FORT DRUM INTEGRATED RESOURCE ASSESSMENT
VOLUME 2: BASELINE DETAIL

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ABSTRACT

The U.S. Army Forces Command (FORSCOM) has tasked the Pacific Northwest Laboratory (PNL)^(a) as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program's (FEMP) mission to identify, evaluate, and assist in acquiring all cost-effective energy projects at Fort Drum. This is a model program PNL is designing for federal customers served by the Niagara Mohawk Power Company (Niagara Mohawk). It will 1) identify and evaluate all electric and fossil fuel cost-effective energy projects; 2) develop a schedule at each installation for project acquisition considering project type, size, timing, and capital requirements, as well as energy and dollar savings; and 3) secure 100% of the financing required to implement electric energy efficiency projects from Niagara Mohawk and have Niagara Mohawk procure the necessary contractors to perform detailed audits and install the technologies.

This report documents the assessment of baseline energy use at one of Niagara Mohawk's primary federal facilities, the FORSCOM Fort Drum facility located near Watertown, New York. It is a companion report to Volume 1, the Executive Summary, and Volume 3, the Resource Assessment. This analysis examines the characteristics of electric, gas, oil, propane, coal, and purchased thermal capacity use for fiscal year (FY) 1990. It records energy-use intensities for the facilities at Fort Drum by building type and energy end use. It also breaks down building energy consumption by fuel type, energy end use, and building type. A complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, central systems, and applicable losses.

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

SUMMARY

The U.S. Army Forces Command (FORSCOM) has tasked the Pacific Northwest Laboratory (PNL) as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program's (FEMP) mission to identify, evaluate, and assist in acquiring all cost-effective energy projects at Fort Drum. This is a model program PNL is designing for federal customers served by the Niagara Mohawk Power Company (Niagara Mohawk). This report, Volume 2, documents the assessment of baseline energy use at the FORSCOM Fort Drum facility located near Watertown, New York. This analysis examines the characteristics of electric, natural gas, #2 fuel oil, propane, purchased high-temperature hot water, and coal use for fiscal year (FY) 1990. It records energy-use intensities for the Fort Drum facilities by building type and energy end use. It also breaks down building energy consumption by fuel type, energy end use, and building type. A complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, central systems, and applicable losses.

In FY 1991, over 11,000 active military personnel were assigned to the FORSCOM Fort Drum facility located near Watertown, New York. The annual Reserve and National Guard training involved nearly 38,000 military personnel that year. The Fort's primary mission is to provide training and support for the Army's 10th Mountain Division. The 107,000-acre facility is divided into six major areas (for energy consumption and billing purposes), including Old Post commercial, New Post commercial, on-post housing, on-post utility (including exterior lighting, pumping, and transmission and distribution losses), off-post housing, and the off-post commercial, which includes the Semi Automatic Ground Environment (SAGE) facility in Syracuse. Of these six areas, five contain structures; Table S.1 records the number of buildings and total square feet for each of the areas. The Fort contains 5,167 buildings, for a total area of 12,784,878 ft².

Table S.2 shows a summation of the typical yearly energy consumption and cost for all facilities at Fort Drum. For each energy type, the yearly total is shown in units appropriate to the energy type and in a common unit as a

TAB S.1. Fort Drum Building Characterization

<u>Fort Area</u>	<u>Number of Buildings</u>	<u>Total Floorspace (ft²)</u>	<u>Percent of Total Floorspace</u>
Old Post Commercial	694	3,075,025	24.1
New Post Commercial	200	3,380,890	26.4
On-Post Housing	2,272	3,183,047	24.9
Off-Post Housing	2,000	2,937,384	23.0
Off-Post Commercial	<u>1</u>	<u>208,532</u>	<u>1.6</u>
Total	5,167	12,784,878	100.0

TABLE S.2. Typical Yearly Energy Consumption and Energy Cost at Fort Drum

<u>Energy Type</u>	<u>Yearly Total</u>	<u>Yearly Total [MBtu (a)]</u>	<u>Percent of Total Energy Consumption</u>	<u>Energy Cost [1990\$ x 10³]</u>	<u>Percent of Total Cost</u>
Electricity	105,849 MWh	361,260 ^(b)	22.6	5,523	46.4
Natural Gas	3,857 ktherm	385,720 ^(c)	24.1	2,353	19.8
#2 Fuel Oil	2,407 kgallon	334,146 ^(d)	20.9	1,661	14.1
Propane	652 kgallon	59,524 ^(e)	3.7	358	3.0
HTHW	458,048 MBtu	458,048 ^(f)	28.6	1,967	16.5
Coal	98 Ton	<u>2,205</u>	<u>0.1</u>	<u>9</u>	<u>0.01</u>
Totals:		1,600,903	100.0	11,891	100.01

(a) 1 MBtu = 1,000,000 Btu.

(b) 3,413 Btu/kWh.

(c) 100,000 Btu/therm; 1,050 Btu/ft³ of natural gas.

(d) 0.1388 MBtu/gal of #2 fuel oil.

(e) 0.0913 MBtu/gal of propane.

(f) 22.5 MBtu/ton of coal.

basis for comparison. The total consumption values represent typical current yearly usage, from the best available data during 1990 and 1991. The yearly energy consumption was 1,600,903 MBtu at a cost of \$11,891,000.

Table S.3 breaks down the energy consumption by fuel type and end use for the Fort's six major areas.

TABLE S.3. Energy Consumption by End Use (MBtu/yr)

Fuel Type/End Use	Fort Area						Total
	Old Post Commercial	New Post Commercial	On-Post Housing	On-Post Utility	Off-Post Housing	Off-Post Commercial	
Electric:							
Fans/Pumps	8,237	31,429	761	0	702	3,559	44,688
Lighting	36,310	54,082	11,977	0	10,527	4,982	117,878
Cooling	1,746	5,955	760	0	702	2,847	12,010
Cooking	0	706	2,921	0	667	0	4,294
Refrigeration	7,301	14,843	9,777	0	9,023	0	40,944
Other	14,161	27,175	26,100	35,817	24,608	13,585	141,446
Total	67,755	134,190	52,296	35,817	46,229	24,973	361,260
Percent of Total	18.8	37.1	14.5	9.9	12.8	6.9	100.0
Natural Gas:							
Heating	0	7,216	171,640	0	95,338	0	274,194
Hot Water	0	5,355	48,180	0	33,999	0	87,534
Food Prep.	0	5,115	6,022	0	8,453	0	19,590
Other	0	4,402	0	0	0	0	4,402
Total	0	22,088	225,842	0	137,790	0	385,720
Percent of Total	0.0	5.7	58.6	0.0	35.7	0.0	100.0
#2 Fuel Oil:							
Heating	252,367	0	2,157	0	0	17,517	272,041
Hot Water	55,637	0	0	0	0	3,337	58,974
Generator	0	0	0	0	0	3,131	3,131
Total	308,004	0	2,157	0	0	23,985	334,146
Percent of Total	92.2	0.0	0.6	0.0	0.0	7.2	100.0
Propane:							
Heating	0	0	0	0	35,137	0	35,137
Hot Water	2,291	0	0	0	12,493	0	14,784
Cooking	5,699	0	0	0	3,904	0	9,603
Total	7,990	0	0	0	51,534	0	59,524
Percent of Total	13.4	0.0	0.0	0.0	86.6	0.0	100.0
HTHW:							
Heating	0	206,608	0	0	0	0	206,608
Hot Water	0	62,983	0	0	0	0	62,983
Vehicle Wash	0	11,183	0	0	0	0	11,183
Loss	0	177,274	0	0	0	0	177,274
Total	0	458,048	0	0	0	0	458,048
Percent of Total	0.0	100.0	0.0	0.0	0.0	0.0	100.0
Coal:							
Heating/DHW	2,205	0	0	0	0	0	2,205
Total	2,205	0	0	0	0	0	2,205
Percent of Total	100.0	0.0	0.0	0.0	0.0	0.0	100.0
Total:	385,954	614,326	280,295	35,817	235,553	48,958	1,600,903
Percent of Total:	24.1	38.4	17.5	2.2	14.7	3.1	100.0

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1.0 PHYSICAL CHARACTERISTICS

1.1 SITE PROFILE

Fort Drum is a 107,000-acre U.S. Army Forces Command (FORSCOM) facility situated a few miles east of Watertown, New York, at 44.0°N and 76.0°E. The Fort's mission is to provide training and support for the 10th Mountain Division (infantry) of the U.S. Army.

Active military personnel assigned to the Fort numbered 11,115 in FY 1991. Almost all of these people live in military housing. The number of families with two active military members assigned to Fort Drum was not determined but is reportedly small. Annual Reserve and National Guard training involved 37,732 military personnel in FY 1991. The average number of Reservists onsite at any time was 3,144. These personnel generally occupied older barracks during their two-week stays. Civilians employed at the Fort numbered 1,501 in FY 1991; these personnel do not live in military housing. Military personnel not assigned to the Fort affect energy consumption to some extent by their use of site facilities such as the PX and recreation centers. There are about 50,000 people in upstate New York who are entitled to use these facilities, but the extent of this use has not been determined.

There are 38 Reserve Centers in New York State associated with Fort Drum, but these centers are not within the scope of this assessment. The buildings at 20 of these Reserve Centers are serviced by Niagara Mohawk Power Company (Niagara Mohawk) and have an aggregate floor area of 709,506 ft². Eighteen other Reserve Centers around the state are served by other utilities and have an aggregate area of 448,423 ft².

There is a natural geographical division of the Fort's buildings and associated facilities into six areas: Old Post, New Post, on-post housing, off-post housing (Army Community Housing), airfield, and the Semi Automatic Ground Environment (SAGE) facility in Syracuse.

The Old Post contains 694 buildings, not including Army Family Housing (AFH) comprising 3,075,025 ft² of total floor area. These buildings are situated on approximately 100 acres of land bounded to the north by a spur of the

Conrail tracks and to the south by the Black River. The Old Post buildings are predominantly one- and two-story frame structures constructed in the 1940s. Some are used only for summer training. Others have been renovated with metal siding, wall and attic insulation, storm windows, fluorescent lighting, and coal-to-oil heat conversion furnaces. The two Old Post structures that are exceptions are Building P173-175, a 150,000-ft² barracks built in 1970; and P-36, a 13,500-ft² clinic built in 1987.

Several barracks on the New Post had more than one function. To facilitate an accurate assessment of energy use by building type, the possible floor area of each New Post barracks was divided into an administrative area and a barracks area. The 30 dual-function barracks buildings were thus treated as 60 single-function buildings. The remaining 140 New Post buildings were treated as single-function buildings, giving a total of 200 equivalent single-function buildings, which is the total building count shown in Table 1.1. The aggregate floor area of these buildings is 3,380,890 ft²; they are situated north of the Conrail railroad spur on approximately 6,000 acres of land. The New Post buildings were constructed during the Fort expansion program of 1985-1988.

There are 15 on-post family housing areas containing 2272 family dwelling units with a total floor area of 3,183,047 ft². The Ravenwood area is all-electric. Senior officer dwellings in the Leray area are heated by oil and have electric cooking appliances. All other on-post AFH areas have natural gas service for heating and cooking.

There are 14 off-post housing areas containing 2000 family dwelling units. The aggregate floor area is 2,937,384 ft². Housing is typically grouped in areas of 75 to 300 units and located from 1 to 30 miles outside the post. All off-post housing is privately owned. The Fort has long-term operating leases with the private owners and operators. The Clayton, Copenhagen, Gouverneur, Lowville, and Philadelphia areas use propane for heating and cooking; all other areas use natural gas.

