Tables

Table 3.10-1. Population in Region (1990 to 2007)

County	1990	2000	2006	Percent Change, 1990–2000	Percent Change, 2000–2007	Percent Change, 1990–2007
Brunswick	50,985	73,143	94,945	43.5	29.8	86.2
New Hanover	120,284	160,307	182,591	33.3	13.9	51.8
Pender	28,855	41,082	48,630	42.4	18.4	68.5
Three-County Total	200,124	274,532	326,166	37.2	18.8	63.0
North Carolina	6,632,448	8,049,313	8,856,505	21.4	10.0	33.5

Reference: U.S. Census Bureau, 2000; U.S. Census Bureau, 2007a.

Table 3.10-2. Population Projections for Region

County	2000	2015	2030	Percent Change, 2000–2015	Percent Change, 2015–2030	Percent Change, 2000–2030
Brunswick	73,143	125,107	164,165	71.0	31.2	124.4
New Hanover	160,307	219,531	271,030	36.9	23.5	69.1
Pender	41,082	61,200	78,479	49.0	28.2	91.0
Three-County Total	274,532	405,838	513,674	47.8	26.6	87.1
North Carolina	8,049,313	10,178,807	12,274,433	26.5	20.6	52.5

Reference: U.S. Census Bureau, 2000; NC OSBM, 2007.

Table 3.10-3. Regional Minority Population by Census Block (2000)

Area	Total Minority	Total Population	Minority Percent of Population
North Carolina	2,402,158	8,049,313	29.8
Brunswick County	13,789	73,143	18.9
New Hanover County	33,854	160,307	21.1
Pender County	11,641	41,082	28.3
NC Census Tract 020100, Census Block Group 1 (Brunswick County)	900	1,983	45.4
NC Census Tract 011500, Census Block Group 5 (New Hanover County)	1,248	2,016	61.9
NC Census Tract 011604, Census Block Group 1 (New Hanover County)	34	155	21.9
NC Census Tract 011500, Census Block Group 1 (New Hanover County)[a]	402	2,193	18.3
NC Census Tract 011604, Census Block Group 2 (New Hanover County)	287	2,429	11.8
NC Census Tract 011603, Census Block Group 1 (New Hanover County)	401	1,079	37.2
NC Census Tract 011500, Census Block Group 2 (New Hanover County)	232	1,665	13.9
NC Census Tract 011603, Census Block Group 2 (New Hanover County)	621	3,285	18.9
NC Census Tract 011500, Census Block Group 4 (New Hanover County)	40	957	4.2
NC Census Tract 011603, Census Block Group 3 (New Hanover County)	577	1,410	40.9
NC Census Tract 011500, Census Block Group 3 (New Hanover County)	93	494	18.8
NC Census Tract 980500, Census Block Group 4 (Pender County)	835	1,992	41.9
NC Census Tract 980600, Census Block Group 3 (Pender County)	538	1,232	43.7
NC Census Tract 980600, Census Block Group 1 (Pender County)	451	827	54.5
NC Census Tract 980600, Census Block Group 2 (Pender County)	1,492	4,993	29.9

Reference: U.S. Census Bureau, 2000.

[a] Census Block Group within which the Wilmington Site is located.

Table 3.10-4. Regional Population below Poverty (1999)

Area	Population for Whom Poverty Status Is Determined: Total	Population for Whom Poverty Status Is Determined: Income in 1999 Below Poverty Level	Percent of Population with 1999 Income Below the Poverty Level
North Carolina	7,805,328	958,667	12
Brunswick County	72,293	9,095	13
New Hanover County	156,609	20,445	13
Pender County	39,956	5,429	14
NC Census Tract 020100, Census Block Group 1 (Brunswick County)	1,952	283	14
NC Census Tract 011500, Census Block Group 1 (New Hanover County)[a]	2,168	146	7
NC Census Tract 011500, Census Block Group 2 (New Hanover County)	1,665	139	8
NC Census Tract 011500, Census Block Group 3 (New Hanover County)	494	8	2
NC Census Tract 011500, Census Block Group 4 (New Hanover County)	957	79	8
NC Census Tract 011500, Census Block Group 5 (New Hanover County)	2,016	324	16
NC Census Tract 011603, Census Block Group 1 (New Hanover County)	1,054	76	7
NC Census Tract 011603, Census Block Group 2 (New Hanover County)	3,285	258	8
NC Census Tract 011603, Census Block Group 3 (New Hanover County)	1,012	171	17
NC Census Tract 011604, Census Block Group 1 (New Hanover County)	155	29	19
NC Census Tract 011604, Census Block Group 2 (New Hanover County)	2,411	258	11
NC Census Tract 980500, Census Block Group 4 (Pender County)	1,932	231	12
NC Census Tract 980600, Census Block Group 1 (Pender County)	826	302	37
NC Census Tract 980600, Census Block Group 2 (Pender County)	4,958	789	16
NC Census Tract 980600, Census Block Group 3 (Pender County)	1,232	108	9

Reference: U.S. Census Bureau, 2000.

[a] Census Block Group within which the Wilmington Site is located.

Table 3.10-5. Population Density in Region (2007)

County	Total 2006 Population	Total 2030 Population	Land Area (mi2)	Population per Square Mile (2006)	Population per Square Miles (2030)
Brunswick County	94,945	164,165	864	109.9	190.0
New Hanover County	182,591	271,030	207	882.1	1309.3
Pender County	48,630	78,479	871	55.8	90.1
Three-County Total	326,166	513,674	1,942	168.0	264.5

Reference: U.S. Census Bureau, 2007a; NC OSBM, 2007 .

Table 3.10-6. Employment Characteristics of Region (2000)

County	Total Labor Force	Labor Force in Armed Services	Employed Civilian Labor Force	Unemployed Labor Force	Percent Unemployed Labor Force[a]
Brunswick County	34,240	318	32,355	1,567	4.58
New Hanover County	86,628	454	81,238	4,936	5.70
Pender County	19,087	115	17,896	1,076	5.64
Three-County Total	139,955	887	131,489	7,579	5.42

Reference: U.S. Census Bureau, 2000.

[a] Percent Unemployed Labor Force is calculated by dividing the number of unemployed workers in each county by the total labor force in that county.

Table 3.10-7. Employment by Industry in Region (2000)

Industry	Brunswick County		New Hanover County		Pender County		Three-County Total		North Carolina	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Agriculture, forestry, fishing and hunting, and mining	422	1.3	369	0.5	630	3.5	1,421	1.1	61,185	1.6
Construction	5,375	16.6	8,130	10.0	2,468	13.8	15,973	12.1	312,038	8.2
Manufacturing	2,660	8.2	8,001	9.8	2,632	14.7	13,293	10.1	755,252	19.7
Wholesale trade	799	2.5	2,480	3.1	645	3.6	3,924	3.0	131,330	3.4
Retail trade	4,301	13.3	11,407	14.0	2,367	13.2	18,075	13.7	439,868	11.5
Transportation and warehousing, and utilities	2,027	6.3	3,349	4.1	984	5.5	6,360	4.8	176,412	4.6
Information	451	1.4	2,013	2.5	253	1.4	2,717	2.1	89,797	2.3
Finance, insurance, real estate, and rental and leasing	1,930	6.0	5,060	6.2	749	4.2	7,739	5.9	231,222	6.0
Professional, scientific, management, administrative, and waste management services	2,469	7.6	7,693	9.5	1,313	7.3	11,475	8.7	296,075	7.7
Educational, health and social services	4,779	14.8	16,202	19.9	2,704	15.1	23,685	18.0	733,440	19.2
Arts, entertainment, recreation, accommodation and food services	3,957	12.2	8,761	10.8	953	5.3	13,671	10.4	265,585	6.9
Other services (except public administration)	1,675	5.2	4,408	5.4	1,089	6.1	7,172	5.5	176,908	4.6
Public administration	1,510	4.7	3,365	4.1	1,109	6.2	5,984	4.6	155,629	4.1
Total	32,355	100	81,238	100	17,896	100	131,489	100	3,824,741	100

Reference: U.S. Census Bureau, 2000.

Table 3.10-8. Income Data for Region

	Brunswick County	New Hanover County	Pender County	North Carolina
Per capita income in 1999	$19,857	$23,123	$17,882	$20,307
Percent of State per capita income	98%	114%	88%	100%
Median household income in 1999	$35,888	$40,172	$35,902	$39,184
Percent of State median household income	92%	103%	92%	100%

Reference: U.S. Census Bureau, 2000.

Table 3.10-9. Measures of Economic Output by Sector and County for Counties in the Region (2002)

NAICS[a]	Description	Units ($1,000)	Brunswick County, NC	New Hanover County, NC	Pender County, NC	Three-County Total	Wilmington, NC Metropolitan Statistical Area
11	Agriculture	Sales	34,856	3,345	101,662	139,863	N/A
31-33	Manufacturing	Total value of shipments	653,606	1,919,162	111,443	2,684,211	2,684,211
42	Wholesale Trade	Sales	68,970	1,229,257	289,834	1,588,061	1,588,061
44-45	Retail Trade	Sales	648,538	2,993,200	172,901	3,814,639	3,814,639
51	Information	Receipts	N/A	N/A	N/A	N/A	N/A
53	Real Estate and Rental and Leasing	Revenue	D	179,303	D	179,303	289,648
54	Professional, Scientific, and Technical Services	Receipts	D	690,626	D	690,626	741,996
56	Administrative and Support and Waste Management and Remediation Services	Receipts	45,625	264,734	7,962	318,321	318,321
61	Education Services	Receipts	D	D	D	D	25,646
62	Health Care and Social Assistance	Receipts	142,796	1,029,389	52,152	1,224,337	1,224,337
71	Arts, Entertainment, and Recreation	Receipts	44,407	65,013	4,253	113,673	113,673
72	Accommodation and Food Services	Sales	92,047	350,447	19,214	461,708	461,708
81	Other Services (except Public Administration)	Receipts	29,820	181,773	13,220	224,813	224,813
Total			1,725,809	8,902,904	670,979	11,299,692	11,487,053

Notes: D = Withheld by the U.S. Census Bureau to avoid disclosing data for individual companies; N/A = Not available or not comparable.

Reference: U.S. Census Bureau, 2002; USDA, 2004.

[a] North American Industry Classification System. http://www.census.gov/epcd/www/naics.html

Table 3.10-10. Property Tax Rates in Region (Fiscal Year 2006 to 2007)

County	County Property Tax Rate ($/$100 of value)	Range of Tax Rates for Municipalities inside County ($/$100 of value)
Brunswick County	0.54	0.05 to 0.465
New Hanover County	0.685	0.143 to 0.46
Pender County	0.65	0.05 to 0.66

Reference: NCDOR, 2007.

Table 3.10-11. North Carolina Personal Income Tax Rates (Fiscal Year 2006 to 2007)

Income	Income Tax Rate
$0 to $12,750	6%
$12,751 to $60,000	$765 + 7% of income over $12,750
$60,001 to $120,000	$4,072.50 + 7.75% of income over $60,000
Over $120,001	$8,722.50 + 8.25% of income over $120,000

Reference: NCDOR, 2006.

Table 3.10-12. Housing Characteristics in Region (2000)

	Brunswick County	New Hanover County	Pender County	3-County Total
Total	51,431	79,616	20,798	151,845
Urban	20,494	76,291	987	97,772
Percent urban	40%	96%	5%	64%
Rural	30,937	3,325	19,811	54,073
Percent rural	60%	4%	95%	36%
Occupied	30,438	68,183	16,054	114,675
Owner occupied	25,013	44,109	13,260	82,382
Renter occupied	5,425	24,074	2,794	32,293
Vacant	20,993	11,433	4,744	37,170
For rent	2,134	3,946	438	6,518
For sale only	981	1,470	322	2,773
Rented or sold, not occupied	389	541	177	1,107
For seasonal, recreational, or occasional use	15,540	4,387	2,881	22,808
For migrant workers	23	2	29	54
Other vacant	1,926	1,087	897	3,910

Reference: U.S. Census Bureau, 2000.

Table 3.10-13. Value of All Owner-Occupied Housing Units in Region (2000)

Value	Number of Units			
	Brunswick County	New Hanover County	Pender County	Region Total
Less than $24,999	2,002	1,771	1,315	5,088
$25,000 to $49,999	2,955	1,417	1,408	5,780
$50,000 to $99,999	8,414	10,951	5,268	24,633
$100,000 to $199,999	7,846	20,172	3,545	31,563
$200,000 to $499,999	3,376	8,034	1,597	13,007
Over $500,000	427	1770	127	2,324
Total Owner-Occupied Units	25,020	44,115	13,260	82,395
Median Value				
Median value for all Owner-Occupied Housing Units	$95,200	$127,900	$86,900	

Reference: U.S. Census Bureau, 2000.

Table 3.10-14. Privately Owned Residential Building Permits in Region[a]

Year	Brunswick County			New Hanover County			Pender County			Regional Total		
	Bldgs	Units	Construction Cost	Bldgs	Units	Construction Cost	Bldgs	Units	Construction Cost	Bldgs	Units	Construction Cost
2000	1,354	1,449	161,460,915	1444	1860	207,884,861	302	348	53,954,610	3,100	3,657	423,300,386
2001	2,035	2,104	258,948,811	1604	2459	258,610,440	324	330	50,604,333	3,963	4,893	568,163,584
2002	2,483	2,642	353,737,759	1893	2432	349,512,815	423	423	62,556,363	4,799	5,497	765,806,937
2003	2,841	2,870	399,326,970	2132	2904	410,707,087	645	681	72,734,164	5,618	6,455	882,768,221
2004	3,599	3,829	529,518,553	2601	3594	548,287,493	868	909	108,229,724	7,068	8,332	1,186,035,770
2005	4,320	4,710	724,937,974	2560	3401	594,003,743	1,068	1,095	145,927,904	7,948	9,206	1,464,869,621
2006	4,163	4,418	721,389,626	1526	2011	417,281,551	597	678	85,435,124	6,286	7,107	1,224,106,301

Reference: U.S. Census Bureau, 2007b.

[a] Represents new buildings or units per month.

Table 3.10-15. Number of Schools in Region by Type

County	Elementary	Middle	Secondary	Combined	Post Secondary
Brunswick	11	3	3	5	1
New Hanover	36	6	3	5	5
Pender	6	3	2	1	0
Total	53	12	8	11	6

Reference: ESRI, 2007.

Table 3.10-16. Enrollment by Level of School in Region (2000)

	Brunswick County	New Hanover County	Pender County
Enrolled in nursery school, preschool	869	2,921	479
Enrolled in kindergarten	838	1,893	569
Enrolled in grade 1 to grade 4	3,434	8,068	2,223
Enrolled in grade 5 to grade 8	3,876	7,065	2,480
Enrolled in grade 9 to grade 12	3,514	7,384	2,113
Enrolled in college, undergraduate years	1,853	13,664	1,178
Enrolled in graduate or professional school	209	1,298	161
Total	14,593	42,293	9,203

Reference: U.S. Census Bureau, 2000.

Table 3.10-17. Educational Facilities in the Vicinity of Wilmington Site[a]

Name	Type	Public or Private	Distance (miles)	Total Students	Teachers (FTEs)	Student to Teacher Ratio
Wrightsboro Elementary	Elementary	Public	3.35	584	34	17.2
Emma B. Trask Middle	Middle	Public	4.14	804	50	16.1
Emsley A. Laney High	Secondary	Public	4.55	1938	106	18.3
Sonshine Academy	Combined	Private	5.36	NA	NA	NA
D. C. Virgo Middle	Middle	Public	6.13	365	31	11.8
Dorothy B. Johnson Elementary	Elementary	Public	6.23	270	18	15.0
Wilmington Christian Academy	Combined	Private	6.34	NA	NA	NA
Kings Memorial Christian Academy	Elementary	Private	6.38	NA	NA	NA
Calvary Education Center (Calvary Christian Schools)	Elementary	Private	6.66	96	13	
Cape Fear Community College	Post Secondary	Public	6.82	7,501	NA	NA
Annie H. Snipes Elementary	Elementary	Public	6.97	424	28	15.1
William H. Blount Elementary	Elementary	Public	7.00	NA	NA	NA
Wilmington Academy Of Arts & Sciences	Elementary	Private	7.04	58	6	9.7
New Hanover High	Secondary	Public	7.10	1855	94	19.7
Wilmington Seventh Day Adventist (SDA) School	Elementary	Private	7.12	18	2.4	7.5
Mr. Davids School Of Hair Design	Post Secondary	Private	7.27	14	NA	NA
St. Mary Elementary School (St. Mary Catholic School)	Elementary	Private	7.35	178	13.8	12.9
Rocky Point Elementary (Rocky Point Primary)	Elementary	Public	7.36	428	30	14.3
Gregory Elementary	Elementary	Public	7.41	570	37	15.4
Williston Middle	Middle	Public	7.48	907	45	20.2
Forest Hills Elementary	Elementary	Public	7.76	374	29	12.9
Dr. Hubert Eaton, Sr. Elementary	Elementary	Public	7.98	596	34	17.5

Reference: ESRI, 2007; NCES, 2008.

