzene | 0.11 | 12 | <0.3 | <0.05 |
| 2-Amino-dinitrotoluene | ND | 16 | ND | ND |
| 4-Amino-dinitrotoluene | ND | 21 | ND | ND |
| 2-Amino-4,6-dinitrotoluene | 47,000 | 53 | <0.3 | <0.05 |
| 2,4-Dinitrotoluene | 0.54 | 5.5 | <0.3 | <0.05 |
| 2,6-Dinitrotoluene | ND | 2.9 | <0.3 | <0.05 |
| HMX | ND | 1.3 | <0.5 | <0.1 |
| RDX | ND | 13 | <2.2 | <0.4 |
| Tetryl | ND | 3.0 | <0.5 | <0.1 |
| 1,3,5-Trinitrobenzene | 4.4 | 16 | <0.3 | <0.05 |
| Trinitrotoluene | 2,150 | 125 | ND | ND |
| 2,4,6-Trinitrotoluene | 650 | 170 | <0.3 | <0.05 |
| Nitroglycerin | 1.6 | ND | ND | ND |

ND: Not detected; detection limit not available

## References

Gannett Fleming. 1998a. Preliminary draft data acquisition/summary report, Former Nansemond Ordnance Depot, Suffolk, VA. Philadelphia: U.S. EPA, Region III.

Gannett Fleming. 1998b. Former Nansemond Ordnance Depot, Draft sampling report, "J-Area" Lake, Tidewater Community College Lake, XXCC3 Impregnation Kit Area, and "Horseshoe-Shaped" Pond. Philadelphia: U.S. EPA, Region 3.

Gillingham, L., Fisheries Biologist, Virginia Marine Resources Commission, Newport News, personal communication, May 1, 2000.

Lindsay, W.L. 1979. *Chemical Equilibria in Soils.* New York: John Wiley & Sons. 449 pp.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environ. Mgmt. 19*(1):81-97.

Long, E.R., L.J. Field, and D.D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. *Environ. Toxicol. Chem. 17*(4):714-727.

Majumdar, S.K., L.W. Hall, Jr., H.M. Austin. 1987. *Contaminant Problems and Management of Living Chesapeake Bay Resources.* Harrisburg: Pennsylvania Academy of Science. 573 pp.

Rust Environment & Infrastructure. 1998. Final site management plan, Former Nansemond Ordnance Depot. Norfolk: U.S. Army Corps of Engineers.

**References** *cont.*

Shacklette, H.T. and J.G. Boerngen. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. USGS Professional Paper 1720. Washington, D.C.: U.S. Geological Survey.

Smith, S.L., D.D. MacDonald, K.A. Keenleyside, C.G. Ingersoll and L.J. Field. 1996. A preliminary evaluation of sediment quality assessment values for freshwater ecosystems. *J. Great Lakes Res*. *22*(3): 624-638.

Stone, S.L., T.A. Lowrey, J.D. Field, C.D. Williams, D.M. Nelson, S.H. Jury, M.E. Monaco, and L. Andreasen. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rept. No. 12. Silver Spring, Maryland: NOAA/NOS Strategic Environmental Assessments Division. 280 pp.

U.S. Geological Survey (USGS). 1986. Newport News South Quadrangle, Virginia 7.5 minute series (topographic-bathymetric), 1:24,000 scale.

USGS. 1989. Norfolk North Quadrangle, Virginia 7.5 minute series (topographic-bathymetric), 1: 24,000 scale.

U.S. EPA. 1999. National Recommended Water Quality Criteria—Correction. EPA 822-Z-99-001. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water.

U.S. EPA. 2000. National Priorities List Sites in Virginia [webpage]. Available: http:/www.epa.gov/superfund/sites/npl/va.htm

Virginia Institute of Marine Science (VIMS). 1989. Trawl survey database for juvenile fishes: 1975-1985, Gloucester Point, Virginia.

Wright, M., Biologist, Virginia Department of Health, Division of Shellfish Sanitation, Newport News, personal communication, April 18, 2000.