TABLE 1.1. Fort Drum Commercial Building Characterization

BUILDING TYPE	DESCRIPTION	ENERGY TYPES	AVERAGE AGE (Years)	BUILDING COUNT	TOTAL FLOORSPACE (sq ft)	AVERAGE FLOORSPACE (sq ft)	FLOORSPACE (percent)
OLD POST COMMERCIAL:							
OADM	Administration	E/O	45	221	634,848	2,873	9.5%
OASS	Assembly	E/O	45	29	113,050	3,898	1.7%
OBAM	Barracks w/Mess	E/O	25	1	85,139	85,139	1.3%
OBAR	Barracks	E/O	45	198	1,033,309	5,219	15.5%
OCLB	Club/Restaurant	E/O	25	4	33,249	8,312	0.5%
OCLD	Cold Storage	E/O	45	1	45,319	45,319	7%
OCOM	Communications	E/O	35	6	27,625	4,604	0.4%
ODGR	Dry Goods Retail	E/O	45	9	35,857	3,984	0.5%
OHAN	Hanger	E/O	45	1	32,540	32,540	0.5%
OHOT	Hotel/Motel	E/O	5	1	7,728	7,728	0.1%
OLAU	Laundry	E/O	45	2	13,427	6,714	0.2%
OMED	Medical facility	E/O	45	16	74,881	4,680	1.1%
OMES	Dining/Mess Hall	E/O/P	45	39	101,012	2,590	1.5%
OMTH	Motor House	E/O	45	7	18,901	2,700	0.3%
OOTH	Other Facilities	E/O	45	10	12,635	1,264	0.2%
OREC	Recreation	E/O	25	9	55,463	6,163	0.8%
OSHP	Shop/Maintenance	E/O	45	37	334,218	9,033	5.0%
OSIM	Simulator	E/O	5	1	13,726	13,726	0.2%
OWAR	Warehouse/Storage	E/O	45	102	402,098	3,942	6.0%
OLD POST COMMERCIAL SUB TOTALS				694	3,075,025		46.1%
NEW POST COMMERCIAL:							
NADM	Administration	E/HTHW	3	52	714,269	13,736	10.7%
NASS	Assembly	E/HTHW	3	4	39,920	9,980	0.6%
NBAR	Barracks	E/HTHW	3	30	1,102,549	36,752	16.5%
NCLB	Club/Restaurant	E/HTHW	3	4	51,428	12,857	0.8%
NCOM	Communications	E/HTHW	3	1	26,400	26,400	0.4%
NDGR	Dry Goods Retail	E/HTHW	3	7	115,375	16,482	1.7%
NGRO	COMMISSARY	E/HTHW	3	1	82,800	82,800	1.2%
NHOT	Hotel/Motel	E/HTHW	3	1	54,123	54,123	0.8%
NMED	Medical facility	E/HTHW	3	3	104,227	34,742	1.6%
NMES	Dining/Mess Hall	E/HTHW/G	3	6	87,367	14,561	1.3%
NMTH	Motor House	E/HTHW	3	14	8,528	609	0.1%
NOTH	Other Facilities	E/HTHW	3	13	7,026	540	0.1%
NREC	Recreation	E/HTHW	3	9	251,935	27,993	3.8%
NSHP	Shop/Maintenance	E/HTHW	3	25	465,713	18,629	7.0%
NSMA	Overhaul Facility	E/HTHW	3	1	195,670	195,670	2.9%
NWAR	Warehouse/Storage	E/HTHW	3	29	73,560	2,537	1.1%
NEW POST COMMERCIAL SUB TOTALS				200	3,380,890		50.7%

TABLE 1.1. (contd)

BUILDING TYPE	DESCRIPTION	ENERGY TYPES	AVERAGE AGE (Years)	BUILDING COUNT	TOTAL FLOORSPACE (sq ft)	AVERAGE FLOORSPACE (sq ft)	FLOORSPACE (percent)
OFF POST COMMERCIAL:							
SAGE	Communications	E/O	40	1	208,532	208,532	3.1%
OFF POST COMMERCIAL SUB TOTALS				1	208,532		3.1%
COMMERCIAL BUILDING TOTALS				896	6,664,447		100.0%

Notes:

- E: Electricity
- O: Oil
- P: Propane
- HTHW: High Temperature Hot Water
- G: Natural Gas

The new Wheeler-Sack Airfield is currently under construction east of the New and Old Post areas. Because the airfield is in the initial construction stages, the facilities were not considered in this analysis and the associated floorspace was not included in the baseline.

The SAGE facility, a 208,532-ft² building located near the Syracuse Airport, was recorded in the baseline (this report, Volume 2) but not in the development of energy conservation and fuel-switching measures (Volume 3).

1.2 BUILDING AND FACILITY PROFILE

This section includes a physical characterization by facility, including buildings, family housing, central thermal system, and utilities. For buildings, major energy sources, age, building count, and floorspace are described. The aggregate floor areas of each building type that represent a load on each feeder are tabulated. Finally, the inventories of sewage lift station motors and street-lighting equipment are documented.

1.2.1 Building Characterization

1.2.1.1 Site Commercial Facilities

The site commercial facilities at Fort Drum are divided into Old Post and New Post buildings. While functions of buildings in the two areas are similar, their construction and size are generally quite different. Thirty-five primary building categories were created based on identifiable function or uniqueness in terms of operation, construction, age, and energy use. They are representative of the building types found at the Fort. The "O" and "N" prefixes denote Old Post and New Post buildings. This prefix is followed by a three-letter code identifying the building type. The electronic buildings database supplied by the Fort provide building descriptions that were used in the following categorization.

Old Post Commercial Buildings

- OADM - Administration, headquarters, and other office type buildings with weekday operation and function. Construction is wood frame, 1940s style.
- OASS - Assembly buildings including religious and youth development facilities and classrooms. Construction is wood frame, 1940s style.
- OBAM - Barracks with attached dining facility housing unaccompanied enlisted personnel. Construction is concrete block or brick.
- OBAR - Barracks for housing unaccompanied enlisted personnel. Construction is typically wood frame.
- OCLB - Officer, enlisted, and noncommissioned officer dining facilities. Construction is typically of concrete block or brick.
- OCLD - Cold storage warehouse.
- OCOM - Communications or computer data processing facilities. Construction is typically wood frame, 1940s style.
- ODGR - Retail sales facility for non-food items including PX, craft shop, etc. Construction is typically wood frame, 1940s style.
- OHAN - Hanger for aircraft storage and maintenance. Wood frame construction.

- OHOT - Hotel/motel primarily for visiting officers billeting. Wood frame construction.
- OLAU - Laundry collection facility. No actual laundry functions performed other than clothing sorting and issue. Construction is wood frame.
- OMED - Medical service facilities including aid stations and clinics with no overnight stay or treatment capabilities. Wood frame construction.
- OMES - Dining facilities for military personnel. Wood frame construction.
- OMTB - A variety of facilities that house utility equipment; these include water pump stations, flammable fuel tank storage, and electrical switch stations. Construction is usually concrete, block, or brick.
- OOTH - All other facilities including guard stations and smaller, intermittently used buildings. Wood frame construction.
- OREC - Recreational facilities including gymnasiums, swimming pools, recreation halls, etc. Wood frame or concrete block construction.
- OSHP - Vehicle and other stationary equipment maintenance facilities, wood frame construction.
- OSIM - Battle simulation training facility of wood frame construction.
- OWAR - Warehouse and storage facilities of wood frame construction.

New Post Commercial Buildings

New Post commercial buildings provide similar functions to their Old Post counterparts. The primary differences are size (larger) and construction (concrete block or brick except as noted). The New Post building categories include

- NADM - Administration, headquarters, and other office-type buildings with weekday operation and function.
- NASS - Assembly buildings, including religious and youth development facilities, and classrooms.
- NBAR - Barracks for housing unaccompanied enlisted personnel.

- NCLB - Officer, enlisted, and noncommissioned officer dining facilities.
- NCOM - Communications or computer data processing facilities.
- NDGR - Retail sales facility for non-food items including PX, craft shop, etc.
- NGRO - The commissary building supplying retail food and household products to military personnel and dependents.
- NHOT - A government-owned motel facility serving military visitors.
- NMED - Medical service facilities, including aid stations and clinics with no overnight stay or treatment capabilities.
- NMES - Dining facilities for military personnel.
- NMTH - A variety of facilities that serve as shelters for motor and fuel storage functions including water pump stations, flammable fuel tank storage, and electrical switch housing. Concrete block or brick construction.
- NREC - Recreational facilities including gymnasiums, swimming pools, recreation halls, etc.
- NSHP - Motor vehicle and stationary equipment maintenance facilities.
- NSMA - The main vehicle overhaul facility including paint, machine, radio, and canvas shops as well as warehouse and administration facilities.
- NWAR - Warehouse and storage facilities of wood frame construction.
- NOTH - All other facilities including guard stations and smaller, intermittently used buildings.

1.2.1.2 Commercial Building Characterization

Breaking the commercial building types into Old Post and New Post, Table 1.1 provides the characterization by energy type used, age, building count, and floor area. Each "V-shaped" barracks building on the New Post was split from its attached administration wing for purposes of the analysis in this report. The barracks section was classified as NBAR and the attached administration area as NADM. For this reason, the NADM building count used in this report may not match other sources.

1.2.1.3 Family Housing Characterization

The on-post and off-post family housing units are located in areas that correspond to different construction contracts. Each of the 29 sub-areas is composed of various housing types from single family to multi-apartment complexes. Each area also contains a variety of one- to four-bedroom units. Table 1.2 provides characterization detail for each housing area. The "average floorspace" refers to the actual living unit size.

1.2.2 Utility and Other Energy-Use Characterization

Utilities at the Fort include electricity, a high-temperature hot water (HTHW) system supplied from a privately owned cogeneration plant, water, fire protection water sewage and outdoor lighting.

1.2.2.1 Electricity

Electrical service is provided by Niagara Mohawk at Substation 1, located on the south side of the Old Post, and at Substation 2, located at the northern tip of the New Post. Power enters each substation on a 115-kV delta circuit, is dropped to 13.2/7.6 kV by multi-tap (manual, not auto tap-changing) transformers, and is distributed via 15 feeder circuits. The Fort owns and operates both substations, including the primary transformers. Two 5,000-kVA transformers are located at Substation 1, and two 10,000-kVA transformers are located at Substation 2.

1.2.2.2 Central Thermal System Characterization

The central thermal high-temperature hot water system at Fort Drum is an underground distribution network of insulated pipe and conduit providing high-temperature water to much of Fort Drum's New Post area (about 100 buildings). There are approximately 25 miles of buried pipeline. System temperature ranges from 300°F in summer to 360°F in winter. Each building on the system has a heat exchanger for space heating and a separate heat exchanger for domestic water heating. The HTHW system was activated in October of 1988. High-temperature hot water is supplied to Fort Drum by heat rejected from the privately owned and operated J. A. Jones cogeneration facility and is centrally located on the railroad spur that divides Fort Drum's Old and New Post areas at 2nd Street West. The Jones facility uses bituminous and anthracite

TABLE 1.2. Fort Drum Family Housing Characterization

BUILDING TYPE	DESCRIPTION	AREA NUMBERS	ENERGY TYPES	AVERAGE AGE (Years)	BUILDING COUNT	TOTAL FLOORSPACE (sq ft)	AVERAGE FLOORSPACE (sq ft)	AVERAGE FLOORSPACE (%)
ON POST HOUSING:								
HGLE	LERAY	4700	E/O	1	15	36,556	2,437	0.6%
HGRA	RAVENWOOD	8000	E	22	88	135,268	1,537	2.2%
HGRH	RHICARD	8400	E/G	13	232	310,110	1,337	5.1%
HGRE	REMINGTON	8500	E/G	2	188	260,134	1,384	4.3%
HGBO	BOULDER	9000	E/G	2	89	147,954	1,662	2.4%
HGLI	LIBERTY	9200	E/G	2	218	320,116	1,468	5.2%
HGCL	CLIFFSIDE	9300	E/G	2	182	268,808	1,477	4.4%
HGSL	ST. LAWRENCE	9400	E/G	2	188	239,730	1,275	3.9%
HGAD	ADIRONDACK	9500	E/G	2	193	246,763	1,279	4.0%
HGSU	SUNSET	9600	E/G	2	312	399,898	1,282	6.5%
HGYO	YORKTOWN	9700	E/G	2	162	207,637	1,282	3.4%
HGWT	WINDY	9800	E/G	2	80	114,708	1,434	1.9%
	CAISSON	10800	E/G	2	150	238,154	1,588	3.9%
-A	PATTON	10900	E/G	2	75	103,979	1,386	1.7%
HGSA	SANDY ACRES	9900	E/G	2	100	153,232	1,532	2.5%
ON POST HOUSING SUB TOTALS					2,272	3,183,047		52.0%
OFF POST HOUSING:								
HGAC	ACADEMY		E/G	12	120	163,360	1,361	2.7%
HGAR	ARSENAL		E/G	12	256	382,684	1,495	6.3%
HGEB	EAST BLVD.		E/G	12	224	338,352	1,511	5.5%
HGCA	CALCIUM A		E/G	12	150	225,774	1,505	3.7%
HGCB	CALCIUM B		E/G	12	150	208,590	1,391	3.4%
HGCR	CARTHAGE		E/G	12	126	189,526	1,504	3.1%
HGWC	WEST CARTHAGE		E/G	12	122	176,262	1,445	2.9%
HGCL	CLAYTON		E/P	12	100	152,032	1,520	2.5%
HGCO	COPENHAGEN		E/P	12	75	94,125	1,255	1.5%
HGGN	GOUVERNEUR (NORTH)		E/P	12	96	136,652	1,423	2.2%
HGGC	GOUVERNEUR (LUK)		E/P	12	75	110,549	1,474	1.8%
HGEM	EVANS MILLS		E/G	12	300	440,366	1,468	7.2%
HGLO	LOWVILLE		E/P	12	56	84,304	1,505	1.4%
HGPH	PHILADELPHIA		E/P	12	150	234,808	1,565	3.8%
OFF POST HOUSING SUB TOTALS					2,000	2,937,384		48.0%
FAMILY HOUSING TOTALS					4,272	6,120,431		100.0%

Notes:

- E: Electricity
- O: Oil
- G: Natural Gas
- P: Propane

coals as primary fuel and wood chips as a secondary fuel in a fluidized-bed reactor. Fuel oil (#2) is also burned as a backup fuel. The facility has a generating capacity of approximately 50 MW, and power is sold to Niagara Mohawk.