N/A = Not available, FTE = Full Time Equivalent Employee (part-time workers are reported as a fraction of one full-time worker).

[a] Within 8 miles of Wilmington Site.

Table 3.10-18. Level of Educational Attainment in Region (2000)

Level Attained	Brunswick County		New Hanover County		Pender County		North Carolina	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
No schooling completed	524	1	585	1	236	1	62,106	1
Nursery to 4th grade	292	1	269	0	231	1	39,672	1
5th and 6th grade	784	1	881	1	497	2	101,549	2
7th and 8th grade	1,737	3	2,083	2	1,166	4	210,168	4
9th grade	1,939	4	2,070	2	990	3	173,305	3
10th grade	2,546	5	2,918	3	1,205	4	214,182	4
11th grade	1,878	4	2,826	3	1,355	5	181,982	3
12th grade, no diploma	1,735	3	3,124	3	936	3	171,760	3
High-school graduate (includes equivalency)	17,482	33	26,327	24	9,574	34	1,502,978	28
Some college, less than 1 year	4,313	8	7,532	7	2,273	8	362,337	7
Some college, 1 or more years, no degree	7,508	14	17,235	16	4,409	15	718,167	14
Associate degree	3,417	6	8,481	8	1,822	6	358,075	7
Bachelor's degree	5,774	11	23,985	22	2,840	10	808,070	15
Master's degree	1,854	4	6,149	6	635	2	253,794	5
Professional school degree	561	1	2,055	2	260	1	78,279	1
Doctorate degree	261	0	1,151	1	137	0	46,570	1
Total	52,605	100	107,671	100	28,566	100	5,282,994	100

Reference: U.S. Census Bureau, 2000.

Table 3.10-19. Regional Health Care Facilities

Brunswick County		
The Brunswick Community Hospital 1 Medical Center Drive P.O. Box139 Supply, NC 28462 910-755-812	**J. Arthur Dosher Memorial Hospital** 924 Howe St. Southport, NC 28461 910-457-5271	**Coastal Primary & Immediate Care** 4654 Long Beach Rd. Southport, NC 28461 910-457-0055
New Hanover County		
Cape Fear Hospital 5301 Wrightsville Ave. Wilmington, NC 28403 910-452-8100	**Family Medicine** 2523 Delaney Avenue Wilmington, NC 28401 910-763-5522	**The Oaks Behavioral Health Center** 2131 S. 17th Street Wilmington, NC 28401 910-343-7787
Coastal Rehabilitation Hospital 2131 S.17th Street Wilmington, NC 28401 910-343-7845	**New Hanover Regional Medical Center** 2131 South 17th Street Wilmington, NC 28401 910-343-7000	**Zimmer Cancer Center** 2131 S. 17th Street Wilmington, NC 28401 910-342-3000
Cornelia Nixon Davis Health Care Center 1011 Porter's Neck Rd. Wilmington, NC 28405 910-686-7195		
Pender County		
Maple Hill Medical Center 4811 N.C. Highway 50 Maple Hill, NC 28454 910-259-6444	**Pender Memorial Hospital** 507 Freemont Street P.O. Box 835 Burgaw, NC 28425 910-259-5451	

Reference: NHHN, 2007a

Table 3.10-20. Regional Facilities Serving Senior Citizens and Those Needing Rehabilitation

Assisted Living Facilities		
Brunswick County		
Carillon Assisted Living 1125 East Leonard Street Southport, NC 28461 910-454-4001 Adult Care: 72; Alzheimer's Care: 24	**Eldo #1 Family Care Home** 2180 Maco Road Leland, NC 28451 910-655-4102 Adult Care: 6	**Shallotte Assisted Living** P.O. Box 1559, 424 Mulberry Shallotte, NC 28459 910-754-6621 Adult Care: 80
Corinthian Place Assisted Living 1935 Lincoln Road Leland, NC 28451 910-383-6235		
New Hanover County		
Alterra-Clare Bridge Memory Impairment Facility 3501 Converse Dr. Wilmington, NC 28403 910-790-8664 Dementia Care: 38	**Judge Family Care Home #1** 400 Judges Road, P.O. Box 3463 Wilmington, NC 28406 910-791-4862 Adult Care: 6	**Port South Village** 210 Covil Avenue, P.O. Box 4669 Wilmington, NC 28406 910-762-4550 Adult Care: 72; Cottages: 6
Champion's Assisted Living 1007 Porter's Neck Road Wilmington, NC 28411 910-686-6462 Adult Care: 125; Dementia Care: 23	**Judge Family Care Home #4** 400 Judges Road, P.O. Box 3468 Wilmington, NC 28406 910-395-4314 Adult Care: 5	**Sherwood Manor Rest Home** 1605 Robinhood Rd. Wilmington, NC 28401 910-762-9531 Adult Care: 40
Diversicare of Carolina Beach 400 Goldsboro Ave., P.O. Box 1309 Carolina Beach, NC 28428 910-458-5833 Adult Care: 61	**Lowe's Family Care Home #1** 6961 Carolina Beach Road, Wilmington, NC 28412 910-799-9164 Adult Care: 5	**Spring Arbor of Wilmington** 809 John D. Barry Drive Wilmington, NC 28412 910-799-4999 Adult Care: 54; Dementia Care: 12
Eldo Family Care Home 1803 Castle Street, P.O. Box 2028 Wilmington, NC 28403 910-772-8052 Adult Care: 6	**Lowe's Family Care Home #2** 132 McQuillan Drive Wilmington, NC 28412 910-791-2852 Adult Care: 6	**The Commons at Brightmore** 2320 41st Street Wilmington, NC 28403 910-392-6899 Adult Care: 169; Dementia Care: 32
Fannie Norwood Memorial Home 501 S. 15th Street Wilmington, NC 28401 910-762-0209 Adult Care: 16	**Lowe's Family Care Home #3** 136 McQuillan Drive Wilmington, NC 28412 910-791-7067 Adult Care: 6	**The Kempton at Brightmore** 2298 41st Street Wilmington, NC 28403 910-332-6899 Adult Care: 136
Hermitage House 4724 Castle Hayne Road Castle Hayne, NC 28429 910-675-2988 Adult Care: 84	**Oakdale Heights** 2744 S. 17th Street Wilmington, NC 28412 910-452-1114 Adult Care: 75; Dementia Care: 26	**The Meadows of Wilmington** 4200 Jasmine Cove Way Wilmington, NC 28408 910-395-5220 Adult Care: 64
Jordan's Family Care Home 502 Manley Avenue Wilmington, NC 28406 910-763-2761 Adult Care: 6		

(continued)

Table 3.10-20. Regional Facilities Serving Senior Citizens and Those Needing Rehabilitation (continued)

Assisted Living Facilities (continued)		
Pender County		
DaySpring of Burgaw 300 West Ashe St., P.O. Box 129 Burgaw, NC 28425 910-259-8070 Adult Care: 62	**Forest Lane Family Care Home #1** 71 Forest Lane, Highway 133 Rocky Point, NC 28457 910-675-2835 Adult Care: 5	**Karon's Family Care Home** 570 Oak Tree Road Willard, NC 28478 910-285-3246 Adult Care: 6
Edith's Family Care Home 4477 Shiloh Church Road, Watha, NC 28478 910-283-9988 Beds: 3	**Forest Lane Family Care Home #2** 71 Forest Lane, Highway 133, Rocky Point, NC 28457 910-675-3091 Adult Care: 6	**PenDu Rest Home** 685 North Carolina Hwy. 50, Wallace, NC 28466 910-259-4469 Adult Care: 19
Nursing Facilities		
Brunswick County		
Autumn Care Nursing and Rehab Center of Shallotte 237 Mulberry Street P.O. Box 2337 Shallotte, NC 28459 910-754-8858 Skilled: 130; Dementia Care: 40	**Dosher Memorial Hospital Extended Care** 924 N. Howe Street Southport, NC 28461 910-454-4607 or 457-7696 Skilled: 50; Adult Care: 14	**Ocean Trail Convalescent Ctr** 430 Fodale Ave., P.O. Box 10249 Southport, NC 28461 910-457-9581 Skilled: 99; Adult Care: 17
Brunswick Cove Nursing Center 1478 River Road, Hwy. 133 S. P.O. Box 916 Winnabow, NC 28479 910-371-9894 Skilled: 175; Adult Care: 40		
New Hanover County		
Autumn Care of Myrtle Grove 5725 Carolina Beach Road Wilmington, NC 28412 910-792-1455 Skilled: 90; Adult Care: 20	**Cypress Pointe Rehabilitation and Health Care Centre** 2006 S. 16th Street Wilmington, NC 28401 910-763-6271 Skilled: 100	**Mariner Health Care of Wilmington** 820 Wellington Ave. Wilmington, NC 28401 910-343-0425 Skilled: 120; Adult Care: 30
Britthaven of Northchase 3015 Enterprise Drive Wilmington, NC 28405 910-791-3451 Skilled: 110; Adult Care: 20	**Davis Health Care Center** 1011 Porter's Neck Road Wilmington, NC 28411 910-686-7195 Skilled: 159; Dementia Care: 40	**Silver Stream Nursing & Rehab. Ctr** 2305 Silver Stream Drive Wilmington, NC 28401 (910) 362-3621 Skilled: 110
Britthaven of Wrightsville 221 Summer Rest Road Wilmington, NC 28405 910-256-3733 Skilled: 80	**Liberty Commons Nursing Center** 121 Racine Drive Wilmington, NC 28403 910-452-4070 Skilled: 100; Adult Care: 40	

(continued)

Table 3.10-20. Regional Facilities Serving Senior Citizens and Those Needing Rehabilitation (continued)

Nursing Facilities (continued)		
Pender County		
Huntington Health Care and Retirement Center 311 S. Campbell Street Burgaw, NC 28425 910-259-6007 Skilled: 121; Adult Care: 23	**Pender Memorial Hospital Extended Care Skilled Nursing Unit** 507 E. Fremont St. Burgaw, NC 28425 910-259-5451 Skilled: 43	**Woodbury Wellness Center** 2778 Country Club Drive Hampstead, NC 28443 910-270-1443 Skilled: 88; Adult: 24
Senior Citizen Centers		
Brunswick County		
Leland Senior Center 1490 Village Rd. NE Leland, NC 28451 910-371-3560	**Shallotte Senior Citizens Center** 450 Main Street P.O. Box 295 Shallotte, NC 28470 910-754-8776	
New Hanover County		
Katie B. Hines Center 308 Cape Fear Blvd. Carolina Beach, NC 28428 910-458-6609	**New Hanover County Senior Center** New Hanover County Dept. of Aging 2222 S. College Road Wilmington, NC 28403 910-798-6400	
Pender County		
Heritage Place, Pender Adult Services P.O. Box 1251, 901 S. Walker Street Burgaw, NC 28425 877-259-9119 toll free, 910-259-9119	**Maple Hill Senior Center** 545 Maple Hill School Road Maple Hill, NC 28454 910-259-8282	**Topsail Senior Center** 20959 U.S. Highway 17 N. Hampstead, NC 28443 910-270-0708

Reference: NHHN, 2007b.

Table 3.10-21. Number of Persons per Type of Health Care Personnel in the Region

County	Primary Care Physicians	Registered Nurses	Dentists
Brunswick	2,294	210	3,441
New Hanover	788	70	1,443
Pender	3,878	304	4,654

Reference: NCSCHS, 2005.

Figures

Figure 3.10-1. Population centers in the three counties surrounding the Wilmington Site.

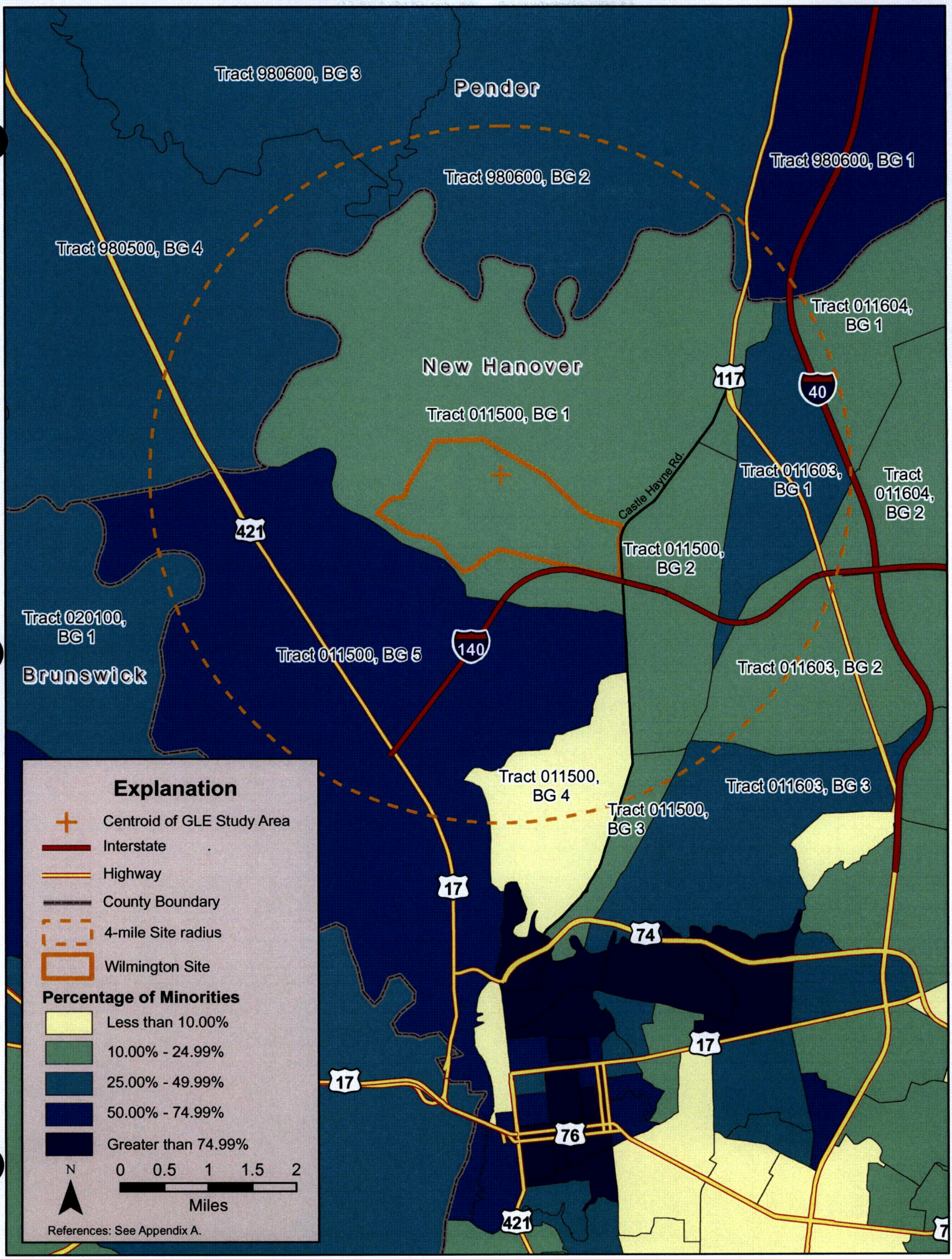

Figure 3.10-2. Minority share of population by census block group within 4 miles (6.4 km) of the Wilmington Site.