The feeder circuits are all 4-wire wye circuits wired with number 3/0 conductors. The Old Post feeders (Fdr) are numbered Fdr0, Fdr1, Fdr2, Fdr3, Fdr4, Fdr5, and Fdr6 and are predominantly overhead lines. The Old Post transformers are predominately single-phase. There are 244 single-phase transformers, 60 three-phase banks, and 37 three-phase units. The New Post is a mix of overhead and underground distribution. The feeders are numbered A-1, A-2, A-3, A-4, B-1, B-2, and B-3. The New Post transformers are virtually all three-phase units. There are 28 112-kVA transformers, 44 500-kVA units, and 27 units in other sizes from 25 to 2,000 kVA. In addition, there are 19 streetlight transformers of 15 to 50 kVA and a number of single-phase transformers of 25 to 100 kVA capacity serving 1935 family housing units in Areas 8500, 9000-9900, 10800, and 10900. Tables 1.3 and 1.4 give the distribution of floor area by building type that is served by each feeder.

1.2.2.3 Water

Domestic water is supplied from 11 wells located in the area around the intersection of the New Post, Old Post, and new airfield (Wheeler-Sack Airfield). The aggregate capacity of the well pumps is 2,000 gpm. The aggregate connected load of the pump motors is about 100 kW. Water is pumped to the Old Post water tower where a portion is diverted to the New Post water tower, situated a couple of miles to the north.

In July 1991, delivery of water from a new source, the Development Authority of North County (DANC), commenced. The DANC system includes three 150-hp, 2000-gpm pumps owned by DANC but powered from the Old Post substation. This system is used to feed water into the Old Post water tower. The site is under contract to purchase 550 million gallons of DANC water per year, which corresponds to an average flow rate of 1,050 gpm.

**TABLE 1.3. Fort Drum Old Post Electrical Distribution
(floor area by feeder and building type)**

Building		Distribution by Feeder (Fdr)					
		Floor Area (sq. ft.)					
Type	Description	Fdr0	Fdr1	Fdr2	Fdr3	Fdr4	Fdr6
OADM	Administration	246,197	176,558	6,090	0	31,300	237,860
OASS	Assembly	49,936	74,916	0	0	9,628	0
OBAM	Barracks w/ Mess	85,139	0	0	0	0	23,446
OBAR	Barracks	750,635	557,184	0	11,682	47,536	0
OCLB	Club/Restaurant	4,336	23,750	0	0	1,750	3,717
OCLD	Cold Storage	45,319	0	0	0	0	0
OCOM	Communications	0	5,590	115	0	9,456	12,579
ODGR	Dry Goods Retail	12,258	29,716	7,824	684	0	16,584
OHAN	Hanger	0	32,540	0	0	0	0
OHOT	Hotel/Motel	0	7,728	0	0	0	0
OHSP	Hospital	0	0	0	0	0	18,480
OLAU	Laundry	4,160	0	0	0	0	9,267
OMED	Medical	0	0	0	0	61,736	21,524
OMES	Dining/Mess Hall	111,766	63,733	0	0	7,483	0
OMTH	Motor House	0	90,836	160	696	9,732	2,421
OOTH	Other Facilities	9,954	7,373	2,416	290	8,507	110
OREC	Recreation	4,576	31,757	11,579	0	0	9,440
OSHP	Shop/Maintenance	18,556	77,524	93,239	69,438	684	109,365
OSIM	Simulator	13,726	0	0	0	0	0
OWAR	Warehouse/Storage	106,196	234,370	28,531	11,866	161,548	622,680
TOTAL		1,462,754	1,413,575	149,954	94,656	349,360	1,087,473

Building		Distribution by Feeder (Fdr)					
		Floor Area (sq. ft.)					
Type	Description	Fdr0	Fdr1	Fdr2	Fdr3	Fdr4	Fdr6
OADM	Administration	840	36,936	0	0	0	1,448
OASS	Assembly	0	14,157	0	0	0	0
OBAR	Barracks	0	225,422	0	0	12,298	0
OCLB	Club/Restaurant	304	0	0	0	0	0
OMED	Medical Facility	0	0	0	0	5,484	0
OMES	Dining/Mess Hall	0	49,561	0	0	7,483	0
OMTH	Motor House	0	0	0	0	80	0
OOTH	Other Facilities	6,714	0	0	0	0	0
OWAR	Warehouse/Storage	0	76,418	7,920	0	33,130	0
TOTAL		7,858	402,494	7,920	0	58,475	1,448

**TABLE 1.4. Fort Drum New Post Electrical Distribution
(floor area by feeder and building type)**

Bldg- Type	Description	-----Floor area (sq. ft.)-----						
		A-1	A-2	A-3	A-4	B-1	B-2	B-3
NADM	Administration	106,694	141,988	131,077	0	0	98,047	236,463
NASS	Assembly	9,420	0	0	0	21,080	9,420	0
NBAR	Barracks w/Mess	0	471,140	144,462	0	0	0	486,947
NCLB	Club/Restaurant	13,310	0	1,720	4,930	0	18,199	18,199
NCOM	Communications	640	0	0	0	0	0	0
NDGR	Dry Goods Retail	0	0	0	105,820	9,555	0	0
NGRO	Commissary	0	0	0	82,800	0	0	0
NHOT	Hotel/Motel	0	0	0	54,123	0	0	0
NMED	Medical Facility	0	67,295	0	0	0	18,546	18,386
NMES	Dining/Mess Hall	0	37,013	12,730	0	0	0	37,624
NMTH	Motor House	0	212	909	757	4,740	0	360
NOTH	Other Facilities	0	143	160	326	6,066	91	240
NREC	Recreation	0	77,130	0	104,145	70,660	0	0
NSHP	Shop/Maintenance	0	52,626	153,589	83,763	18,480	0	157,255
NSMA	Overall Facility	195,670	0	0	0	0	0	0
NWAR	Warehouse/Storage	0	17,698	28,224	7,132	0	0	20,506
NFH1		0	0	0	413,366	2287747	0	0
TOTAL		325,734	865,245	472,071	857,162	2,418,328	144,303	975,980

1.2.2.4 Fire Protection Water

The fire hydrants on the airfield are supplied by a separate water distribution system. The storage tanks and main pumps are located at the new airport. Two 200,000-gallon tanks are filled from the domestic water system. The tanks are heated in the winter by boilers in the pump house; standby pressure is maintained in the hydrant system by a 25-gpm pump. Three 3,500-gpm pumps are controlled to come on-line in sequence when hydrant water is being used. The first-stage pump is powered by a 480-V motor. The second- and third-stage pumps are powered by diesel engines. Continuously energized 1.5-kW heaters maintain the diesel engine pumps at an elevated temperature for easy starting.

1.2.2.5 Sewage

Two 30-hp pumps and one 25-hp pump operate at a plant on the Old Post to lift effluent from Old Post facilities to the Development Authority plant. The main Old Post lift station is fed by 11 small lift stations that have an

aggregate connected pump load (lead pumps only) of 63 hp. The main New Post lift station is equipped with three 250-hp, variable-speed drive (VSD) pumps. It is fed by two smaller lift stations having an aggregate pump load (lead pumps only) of 95 hp. The sewage collection system used 340,000 kWh in 1991. Table 1.5 provides an inventory of the sewage lift station motors at the Fort and their location and pump motor size.

1.2.2.6 Outdoor Lighting

The New Post streets are illuminated by 1,288 pole-mounted, 250-W, high-pressure sodium lamps. A ballast for this type lamp typically dissipates 63 W. The main entrance road and portions of Memorial Drive, Ring Roads 1 and 3, Fourth Street East, and Conway Road are wide, four-lane, divided thoroughfares with lamps on both sides. These sections contain 662 lamps mounted on poles spaced approximately 230 feet apart. All other streets have lamps on one side only with poles spaced approximately every 200 feet. The lamp circuits are powered by 19 three-phase transformers of 15, 25, 37.5 and 50 kVA capacity. Each transformer powers two, three, or four streetlamp circuits and may power a traffic-signal circuit or an HTHW loop manhole sump pump as well.

TABLE 1.5. Sewage Lift Station Motor Inventory

Bldg# Location or Area	-----Motor size (hp)-----		
	motor 1	motor 2	motor 3
2162 Old Sewage Plant	30	25	30
2466	5	5	0
4779 4800 Area	7.5	7.5	0
11470 Po Valley & 4th St.	90	90	0
1388	5	5	0
8055	10	10	0
NA 8400 Area Housing	5	5	0
NA 8300 Area Housing	5	5	0
2053	3	3	0
2058	7.5	7.5	0
2069	5	5	0
11000 North Gate	250	250	250
NA 4700 Area Housing	5	5	0
2600 currently serves 1 trailer	5	5	0
8500 Area Housing	5	5	0

Streetlamp circuits contain from 10 to 40 lamps and are controlled by astronomical clocks to turn on about 15 minutes after sunset and off about 15 minutes before sunrise. Table 1.6 inventories the transformers used for streetlights and traffic signals on the New Post.

The Old Post streets are illuminated by 250 pole-mounted, 400-W mercury-vapor lamps and 200 pole-mounted, 250-W high-pressure sodium lamps. The Old Post lamps are powered from any convenient transformer, since the Old Post buildings are served by pole-mounted transformers along the streets. These transformers exist at frequent intervals along nearly all of the Old Post streets. Because on-post housing areas are illuminated by efficient 250-W high-pressure sodium lamps, the number of streetlamps in the housing areas was not incorporated into the baseline.

TABLE 1.6. New Post Streetlight, Traffic Signal, and Transformer Inventory

Transformer Name	Transformer Rating (kVA)	Feeder Number	Quantity of Lighting Circuits per Transformer	-----Connected Load (kW)-----			
				Street Light		Traffic Signal	
				Qty	kW	Qty	kW
TR- 1	25.0	B-1	4	60	18.8	0	0.0
TR- 2	25.0	B-1	3	62	19.4	0	0.0
TR- 3	37.5	A-4	4	71	22.2	24	2.8
TR- 4	50.0	A-4	4	129	40.4	24	2.8
TR- 5	37.5	B-1	4	80	25.0	42	4.9
TR- 6	50.0	A-2	4	94	29.4	0	0.0
TR- 7	37.5	A-4	4	79	24.7	26	3.0
TR- 8	25.0	A-1	4	55	17.2	0	0.0
TR- 9	37.5	A-3	2	66	20.7	45	5.2
TR-10	37.5	A-4	4	96	30.0	36	4.2
TR-11	37.5	B-1	4	77	24.1	48	5.6
TR-12	25.0	A-4	4	51	16.0	35	4.1
TR-13	37.5	A-4	4	85	26.6	32	3.7
TR-14	37.5	B-3	2	46	14.4	0	0.0
TR-15	25.0	A-1	4	50	15.7	0	0.0
TR-16	25.0	A-1	4	48	15.0	0	0.0
TR-17	15.0	A-2	4	41	12.8	0	0.0
TR-18	15.0	B-3	4	40	12.5	0	0.0
TR-19	25.0	A-3	4	58	18.2	0	0.0
Total:	605.0		71	1288	403.1	312	36.2

2.0 ENERGY SOURCE CHARACTERISTICS

This section describes energy source characteristics at Fort Drum.

Table 2.1 summarizes the typical yearly energy consumption and cost at the Fort for all on-post facilities, off-post housing, and the SAGE facility. For each energy type, the yearly total is shown in units appropriate to the energy type and in a common unit as a basis for comparison (1 MBtu = 1,000,000 British thermal units). The total consumption values represent typical current yearly usage, from the best available data during 1990 and 1991. In some cases, they are a combination of various yearly or billing consumption amounts and do not match consumption values for any year or values found in Fort Drum DEIS reports. We consider these values representative of normal Fort operational energy consumption.

TABLE 2.1. Typical Yearly Energy Consumption and Energy Cost at Fort Drum

Energy Type	Yearly Total	Yearly Total [MBtu (a)]	Percent of Total Energy Consumption	Energy Cost [1990\$ x 10 ³]	Percent of Total Cost
Electricity	105,849 MWh	361,260 ^(b)	22.6	5,523	46.4
Natural Gas	3,857 ktherm	385,720 ^(c)	24.1	2,353	19.8
#2 Fuel Oil	2,407 kgallon	334,146 ^(d)	20.9	1,661	14.1
Propane	652 kgallon	59,524 ^(e)	3.7	358	3.0
HTHW	458,048 MBtu	458,048 ^(f)	28.6	1,967	16.5
Coal	98 ton	2,205	0.1	9	0.01
TOTALS:		1,600,903	100.0	11,891	100.0

(a) 1 MBtu = 1,000,000 Btu.

(b) 3,413 Btu/kWh.