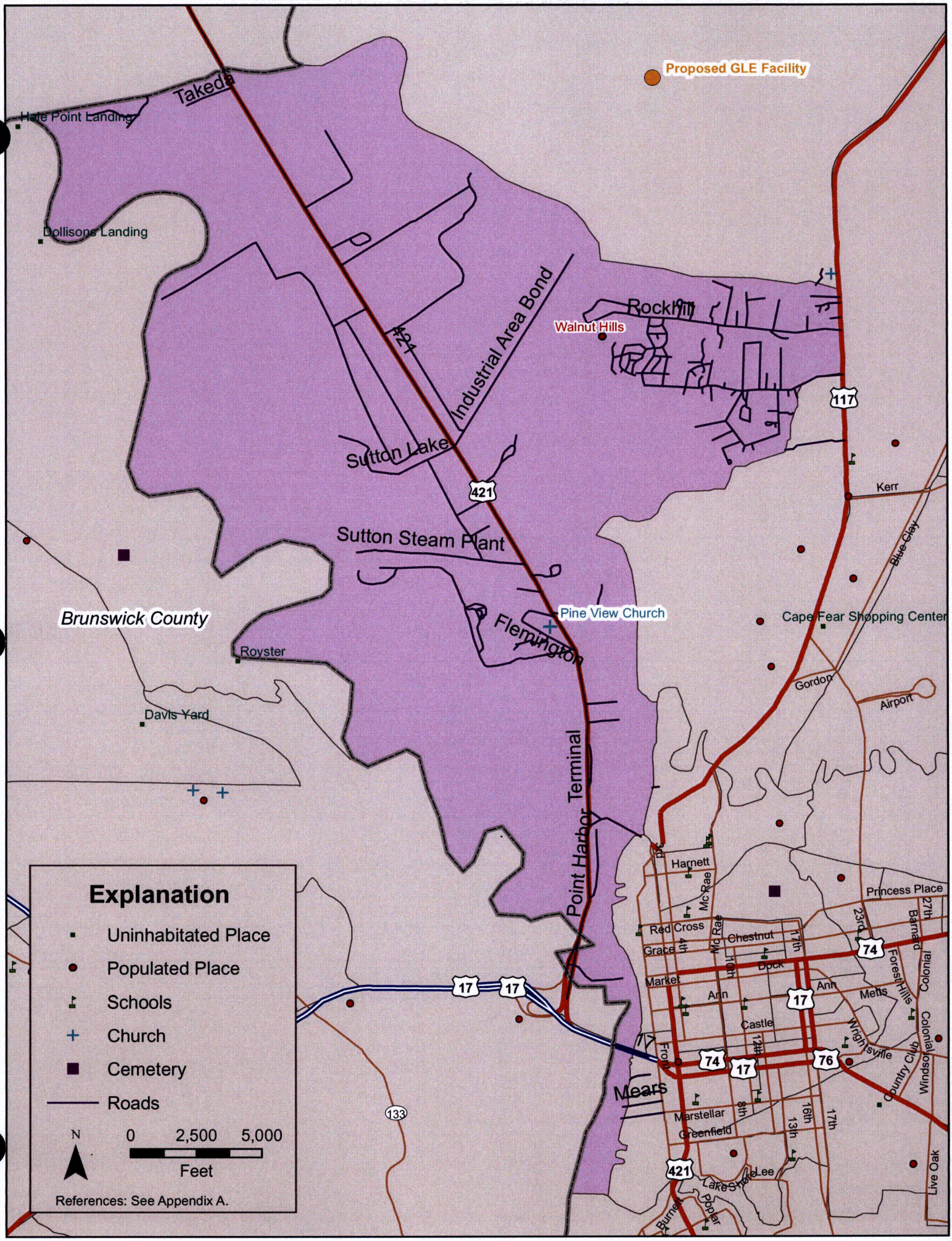

Figure 3.10-3. Map of Census Tract 011500, Census Block Group 5.

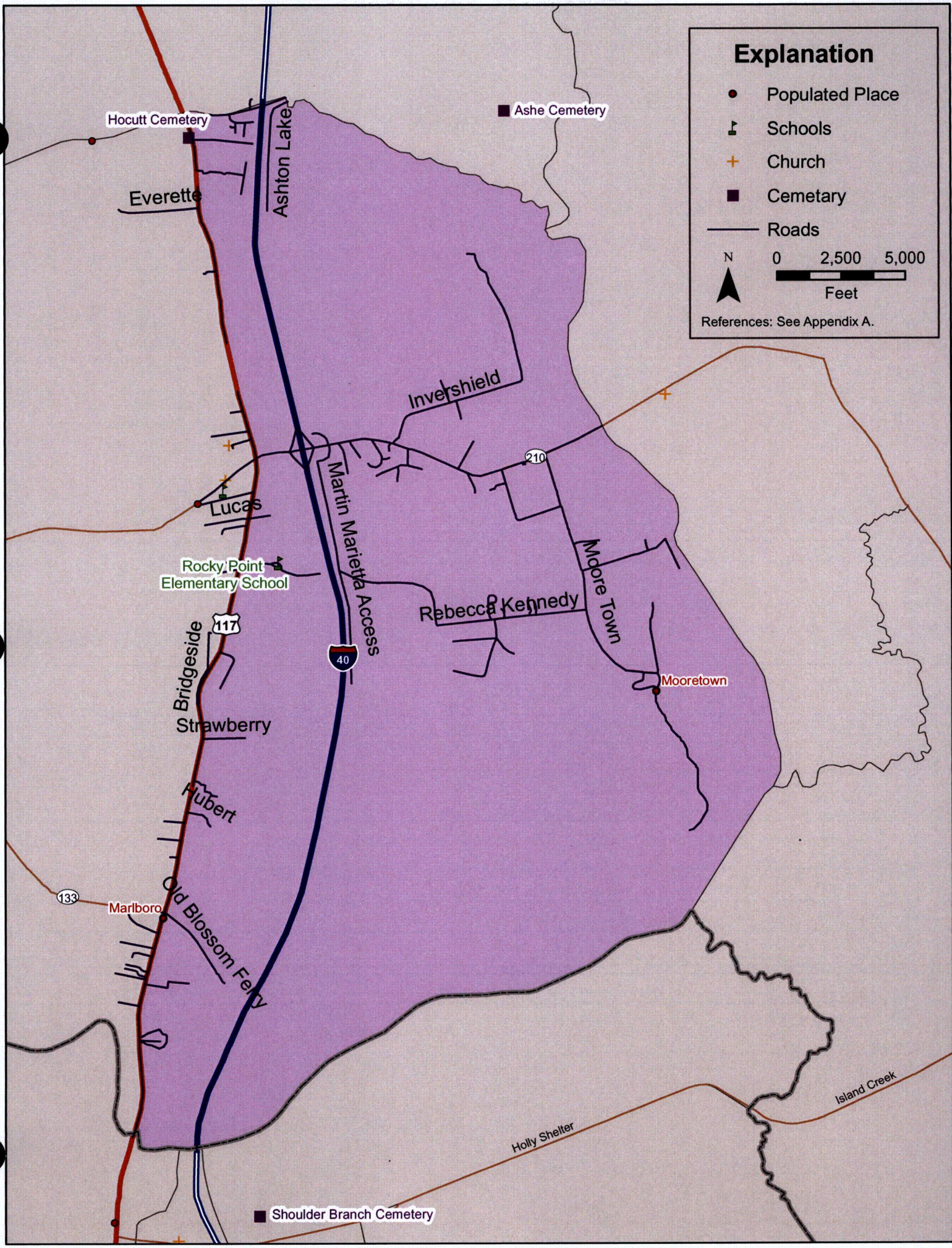

Figure 3.10-4. Map of Census Tract 980600, Census Block Group 1.

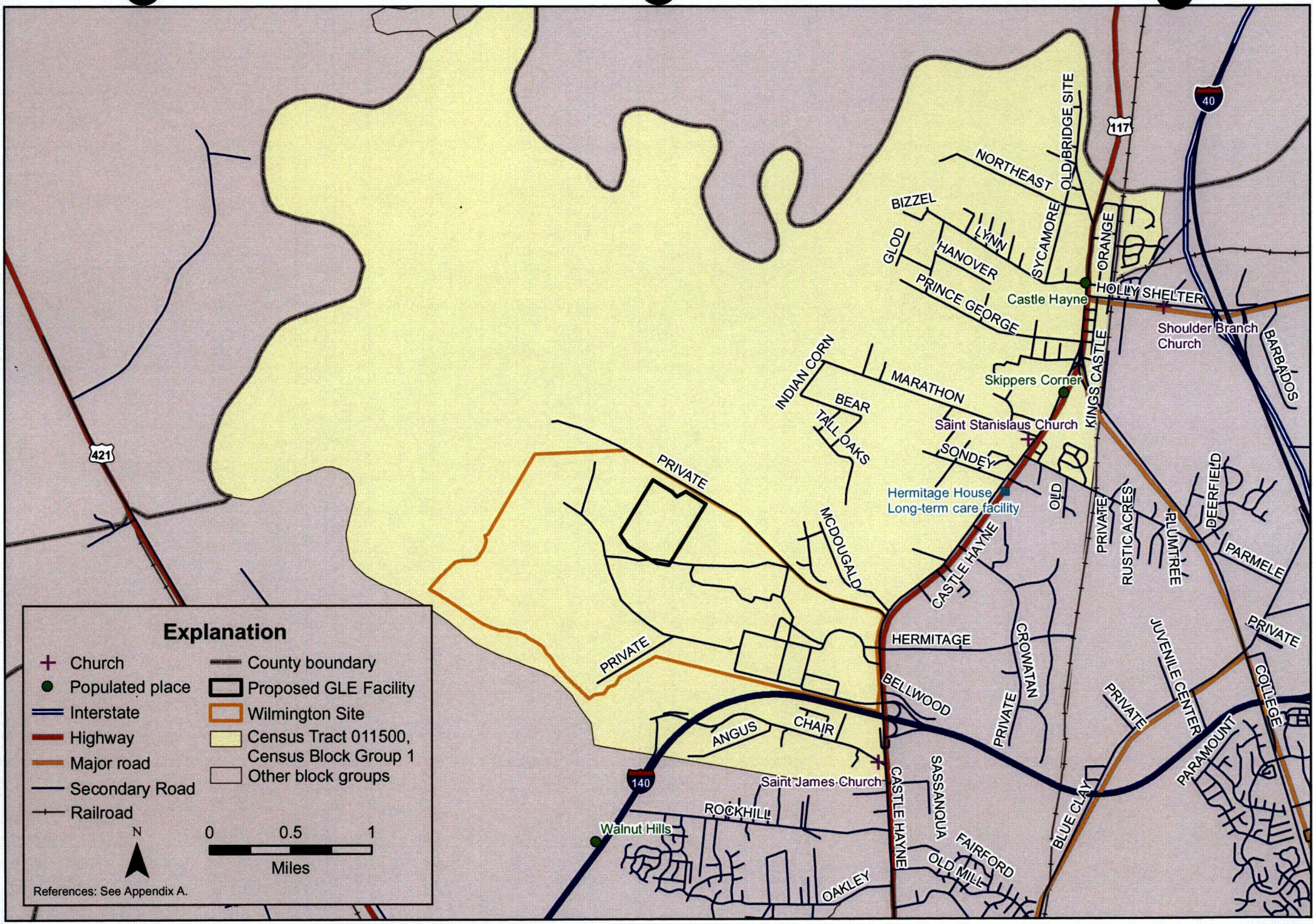

Figure 3.10-5. Map of Census Tract 011500, Census Block Group 1.

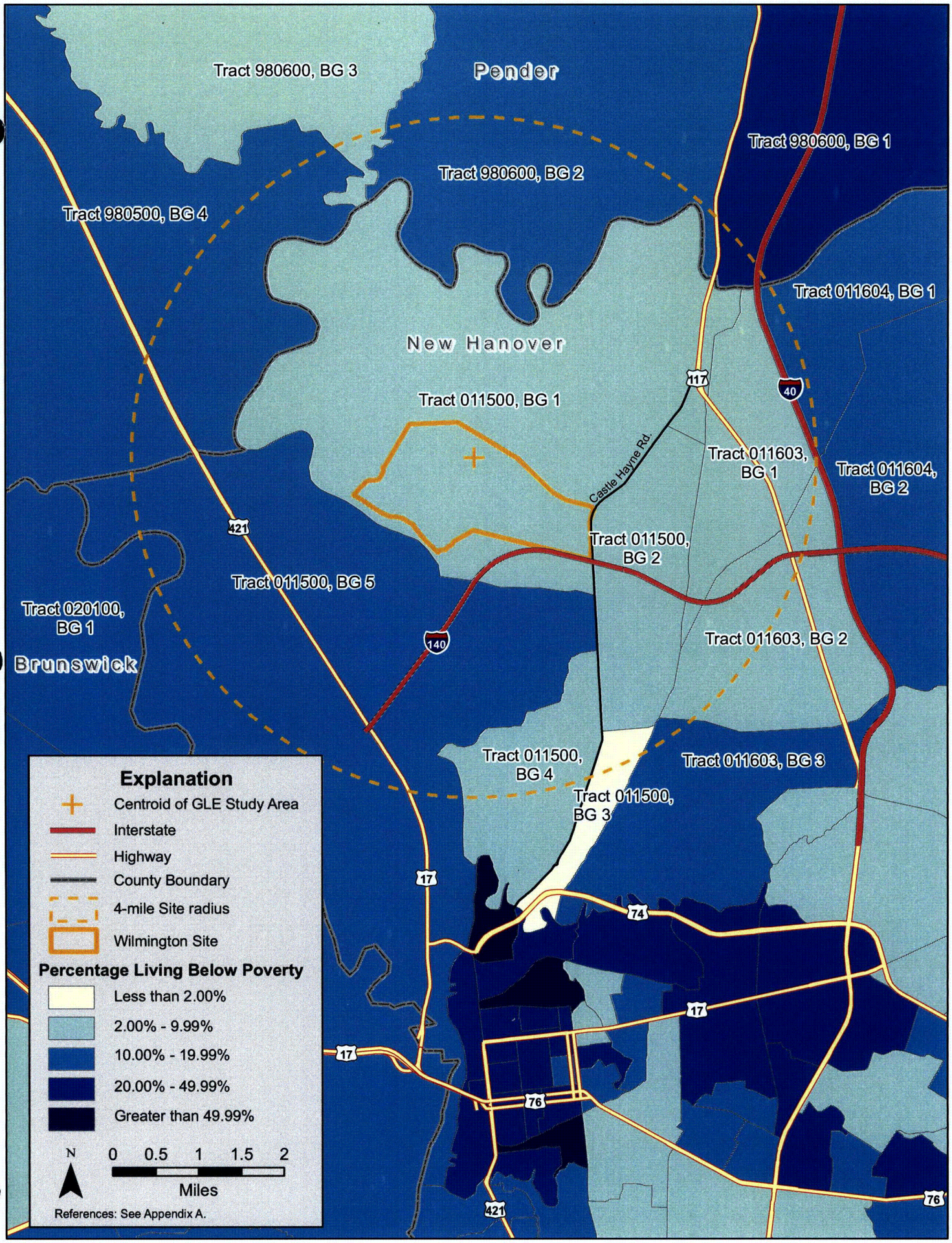

Figure 3.10-6. Population with income below poverty in counties within 4 miles (6.4 km) of the Wilmington Site by census block group.