(c) 100,000 Btu/therm; 1,050 Btu/ft³ of natural gas.

(d) 0.1388 Btu/gal of #2 fuel oil.

(e) 0.0913 Btu/gal of propane.

(f) 22.5 Btu/ton of coal.

2.1 ELECTRIC SUPPLY SOURCE DESCRIPTION

2.1.1 Purchased Electricity

Billing records for a typical year (FY 1990) indicate on-post use of 84,000 MWh at an average cost of \$0.05 per kWh. Electricity is billed under a two-tiered time-of-use rate structure designated SC-3A. The on-peak period is from 08:00 to 22:00 weekdays except for six holidays. The off-peak period covers all other times. The rate in effect in 1990 and the first half of

calendar year 1991 was \$0.04834 per on-peak kWh, \$0.03456 per off-peak kWh, \$4.69 per on-peak kW, and \$0.76 per excess kVAR. No demand charges are levied on off-peak demand. The rate that has been in effect since July 1, 1991, is \$0.05859 per on-peak kWh, \$0.04382 per off-peak kWh, \$5.51 per on-peak kW, and \$0.83 per excess kVAR. Excess reactive demand for a given month is defined as peak kVAR minus one-third the on-peak demand. These rates are for SC-3A customers who receive power at transmission voltages of 65 kV or higher.

Off-post housing areas are on a flat rate. Off-post housing used 12,500 MWh at a cost of \$0.067 per kWh. One off-post housing area is served by the Philadelphia Electric Utility, a municipal utility serving the town of Philadelphia, a few miles northwest of Watertown. The SAGE facility used 7,300 MWh in FY 1990 at an average cost of \$0.050 per kWh. The total Fort electricity use was 105,849 MWh (361,260 MBtu) for a total cost of \$5,523,000 including demand charges. This is 22.6% of the energy (MBtu basis) used at the Fort in FY 1990 and 46.4% of the Fort's total energy cost.

2.1.2 Onsite Electric Generation

Table 2.2 characterizes the diesel generators at the Fort. There are 12 diesel generators with 50-kVA or greater capacity and these generators, along with the smaller capacity generators, have a total capacity of 3,293 kVA. The 12 largest generators currently provide emergency power for critical buildings and for the three largest sewage lift stations. The smaller lift stations and two of the domestic water wells have emergency generators of under 50-kVA capacity.

The J. A. Jones cogeneration plant is currently not connected into the Fort's electrical distribution. It could, however, be connected to an existing feeder that runs between Substations 1 and 2 and passes close to the plant. This action might be considered if the current contract for operating the plant were to be modified.

2.2 GAS SUPPLY SOURCE DESCRIPTION

This section describes the distribution and use of gas at the Fort. The total FY 1990 natural gas consumption at the Fort was 3,857 ktherms

TABLE 2.2. Diesel Generators at Fort Drum

Bldg# Function	KVA	Volts
1 MP Station	5	120/240
2570 Control Tower	15	120/240
36 Wilcox Clinic	20	480
36 UCC	20	480
8400 Lift Stn (New Hsg)	22.5	480
2466 Lift Stn (old Hosp)	30	480
2600 Lift Stn (Trailer Crt.)	30	480
1388 Lift Stn	30	208
4779 Lift Stn (4800 Area)	30	208
8041 Lift Stn (Old Hsg)	45	208
2573 Well#3	70	208
2534 Well#5	70	208
10730 Commissary	75	480
2312 Telephone Exchange	100	480
11470 Lift Station	130	480
10730 New PX	150	480
8000 Lift Stn (Conway Rd-Rec Ctr)	150	480
11050 Guthrie Clinic #1	275	480
11050 Guthrie Clinic #2	275	480
2162 Lift Stn (Old Sewage Plant)	350	480
10000 Command Bldg	350	480
1100 ISF (Computer Center)	450	480
11000 Lift Stn (N.Entry)	600	480
Total	3292.5	

(385,720 MBtu) at an average cost of \$0.61/therm, for a total cost of \$2,353,000. This is 24.1% of the overall energy use (MBtu basis) at the Fort and 19.8% of the Fort's total energy cost. Table 2.3 shows a breakout of the gas used at the Fort.

TABLE 2.3. Gas Supply Source Description

<u>Building Area</u>	<u>Yearly Total (ktherms)</u>	<u>Yearly Total (MBtu)</u>	<u>Percent of Total</u>
On-Post Housing	2,258	225,842	58.6
New Post Commercial	221	22,088	5.7
Off-Post Housing	<u>1,378</u>	<u>137,789</u>	<u>35.7</u>
Totals:	3,857	385,719	100.0

Fort Drum purchases most of its natural gas from Hudson Bay Natural Gas Corporation (Hudson Bay NGC), with supplemental gas provided by Niagara Mohawk. The Hudson Bay NGC contract extends through May 31, 1993, after which the Fort will be required to purchase gas through Niagara Mohawk or contract through the Defense Fuel Supply Center (DFSC). The estimated annual service is 3,520,000 therms (352,000 MBtu), with an hourly peak demand of 110,000 therms and a daily demand peak of 220,000 therms.

2.2.1 On-Post Housing

Niagara Mohawk supplies natural gas to the New Post housing at Fort Drum under SC8 and SC6 rate schedules. Under schedule SC8, Niagara Mohawk provides transportation service and standby sales service to its customers, such as Fort Drum, who purchase gas from a separate source. Niagara Mohawk customers on SC8 must also take schedule SC6, a supplemental gas service schedule which is available from the utility on a best-effort, interruptible basis. Under SC6, Niagara Mohawk provides gas to the Fort when the monthly amount used by the Fort exceeds the amount the base ordered from its supplier.

Gas metering and billing is performed by Niagara Mohawk. The point of entry for natural gas at Fort Drum is at the North Entry Road and Route 11. Twelve-inch main lines distribute gas throughout the New Post to on-post housing (with the exception of the Ravenwood and LeRay complexes) and to selected commercial buildings in various locations. Main distribution lines are reduced from 12- to 8- and 6-in. lines and eventually to 4-, 2-, and 1.5-in. service lines. Natural gas consumption in FY 1990 for on-post housing was 2,258,417 therms (225,842 MBtu) or 58.6% of the overall gas usage.

2.2.2 New Post Commercial

Commercial buildings on the New Post used 220,884 therms (22,088 MBtu) or 5.7% of the overall gas usage. The primary use for the gas in the commercial buildings on the New Post is for cooking; however, several buildings also use gas for space and water heating.

2.2.3 Off-Post Housing

Niagara Mohawk also provides natural gas service to the off-post Army-commissioned housing under residential rate schedule SC1. Housing units are

individually metered and Niagara Mohawk reads the meters bimonthly. Annual natural gas consumption for off-post housing is approximately 1,377,890 therms (137,789 MBtu) or 35.7% of the overall gas usage.

2.3 OIL SUPPLY SOURCE DESCRIPTION

Fuel oil #2 is used primarily for space and water heating in Old Post commercial buildings, and also to fuel emergency generators and several scattered boilers on the New Post. The exception is the LeRay family housing area, which uses oil heat. In addition, the SAGE complex currently uses oil, although conversion to gas is under way. Most of the fuel oil is stored in underground storage tanks with capacities that range from 300 to 30,000 gallons. A few 275-gallon-capacity above-ground tanks store fuel oil for water heaters in the few remaining buildings on the Old Post that burn coal for space heating.

The Fort has two fuel oil supply contracts, one for large storage tanks and the other for small tanks. Local vendors compete annually for the fuel oil contracts, which are based on prevailing worldwide oil prices and include an adder fee for the distributor. The winning distribution companies are required to keep the tanks full, which involves frequent monitoring and refilling. In FY 1990, Fort Drum purchased 2,407,383 gallons of fuel oil #2 (334,146 MBtu) at a price of \$0.69/gallon, for a total cost of \$1,661,000. Fuel oil use represents 20.9% of the total energy use (MBtu basis) at the Fort and 14.1% of the Fort's total energy cost.

2.4 PROPANE SUPPLY SOURCE DESCRIPTION

In FY 1990, 651,964 gallons of propane (59,524 MBtu) was used at Fort Drum at a cost of \$0.5494/gallon, for a total cost of \$358,000. Propane is used for space heating, water heating, and cooking at five off-post Army Community Housing areas. The Old Post propane is principally used for cooking in the mess halls and at some of the Army/Air Force Exchange Services (AAFES) facilities. Propane is not used on the New Post. Propane is purchased from two local distributors on an annual contract basis. Off-post housing propane is stored in underground tanks, while the Old Post propane is kept in

above-ground tanks situated near the points of use. The propane storage tanks are refilled about once a month. Propane use represents 3.7% of the total energy use (MBtu basis) on the base and 3.0% of the Fort's total energy cost.

2.5 COAL SUPPLY SOURCE DESCRIPTION

Coal is used on a very limited basis on the Old Post for firing commercial warm-air furnaces; it is delivered to a central stockpile as needed. Small reserves are kept in cement bins behind buildings adjacent to each building's mechanical room. The use of coal as a primary fuel for boilers is being phased out at Fort Drum. Most of the few buildings that still burn coal for heating in the winter are scheduled for demolition by 1995.

2.6 PURCHASED THERMAL CAPACITY SOURCE DESCRIPTION

The J. A. Jones cogeneration plant provides high-temperature water through approximately 25 miles of buried insulated pipe ranging in diameter from 2 to 16 inches. The water is supplied to the Fort at approximately 360°F in the winter months and 300°F in the summer months. This high-temperature water exchanges its heat within each building via shell and tube heat exchangers, providing for both space heating and hot water needs.

Heat-loss (i.e., line-loss) calculations were made to estimate the line-loss from the buried pipeline. Estimations of line-loss indicate the heat loss from the system is between 170,000 and 180,000 MBtu per year.

In FY 1990, the J. A. Jones cogeneration plant reported 458,048 MBtu of heat used by buildings served at the Fort. The average fuel charge was \$4.295 per MBtu, for a total charge of \$1,967,000. Purchased thermal capacity represents 28.7% of the energy (MBtu basis) used at the Fort and 16.5% of the Fort's total energy cost.

3.0 ENERGY-USE INTENSITIES

Energy-use intensity (EUI) values are used to help develop baseline consumption for various building types when metered data are not available. This section describes the regional EUI information that was gathered for use in the energy assessment at Fort Drum. Tables 3.1, 3.2, and 3.3 display the basic regional information that was collected. Tables 3.4 and 3.5 summarize the regional EUI data for the building types that exist at Fort Drum. These data provide a range of reasonable EUI values from which site-specific values were based. Tables 3.6 and 3.7 contain the final, site-specific EUI values used for the Fort Drum assessment.

3.1 INITIAL ENERGY-USE INTENSITIES DATA

Energy-use intensities are defined as energy use per unit area, per unit time. EUIs are commonly expressed as thousands of British thermal units per square foot per year (kBtu/ft²-yr), or kilowatt hours per square foot per year (kWh/ft²-yr).

Tables 3.1 through 3.3 summarize the results of several regional end-use EUI surveys. EUIs are estimated by building type, fuel type, and fuel end use. Energy use is expressed in kWh/ft²-yr for electric and kBtu/ft²-yr for fossil fuel EUIs. End-use data are for space heating, cooling, ventilation, domestic hot water (DHW), cooking, lighting (interior and exterior), refrigeration, and "other," which covers various electrical appliances and motors and water/steam heating for laundry or food preparation. Significant differences in how the surveys defined the "other" category are noted in the tables.

Tables 3.1 and 3.3 present the survey and analysis results reported by Xenergy, the Residential Energy Consumption Survey (RECS), and Commercial Buildings Energy Consumption Survey (CBECS). Results of the American Council for an Energy Efficient Economy (ACEEE) analysis of residential end-use EUIs are also included. The electric end-use results are given in Table 3.1, and fossil fuel results are provided in Table 3.3. Table 3.2 presents the electric end-use analysis results reported by ACEEE, Commercial Energy Demand Modeling Systems (CEDMS), Consolidated Edison, Niagara Mohawk Power Company (NMPC), and Massachusetts Electric.