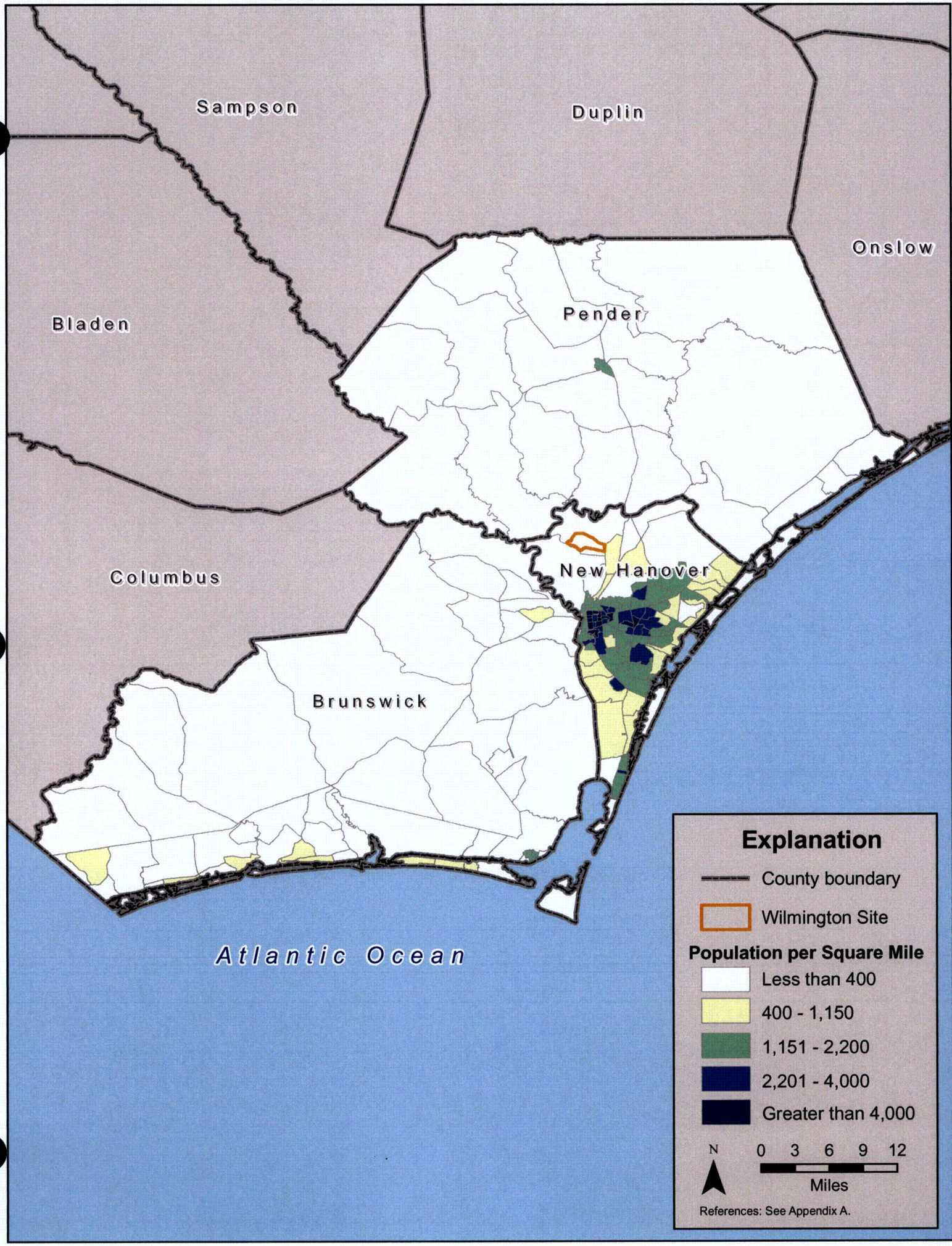

Figure 3.10-7. Population density by census block group within the three-county study area.

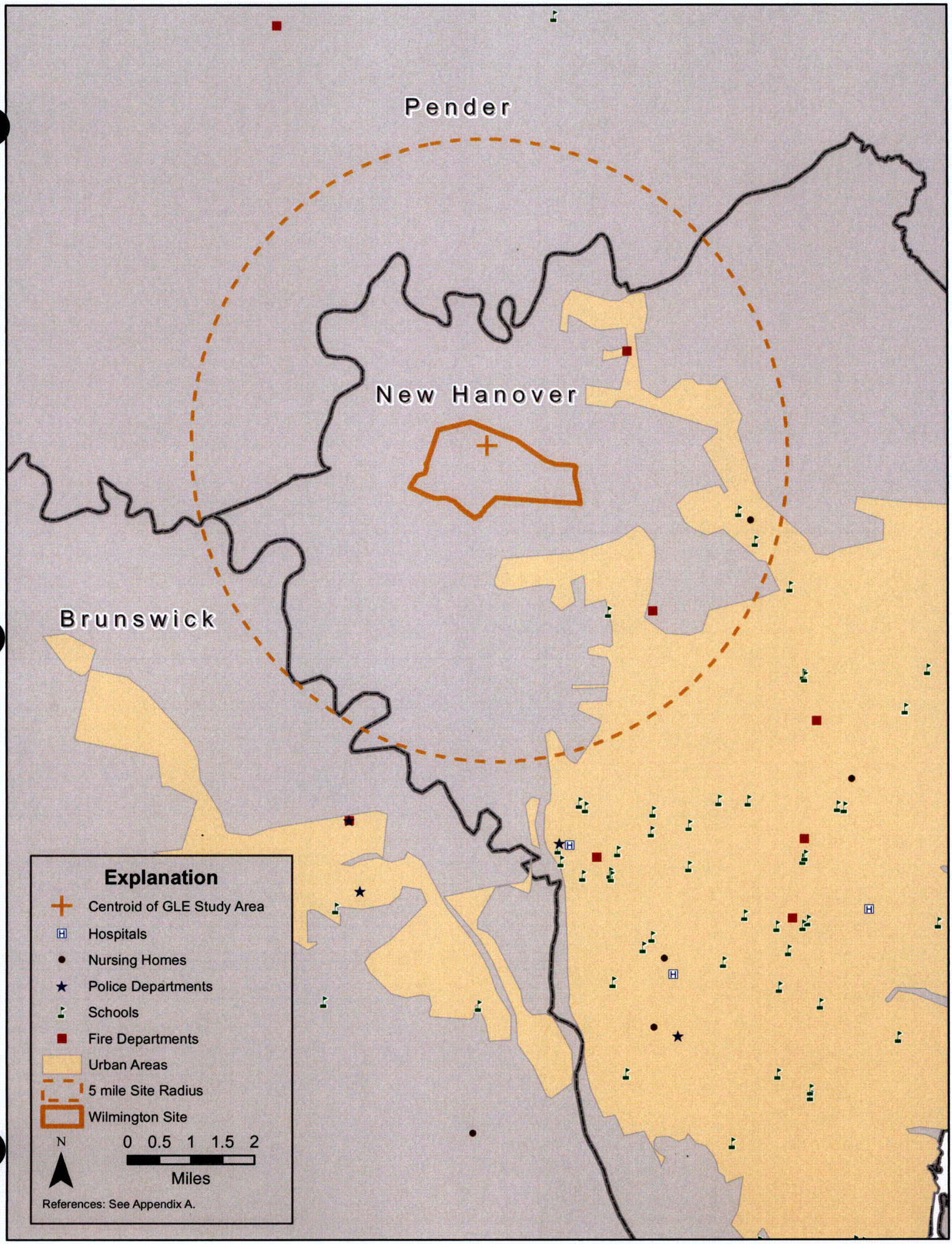

Figure 3.10-8. Community characteristics of the three-county study area.

GLE Environmental Report

Section 3.11 – Public and Occupational Health

Revision 0

December 2008

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3.11 Public and Occupational Health

There are two potential exposure hazards at the Wilmington Site that are described in this section: radiation and hydrogen fluoride (HF). Existing sources of radiation at the Site include natural background radiation sources and the man-made sources associated with the existing GNF-A nuclear FMO facility. The most significant potential non-radiological exposure hazard at the Site is HF; all other chemicals currently used at the FMO facility are used only in laboratory or cleaning agent quantities.

3.11.1 Major Sources and Levels of Background Radiation Exposure

Background radiation is defined by the NRC to be the following:

> "Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. It does not include radiation from source, by-product, or special nuclear materials regulated by the Nuclear Regulatory Commission. The typically quoted average individual exposure from background radiation is 360 millirem (mrem) per year" (NRC, 2007).

Natural radiation sources are either primordial or cosmogenic. Primordial radionuclides are left over from when the earth and the universe were formed. They have long half-lives on the order of hundreds of millions of years and include the progeny or decay products of the long-lived radionuclides. Some common primordial radionuclides include uranium-235 (^{235}U), uranium-238 (^{238}U), thorium-232 (^{232}Th), radium-226 (^{226}Ra), radon-222 (^{222}Rn), and potassium-40 (^{40}K). Alpha, beta, and gamma radiation is emitted from these radionuclides, which eventually decay to a stable nuclide. Naturally occurring radioactivity in soil or rock is primordial in origin, varies with location, and constitutes a significant component of natural background radiation exposure to the public. In particular, radon, a gas from the earth's crust, is responsible for much of the public's exposure to natural radiation. Of an individual's approximate average annual radiation exposure of 300 millirems (mrem) (3 millisieverts [mSv]) from natural sources, radon gas accounts for 200 mrem (2 mSv; NRC, 2004), whereas terrestrial radiation (rocks and soil) accounts for an average annual dose of 28 mrem (0.28 mSv) (Idaho State University, 2007).[1]

Cosmogenic radiation permeates all of space and primarily originates from outside the earth's solar system. From high-speed heavy particles to high-energy photons and muons, cosmic radiation interacts mainly in the upper atmosphere, producing radioactive nuclides, usually with shorter half-lives than the primordial nuclides. The average annual dose attributable to cosmogenic sources is 28 mrem (0.28 mSv) (Idaho State University, 2007).

Additional background radiation exposure for the public from man-made sources includes exposure from medical x-rays, nuclear medicine, and some consumer products. Diagnostic medical procedures account for about 40 mrem (0.4 mSv) each year. Some consumer products such as tobacco, fertilizer, welding rods, gas mantles, luminous watch dials, and smoke detectors contribute another 10 mrem (0.1 mSv) to the public's annual radiation exposure. Natural background radiation contributes about 82% (~300 mrem [~3 mSv]) of the average annual dose received, whereas medical procedures contribute most of the remaining 18% (~60 mrem [~0.6 mSv]) for a total annual average radiation exposure of 360 mrem (3.6 mSv) (NRC, 2004).

[1] As noted in **Section 3.3.1.6** (and shown in **Figure 3.3-14**), the Mid-Atlantic Coastal Plain physiographic province counties are in a Low Potential zone for the presence of radon gas relative to other areas of North Carolina.

3.11.2 Current Sources and Levels of Exposure to Radioactive Materials

A radiation monitoring program has been established for the existing FMO facility at the Wilmington Site. The primary pathway for potential impacts on the general public is via radioactive gaseous emissions to the atmosphere through vent stacks associated with the FMO facility located on the southern portion of the Eastern Site Sector (see **Figure 1-2**). These vent stacks are sampled continuously to assess the uranium concentration in the vent-exhaust gas stream. The collection filter in the stack-sampling system is removed on either a daily or weekly schedule and analyzed for gross alpha activity concentration. Stacks that are sampled daily, as opposed to those that are sampled weekly, are selected on the basis of their past contribution to the total emission levels (i.e., stacks with historically higher concentrations are sampled daily instead of weekly).

Emissions monitoring data presented in **Table 3.11-1** for the years 1995 through 2005 show that the total gross alpha activity released from the FMO facility vent stacks ranged from approximately 15 to 197 microcuries (μCi) per year. For reference purposes, 40 CFR 190 (*Environmental Radiation Protection Requirements for Normal Operations of Activities in the Uranium Fuel Cycle, Final Environmental Statement, Volume 1*) requires written reporting if the gaseous emissions exceed 1,250 μCi per quarter (5,000 μCi per year). Gaseous emissions peaked at 197 μCi in 1997, which was the year that the FMO facility switched from a wet process of converting uranium hexafluoride (UF_6) to uranium dioxide (UO_2) to a Dry Conversion Process (DCP). The gaseous emissions data show a decreasing trend in total gross alpha activity since that year. In the most-recent data available, the gaseous emissions were 22 μCi in 2005, or 0.5% of the reporting threshold value. Between 1995 and 2005, the average gross alpha concentrations have varied from 0.004×10^{-12} to 0.057×10^{-12} μCi/cc. A conservative dilution factor of 100 at the Site boundary decreases the values to well below the most conservative regulatory limit (10 CFR 20, Appendix B, *Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage*) of 5×10^{-14} μCi/cc for uranium 234 (^{234}U) (Class Y) (GNF-A, 2007a).

Ambient air radiation levels are monitored by the North Carolina Division of Radiation Protection (NCRP). Results of the ambient air samples taken at four sampling locations are presented in **Tables 3.11-2 through 3.11-5**. These sampling locations are shown relative to the FMO facility on **Figure 3.11-1**. Annual averages and maximum values are shown on these tables for each year for gross alpha and isotopic concentrations. Less than values (e.g., <0.02 μCi/cc) were treated as a real number (e.g., 0.02 μCi/cc) for averaging purposes, which tended to bias the average in a conservative (high) direction. Operations at the GNF-A FMO facility do not influence ambient air concentrations. Natural background levels of gross alpha particulate activity measured at the GE Dock (i.e., GEDK) on the Northeast Cape Fear River located 1 mile (1.6 km) west of the FMO facility (location AADK) and the activities measured in the vicinity of the FMO building were similar, typically ranging between 2 and 3.5×10^{-15} μCi/cc from 1995 to 1999 (GNF-A, 2007a).

Available NCRP radiological analyses of vegetation samples collected from locations approximately 2 miles (3.2 km) northeast and 0.5 miles (0.8 km) south of the Wilmington Site (**Figure 3.11-2**) show very low gross alpha activity concentrations, thus indicating no radiological impact from Site operations (GNF-A, 2007a). Based on these data, no future radiological impact from the FMO facility to cropland and agricultural areas in the vicinity of the Site would be expected.

Soil samples have been collected to measure uranium concentrations on the Wilmington Site, as well as in the vicinity of the Site, as shown by the current (2005) soil-sampling locations indicated in **Figure 3.11-3** (GNF-A, 2007a). Average uranium concentrations for these current on-site and off-site locations and previous sampling locations are summarized in **Tables 3.11-6 and 3.11-7**, respectively. Data for uranium concentrations in soil at off-site locations for the years 1995 through 2005 are consistent with data from

prior years (e.g., 1989 through 1995, as provided by GE, 1997) and represent background levels. During re-licensing of the FMO facility in 1996, the total number of sampling locations was reduced because of consistent non-detectable levels. Samples from location ID No. 1A are from the sediment in the stormwater channel draining the controlled-access FMO facility area. Sample-site locations ID No. 20 and ID No. 21 were in the waste box storage pad areas (GNF-A, 2007a).

As discussed in **Section 3.4.1.2.2**, *Castle Hayne Aquifer (Regional Aquifers and Confining Layers)*, and **Section 3.4.2.2.2.1**, *Radiological Monitoring (GEH Monitoring Data)*, there are no public gross alpha exposure issues of concern related to groundwater and surface water quality, respectively. Similarly, there are no occupational gross alpha exposure issues of concern related to the Wilmington Site's potable groundwater supply (see **Section 3.4.1.2.2**, *Wilmington Site Groundwater Impacts*).

3.11.3 Major Sources and Levels of Chemical Exposure

The FMO facility at the Wilmington Site currently (since 1997) uses a DCP to convert UF_6 to UO_2. This conversion process offers an environmental advantage over the ammonium diuranate (ADU) process due to the elimination of liquid waste other than a small stream of dilute HF (typically 1%–2%), which can be neutralized through the Site's NPDES–permitted waste treatment operations. A by-product of the process is HF gas. Continuous fluoride monitoring is conducted on the vent stacks for the FMO facility DCP, uranium-recycle process, laboratory, and waste incinerator to measure fluoride releases to the atmosphere. The collection filter used in the stack-sampling system is a Whatman 41 filter impregnated with calcium carbonate or equivalent. The filter is removed either daily or weekly and analyzed for fluoride content. The quantity of fluoride released from the stack is calculated using the analytical results and total daily or weekly exhaust gas volume and the associated stack sampler volume (in ratio). Total annual fluoride emissions from the FMO facility for the years from 1995 through 2005 are summarized in **Table 3.11-8**. The total annual fluoride emissions values range from 1,383 grams (approximately 3 pounds) in the year 2002 to 3,296 grams (approximately 7.3 pounds) in the year 1999. Total annual fluoride emissions in the year 2005 were 1,505 grams (approximately 3.3 pounds) (GNF-A, 2007a). Under the current air quality permit issued by the NC DAQ to GNF-A for operation of air emission sources associated with the FMO facility (Permit No. 1161R19), total HF emissions from the DCP are limited to no greater than 0.63 lb per day (i.e., 24-hour period) and no greater than 0.064 lb in any one hour during the day (see **Table 3.6-23** in **Section 3.6.3.5**, *Wilmington Site Existing Air Emission Sources and Controls*). Monitoring data records demonstrate that the facility is in compliance with the air quality permit levels.

Several other TAPs are emitted from existing stationary sources at the Wilmington Site. These TAPs are discussed in **Section 3.6.3.5**, *Wilmington Site Existing Air Emission Sources and Controls*.