TABLE 3.1. Regional Electric EUI Survey Results (kWh/ft²-yr)

	<u>Heat</u>	<u>Cool</u>	<u>Vent</u>	<u>DHW</u>	<u>Cook</u>	<u>Light</u>	<u>Ref</u>	<u>Other</u>	<u>Total</u>
Single-Family Residence									
Xenergy	--	--	--	--	--	--	--	--	--
NYSEO ^(a)	5.95	0.85	--	2.75	0.55	--	0.94	2.00 ^(c)	13.04
ACEEE ^(b)	6.62	0.77	--	1.83	0.40	0.51	1.08	0.78 ^(e)	11.99
RECS NE ^(d)	--	--	--	--	--	--	--	--	12.51
RECS MA ^(f)	--	--	--	--	--	--	--	--	10.71
Multi-Family Residence									
Xenergy	--	--	--	--	--	--	--	--	--
NYSEO ^(g)	7.32	1.13	--	3.43	0.75	--	1.38	1.32	15.33
ACEEE	--	--	--	--	--	--	--	--	--
RECS- NE	--	--	--	--	--	--	--	--	--
RECS MA	--	--	--	--	--	--	--	--	--
Hotel									
Xenergy ^(h)	12.59	1.38	0.85	3.89	10.84	4.39	1.69	2.91 ⁽ⁱ⁾	38.54
NYSEO ^(j)	11.99	1.37	0.79	3.98	7.88	3.75	0.81	1.64 ^(e)	32.21
CBECS ^(k)	--	--	--	--	--	--	--	--	11.19
Office									
Xenergy	16.23	1.87	1.05	1.29	3.13	5.62	3.37	4.51 ⁽ⁱ⁾	37.07
NYSEO	13.78	2.75	1.75	0.87	2.14	6.50	0.27	3.50 ^(e)	31.56
CBECS	--	--	--	--	--	--	--	--	19.95
Grocery^(l)									
Xenergy ^(m)	21.86	2.60	2.02	1.08	4.48	15.97	23.03	3.19 ^(e)	74.23
NYSEO ⁽ⁿ⁾	20.79	2.68	1.98	1.08	4.34	14.96	24.92	5.80 ^(e)	76.55
CBECS ^(o)	--	--	--	--	--	--	--	--	--
Restaurant									
Xenergy ^(p)	12.89	1.70	1.08	3.95	34.9	7.06	7.06	1.87 ^(e)	70.51
NYSEO ^(q)	19.10	1.90	0.82	4.65	47.57	5.94	8.71	2.86 ^(e)	91.55
CBECS ^(r)	--	--	--	--	--	--	--	--	18.63
Hospital									
Xenergy ^(s)	26.54	1.49	2.02	5.86	9.08	5.01	0.44	9.73 ⁽ⁱ⁾	60.17
NYSEO ^(t)	21.59	1.46	1.84	5.22	8.21	4.48	0.65	4.78 ^(e)	48.23
CBECS ^(u)	--	--	--	--	--	--	--	--	18.17
Retail									
Xenergy ^(v)	11.75	2.14	1.08	0.38	2.11	5.33	3.31	2.08 ⁽ⁱ⁾	28.18
NYSEO ^(w)	11.87	2.17	0.79	0.36	1.82	4.34	1.82	2.86 ^(e)	26.03
CBECS ^(x)	--	--	--	--	--	--	--	--	9.93
Warehouse									
Xenergy ^(y)	15.96	1.35	0.56	0.18	4.72	1.73	0.59	0.79 ^(e)	25.88
NYSEO ^(z)	2.50	1.81	0.51	0.31	--	2.04	3.76	1.99 ^(e)	12.92
CBECS ^(aa)	--	--	--	--	--	--	--	--	6.65

TABLE 3.1. (contd)

Notes for Table 3.1:

- (a) NYSEO data available only as UEC (unit energy consumption); EUI based on 1500 ft² per residence.
- (b) ACEEE data available only as UEC. EUI calculated assumes 1750 ft² per residence for all but space heating end use where the DOE-2 estimate of 2200 ft² per single family residence was used.
- (c) Defined as miscellaneous EUI, includes lighting.
- (d) RECS NE data is for the New England region. EUI based on 1500 ft² per residence.
- (e) Defined as miscellaneous EUI.
- (f) RECS MA data is for the Mid Atlantic region. EUI based on 1500 ft² per residence.
- (g) NYSEO data available only as UEC (unit energy consumption). EUI based on 1000 ft² per residence.
- (h) Xenergy data for hotel/motel category, includes lodging only (26.9%) and multi-function (73.1%).
- (i) Defined as miscellaneous and process EUI.
- (j) NYSEO data for hotel category.
- (k) CBECS data for lodging category.
- (l) Xenergy data for food store category, includes grocery/food store (91%) and convenience market (9%).
- (m) NYSEO data for grocery category.
- (n) CBECS data for food sales category.
- (o) Xenergy restaurant category includes fast food (10.2%), bar/tavern (38.4%), full service (51.4%).
- (p) NYSEO data for restaurant category.
- (q) CBECS data for food services category.
- (r) Xenergy data for hospital category.
- (s) NYSEO data for medical center category.
- (t) CBECS data for health care category.
- (u) Xenergy retail category includes miscellaneous (51.1%), department store (26.6%), auto dealer (20.3%).
- (v) NYSEO data for retail store category.
- (w) CBECS data for mercantile/service category.
- (x) Xenergy data for non-refrigerated warehouse category.
- (y) NYSEO and CBECS data include both refrigerated and non-refrigerated warehouses.

TABLE 3.2. Saturation-Weighted Electric EUI Survey Results (kWh/ft²-yr)

	<u>HVAC^(a)</u>	<u>Lighting</u>	<u>Miscellaneous^(a)</u>	<u>Total</u>
Hotel				
ACEEE	7.7	3.3	1.9	12.9
CEDMS	8.5	4.7	2.3	16.8
Con Ed	2.8	3.4	4.9	11.1
NMPC	5.7	4.0	4.4	14.2
Mass. Elec.	5.2	3.9	4.6	13.7
Office				
ACEEE	16.5	6.6	1.0	24.1
CEDMS	6.8	8.9	0.3	16.2
Con Ed	1.9	6.2	7.6	16.0
NMPC	5.1	5.2	4.3	14.5
Mass. Elec.	4.2	3.3	3.2	10.7
Grocery				
ACEEE	6.1	12.4	34.5	52.9
CEDMS	5.7	12.7	32.5	51.1
Con Ed	4.6	12.4	39.8	56.7
NMPC	5.8	15.7	27.1	48.6
Mass. Elec.	5.6	8.0	13.3	26.9
Ft. Lewis ^(b)	--	--	--	49.0
Hospital				
ACEEE	8.3	6.0	3.9	18.2
CEDMS	5.9	7.3	2.3	16.2
Con Ed	1.9	4.4	8.1	14.4
NMPC	4.7	5.0	8.9	18.6
Mass. Elec.	6.4	6.8	10.8	24.0
Retail				
ACEEE	12.8	6.2	0.5	19.4
CEDMS	4.8	6.1	0.2	11.1
Con Ed	2.0	6.4	5.1	13.5
NMPC	1.9	5.1	2.0	9.0
Mass. Elec.	1.3	4.4	1.5	7.2

(a) Definitions of HVAC & Misc end use differ among studies for all building types.

(b) Based on metered data for Fort Lewis Commissary, built in 1987.

TABLE 3.3. Regional Fossil Fuel EUI Survey Results (kBtu/ft²-yr)

	<u>Heating</u>	<u>DWH</u>	<u>Cooking</u>	<u>Other</u>	<u>Total</u>
Single Family Residence					
NG-NYSEO ^(a)	65.27	19.73	6.33	--	91.33
NG-RECS N.E. ^(b)	--	--	--	--	82.3
NG-RECS	--	--	--	--	78.3
FO-NYSEO	47.67	14.56	--	--	62.23
FO-RECS	--	--	--	--	71.4
FO-RECS	--	--	--	--	74.47
LP-NYSEO	--	--	8.26	--	8.26
LP-RECS N.E. ^(c)	--	--	--	--	6.6
LP-RECS M.A.	--	--	--	--	--
Multi-Family Residence					
NG-Xenergy	--	--	--	--	--
NG-NYSEO ^(d)	81.2	24.1	8.6	--	113.9
FO-Xenergy	--	--	--	--	--
FO-NYSEO	59.53	18.58	--	--	78.11
LP-Xenergy	--	--	--	--	--
LP-NYSEO	--	--	11.6	--	11.6
Hotel					
NG-Xenergy ^(e)	71.7	15.1	23.7	8.3 ^(f)	118.8
NG-NYSEO ^(g)	67.38	26.72	5.96	0.53 ^(h)	100.59
NG-CBECS ⁽ⁱ⁾	--	--	--	--	46.2
FO-Xenergy	169.4	24.	5.9	--	199.3
FO-NYSEO	67.38	13.54	--	--	80.92
FO-CBECS	--	--	--	--	--
LP-Xenergy	45.9	12.6	52.3	--	110.8
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--
Office					
NG-Xenergy	73.5	31.6	14.8	13.5 ^(j)	133.4
NG-NYSEO	77.44	6.65	9.04	0.15 ^(h)	93.28
NG-CBECS	--	--	--	--	26.9
FO-Xenergy	83.0	16.5	--	0.9 ^(h)	100.4
FO-NYSEO	77.4	43.19	--	--	80.63
FO-CBECS	--	--	--	--	36.4
LP-Xenergy	212.0	7.7	27.9	--	247.6
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--
Grocery Store					
NG-Xenergy ^(k)	107.2	3.5	11.1	--	121.8
NG-NYSEO ^(l)	116.84	14.73	58.46	3.14 ^(h)	193.17
NG-CBECS ^(m)	--	--	--	--	--
FO-Xenergy	46.9	--	--	--	46.9
FO-NYSEO	116.84	2.4	--	--	119.24
FO-CBECS	--	--	--	--	--
LP-Xenergy	89.2	--	--	--	89.2
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--

TABLE 3.3. (contd)

	Heating	DWH	Cooking	Other	Total
Restaurant					
NG-Xenergy ⁽ⁿ⁾	76.7	20.4	160.4	5.1 ^(f)	262.6
NG-NYSEO ^(o)	107.34	41.01	125.31	3.6 ^(h)	277.26
NG-CBECS ^(p)	--	--	--	--	144.3
FO-Xenergy	113.2	37.0	--	--	150.2
FO-NYSEO	107.34	83.81	--	--	191.15
FO-CBECS	--	--	--	--	--
LP-Xenergy	192.0	18.9	90.5	7.3 ^(f)	308.7
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--
Hospital					
NG-Xenergy ^(q)	314.3	20.6	44.2	198.1 ^(j)	577.2
NG-NYSEO ^(r)	121.34	15.15	12.81	1.13 ^(h)	150.43
NG-CBECS ^(s)	--	--	--	--	97.1
FO-Xenergy	131.1	32.7	44.9	98.6 ^(j)	307.3
FO-NYSEO	121.34	28.81	--	--	150.15
FO-CBECS	--	--	--	--	--
LP-Xenergy	--	--	38.5	--	38.5
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--
Retail Store					
NG-Xenergy ^(t)	63.3	7.1	10.7	--	81.1
NG-NYSEO ^(u)	66.71	5.86	11.94	2.66 ^(h)	87.17
NG-CBECS ^(v)	--	--	--	--	29.1
FO-Xenergy	71.7	2.6	--	--	74.3
FO-NYSEO	66.71	2.05	--	--	68.76
FO-CBECS	--	--	--	--	54.2
LP-Xenergy	62.9	1.7	22.1	3.6 ^(f)	90.3
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--
Warehouse					
NG-Xenergy ^(w)	37.6	1.2	16.1	4.0 ^(f)	58.9
NG-NYSEO ^(x)	14.05	1.14	6.56	0.65 ^(h)	22.4
NG-CBECS ^(x)	--	--	--	--	24.2
FO-Xenergy	83.9	0.9	--	9.8 ^(f)	94.6
FO-NYSEO	14.05	0.17	--	--	14.22
FO-CBECS	--	--	--	--	34.1
LP-Xenergy	104.4	--	--	--	104.4
LP-NYSEO	--	--	--	--	--
LP-CBECS	--	--	--	--	--

TABLE 3.3. (contd)

Notes for Table 3.3:

- (a) NYSEO data available only as UEC (unit energy consumption). EUI calculated assumes 1500 ft² per single family residence.
- (b) RECS N.E. data for New England region. RECS N.E. data available only as UEC (unit energy consumption). EUI calculated assumes 1500 ft² per single-family residence.
- (c) RECS M.A. data for Mid Atlantic region. RECS M.A. data available only as UEC (unit energy consumption). EUI calculated assumes 1500 ft² per single-family residence.
- (d) Data available only as UEC (unit energy consumption). EUI calculated assumes 1000 ft² per multi-family residence.
- (e) Xenergy data for hotel/motel category, includes lodging-only (26.9%) and multi-function (73.1%).
- (f) Defined as process EUI.
- (g) NYSEO data for hotel category.
- (h) Defined as miscellaneous EUI.
- (i) CBECS data for lodging category.
- (j) Defined as process EUI, includes cooling.
- (k) Xenergy data for food store category, includes grocery/food store (91%) and convenience market (9%).
- (l) NYSEO data for grocery category.
- (m) CBECS data for food sales category.
- (n) Xenergy data for restaurant category, includes fast food (10.2%), bar/tavern (38.4%) and full service (51.4%).
- (o) NYSEO data for restaurant category.
- (p) CBECS data for food service category.
- (q) Xenergy data for hospital category.
- (r) NYSEO data for medical center category.
- (s) CBECS data for health care category.
- (t) Xenergy data for retail category, includes miscellaneous (51.1%), major department stores (24.6%) and auto dealer (20.3%).
- (u) NYSEO data for retail store category.
- (v) CBECS data for mercantile/service category.
- (w) Xenergy data for non-refrigerated warehouse.
- (x) NYSEO and CBECS data for refrigerated and non-refrigerated warehouse.

The results reported in Table 3.1 have been segregated from the results reported in Table 3.2 because different reporting conventions were used. The saturation-weighted electric EUIs found in Table 3.2 were included for documentation completeness but were not used in developing the Fort Drum electric EUIs found in Table 3.5. These EUIs are not as useful as those found in Table 3.1 because their end-use categories are more general. In addition, because saturation-weighted EUIs were developed by dividing general building EUIs and weighing the results by fuel type, they are not as accurate for our purposes as the EUIs found in Table 3.1. Therefore, the discussion that follows pertains to Tables 3.1 and 3.3.

While some of the EUI values correlate very well among the surveys for a given building type, fuel type, and end use, other values do not. The largest discrepancy is between the CBECS survey and the other two surveys. In most cases, the CBECS values are lower than the values from the other two surveys, in some cases by a factor of one-half to one-third. There are a number of explanations for these discrepancies.

One possible explanation for the discrepancies is that the CBECS data are not specific to one particular utility service territory; rather, the data are for nine states that make up the northeast region of the United States. In this region, a large fraction of the population resides in coastal cities, which have relatively mild winter climates that result in relatively low heating EUIs.

A second factor contributing to lower CBECS values is the CBECS EUI reporting convention. CBECS reports EUIs by building type and fuel but does not report the proportions of the different fuels used for each end use. The resulting EUIs represent an average of some, but not all, end uses for a given building and fuel type. The CBECS EUIs are therefore expected to be lower than the EUIs that represent all end uses, as is the case for the EUIs reported by Xenergy and New York State Energy Office (NYSEO).

Discrepancies between data from the two sources specific to the Niagara Mohawk service area are significant for some building types. Again, there are a number of possible reasons for these discrepancies.

One possible reason for discrepancies is variation in building geometry (size and shape) sampled by each survey. Small buildings of a given building type are generally less energy intensive (lower EUI) than large buildings. The number of stories also affects the energy-use intensity of a building. A building having 100,000 ft² and five stories would be expected to have a lower heating EUI than a 100,000-ft², one-story building.

A second possible source of discrepancy is variation in function within a building type category. The hospital category is a good example. Xenergy reports an electric EUI of 60.17 kWh/ft²-yr for the hospital category. NYSEO reports an electric EUI of 48.23 kWh/ft²-yr but includes medical centers as well as hospitals in the building-type category. Medical centers tend to be smaller, less energy-intensive buildings than hospitals and would therefore be expected to have a lower average EUI.

Other factors that can contribute to the discrepancies are building age, construction type, occupant density, and implemented energy conservation measures. All these factors can lead to significant variation in average EUI for a given building type category.

3.2 ENERGY END-USE VALUES

A primary product of the energy consumption analysis for Fort Drum is a set of site-specific EUI values for the building types and end uses at the base. The EUIs have been determined from aggregate, rather than directly measured, energy deliveries. Some error is inevitable in the disaggregation process; however, these EUI estimates are consistent with all available energy use records and are consistent with regional estimates of energy use by building type. The estimates are therefore considered to be sufficiently accurate for identifying and ranking energy projects. More detailed connected load inventories of targeted end-use equipment should be obtained in many cases prior to implementation of the conservation and efficiency measures recommended in Volume 1 of this report.

The initial step in estimating site-specific EUIs was to assess all available regional and published EUI data that might be applicable to Fort Drum (see Section 3.1 for descriptions). After reviewing all sources and matching existing data building types with Fort Drum building types, a set of initial EUI values was created. This set of values provides a range of reasonable EUI values within which the site-specific values are expected to fall.

Table 3.4 shows the minimum, maximum, and median electric EUI values derived from the regional and published data that were found to be applicable to Fort Drum. The minimum end-use EUIs are 25% to 90% of the median, and the maximum end-use EUIs range from 110% to 200% of the corresponding median. The minimum whole-building EUIs are 40% to 85% of the median, and the maximum whole-building EUIs range from 115% to 190% of the corresponding median. The data on commissary, club/dining facilities, and family housing show the best agreement among the regional studies; the EUIs for warehouses exhibit the greatest disparity.

Table 3.5 shows the minimum, maximum, and median fossil EUI values derived from the regional and published data that were found to be applicable to Fort Drum.

3.3 ENERGY USE BY BUILDING TYPE AND END USE

The final step in EUI development was completed as part of the final allocation of energy process (Volume 4 of this series will contain details on the methodology of this process). This process incorporates various factors that influence energy consumption (and hence EUIs) among buildings, including weather, occupancy, construction, age, operation, and function. In some cases, actual building metering data or single-building-type area metering provided an exact whole-building EUI for a particular building type. In other cases, EUI values are derived by an energy balance method. This procedure accounts for all energy use at the Fort while apportioning it as accurately as possible among the building types and other uses.

Tables 3.6 and 3.7 detail the EUI values for the end uses and building types represented at Fort Drum. The EUI values are shown for building types that use a particular fuel for a specific end use. For example, the existence

TABLE 3.4. Regional Electric EUIs (min/median/max) Applied to the Fort Drum EUI Analysis

Building Type	Min/Median/Max End-Use EUIs Given in kWh/ft ² -yr				
	Cooling	Ventilation	Lighting	Refrigeration	Other
Family Housing	5/6/8	NA	0.3/0.7/1	0.8/1/1.4	1/1.5/2
Barracks (a)	10/11/13	0.5/0.75/1	2/4/6	0.5/1/2	1/2/3
Office/Admin.	10/15/20	0.75/1/2	4/5.5/7	0.5/2/4	2/3.5/5
Commissary	2/2.5/3	1/1.75/2.5	13/15/17	20/23/25	7/9/11
Club/Dining Hall	1/2/3	0.5/1/1.5	5/7/9	7/8/9	30/40/50
Hospital	1/2/3	1/2/3	4/7/10	0.5/1/1.5	12/17/22
Retail Store	1.5/2/2.5	0.5/1/1.5	4/7/9	1/3/5	2/3/4
Warehouse/Shop	1/2/3	0.25/0.5/1	1/2/3	0.5/1/2	0.75/3/7

(a) Barracks without dining.

TABLE 3.5. Regional Fossil EUIs (min/median/max) Applied to the Fort Drum EUI Analysis

Building Type	Fuel Type	Total EUI Median and Range (kBtu/ft ² -yr)	Heating EUI Median and Range (kBtu/ft ² -yr)	DHW EUI Median and Range (kBtu/ft ² -yr)	Cooking EUI Median and Range (kBtu/ft ² -yr)
Residential:					
Single Family & Multi-Family	Gas/Propane	75/85/115	54/61/82	16/18/25	5/6/8
Single Family & Multi-Family	Oil	*Note: actual EUI data from Fort are used.			
Commercial:					
Concrete Barracks without Dining	Gas/Oil	80/100/130	57/91/93	23/29/37	N/A
Wood Barracks	Gas/Oil	80/100/130	57/91/93	23/29/37	N/A
Office/Admin.	Oil	70/100/130	53/83/108	12/17/22	N/A
Commissary	Gas/Oil	40/60/110	40/60/110	N/A	N/A
Clubs	Gas/Oil	100/150/200	40/59/78	22/33/45	38/58/77
Dining Hall	Gas/Oil	100/150/200	40/59/78	22/33/45	38/58/77
Hospital	Gas/Oil	100/150/180	80/120/145	20/30/35	N/A
Retail Store (Old Post)	Gas/Oil	90/110/130	81/99/117	9/11/13	N/A
Retail Store (New Post)	Gas/Oil	60/80/100	54/72/90	6/8/12	N/A
Warehouse	Gas/Oil	50/90/130	48/86/124	2/4/6	N/A
Motor Pool/Hanger	Gas/Oil	50/90/130	48/86/124	2/4/6	N/A

TABLE 3.6. Fort Drum Electric EUI Values (kWh/ft²-yr)

BUILDING TYPE	HVAC AUX. (FANS/PUMPS)	LIGHTING	COOLING	FOOD PREP	REFRIGERATION	OTHER	ELECTRIC BUILDING TOTAL
OFF POST HOUSING:							
HGAC	0.070	1.050	0.700	0	0.900	1.995	4.715
HGAR	0.070	1.050	0.700	0	0.900	2.048	4.768
HGEB	0.070	1.050	0.700	0	0.900	2.238	4.958
HGCA	0.070	1.050	0.700	0.450	0.900	1.572	4.742
HGCB	0.070	1.050	0.700	0.450	0.900	1.572	4.742
HGCR	0.070	1.050	0.700	0	0.900	1.648	4.368
HGWC	0.070	1.050	0.700	0	0.900	1.747	4.467
HGCL	0.070	1.050	0.700	0	0.900	1.830	4.550
HGCO	0.070	1.050	0.700	0	0.900	1.991	4.711
HGGN	0.070	1.050	0.700	0	0.900	1.544	4.264
HGGC	0.070	1.050	0.700	0	0.900	1.351	4.071
HGEM	0.070	1.050	0.700	0	0.900	1.830	4.550
HGLO	0.070	1.050	0.700	0	0.900	1.520	4.240
HGPH	0.070	1.050	0.700	0	0.900	1.830	4.550
NEW POST COMMERCIAL:							
NADM	3.000	6.250	0.738	0	0.200	2.500	12.688
NASS	1.000	3.150	0	0	0	2.000	6.150
NBAR	3.000	3.360	0	0	0.800	1.000	8.160
NCLB	5.000	9.450	6.140	0	8.000	11.000	39.590
NCOM	0.100	5.250	14.085	0	0	5.000	24.435
NDGR	4.000	7.000	3.502	0	1.000	2.000	17.502
NGRO	4.000	12.000	1.123	2.500	24.000	7.500	51.123
NHOT	3.000	3.150	0	0	0	1.500	7.650
NMED	5.000	9.400	2.525	0	0.500	4.500	21.925
NMES	6.000	9.450	0	0	8.000	13.000	36.450
NMTH	0.050	0.100	0	0	0	0	0.150
NOTH	0.500	3.150	1.720	0	0	0.500	5.870
NREC	3.000	4.200	1.363	0	0	1.000	9.563
NSHP	1.000	2.835	0.766	0	0	2.000	6.601
NSMA	1.000	2.835	0.298	0	0	2.000	6.133
NWAR	0.100	2.000	0	0	0	0.500	2.600
BRKG	6.000	9.450	0	0	12.000	30.000	57.450
ON POST HOUSING:							
HGLE	0.070	1.103	0.700	0.600	0.900	2.000	7.800
HGRA	0.070	1.103	0.700	0.600	0.900	6.900	10.973
HGRH	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGRE	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGBO	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGLI	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGCL	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGSL	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGAD	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGSU	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGYO	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGWI	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGCA	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGPA	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGSA	0.070	1.103	0.700	0.500	0.900	2.200	5.200

TABLE 3.6. (contd)

BUILDING TYPE	HVAC AUX. (FANS/PUMPS)	LIGHTING	COOLING	FOOD PREP	REFRIGERATION	OTHER	ELECTRIC BUILDING TOTAL
OLD POST COMMERCIAL:							
OADM	0.100	5.000	0.231	0	0.200	0.500	6.531
OASS	0.100	3.150	4.069	0	0	0.500	7.819
OBAM	0.100	3.150	0	0	5.000	0.800	10.250
OBAR	1.200	2.100	2.390	0	0	1.000	6.490
OCLB	0.100	9.450	1.223	0	8.000	7.000	25.773
OCLD	0.100	1.050	0	0	10.000	1.000	12.150
OCOM	0.100	5.200	3.001	0	0	2.500	12.301
ODGR	1.000	8.400	1.780	0	0.500	0.500	12.180
OHAN	0.500	2.100	0	0	0	1.000	3.600
OHOT	0.100	3.465	0	0	0.500	2.500	6.565
OHSP	0.100	8.400	5.212	0	0.500	5.500	21.712
OLAU	0.100	4.150	0	0	0	1.000	5.250
OMED	3.037	9.153	4.714	0	0.500	5.500	22.904
OMES	0.100	7.250	0	0	8.000	12.000	35.350
OMTH	0.100	1.050	0	0	0	0.500	1.650
OOTH	0.100	3.150	5.303	0	0	1.000	9.553
OREC	1.000	6.200	10.600	0	0	1.000	26.539
OSHP	2.000	2.835	0.982	0	0	1.000	6.817
OSIM	1.500	7.250	4.572	0	0	15.000	31.322
OWAR	0.100	2.100	0.475	0	0	0.500	3.175
OFF POST COMMERCIAL:							
SAGE	5.000	7.000	4.000	0	0	19.088	35.088

of both gas and purchased thermal EUIs for recreation heating and water heating indicates use of gas only by some recreation buildings and purchased thermal only by others.