3.11.4 Historical Exposure to Radioactive Materials

3.11.4.1 Public Exposure

As discussed further below, to minimize the possibility of accidental releases of radioactive and chemical gaseous materials to the atmosphere, the licensed material processing portion of the FMO facility is maintained under a negative pressure with respect to the outside environment. For the potentially exposed public, direct inhalation of routine, low-level airborne releases is the most-likely intake pathway. Using the nearest population center 2 miles (3.4 km) south of the Site and 2005 air stack releases, an individual dose of 8.5×10^{-4} mrem was calculated using EPA's COMPLY code (GNF-A, 2007a), and releases were conservatively assumed to be ^{234}U (Class Y). Applying the individual dose to the entire 200,000 persons living in the area modeled, 0.17 person-rems was estimated for the surrounding population in the vicinity of the Site, which is several orders of magnitude lower than the annual average 60,000 person-rems received by this population due to natural background radiation. The annual natural background radiation

dose for the region of the Site is typical of that received from natural background radiation elsewhere in the United States (GNF-A, 2007a).

Using EPA's COMPLY code, annual radiation doses (1995–2005) to the nearest resident are shown in **Table 3.11-9**. The nearest known resident (current as of 2006) is located between 426 and 1260 ft (130 to 384 m) south of the FMO facility release points (i.e., stacks). Annual doses for the 1995–2005 period ranged from 0.03 mrem to 0.4 mrem. The NRC off-site individual exposure limit (10 CFR 20.1301, *Dose limits for individual members of the public*) is 100 mrem (1 mSv) per year. The dose has been decreasing over time, which coincides with GE's installation in 1997 of the DCP that eventually replaced the ADU process. In 2005, the dose to the nearest resident was 0.03% of the NRC limit (GNF-A, 2007a).

Direct irradiation of the public from the GNF-A FMO facility is not significant because gamma radiation exposure levels measured at the Site boundary are at background levels. Gross alpha ambient airborne concentrations measured at the southern fenceline are typically on the order of $4x10^{-15}$ µCi/cc (see **Table 3.11-4**). The air submersion dose for this concentration of mixtures of uranium isotopes is insignificant (GNF-A, 2007a).

3.11.4.2 Occupational Exposure

Worker health and safety at the Wilmington Site is protected as a result of the Industrial Safety Program and a Nuclear Safety Program administered by GNF-A. These programs comply with applicable state, NRC (10 CFR 20), and OSHA (29 CFR 1910, *Occupational Safety and Health Standards*) requirements.

The manager for Industrial Hygiene and Safety (IHS) is responsible for implementing the Industrial Safety Program. This individual's responsibilities include exposure assessment and monitoring, communication, training, program assessment, and recordkeeping. Any new projects that are initiated on the Wilmington Site, including the operations at the Proposed GLE Facility, have to be approved by the IHS manager to ensure that appropriate industrial safety measures are implemented. All work environments that present the potential for exposure to chemical, biological, or physical agents (e.g., radiation, noise, heat/cold, vibration) are evaluated, and appropriate safety controls are implemented and/or equipment is assigned to workers. Shop-wide assessments are conducted every 2 years. Processes are also assessed upon installation of new equipment or introduction of a new chemical. Continuing efforts are made to further reduce or eliminate the hazards associated with the use of chemical and physical agents. The Industrial Safety Program is evaluated on an annual basis (GNF-A, 2007b).

The Nuclear Safety Function at the Wilmington Site is responsible for implementing the Nuclear Safety Program and maintaining criticality and radiological safety for all aspects of the nuclear fuel processes. This includes the receipt, conversion, fabrication, storage, and shipment of radioactive material. The Radiation Protection group within the Nuclear Safety Function provides support to operations, manages nuclear instrumentation, inventories radioactive material, and monitors State and federal radiation programs to ensure that worker dose is maintained As Low As Reasonably Achievable (ALARA). Exposure monitoring is conducted on radiation workers to evaluate the potential for personal exposure; if personal monitoring is not feasible for some reason, area monitoring in the work area may be used as representative of personal exposure. Time-weighted average and peak exposure doses are determined. Exposure monitoring records are maintained for a minimum of 30 years.

Operations are conducted under procedures that are written, reviewed, and verified by appropriate individuals in the Nuclear Safety Function to ensure worker dose at the Wilmington Site is ALARA. Any operational changes are reviewed to ensure that safe conditions are maintained. Radiation Work Permits (RWPs) are required for non-routine activities, particularly those performed by non-GNF-A employees, which generally are not covered by documented procedures. RWPs are issued by a radiation safety technician or supervisor for non-routine operations not addressed by an operating procedure when special

radiation-control requirements are necessary. The RWP specifies the necessary radiation safety controls, as appropriate, including personnel monitoring devices, protective clothing, and measures to be taken. RWPs are reviewed by a radiation safety supervisor. The RWP requirements are reviewed by each affected individual, and a copy of the RWP is made available to the affected workers throughout the duration of the activity. Work is monitored by the radiation safety technician or supervisor as required. RWPs have expiration dates, and the status of issued RWPs is reviewed on a weekly basis by a radiation safety technician or supervisor (GNF-A, 2007c).

Personal protective equipment (PPE) requirements are based on the nature of the work and chemical and/or radiological hazards present. PPE and personal safety systems are inspected and tested periodically and include the following:

- Protective clothing (e.g., anti-contamination clothing, gloves, shoe covers, hats, steel-toe shoes, hard hat, safety glasses, respirators)
- Self-contained breathing air supply and respirators (i.e., air purifying and air supplying)
- Safety showers and eyewash stations
- Stationary air samplers at work locations throughout the uranium-processing areas (samplers are read each shift)
- Bioassay monitoring program for workers working in radiological areas
- Time-in-area recording for each worker working in each radiological area
- Availability of first aid kits, on-location assistance for all shifts by emergency medical treatment team, on-site medical clinic for first-aid treatment, and special chemical exposure kits
- Health and hygiene programs, including periodic workplace monitoring for occupational exposure levels (GNF-A, 2007b).

Standard operating procedures (SOPs) used in the FMO facility specify confinement of uranium to process equipment, containers, or ventilated enclosures. Hoods and other localized ventilation designs are utilized to minimize personnel exposure to airborne uranium. Uranium-processing equipment is physically isolated in ventilated rooms. A defined controlled area provides physical isolation of uranium processing areas via access control, change rooms, and ventilation. The Radiation Protection group determines the appropriate PPE requirements for routine and non-routine tasks involving radiological hazards. Operators wear appropriate PPE when working in a radiological area, including anti-contamination clothing, gloves, shoe covers, and hats. Operators are required to wear respirators when cleaning up a spill of uranium or when opening a hood, enclosure, or primary containment. If a large uranium spill occurs, procedures direct operators to isolate the spill area, evacuate the area, and contact the Radiological Protection group. If a small uranium spill occurs, procedures direct operators to clean up the spill immediately.

The Radiation Protection group performs contamination surveys (swipes) of work areas each week. Workers are required to self-monitor for contamination before exiting a radiological area. The Radiation Protection group performs a random contamination survey of workers exiting radiological areas. Operations involving radiological material likely to create airborne contamination are conducted inside a glove box or enclosure that provides containment. Airflow face velocity at all openings on glove boxes and enclosures is periodically measured to ensure adequate air flow. Building ventilation maintains all areas in which uranium is handled or processed at a negative pressure to prevent releases outside of the building. Direction of air flow between areas is checked monthly or after significant changes to the ventilation system. Periodically scheduled audits of processing areas are performed, and stationary air

samplers are located at processing stations and are monitored each shift. Stacks are continuously sampled (GNF-A, 2007b, 2007c).

Equipment maintenance includes periodic walkthroughs by personnel inspecting for leaks or other abnormalities and checking local instrumentation. Preventive-maintenance systems include documented routine inspections, calibrations, and periodic maintenance program; lubrication schedule; and records of equipment failures (GNF-A, 2007b, 2007c).

Because process spills or spills during container transport are unlikely and most equipment is contained in hoods, exposure among workers inside the building due to airborne UO_2 and triuranium octaoxide (U_3O_8) powder (Class-Y compounds) has been well below regulatory limits. Powder is stored in unicone, bicone, and hybrid containers, as well as Favorable Geometry Hybrid Containers (FGHC). Powder containers are closed when not in process, and the integrity of these containers has been certified and tested. Process rooms are enclosed in concrete walls with negative air pressure. Air exits the room through air exhausts into high-efficiency particulate air (HEPA) filters. The FMO building design and negative air pressure are barriers for powder containment (GNF-A, 2007b, 2007c).

The fire protection installation and testing at the FMO facility complies with NFPA Standards, North Carolina State Building Code system, and Factory Mutual requirements. Sprinkler protection in moderator-restricted areas is prohibited because the presence of water is contrary to nuclear criticality moderation-control requirements. Fire alarm initiating devices and signaling devices are controlled and monitored through the FMO facility's fire alarm system, which will signal at the local annunciator on the DCP control room panel and simultaneously alarm at the Emergency Control Center in the event of fire (GNF-A, 2007b, 2007c).

3.11.5 Occupational Injury Rates

The occupational injury rate at the Proposed GLE Facility is expected to be similar to that at the GNF-A facility. Recordable accidents, recordable injury and illness rates, lost-time accidents, and number of first aids for the GNF-A facility are summarized in **Table 3.11-10**. In 2006, 40% of first-aid injuries were to the hands, 20% were to the arms, and the rest were miscellaneous. The recordable injury and illness rate (1.01) at the GNF-A facility in 2006 was lower than the U.S. average (5.0). The recordable accidents in 2006 consisted of a finger fracture, finger laceration, cut to a hand, hand laceration, head gash, torn rotator cuff, abdominal strain, lower back strain, and ankle fracture. No fatalities have occurred in the nuclear facilities on the Wilmington Site.

For chemical exposures from 2000 to 2006, most were minor allergic reactions that resulted in skin irritations from unspecified chemicals. There were several acid burns and a few cases of chemical burns from caustics. All of the chemical exposures were treated with minor first aid. None required hospitalization.

3.11.6 Summary of Health Effects

3.11.6.1 Health Effects from Radiological Source Exposures

Uranium may cause health effects in humans due to its chemical toxicity or its radioactive properties, and ingesting large amounts of uranium may damage the kidneys (ATSDR, 1999). Because the body has repair mechanisms against damage from radiation and chemical carcinogens, the biological effects of radiation on living cells may result in three outcomes: 1) injured or damaged cells repair themselves, resulting in no residual damage; 2) cells die, but are replaced through normal biological processes; or 3) cells incorrectly repair themselves, resulting in a biophysical change (NRC, 2004).

Studies of the association between radiation exposure and cancer development are mostly based on populations exposed to high levels of ionizing radiation, such as survivors of the atomic bombs dropped on Japan and recipients of selected diagnostic or therapeutic medical procedures. Cancers associated with high-dose exposure (>50,000 mrem [500 mSv]) include leukemia, breast, bladder, colon, liver, lung, esophagus, ovarian, multiple myeloma, and stomach cancers. There may also be an association between ionizing radiation exposure and cancers of the prostate, nasal cavity/sinuses, pharynx and larynx, and pancreas (NRC, 2004).

The time between radiation exposure and detection of cancer is known as the latent period and can be many years. Cancers that are the result of radiation exposure are indistinguishable from those that occur naturally or a result of chemical exposures. The National Cancer Institute suggests that other chemical and physical hazards and lifestyle factors significantly contribute to many of the same diseases. Although radiation may cause cancers at high doses, there are currently no data to unequivocally establish the occurrence of cancer following exposure to low doses and dose rates, i.e., below about 10,000 mrem (100 mSv) (NRC, 2004). Populations in areas having high background levels, above 1,000 mrem (10 mSv) per year, such as Denver, have shown no adverse biological effects (NRC, 2004).

Radiation exposure limits for the general public have been established by the NRC in 10 CFR 20 and by EPA in 40 CFR 190. These limits are based on health-effects data from animal and human epidemiological studies. Exposure limits for the general public and occupational exposures are summarized in **Table 3.11-11**. The NRC limits annual exposure on a total-dose-equivalent exposure (100 mrem or 1 mSv), which includes external plus internal radiation exposures and a dose-equivalent rate (2 mrem or 0.02 mSv) in any 1-hour period in unrestricted areas accessible by members of the public who are not employees, but who may be present during the year at an enrichment facility (10 CFR 20). The annual whole body (25 mrem or 0.25 mSv), organ (25 mrem or 0.25 mSv), and thyroid (75 mrem or 0.75 mSv) dose-equivalent limits established by EPA (40 CFR 190) apply to the general public who are at off-site locations at or beyond a plant's site boundary. Public exposure at off-site locations due to routine operations at GNF-A comply with the more restrictive EPA limits.

The NRC standards also limit occupational radiation exposures to a total effective dose equivalent (TEDE) of 50 mSv (5 rem), which includes external and internal exposure (10 CFR 20). The NRC standards also restrict the dose equivalent to the lens of the eye (0.15 Sv [15 rem]), skin (0.5 Sv [50 rem]), and extremities (0.5 Sv [50 rem]), and the committed dose equivalent (CDE) to any internal organ (0.5 Sv [50 rem]) (10 CFR 20).

3.11.6.2 Health Effects from Chemical Source Exposures

The most significant potential nonradiological exposure hazard at the Wilmington Site is HF. Uranium hexafluoride readily reacts with air, moisture, and other compounds to produce HF. Compounds including uranyl fluoride (UO_2F_2) and small amounts of uranium tetrafluoride (UF_4) may also be produced (ATSDR, 1999). HF is a colorless, highly corrosive gas or liquid with a sharp, penetrating odor. HF can cause severe eye and respiratory irritation, necrosis, and edema, and ingestion of HF can result in vomiting, diarrhea, and circulatory collapse. Tissue burns and destruction can occur with contact to HF, and in large doses, HF's effects on the heart and lungs can result in death (ATSDR, 2003).

EPA and OSHA have established exposure limits for HF. Recommendations regarding exposure to HF have also been established by the Agency for Toxic Substances and Disease Registry and the National Institute for Occupational Safety and Health. The American Conference of Governmental Industrial Hygienist also recommend exposure levels for HF. **Table 3.11-12** summarizes EPA and OSHA standards, as well as other federal and state exposure guidelines.

Other chemicals currently used at the FMO facility are used only in laboratory or cleaning agent quantities.

Tables

Table 3.11-1. Radioactive Gaseous Emissions Monitoring Data[a]

Year	No. of Vent Stacks	Total Air Volume Vented per Year (10^{15} cc/yr)	Total Gross Alpha Activity (μCi)	Average Gross Alpha Concentration at Emission Points (x 10^{-12} μCi/cc)
1995	30	2.38	115.5	0.049
1996	30	3.07	114.1	0.037
1997	32	3.43	197.0	0.057
1998	29	3.59	126.2	0.035
1999	27	3.56	43.0	0.012
2000	26	3.50	32.8	0.009
2001	26	3.54	23.2	0.007
2002	26	3.58	18.0	0.005
2003	26	3.53	16.3	0.005
2004	26	3.46	14.9	0.004
2005	26	3.24	22.2[b]	0.007

Reference: GNF-A, 2007a.

[a] Summary for the years 1995–2005 from FMO vent stacks, Wilmington Site.

[b] HEPA filters were changed in 2005, resulting in slight increase in stack emissions.

Table 3.11-2. Airborne Gross Alpha and Isotopic Concentrations: Northeast[a]

Year	Total Annual Site Uranium Emissions (grams/year)	Gross Alpha ($\times 10^{-15}$ µCi/cc)		U-234 ($\times 10^{-15}$ µCi/cc)		U-235 ($\times 10^{-15}$ µCi/cc)		U-238 ($\times 10^{-15}$ µCi/cc)	
		Ave	Max	Ave	Max	Ave	Max	Ave	Max
1995	21	2.16	5.50	<0.02	0.08	<0.01	<0.02	<0.01	<0.02
1996	167	<2.67	5.60	<0.03	<0.07	<0.02	<0.04	<0.02	<0.04
1997	290	<2.32	16.00	<0.09	0.22	<0.01	<0.03	<0.03	0.06
1998	189	2.52	4.80	<0.01	0.03	<0.01	<0.02	<0.01	<0.03
1999	62	3.46	9.10	<0.03	<0.07	<0.02	<0.05	<0.02	<0.06
2000	48	3.39	8.60	<0.04	0.09	<0.01	<0.02	<0.01	<0.02
2001	33	<2.64	6.70	<0.03	0.22	<0.01	0.06	<0.02	0.09
2002	26	3.55	7.94	<0.03	0.06	<0.01	<0.02	<0.02	0.04
2003	23	2.94	10.30	<0.02	0.04	<0.01	<0.01	<0.02	<0.03
2004	21	3.81	11.10	<0.05	0.25	<0.01	<0.07	<0.03	<0.20
2005	32	4.08	13.80	<0.03	0.06	<0.01	<0.02	<0.02	0.04

Reference: GNF-A, 2007a.