TABLE 3.7. Fort Drum Fossil Fuel EUI Values (MBtu/ft²-yr)

P R O P A N E				G A S				O I L				P U R C H A S E D				T H E R M A L	
BUILDING TYPE	HEATING	HOT WATER	COOKING	PROPANE BUILDING TOTAL	HEATING	HOT WATER	COOKING	GAS BUILDING TOTAL	HEATING	HOT WATER	OIL BUILDING TOTAL	HEATING	HOT WATER	VEHICLE WASH	THERMAL BUILDING TOTAL		
OFF POST HOUSING:																	
HGAC	0	0	0	0	0.044	0.016	0.005	0.065	0	0	0	0	0	0	0	0	
HGAR	0	0	0	0	0.046	0.016	0.005	0.067	0	0	0	0	0	0	0	0	
HGEB	0	0	0	0	0.041	0.016	0.005	0.062	0	0	0	0	0	0	0	0	
HGCA	0	0	0	0	0.041	0.016	0	0.057	0	0	0	0	0	0	0	0	
HGCB	0	0	0	0	0.041	0.016	0	0.057	0	0	0	0	0	0	0	0	
HGCR	0	0	0	0	0.053	0.016	0.005	0.074	0	0	0	0	0	0	0	0	
HGWC	0	0	0	0	0.049	0.016	0.005	0.070	0	0	0	0	0	0	0	0	
HGCL	0.045	0.016	0.005	0.066	0	0	0	0	0	0	0	0	0	0	0	0	
HGCO	0.045	0.016	0.005	0.066	0	0	0	0	0	0	0	0	0	0	0	0	
HGNN	0.045	0.016	0.005	0.066	0	0	0	0	0	0	0	0	0	0	0	0	
HGEC	0.045	0.016	0.005	0.066	0	0	0	0.066	0	0	0	0	0	0	0	0	
HGEM	0	0	0.005	0.005	0.045	0.016	0.005	0.066	0	0	0	0	0	0	0	0	
HGLO	0.045	0.016	0.005	0.066	0	0	0	0	0	0	0	0	0	0	0	0	
HGPH	0.045	0.016	0.005	0.066	0	0	0	0	0	0	0	0	0	0	0	0	
ON POST HOUSING:																	
HGLE	0	0	0	0	0	0	0	0	0.059	0	0.059	0	0	0	0	0	
HGRA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
HGRH	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGRE	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGB0	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGLI	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGCL	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGSL	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGAD	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGSU	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGY0	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGWI	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGCA	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGPA	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
HGSA	0	0	0	0	0.057	0.016	0.004	0.077	0	0	0	0	0	0	0	0	
NEW POST COMMERCIAL:																	
NADM	0	0	0	0	0	0	0	0	0	0	0	0.075	0.015	0	0	0.090	
NBAR	0	0	0	0	0.020	0.025	0.022	0.067	0	0	0	0.065	0.025	0	0	0.090	
NCLB	0	0	0	0	0	0	0	0	0	0	0	0.085	0.041	0	0	0.126	
NCLD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NCOM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NDGR	0	0	0	0	0.190	0.025	0.035	0.250	0	0	0	0.040	0.013	0	0	0.053	
NHAN	0	0	0	0	0	0	0	0	0	0	0	0.060	0.003	0	0	0.063	
NHOT	0	0	0	0	0	0.028	0	0.028	0	0	0	0	0	0	0	0	
NHSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NLAU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NMED	0	0	0	0	0	0	0	0	0	0	0	0.100	0.029	0	0	0.129	
NMES	0	0	0	0	0	0	0.041	0.041	0	0	0	0.090	0.041	0	0	0.131	
NOTH	0	0	0	0	0	0	0	0	0	0	0	0.040	0.015	0	0	0.055	
NMTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NREC	0	0	0	0	0.055	0.040	0.003	0.098	0	0	0	0.065	0.030	0	0	0.095	
NSHP	0	0	0	0	0	0	0	0	0	0	0	0.055	0.015	0	0.017	0.087	
NWAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NGRO	0	0	0	0	0	0	0	0	0	0	0	0.075	0.015	0	0	0.090	
NSMA	0	0	0	0	0	0	0	0	0	0	0	0.055	0.015	0	0.017	0.087	

TABLE 3.7. (contd)

BUILDING TYPE	P R O P A N E			G A S			O I L			P U R C H A S E D			T H E R M A L		
	HEATING	HOT WATER	COOKING	PROpane BUILDING TOTAL	HEATING	HOT WATER	COOKING	GAS BUILDING TOTAL	HEATING	HOT WATER	OIL BUILDING TOTAL	HEATING	HOT WATER	VEHICLE	WASH TOTAL
OLD POST COMMERCIAL:															
QADM	0	0	0	0	0	0	0	0	0.090	0.020	0	0	0	0	0
QBAR	0	0	0.005	0	0	0	0	0	0.072	0.041	0	0	0	0	0
QCLB	0	0	0	0	0	0	0	0	0.072	0.035	0	0	0	0	0
QCLD	0	0	0.041	0	0	0	0	0	0.113	0	0	0	0	0	0
QCOM	0	0	0	0	0	0	0	0	0.034	0	0	0	0	0	0
QASS	0	0	0	0	0	0	0	0	0.083	0	0	0	0	0	0
QDGR	0	0	0	0	0	0	0	0	0.116	0.020	0	0	0	0	0
QHAN	0	0	0	0	0	0	0	0	0.112	0	0	0	0	0	0
QHOT	0	0	0	0	0	0	0	0	0.100	0.008	0	0	0	0	0
QHSP	0	0	0	0	0	0	0	0	0.081	0.032	0	0	0	0	0
QLAU	0	0	0	0	0	0	0	0	0.143	0.034	0	0	0	0	0
QMED	0	0	0	0	0	0	0	0	0.083	0.020	0	0	0	0	0
QMES	0	0.041	0.041	0	0	0	0	0	0.088	0.030	0	0	0	0	0
QOTH	0	0	0	0	0	0	0	0	0.113	0.041	0	0	0	0	0
QKTH	0	0	0	0	0	0	0	0	0.118	0	0	0	0	0	0
QREC	0	0	0	0	0	0	0	0	0.060	0.008	0	0	0	0	0
QSHP	0	0	0	0	0	0	0	0	0.093	0.035	0	0	0	0	0
QVAR	0	0.008	0	0	0	0	0	0	0.120	0.057	0	0	0	0	0
OSIM	0	0	0	0	0	0	0	0	0.041	0.008	0	0	0	0	0
OFF POST COMMERCIAL:															
SAGE	0	0	0	0	0	0	0	0	0.116	0.017	0	0	0	0	0
									0.084	0.016	0	0	0	0	0

4.0 ELECTRICAL CONSUMPTION

4.1 METERING AND DATA SUMMARY

There were four sources of electric metering and consumption data at Fort Drum: utility company whole-post meter readings, off-post family housing meters, on-post meters (buildings, areas, other), and PNL substation feeder readings.

The substations have a kWh meter with a demand register on each feeder. Effort is made to log these meter readings monthly. Most of the buildings owned or occupied by agencies that are required to pay their utilities (e.g., AAFES facilities like the Commissary and PX) have meters that are read monthly. One notable exception is on-post housing. Army Family Housing is required to reimburse FORSCOM for its utility services. The reimbursement for on-post electric consumption, however, is currently based on engineering estimates rather than meter readings, because the meters appear to be in error.

The New Post is unusual in that most of the non-reimbursable buildings also have meters. These have been read sporadically in the past and were read at the end of June 1991, September 1991, and December 1991, to provide detailed data for this assessment.

Hours of operation are logged monthly for most of the pumps on the water and sewer systems. Electrical consumption has been estimated from these logs and one-time current measurements or name-plate power ratings.

The monthly values of post total consumption from Niagara Mohawk electric bills for fiscal years 1990 and 1991 are shown in Table 4.1. The table is split into on- and off-peak periods consistent with the Niagara Mohawk billing structure. Also included are the monthly peak billing demands, which occurred during the on-peak period in all cases, and the excess reactive kVA demands.

TABLE 4.1. Niagara Mohawk Electric Meter Readings

<u>FY 1990</u>	<u>kWh On-Peak</u>	<u>kWh Off-Peak</u>	<u>Total kWh</u>	<u>kW</u>	<u>Excess kVAR</u>
OCT	3,050,000	3,370,000	6,420,000	12,800	2,357
NOV	3,470,000	4,490,000	7,960,000	13,100	1,345
DEC	3,720,000	4,660,000	8,380,000	14,800	1,355
JAN	3,570,000	4,930,000	8,500,000	14,000	1,189
FEB	3,630,000	4,140,000	7,770,000	13,800	1,640
MAR	3,760,000	4,000,000	7,760,000	13,700	1,673
APR	3,060,000	3,320,000	6,380,000	12,600	1,704
MAY	2,820,000	3,550,000	6,370,000	11,600	1,989
JUN	2,740,000	2,870,000	5,610,000	10,700	2,289
JUL	2,730,000	3,020,000	5,750,000	11,000	2,285
AUG	3,260,000	3,750,000	7,010,000	12,700	1,767
SEP	<u>2,890,000</u>	<u>3,340,000</u>	<u>6,230,000</u>	<u>12,000</u>	<u>1,616</u>
Totals:	38,700,000	45,440,000	84,140,000	152,800 (kW-mo)	21,209 (kVAR-mo)

<u>FY 1990</u>	<u>kWh On-Peak</u>	<u>kWh Off-Peak</u>	<u>Total kWh</u>	<u>kW</u>	<u>Excess kVAR</u>
OCT	3,290,000	3,550,000	6,840,000	12,000	1,742
NOV	3,520,000	4,500,000	8,020,000	12,900	1,508
DEC	3,520,000	4,150,000	7,670,000	13,200	1,696
JAN	3,620,000	4,850,000	8,470,000	13,700	1,529
FEB	3,580,000	4,100,000	7,680,000	13,700	1,769
MAR	3,620,000	4,480,000	8,100,000	13,300	1,567
APR	3,190,000	3,620,000	6,810,000	13,000	1,955
MAY	3,170,000	3,680,000	6,850,000	12,700	1,671
JUN	2,740,000	2,870,000	5,610,000	10,700	2,289
JUL	3,190,000	4,120,000	7,310,000	12,700	1,719
AUG	3,500,000	3,690,000	7,190,000	12,800	2,609
SEP	<u>3,090,000</u>	<u>3,560,000</u>	<u>6,650,000</u>	<u>12,900</u>	<u>2,132</u>
Totals:	40,030,000	47,170,000	87,200,000	153,600 (kW-mo)	22,186 (kVAR-mo)

This information was used to reconcile the initial estimates of energy use by building type with the actual electric consumption. In most cases the 1990 data were used, since it represented the most accurate, complete set of information available.

The off-post family housing meter readings were available on a bimonthly, per-housing-unit basis. This allowed calculating EUIs for all

housing areas, as well as accurate estimates of the EUIs for the on-post family housing. Annual consumption in FY 1990 and the number of units for each off-post family housing area are shown in Table 4.2.

The on-post meter readings were compiled in several spreadsheets (for 1989, 1990, and 1991) containing individual, monthly meter readings. The main spreadsheet contained data used for building/housing reimbursable accounting; a second spreadsheet included meter readings from other, mainly New Post, buildings. These were used to further define electric consumption as well as to provide some estimates of building-level EUIs for the buildings where meter reading took place.

Time-of-use data were used in assessing peak-shaving and demand-limiting measures. Monthly feeder consumption was used in refining the EUIs assigned to each New Post and Old Post building type.