Note: The minimum detection concentration (MDC) varies based on instrument calibration. The notation of "<" in the maximum column indicates that the sample was at or below the MDC. The notation of "<" in the average column indicates that at least one data point used to calculate the average by GE-Hitachi Nuclear Energy (GEH) was at or below the MDC.

[a] Ambient Air Northeast (AANE) monitoring location, northeast of FMO near sanitary lift station, Wilmington Site (see **Figure 3.11-1**).

Table 3.11-3. Airborne Gross Alpha and Isotopic Concentrations: Southeast[a]

Year	Total Annual Site Uranium Emissions (grams/year)	Gross Alpha ($\times 10^{-15}$ µCi/cc)		U-234 ($\times 10^{-15}$ µCi/cc)		U-235 ($\times 10^{-15}$ µCi/cc)		U-238 ($\times 10^{-15}$ µCi/cc)	
		Ave	Max	Ave	Max	Ave	Max	Ave	Max
1995	21	2.27	5.30	<0.05	0.37	<0.01	<0.02	<0.01	0.05
1996	167	2.96	5.80	<0.04	0.06	<0.02	<0.03	<0.02	<0.04
1997	290	2.92	5.90	<0.05	0.13	<0.01	<0.03	<0.02	0.04
1998	189	<2.61	5.00	<0.02	0.04	<0.01	<0.02	<0.01	<0.02
1999	62	3.51	8.70	<0.03	0.04	<0.02	<0.04	<0.02	<0.04
2000	48	3.85	9.10	<0.09	0.27	<0.02	0.05	<0.02	0.03
2001	33	<2.93	7.50	<0.04	0.25	<0.02	0.11	<0.02	0.04
2002	26	<3.52	6.20	<0.03	0.08	<0.01	<0.02	<0.03	0.08
2003	23	3.19	7.54	<0.03	0.05	<0.01	<0.02	<0.02	<0.04
2004	21	4.24	12.80	<0.02	0.05	<0.01	<0.01	<0.02	<0.04
2005	32	4.19	13.00	<0.02	0.03	<0.01	<0.02	<0.02	0.03

Reference: GNF-A, 2007a.

Note: The minimum detection concentration (MDC) varies based on instrument calibration. The notation of "<" in the maximum column indicates that the sample was at or below the MDC. The notation of "<" in the average column indicates that at least one data point used to calculate the average by GE-Hitachi Nuclear Energy (GEH) was at or below the MDC.

[a] Ambient Air Southeast (AASE) monitoring location, southeast of FMO, Wilmington Site (see **Figure 3.11-1**).

Table 3.11-4. Airborne Gross Alpha and Isotopic Concentrations: South[a]

Year	Total Annual Site Uranium Emissions (grams/year)	Gross Alpha ($\times 10^{-15}$ µCi/cc)		U-234 ($\times 10^{-15}$ µCi/cc)		U-235 ($\times 10^{-15}$ µCi/cc)		U-238 ($\times 10^{-15}$ µCi/cc)	
		Ave	Max	Ave	Max	Ave	Max	Ave	Max
1995	21	2.31	5.80	<0.04	0.10	<0.01	<0.02	<0.01	0.03
1996	167	<2.88	6.30	<0.05	0.11	<0.02	<0.10	<0.02	<0.07
1997	290	<3.03	6.10	<0.09	0.24	<0.01	<0.04	<0.03	0.08
1998	189	2.65	5.10	<0.02	<0.04	<0.01	<0.02	<0.01	<0.03
1999	62	3.55	8.30	<0.02	0.05	<0.01	<0.03	<0.02	<0.03
2000	48	<3.65	11.00	<0.08	0.36	<0.02	0.13	<0.02	0.10
2001	33	2.65	6.10	<0.04	0.25	<0.02	0.13	<0.01	0.06
2002	26	<3.55	6.77	<0.02	0.05	<0.00	<0.01	<0.02	0.04
2003	23	<3.11	6.26	<0.03	0.11	<0.01	<0.02	<0.02	<0.03
2004	21	<3.96	9.07	<0.06	<0.43	<0.02	<0.13	<0.04	<0.33
2005	32	4.13	10.50	<0.03	0.05	<0.00	<0.01	<0.01	0.02

Reference: GNF-A, 2007a.

Note: The minimum detection concentration (MDC) varies based on instrument calibration. The notation of "<" in the maximum column indicates that the sample was at or below the MDC. The notation of "<" in the average column indicates that at least one data point used to calculate the average by GE-Hitachi Nuclear Energy (GEH) was at or below the MDC.

[a] Ambient Air South (AASS) monitoring location, south of FMO, Wilmington Site (see **Figure 3.11-1**).

Table 3.11-5. Airborne Gross Alpha and Isotopic Concentrations: Southwest[a]

Year	Total Annual Site Uranium Emissions (grams/year)	Gross Alpha ($\times 10^{-15}$ µCi/cc)		U-234 ($\times 10^{-15}$ µCi/cc)		U-235 ($\times 10^{-15}$ µCi/cc)		U-238 ($\times 10^{-15}$ µCi/cc)	
		Ave	Max	Ave	Max	Ave	Max	Ave	Max
1995	21	2.24	4.00	0.05	0.08	<0.01	<0.02	<0.01	0.02
1996	167	2.57	4.60	<0.04	0.08	<0.02	<0.03	<0.02	<0.04
1997	290	<2.90	6.03	0.09	0.26	<0.01	<0.02	<0.03	0.09
1998	189	2.65	5.20	<0.02	<0.08	<0.01	<0.04	<0.02	<0.07
1999	62	3.48	9.80	<0.03	0.12	<0.01	<0.02	<0.02	<0.04
2000	48	3.79	9.80	<0.04	0.14	<0.01	0.04	<0.01	0.02
2001	33	<2.71	7.30	<0.02	0.05	<0.01	<0.01	<0.01	0.03
2002	26	<3.38	6.23	<0.03	0.07	<0.01	<0.02	<0.02	0.06
2003	23	3.08	6.00	<0.02	0.06	<0.01	<0.03	<0.02	<0.03
2004	21	3.87	13.30	<0.03	<0.06	<0.01	<0.01	<0.02	<0.04
2005	32	4.46	12.20	<0.02	0.05	<0.01	<0.02	<0.01	0.02

Reference: GNF-A, 2007a.

Note: The minimum detection concentration (MDC) varies based on instrument calibration. The notation of "<" in the maximum column indicates that the sample was at or below the MDC. The notation of "<" in the average column indicates that at least one data point used to calculate the average by GE-Hitachi Nuclear Energy (GEH) was at or below the MDC.

[a] Ambient Air Southwest (AASW) monitoring location, southwest of FMO, Wilmington Site (see **Figure 3.11-1**).

Table 3.11-6. Average Soil Uranium Concentrations (ppm): Sampling Locations on the Wilmington Site[a]

Year	Sampling Location ID Number					
	1	1A	2	3	20	21
1995	1.53	7.34	1.63	0.46	9.55	3.21
1996	1.48	9.49	0.61	0.26	15.48	4.92
1997	0.66	2.66	0.85	0.50	16.10	3.97
1998	0.67	3.87	0.73	0.38	-	-
1999	0.24	1.66	1.28	0.54	-	-
2000	<0.87	0.86	1.62	0.44	-	-
2001	0.73	1.73	0.87	0.56	-	-
2002	0.50	2.48	0.33	0.26	-	-
2003	2.53	8.06	20.46	0.30	-	-
2004	0.39	2.79	1.56	0.14	-	-
2005	3.99	1.72	0.31	0.16	-	-

Units = ppm.

Sample locations 20 and 21 discontinued in 1998 because the use of the storage pad was minimized at that time and the soil concentration at those locations had stabilized.

Reference: GNF-A, 2007a.

[a] See **Figure 3.11-3** for location of current (2005) soil sampling locations.

Table 3.11-7. Average Soil Uranium Concentrations (ppm): Sampling Locations in the Vicinity of the Wilmington Site[a]

Year	Sampling Location ID Number											
	4	5	6	7	8	11	12	13	15	16	17	18
1995	0.26	0.58	0.19	0.45	0.27	0.43	0.83	0.27	0.37	0.13	0.47	0.25
1996	0.36	0.33	0.21	0.83	0.34	0.38	0.48	0.20	0.41	0.15	0.34	0.34
1997	0.41	0.42	0.16	0.77	0.65	0.68	0.41	0.18	0.81	0.26	0.56	0.22
1998	0.38	0.29	0.17	0.75	-	-	-	-	-	-	-	-
1999	0.32	0.23	0.13	0.94	-	0.79	-	-	-	-	-	-
2000	0.31	0.07	0.14	0.49	-	1.46	-	-	-	-	-	-
2001	0.63	0.29	0.35	-	-	0.42	-	-	-	-	-	-
2002	0.40	0.15	0.27	-	-	0.71	-	-	-	-	-	-
2003	0.20	0.38	0.36	-	-	0.39	-	-	-	-	-	-
2004	0.29	0.41	0.53	-	-	1.66	-	-	-	-	-	-
2005	0.24	-	0.48	-	-	0.39	-	-	-	-	-	-

Units = ppm.

Sample locations 8, 12, 13, 15, 16, 17, and 18 discontinued in 1998; sample location 7 discontinued in 2001; and sample location 5 discontinued in 2005. Sampling locations are chosen based on a number of factors (e.g., facility operations, historical values at the location); as concentrations stabilize or as operations change, sampling locations are removed or added.

Reference: GNF-A, 2007a.

[a] See **Figure 3.11-3** for location of current (2005) soil sampling locations.

Table 3.11-8. Fluoride Emissions Monitoring Data Summary for Years 1995–2005: Wilmington Site FMO Building

Year	Total Annual Fluoride Emissions (grams/yr)	Total Air Volume Vented Per Year (10^{15} cc/yr)	Average Fluoride Concentration ($\mu g/m^3$)
1995	2,083	0.26	0.80
1996	1,642	1.45	0.11
1997	2,350	1.60	0.15
1998	3,042	1.66	0.18
1999	3,296	1.59	0.21
2000	2,388	1.56	0.15
2001	1,813	1.55	0.12
2002	1,383	1.54	0.09
2003	1,466	1.58	0.09
2004	2,292	1.40	0.16
2005	1,505	1.32	0.11

Reference: GNF-A, 2007a.

Table 3.11-9. Annual Radiation Dose to Nearest Resident [a]

Year	Committed Effective Dose Equivalent (mrems)
1995	0.060
1996	0.200
1997	0.400
1998	0.200
1999	0.064
2000	0.056
2001	0.039
2002	0.027
2003	0.029
2004	0.031
2005	0.033

Reference: GNF-A, 2007a.

[a] Calculated using EPA's COMPLY code for nearest known residence (current as of 2006), which is located 426 and 1260 feet (130 to 384 meters) south of the FMO building stacks.

Table 3.11-10. Recordable Accidents at GNF-A Facility

Year	Recordable Accidents	Recordable Injury and Illness Rates[a]	Total Number of Lost Time Accidents	Total Number of First Aids
2000	22	1.64	11	165
2001	7	0.65	5	115
2002	11	1.04	0	96
2003	8	0.81	1	87
2004	3	0.46	2	79
2005	4	0.63	0	91
2006	9	1.01	4	93

[a] Recordable Injury and Illness Rate – Total number of injuries and illnesses divided by the number of hours worked by employees x 200,000 hours worked.

Table 3.11-11. Public and Occupational Radiation Exposure Limits

Exposure Group	Annual Dose Equivalent Limit	Reference
Worker	50 mSv (5 rem) TEDE 0.5 Sv (50 rem) CDE to any organ 0.15 Sv (15 rem) lens of eye 0.5 Sv (50 rem) skin 0.5 Sv (50 rem) extremity	NRC (10 CFR 20)
General Public	1 mSv (100 mrem) TEDE 0.02 mSv (2 mrem) in any 1 hour period	NRC (10 CFR 20)
	0.25 mSv (25 mrem) whole body 0.25 mSv (25 mrem) any organ 0.75 mSv (75 mrem) thyroid	EPA (40 CFR 190)

CDE = committed dose equivalent.
TEDE = total effective dose equivalent.

3.11-12. Hydrogen Fluoride Regulations and Guidelines

Agency	Description	Limit or Guideline
ACGIH	STEL (ceiling)	3.0 ppm
NIOSH	REL (TWA)	2.5 mg/m^3
NIOSH	IDLH	30 ppm
OSHA	PEL (8-hour TWA)	2.0 mg/m^3
EPA	Accidental release prevention toxic endpoint	0.0160 mg/L
EPA	Accidental release prevention threshold quantity	1,000 lbs
OSHA	Highly hazardous chemicals threshold quantity	1,000 lbs
EPA	Superfund – reportable quantity	5,000 lbs

Reference: ATSDR, 2003.
ACGIH = American Conference of Governmental Industrial Hygienists.
IDLH = immediately dangerous to life and health.
EPA = U.S. Environmental Protection Agency.
NIOSH = National Institute for Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
PEL = permissible exposure limit.
REL = recommended exposure limit.
STEL = short term exposure limit.
TWA = time-weighted average.

Figures

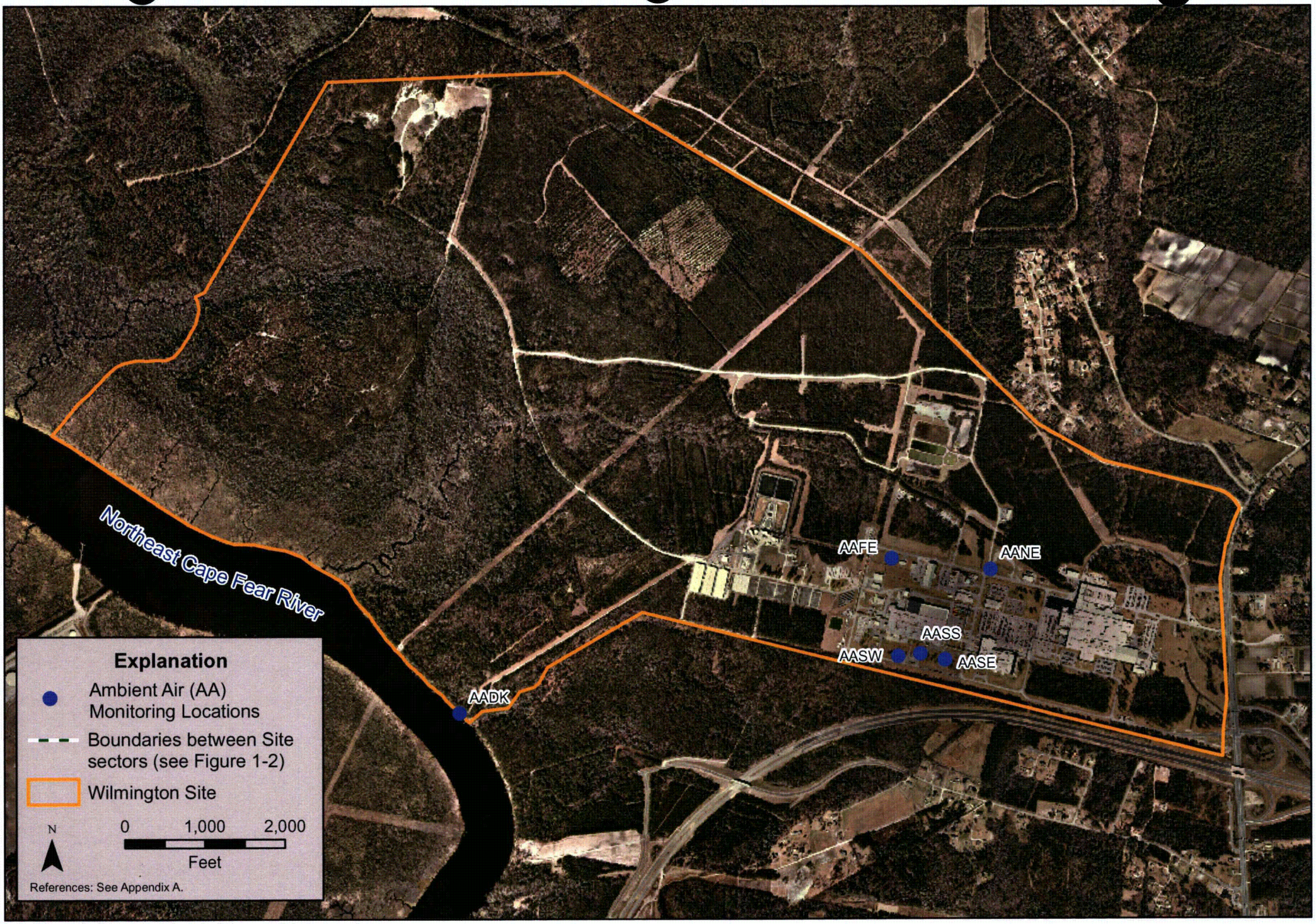

Figure 3.11-1. On-site ambient air monitoring locations for gross alpha and uranium isotopes.

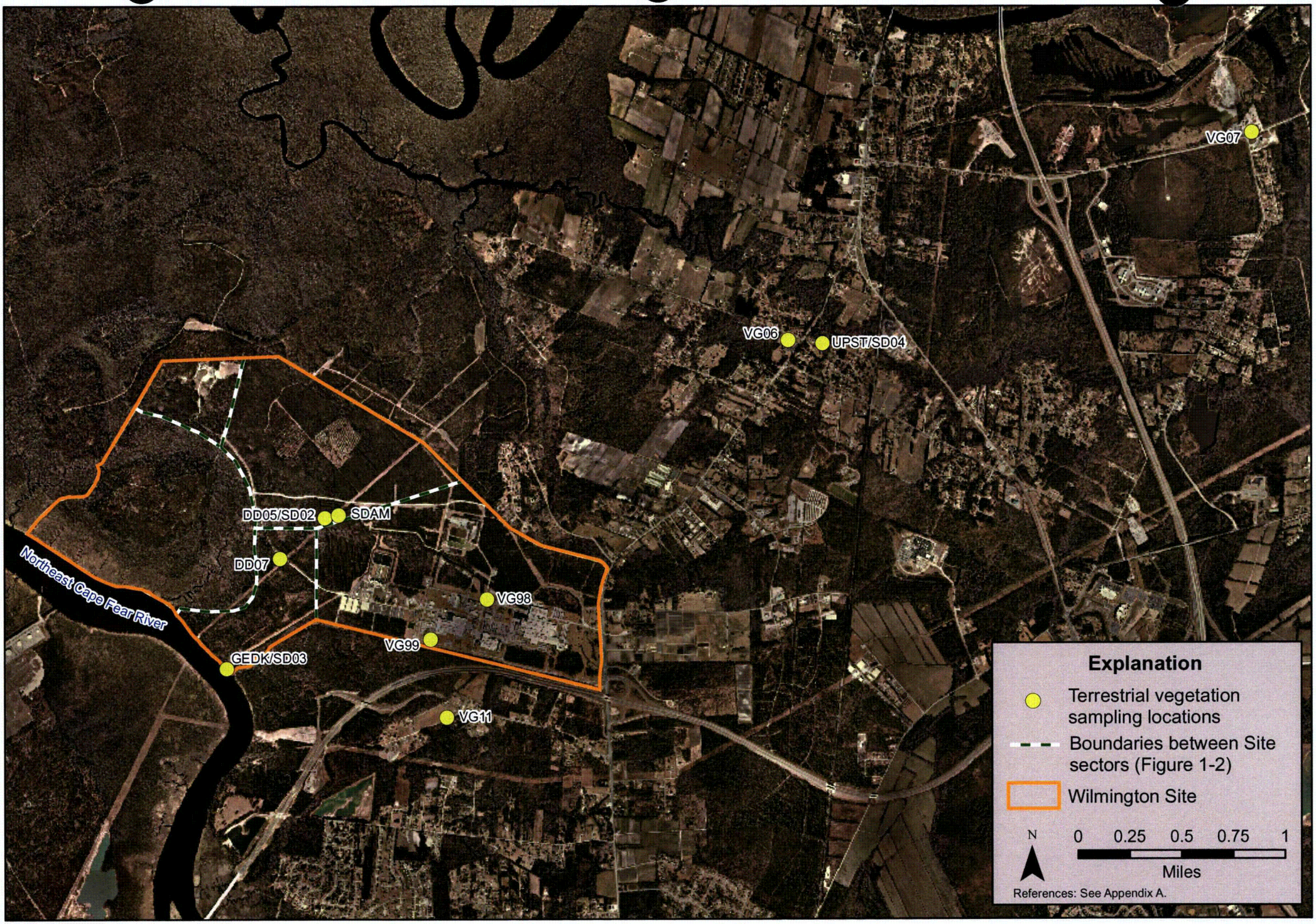

Figure 3.11-2. Terrestrial vegetation sampling locations for gross alpha on and in the vicinity of the Wilmington Site.

Figure 3.11-3. Current (2005) soil sampling locations for uranium on and in the vicinity of the Wilmington Site.

GLE Environmental Report

Section 3.12 – Waste Management

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3.12 Waste Management

This section describes the generation, management, and disposal of various wastes from current operations at the Wilmington Site. EPA's solid waste management and disposal regulatory programs implemented under Resource Conservation and Recovery Act (RCRA) Subtitle C (*Hazardous Wastes*) and Subtitle D (*Nonhazardous Wastes*) regulate many liquids and semi-solids that are stored and managed in containers (e.g., drums, tanks) as solid wastes. The hazardous liquid wastes, used oil, and other liquid wastes currently generated at the Wilmington Site and shipped off-site for final treatment, disposal, or recycling/reuse are addressed in **Section 3.12.3**.

3.12.1 Gaseous Wastestreams

Gaseous wastes generated at the Wilmington Site occur in the form of air emissions released to the atmosphere from the current manufacturing operations. Sources, quantities, and control of nonradioactive gaseous air emissions from the current operations at the Wilmington Site are described in **Section 3.6.3.5**, *Wilmington Site Existing Air Emission Sources and Controls*. Sources, quantities, and control of gaseous radionuclides from the current operations at the Wilmington Site are described in **Section 3.11.2**, *Current Sources and Levels of Exposure to Radioactive Materials*.

3.12.2 Wastewaters

Liquid wastes generated at the Wilmington Site include process wastewater effluents from the current manufacturing operations, and sanitary wastewater from the existing building restrooms, cafeteria, and other sanitary facilities. **Table 3.12-1** summarizes the wastewater streams generated by current operations at the Wilmington Site.

Process wastewaters from existing Site operations are routed for treatment to the existing Site final process lagoon facility, and sanitary wastewaters are routed to the existing Site sanitary wastewater treatment facility. **Figure 3.12-1** shows the locations of these wastewater treatment facilities and their associated effluent discharge points. Effluents from the final process lagoon facility and sanitary wastewater treatment facility are monitored at the locations identified on **Figure 3.12-1** as Outfall 001 and Outfall 002, respectively. The effluent from the final process lagoon facility then drains to the effluent channel (Discharge Location 001 on **Figure 3.12-1**), which also receives stormwater and groundwater discharge. The effluent channel then drains to Unnamed Tributary #1 to Northeast Cape Fear River. Additional information on Site surface waters and drainage is discussed in **Section 3.4.2.1.1**, *Streams*. During the timeframe that the baseline set of data presented in this chapter to describe the affected environment were generated (i.e., through 2006), the treated effluent from the sanitary wastewater treatment facility also drained to the effluent channel (Discharge Location 002 on **Figure 3.12-1**). More recent changes to the treatment and handling of sanitary wastewater effluent are discussed in **Section 3.12.2.2**.

3.12.2.1 Process Wastewater

A common process wastewater drain system is used for the various current manufacturing operations at the Wilmington Site. This is a dedicated system for collection of treated process wastewater, non-treated process wastewater, filter backwash water, and non-contact cooling water from the combined GNF-A FMO facility, GNF-A FCO facility, GE AE operations, and GE SCO facility. The GE/GNF-A facility is permitted to discharge up to 1.8 million gpd (6,813,741 lpd)) of treated process wastewater under the current NPDES discharge permit (NPDES permit number NC0001228). The 2006 average daily discharge from the final process lagoon facility to the effluent channel was 476,200 gpd (1,802,613 lpd) (see **Table 3.12-1**).

Since the process wastewater drain system was installed, changes to manufacturing processes and waste management practices for GNF-A and AE facility operations have eliminated most of the process wastewater streams discharged into the drain system. These pollution-prevention initiatives include the following:

- Replacement of the GNF-A FMO facility's ammonium diuranate (ADU) process with a Dry Conversion Process (DCP) for direct conversion of UF_6 to UO_2, which eliminated ammonia and fluoride wastewater streams being discharged to the drain system
- Placement of the GNF-A facility's uranium-recovery unit in standby status, which eliminated the nitrate wastewater stream being discharged to the drain system
- Shipment of the etch-acid solution waste generated by the GNF-A FCO facility to an off-site disposal facility, which eliminated use of the on-site waste treatment nitrate basins
- Elimination of waste streams from GE AE/SCO facility operations
- Replacement of the GNF-A FMO facility's radioactive wastewater (radwaste) treatment system with an improved system.

In the DCP used by the GNF-A FMO facility, UF_6 is reacted with steam and hydrogen, resulting in the formation of UO_2 and aqueous HF. This process generates no liquid waste stream other than a small quantity of uranium-contaminated dilute aqueous HF stream (typically 1% to 2% HF). A more concentrated aqueous HF stream (<50% HF) also is produced as a co-product of the conversion process. Under a condition of GNF-A's NRC license, this concentrated HF product can be transferred to any commercial chemical company or supplier without either company possessing an NRC or Agreement State license for special nuclear material, provided that the concentration of uranium does not exceed 3 ppm by weight of the liquid and the enrichment is less than or equal to 5 weight percent ^{235}U. The HF product is sold to companies for industrial and commercial uses in such a manner that the minute quantity of uranium does not enter into any food, beverage, cosmetic, drug, or other commodity designated for ingestion or inhalation by, or application to, people such that the uranium concentration in these items would exceed that which naturally exists.

The dilute aqueous HF waste stream from the DCP is mixed with lime (calcium hydroxide) to form calcium fluoride (CaF_2). This material is dewatered, and the dewatered solids are collected and included with the other wastes shipped to the Energy*Solutions* disposal facility in Clive, UT (discussed in **Section 3.12.3.4**). The liquid effluent from the dewatering unit is pH adjusted and combined with the FMO-treated radwaste in the aeration basin and final process lagoons. Before the treated wastewater is discharged to the effluent channel, the water is tested at various sample points. If the pH needs to be further adjusted, the water is retained until the proper pH levels are obtained.

The GNF-A FCO facility generates a used sodium hydroxide (NaOH) solution waste and a spent etch-solution waste that are not discharged to the on-site wastewater drain system, but are instead collected in tanks for further off-site treatment. These liquid process streams are further discussed in **Sections 3.12.3.2 and 3.12.3.3**, respectively.

As required by the NPDES permit issued by NC DWQ, GNF-A monitors effluent quality for compliance with permit limitations set for various analytes. Process wastewater effluent is monitored for these analytes at Outfall 001, which is a location along the discharge pipe that drains from the final process lagoon facility to the effluent channel slightly upstream of the Site dam. Although effluent flow is monitored continuously to estimate total daily flow, other effluent characteristics are monitored weekly, monthly, or quarterly in composite or grab samples as specified by the permit. In addition, monitoring results are reported monthly to the NC DWQ. The permit limitations, monitoring requirements, and a

summary of the monthly Discharge Monitoring Reports (DMRs) for the 2002 through 2006 calendar years are provided in **Table 3.12-2**.

3.12.2.2 Sanitary Wastewater

Liquid wastes originating in bathrooms, the cafeteria, and other sanitary facilities are collected and routed through the sanitary waste sewer system to an on-site, activated sludge-aeration treatment plant. The treatment of the sanitary wastes at this plant is designed to achieve the biochemical oxygen demand (BOD) reductions typical of similar systems.

Under the current NPDES discharge permit (NPDES permit number NC0001228), up to 75,000 gpd (283,906 lpd) of sanitary wastewater effluent can be discharged from the Wilmington Site. The 2006 average daily discharge from the sanitary wastewater treatment facility to the effluent channel was 33,000 gpd (124,919 lpd) (see **Table 3.12-1**). Sanitary wastewater must also meet similar monitoring requirements and effluent limitations as described above for the process wastewater effluent. The sanitary wastewater effluent is monitored at Outfall 002, which is a location along the discharge pipe that drains from the sanitary wastewater treatment facility to the effluent channel just south of the treatment facility. The permit limitations, monitoring requirements, and a summary of the monthly DMRs for the 2002 through 2006 calendar years are provided in **Table 3.12-3**.

During the timeframe that the baseline set of data presented in this chapter to describe the affected environment were generated (i.e., through 2006), the treated effluent from the sanitary wastewater treatment facility drained to the effluent channel per the NPDES discharge permit discussed above. However, as presented in **Section 2.3** of this Report, *Cumulative Effects*, sanitary wastewater treatment facility upgrades became operational in April 2008 and, along with securing a re-use permit from NCDENR, these upgrades enabled the industrial re-use of treated sanitary wastewater effluent as make-up water in Wilmington Site cooling towers. This effluent re-use process resulted in a switch away from discharge of treated sanitary wastewater effluent to the effluent channel, which flows to Unnamed Tributary #1 to Northeast Cape Fear River (Waters of the United States). The NPDES discharge permit remains valid should discharges of treated sanitary wastewater become necessary in the future.

3.12.3 Solid Wastes

Solid wastes generated at the Wilmington Site from the current manufacturing operations vary in form and type. These wastes include packaging and construction materials, worn-out tools and equipment, spent process chemicals, used oils, and uranium sludges. The current Wilmington Site waste management program is both comprehensive and flexible, allowing the Site to tailor waste management techniques to specific solid-waste types. The waste management practices currently used at the Site include waste elimination, waste-volume reduction achieved by source separation of recyclable or recoverable materials, waste compaction, and on-site waste incineration.

Four types of solid waste are generated at the Wilmington Site by the current operations: municipal solid waste (MSW), nonhazardous industrial wastes, hazardous wastes, and low-level radioactive wastes (LLRW). High-level radioactive wastes or mixed wastes (a type of waste that contains both hazardous and radioactive source, special nuclear, or by-product material, as defined by the Atomic Energy Act) are not generated at the Wilmington Site. **Table 3.12-4** describes the composition and quantities of solid and liquid wastes generated by current operations at the Wilmington Site and shipped off-site for final treatment, disposal, or reuse. The treatment and disposal facilities listed in **Table 3.12-4** have adequate capacity to continue accepting solid-waste materials generated at the Wilmington Site for the foreseeable future. GEH is not aware of closure or other plans by the facility owners and operators that would impede the future acceptance of the appropriate waste materials generated by operations at the Wilmington Site.

3.12.3.1 Municipal Solid Wastes

In 2006, a total of approximately 990 tons (898 metric tons [mt]) of MSW was generated at the Wilmington Site from both the GNF-A and GE AE/SCO facility operations. A commercial refuse service regularly collects and disposes this waste off-site at the New Hanover County municipal landfill. This RCRA-permitted Subtitle D landfill is located on US 421, approximately 4.5 driving miles (7.2 km) southwest of the Wilmington Site. This landfill has a current permitted capacity of 4.2 million tons (3.8 million mt) and an estimated closure year of 2016. The county is currently permitting a new 115-acre (47-ha) area which will extend the capacity and lifetime of the landfill.

3.12.3.2 Nonhazardous Industrial Wastes

Industrial waste that is neither an RCRA MSW nor an RCRA hazardous waste under federal or State laws is regulated under RCRA Subtitle D as nonhazardous wastes. Nonhazardous industrial wastes generated by current manufacturing operations at the Wilmington Site that are not accepted by the local New Hanover county municipal landfill are collected and stored on-site before being periodically shipped via Heritage Environmental Services to approved treatment and disposal facilities. Depending on the composition of the nonhazardous waste, these materials are either shipped directly to the Heritage Environmental Services facility in Indianapolis, IN, for treatment and burial, or routed through Heritage Environmental Services to be reused, reclaimed, or treated at other GE-approved facilities.

The GNF-A FCO facility generates a used NaOH solution that is recycled. In 2006, the quantity of reused NaOH was 77 tons (70 mt) of the total 107 tons (97 mt) of nonhazardous industrial waste listed in **Table 3.12-4** shipped to Heritage Environmental Services from the GNF-A operation. Similarly, the 1,755 tons (1,592 mt) of used oils listed in **Table 3.12-4** shipped to the FCC Environmental Treatment Facility in Concord, NC, is recycled.

3.12.3.3 Hazardous Wastes

Hazardous wastes generated by the existing Wilmington Site facilities are predominately spent etch-acid solutions generated by GNF-A FCO activities. Minor additional hazardous wastes from the GNF-A and GE AE facility operations typically include used paints, spent solvents, and X-ray wastes. The hazardous wastes generated at the Wilmington Site are collected, packaged in DOT-approved shipping containers, and stored temporarily on-site. At least once every 90 calendar days, the containers are shipped to the Heritage Environmental Services RCRA-permitted Subtitle C treatment, storage, and disposal facility in Indianapolis, IN.

3.12.3.4 Low-Level Radioactive Wastes

Another classification of solid waste that is generated by GNF-A operations is LLRW. Industrial or commercial waste that has been contaminated by radioactive material falls into this classification. At the Wilmington Site, the low-level contaminated material generated by GNF-A operations is segregated between combustible and noncombustible materials. No LLRW is generated by the GE AE/SCO operations.

Used, noncombustible, uranium-contaminated preventative and corrective maintenance items (e.g., air-cleaning system filters, pumps, motors, valves, metal containers, process piping segments, various filtrates, DCP CaF_2 solids) are shipped off-site for disposal. These materials are collected and packaged in DOT/NRC–approved shipping containers, which then are stored temporarily on-site. When a full truck load is collected, the containers are shipped to the LLRW disposal facility operated by Energy*Solutions* (formerly Envirocare) in Clive, UT.

Used combustible, uranium-contaminated maintenance items are incinerated in an on-site natural-gas-fired, multiple-chamber waste incinerator. Approximately 367,000 lbs (166,468 kg) of LLRW are burned in the incinerator per year. The waste incinerator is permitted by the NC DAQ to burn up to 1,200 lb (544 kg) per hour of Type 0 Waste (see **Section 3.6.3.5.1**, *Wilmington Site Existing Air Quality Permits*). Although the GNF-A's air quality permit for the waste incinerator allows the burning of used oil, no used oil generated at the Wilmington Site is fed to the incinerator. The incinerator air-emission control system is described in **Table 3.6-23**. The incinerator ash is shipped to the Energy*Solutions* LLRW disposal facility in Clive, UT.

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Tables

Table 3.12-1. Wastewater Streams Generated by Current Operations at the Wilmington Site and Treated On-site

Wastewater Stream	Generation Frequency	NPDES Limit[a]	2006 Average Daily Flow Rate	Wastewater Treatment
Process wastewater	Continuous	1,800,000 gpd (6,813,741 lpd)	476,200 gpd (1,802,613 lpd)	pH adjustment, settling, aeration
Sanitary waste effluent	Continuous	75,000 gpd (283,906 lpd)	33,300 gpd (124,919 lpd)	Dual-train, extended, activated sludge-aeration wastewater treatment facility with chlorination/dechlorination[b]

[a] NPDES = National Pollutant Discharge Elimination System.

The Wilmington Site sanitary wastewater treatment facility has recently been upgraded to a single-train, extended aeration activated sludge wastewater treatment facility with membrane ultrafiltration and ultraviolet (UV) filtration (operational March 2008).

Table 3.12-2. Summary of NPDES Outfall 001 Treated Process Wastewater Effluent Monitoring Results (2002–2006)

Permit Limitation				Outfall 001 (Treated Process Wastewater Effluent)					
Characteristic	Daily Maximum Limit	Monthly Average Mean Limit	Units	# Samples	Minimum (of daily values)	Mean [a] (of daily values)	Maximum (of daily values)	# Months	Maximum of monthly means
Biological oxygen demand (5 days)	NL	NL	mg/L	260	ND	6.81	41.0	60	18.0
Cadmium	15	NL	µg/L	172	ND	1.19	10.0	60	10.0
Chromium	4.49	2.41	lbs/day	151	ND	0.26	0.41	60	0.29
Copper	5.34	2.86	lbs/day	151	ND	0.16	0.26	60	0.21
Cyanide	22	NL	µg/L	60	ND	2.54	5.0	60	5.0
Dissolved oxygen	NL	NL	mg/L	261	3.17	7.65	13.6	60	10.9
Flow	NL	1.8	MGD	2659	0.12	0.50	5.34	60	0.78
Fluoride	45	23	lbs/day	153	3.58	8.05	27.2	60	19.9
Lead	34	NL	µg/L	68	ND	ND [b]	3.0	60	ND [b]
Nickel	6.79	3.63	lbs/day	151	ND	0.16	0.21	60	0.21
Nitrogen, total as N [c]	183	86	lbs/day	267	ND	14.1	71.0	60	52.5
Oil and grease	118.4	57.7	lbs/day	261	ND	7.84	36.1	60	36.1
pH [d]	6.0/9.0 NL [d]	NL	SU	1255	6.20	7.2847 [e]	8.85	60	6.81/8.0516 [e, f]
Phosphorus, total as P	NL	NL	mg/L	40	0.025	0.33	1.3	39	1.3
Silver	0.68	0.33	lbs/day	151	ND	0.009	0.011	60	0.01
Solids, Total Suspended (TSS)	390	178	lbs/day	708	ND	59.1	188	60	125.6
Temperature, water	NL	NL	deg C	1253	5.75	21.1	33.2	60	29.9
Trichloroethylene	NL	NL	µg/L	60	ND	1.66	6.98	60	6.98
Zinc	4.12	2.05	lbs/day	151	ND	0.11	0.47	60	0.47

Reference: GEH environmental database.

ND = The analyte was not detected or not detected above the reported practical quantitation limit.

NL = The analyte not listed with a permit limitation.

[a] Non-detect results were included in the mean calculations as half of the laboratory-reported practical quantitation limit (PQL) for radiological, inorganic and physical constituents, and as one-fifth the laboratory-reported PQL for organic constituents.

[b] All lead results were non-detect except one sample collected in March 2005, which had a reported concentration of 3.0 µg/L.

[c] Total Nitrogen (as N) = $NO_2 + NO_3 + NH_3$.

[d] The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units.

[e] Mean pH values were calculated by converting the pH measurements to their corresponding hydrogen-ion concentration (H^+_c), performing the statistical calculation on those concentrations, and converting the statistical result back to pH per the equation, $pH = -\log_{10}(H^+_c)$.

[f] Minimum of monthly means/maximum of monthly means.

Table 3.12-3. Summary of NPDES Outfall 002 Treated Sanitary Wastewater Effluent Monitoring Results and Requirements (2002–2006)

Permit Limitation				Outfall 002 (Treated Sanitary Wastewater Effluent)					
Characteristic	Daily Maximum Limit	Monthly Average Mean Limit	Units	# Samples	Minimum (of daily values)	Mean [a] (of daily values)	Maximum (of daily values)	# Months	Maximum of monthly means
Biological oxygen demand (5 days)	45	30	mg/L	518	ND	3.63	21	60	12.5
Chlorine, total residual	28	NL	µg/L	525	ND	10.2	24	60	15
Dissolved oxygen [b]	NL [b]	NL	mg/L	1708	5.0	7.14	15.6	60	9.85
Fecal coliform	400	200	cfu/100 mL	263	ND	14.7	300	60	91.4
Flow	NL	0.075	MGD	1826	0.001	0.025	0.077	60	0.036
Phosphorus, total	NL	NL	mg/L	20	1.0	5.35	9.31	20	9.31
Nitrogen, total as N [c]	NL	NL	mg/L	20	0.53	29.7	52.1	20	52.1
Nitrogen, ammonia as N	NL	NL	mg/L	343	ND	0.91	34	60	13.8
pH [d]	6.0/9.0 [d]NL	NL	SU	281	5.87	6.764 [e]	7.56	60	6.24/7.356 [e]
Solids, Total Suspended (TSS)	45	30	mg/L	518	ND	3.46	45	60	20.7
Temperature, water	NL	NL	deg C	1799	3	20.1	33	60	27.4

Reference: GEH environmental database.

ND = The analyte was not detected or not detected above the reported practical quantitation limit.

NL = The analyte not listed with a permit limitation.

[a] Non-detect results were included in the mean calculations as half of the laboratory-reported practical quantitation limit.

[b] The daily average dissolved oxygen effluent concentration shall not be less than 5.0 mg/L.

[c] Total Nitrogen (as N) = $NO_2 + NO_3 + TKN$.

[d] The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units.

[e] Mean pH values were calculated by converting the pH measurements to their corresponding hydrogen-ion concentration (H^+_c), performing the statistical calculation on those concentrations, and converting the statistical result back to pH per the equation, $pH = -\log_{10}(H^+_c)$.

[f] Minimum of monthly means/maximum of monthly means.

Table 3.12-4. Solid and Liquid Wastes Generated by Current Operations at the Wilmington Site and Shipped Off-site for Final Treatment, Disposal, or Reuse

Waste Type	Waste Generation Source (Wilmington Site)	Waste Composition	Annual[a] Quantity Generated	Offsite Treatment or Disposal Facility (Type and Location)
Municipal solid waste	GNF-A operations and GE Aircraft Engines/ Services Components Operations (AE/SCO)	▪ Refuse and other nonhazardous solid wastes accepted at landfill	990 tons (898 mt)	New Hanover County Landfill Wilmington, NC
Nonhazardous industrial wastes	GNF-A operations	▪ Used NaOH solution[b] ▪ Clean-room sludge ▪ Spent coolant ▪ Used tube reducer ▪ Nonhazardous caustic ▪ Filter medium	107 tons (97 mt)	Heritage Environmental Services RCRA Permitted TSDF[c] Indianapolis, IN, or other facilities depending on the composition of the waste[d]
	GE AE/SCO	▪ Pre-rinse emulsifier ▪ Spill-cleanup adsorbent media ▪ Mixed dry batteries ▪ Metal chips ▪ Process tank and drain cleanout sludges	40 tons (36 mt)	
	GNF-A and GE AE/SCO	▪ Used oils[e]	1,755 tons (1,592 mt)	FCC Environmental Treatment Facility Concord, NC
Hazardous waste	GNF-A and GE AE/SCO	▪ HF/HNO_3 waste[f] ▪ Minor quantities of waste paints and solvents and X-ray wastes	2,175 tons[g] (1,973 mt)	Heritage Environmental Services RCRA Permitted TSDF[c] Indianapolis, IN
Low–level radioactive Waste (LLRW)	GNF-A operations	▪ Metal parts, filters, and other noncombustible wastes ▪ Dewatered CaF_2[h] solids ▪ Waste incinerator ash	208 tons (188 mt)	EnergySolutions LLRW Disposal Facility Clive, UT

[a] Annual waste quantity records for existing Wilmington Site facilities operations for the year 2006, with the exception of LLRW. The value for LLRW is an estimate of annual waste quantity for 2008 and future years to reflect the current LLRW management practices used by the GNF-A operations, which reduce the quantity of LLRW shipped to Energy*Solutions* from the historical levels for the years 2006 and earlier.

[b] Used NaOH solution manifested to Heritage Environmental Services is recycled and reused. In 2006, the quantity of recycled/reused NaOH was 77 tons of the total 107 tons of non-hazardous industrial waste manifested to Heritage Environmental Services from the GNF-A operation.

[c] TSDF = Treatment, storage, and disposal facility permitted under RCRA Subtitle C requirements to manage hazardous wastes. Also accepts nonhazardous wastes for treatment and recycling/reuse.

[d] Depending on the composition of the nonhazardous waste, these materials are either shipped direct to the Heritage Environmental Services facility in Indianapolis, IN, for treatment and burial and or routed through Heritage Environmental Services for reuse, reclaim, or treatment at other GE-approved facilities.

[e] Used oils manifested to FCC Environmental are recycled and reused.

[f] HF/HNO_3 waste = hydrofluoric acid (HF) and nitric acid (HNO_3) wastes.

[g] Hazardous waste predominately generated by GNF-A operation with a small quantity from the GE AE operation.

[h] Calcium fluoride (CaF_2).

Figure

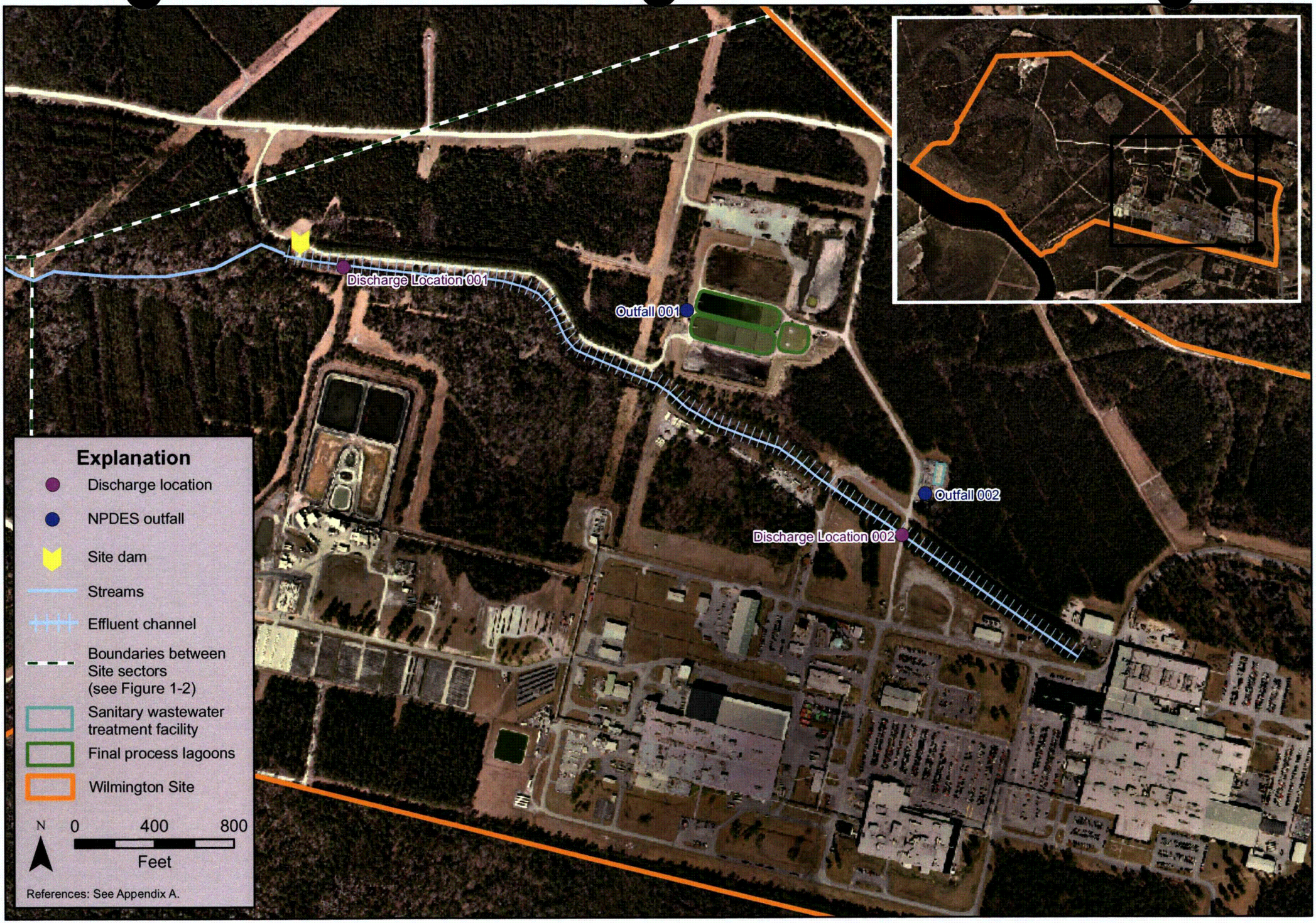

Figure 3.12-1. Existing wastewater treatment facilities and discharge points at the Wilmington Site.