4.2 ENERGY-USE BREAKDOWN

The electrical consumption for Fort Drum is shown in Table 4.3. The table includes consumption for the Fort Drum site, all off-post housing and

TABLE 4.2. Off-Post Family Housing Electric Consumption

<u>Building Type</u>	<u>Description</u>	<u>Number of Units</u>	<u>Consumption FY 1990 kWh</u>
HGAC	Academy	120	770,168
HGAR	Arsenal	256	1,824,813
HGEB	East Blvd.	224	1,677,475
HGCA	Calcium A	150	1,070,731
HGCB	Calcium B	150	989,236
HGCR	Carthage	126	827,935
HGWC	West Carthage	122	787,292
HGCL	Clayton	100	691,696
HGCO	Copenhagen	75	443,381
HGGN	Gouverneur (Northwood)	96	582,711
HGGC	Gouverneur (Constitution)	75	450,030
HGEM	Evans Mills	300	2,003,523
HGLO	Lowville	56	357,449
HGPH	Philadelphia	150	1,068,300
Totals:		2,000	13,544,740

TABLE 4.3. Fort Drum Electric Consumption

BUILDING TYPE	F A M S/P U M P S SQFT	#BLDG KWH	L I G H T I N G SQFT	#BLDG KWH	C O O L I N G SQFT	#BLDG KWH	C O O K I N G SQFT	#BLDG KWH	R E F R I G E R A T I O N SQFT	#BLDG KWH	O T H E R SQFT	#BLDG KWH	TOTAL KWH
NEW POST COMMERCIAL:													
NADM	714,269	52	2,142,807	714,269	135,030	5	99,680	0	0	714,269	52	1,785,673	8,635,195
NBAR	1,102,549	30	3,307,647	1,102,549	0	0	0	0	0	1,102,549	30	1,102,549	8,996,800
NCLB	51,428	4	257,140	51,428	4,485,995	4	315,840	0	0	1,102,549	30	1,102,549	2,036,107
NCOM	26,400	1	2,640	26,400	138,600	0	1,371,840	0	0	51,428	4	51,428	645,080
NASS	39,920	4	39,920	39,920	4,125,748	0	0	0	0	26,400	1	26,400	245,508
NDGR	115,375	7	461,500	115,375	83,800	3	293,440	0	0	115,375	7	230,750	1,906,690
NHOT	54,123	1	162,369	54,123	1,170,487	1	0	0	0	54,123	1	81,185	2,285,204
NMED	104,227	3	521,135	104,227	3,979,734	104,227	0	263,200	0	104,227	3	469,022	3,184,527
NMES	87,367	6	524,202	87,367	6,825,618	0	0	0	0	87,367	6	1,135,771	3,184,527
NMTH	8,528	14	426	8,528	14,853	0	0	0	0	0	0	0	1,279
NMTH	7,026	13	3,513	7,026	1,180	1	2,030	0	0	0	13	3,513	31,188
NREC	251,935	9	755,805	251,935	9,105,127	176,627	5	240,800	0	0	0	251,935	2,306,667
NSRP	465,713	25	465,713	465,713	25,1,320,296	8,769	1	6,720	0	0	0	465,713	2,724,155
NSRP	82,800	1	331,200	82,800	1,993,600	82,800	1	92,960	1,207,000	82,800	1	616,860	4,228,820
NSMA	195,670	1	195,670	195,670	1,554,724	195,670	1	58,240	0	0	0	195,670	1,199,974
NVAR	73,560	29	7,356	73,560	29,147,120	0	0	0	0	73,560	29	36,780	191,256
BRKG	4,930	1	29,580	4,930	1,46,589	4,930	1	0	0	4,930	1	147,900	283,229
NEW POST COMMERCIAL SUB TOTAL													
OLD POST COMMERCIAL:													
OADM	634,848	221	63,485	634,848	66,556	20	15,400	0	0	634,848	221	634,848	4,014,942
OASS	113,050	29	11,305	113,050	3,121	2	12,700	0	0	113,050	29	66,525	436,638
OBAM	85,139	1	8,514	85,139	1,268,188	0	0	0	0	85,139	1	58,111	770,508
OBAR	1,033,309	198	1,239,971	1,033,309	2,169,949	0	5,640	0	0	1,033,309	198	516,655	3,932,215
OCLB	33,249	4	3,325	33,249	4,314,203	29,532	3	36,110	0	33,249	4	232,743	852,373
OCLD	45,319	1	4,532	45,319	1,47,585	0	1,000	0	0	45,319	1	45,319	551,626
OCMD	27,625	6	2,763	27,625	6,143,650	16,873	3	50,640	0	27,625	6	69,063	266,116
ODGR	35,857	9	35,857	35,857	9,301,199	29,260	1	52,080	0	35,857	9	17,929	424,993
OHAR	32,540	1	16,270	32,540	1,68,334	0	0	0	0	32,540	1	32,540	117,144
OHOT	7,728	1	7,728	7,728	1,26,778	0	0	0	0	7,728	1	19,320	50,734
OLAU	13,427	2	1,343	13,427	5,722	0	0	0	0	13,427	2	13,427	70,492
OMED	74,881	16	227,452	74,881	16,685,401	51,318	8	241,920	0	74,881	16	411,846	1,604,060
OMES	101,012	39	10,101	101,012	39,732,337	0	0	0	0	101,012	39	1,212,144	2,762,678
OMTH	18,901	7	1,890	18,901	7,19,846	0	0	0	0	18,901	7	9,451	31,187
OMTH	12,635	10	1,264	12,635	10,39,800	528	1	2,800	0	12,635	10	12,635	56,499
OREC	55,463	9	55,463	55,463	9,343,871	472	1	5,000	0	55,463	9	55,463	459,797
OSHP	334,218	37	668,436	334,218	37,947,508	10,301	3	10,120	0	334,218	37	334,218	1,960,282
OSIM	13,726	1	20,589	13,726	1,99,514	13,726	1	62,760	0	13,726	1	205,890	388,753
OWAR	402,098	102	40,210	402,098	102,844,406	32,442	6	15,400	0	402,098	102	201,049	1,101,065
OLD POST COMMERCIAL SUB TOTAL													
ON POST HOUSING:													
HGLE	36,556	15	2,559	36,556	3,656	NA	2,559	36,556	NA	21,934	15	71,650	171,905
HGRA	135,268	88	9,469	135,268	13,527	NA	9,469	135,268	NA	81,161	88	927,600	1,298,573
HGRH	310,110	232	21,708	310,110	31,011	NA	21,708	155,055	NA	77,528	232	665,343	1,427,281
HGRE	260,134	188	18,209	260,134	26,013	NA	18,209	130,067	NA	65,034	188	574,246	1,196,616
HGRO	147,954	89	10,357	147,954	14,795	NA	10,357	73,977	NA	36,989	89	326,608	680,588
HGLI	320,116	218	22,408	320,116	32,012	NA	22,408	160,058	NA	80,029	218	706,656	1,472,534
HGCL	268,808	182	18,817	268,808	26,881	NA	18,817	134,404	NA	67,202	182	593,394	1,236,517
HGSL	239,730	188	16,781	239,730	23,973	NA	16,781	119,865	NA	59,933	188	529,204	1,102,758
HGSD	246,763	193	17,273	246,763	24,676	NA	17,273	123,382	NA	61,691	193	544,729	1,135,110
HGSS	399,898	312	27,993	399,898	39,990	NA	27,993	199,349	NA	99,975	312	882,775	1,839,531
HGYO	207,637	162	14,535	207,637	20,763	NA	14,535	103,819	NA	51,909	162	458,559	995,130
HGWI	114,708	80	8,030	114,708	11,471	NA	8,030	57,354	NA	28,677	80	253,218	527,657
HGCA	238,154	150	16,671	238,154	23,815	NA	16,671	119,077	NA	59,539	150	525,725	1,095,508
HGPA	103,979	75	7,279	103,979	10,398	NA	7,279	51,990	NA	25,995	75	229,534	478,303
HGSA	153,232	100	10,726	153,232	15,323	NA	10,726	70,616	NA	38,308	100	338,260	704,867
ON POST HOUSING SUB TOTAL													
TOTAL													
19,852,099													

TABLE 4.3. (contd)

BUILDING TYPE	F A N S / P U M P S	L I G H T I N G	C O O L I N G	C O O K I N G	R E F R I G E R A T I O N	O T H E R	TOTAL
	SQFT #BLOG KWH	SQFT #BLOG KWH	SQFT #BLOG KWH	SQFT #BLOG KWH	SQFT #BLOG KWH	#BLOG KWH	KWH
ON POST UTILITY SERVICES							
EXLT	no end use split						2,500,000
PMPS	no end use split						340,000
LMLS	no end use split						7,654,262
ON POST UTILITY SERVICES SUB TOTAL							
							10,494,262
OFF POST HOUSING							
HGAC	163,360	120	11,435	163,360	171,528	120	428,746
HGAR	382,684	256	26,788	382,684	401,818	256	1,025,003
HGEB	338,352	224	23,685	338,352	355,270	224	970,319
HGCA	225,774	150	15,804	225,774	237,063	150	497,265
HGCB	208,590	150	14,601	208,590	219,020	150	459,417
HGCR	189,526	126	13,267	189,526	199,002	126	431,826
HGCL	176,262	122	12,338	176,262	185,075	122	418,904
HGMC	152,032	100	10,642	152,032	159,634	100	373,949
HGCO	94,125	75	6,589	94,125	98,831	75	246,660
HGGO	136,652	96	9,566	136,652	143,485	96	297,108
HGGC	110,549	75	7,738	110,549	116,076	75	218,983
HGGM	440,366	300	30,826	440,366	462,384	300	1,083,158
HGLO	84,304	56	5,901	84,304	88,519	56	181,254
HGPH	234,808	150	16,437	234,808	246,548	150	577,552
OFF POST HOUSING SUB TOTAL							
							13,544,740
OFF POST COMMERCIAL:							
SAGE	208,532	1	1,042,660	208,532	1,459,724	1	3,980,488
							7,317,000
SITE TOTAL							
							105,848,700

Notes:
EXLT - Exterior Lighting
PMPS - Water and Sewer Pumps
LMLS - Line Loss

the SAGE facility. Each building type and utility service is listed individually, as well as being grouped by site area or service. The consumption is apportioned within each building type to each of its primary end uses. Also included for each end use are the number and square footage of buildings within each type that use electricity for that end use. The electrical end uses that are not tied to a specific building type (streetlights, etc.) are shown with totals only. Also shown is a value for the transmission and distribution loss throughout the electrical distribution system.

The following discussion contains additional information relevant to understanding of Table 4.3. End uses with zero consumption (kWh) for a particular building type are considered to have too small a consumption to be apportioned separately. Their end-use contribution is included in the "Other" column. The absence of energy consumption in major end uses such as heating and dining hall cooking indicates that the end use is not electric (see oil, gas, or propane sections).

4.3 ELECTRICAL DEMAND SUMMARY

Time-of-use data and load frequency distribution data are needed to assess peak-shaving and demand-limiting measures as well as the demand consequences of other measures.

4.3.1 Time of Use

The average weekday time-of-use profiles are plotted in Figure 4.1 for each month from July 1991 through January 1992. The corresponding weekend profiles are plotted in Figure 4.2. These data are from PNL recording instruments installed in June 1991.

The weekday and weekend profiles are very similar between 22:00 and 04:00 local standard time, because the nighttime loads consist mainly of exterior lighting, fans and pumps, associated non-electric heating equipment, and equipment that runs continuously including many computers, fans and pumps, controllers, and plug-in appliances.

The seasonal variation in the daily profile indicates that electric demand associated with heating is significant, but that there is relatively

FIGURE 4.1. Monthly Average Weekday Demand Profiles
Fort Drum, New York (07/91 - 01/92)

FIGURE 4.2. Monthly Average Weekend Demand Profiles
Fort Drum, New York (07/91 - 01/92)

little air conditioning. A comparison of weekday and weekend profiles indicates that the air conditioning equipment that operates seven days a week (e.g., Guthrie Clinic, 10th Mountain Division Headquarters, and the computer center in Building P-10690) constitutes half or more of the total nighttime air conditioning load.

The magnitude of exterior and on-post housing lighting load is apparent in the weekend profiles. The abrupt drop in the morning is due to turning off street and exterior lights that are controlled by time clocks or photocells. The abrupt rise in the evening is due to the street and other exterior lights coming on and to manually controlled lights in residences coming on. The turn-on times of the latter are not apparent in the profiles because they are spread over the late evening hours.

The weekday profiles differ from the weekend profiles in having a much larger load immediately before and during working hours. The monthly average weekday-minus-weekend load difference profiles are shown in Figure 4.3. Part of the difference is due to increased activity by personnel who live on-post, and part is due to the activity of personnel who live off-post and work on-post. Residential kitchen appliances and lights, commercial building loads (lights, computers, and power tools), and water and sewer pumps are the main elements of this load difference. Street and exterior lights operated by time clocks and photocells have absolutely no influence on the weekday-weekend difference profile.

Each profile can be analyzed in terms of four components: a morning peak, a business-day load, and two commercial building components for air conditioning and heating. The morning load difference peak is predominantly residential lighting and cooking. It also includes some electric space and water heating and is, therefore, larger in winter. The morning difference peak may also be affected by a higher lighting load in winter. The business load difference consists of HVAC motors, lights, office equipment, and power tools that represent a constant aggregate load between about 07:30 and 16:30 weekdays. Space heating in commercial buildings involves some intermittent fan and pump operation resulting in an aggregate morning load that tapers off through the day in cold months.

FIGURE 4.3. Average Weekday-Weekend Load Profiles (07/91 - 01/92)

Air conditioning also involves intermittent motor operation that results in an aggregate load that increases during the day until about 16:30, when it falls abruptly. The heating and air conditioning components are seasonal in magnitude. The extent to which the weekday-weekend differences in HVAC motor operation is due to weekend setback, as opposed to weekday-weekend differences in internal gains, cannot be readily determined. The one-hour shift that occurs for daylight savings time affects all four components of the load difference profile. The shift is clearly evident during the morning rise from <500 to >2,500 kW and, to a lesser degree, at the afternoon crossings of the 1,400 kW mark.

The monthly profiles for each substation (1, 2A, and 2B) are attached in the appendix of this report as Figures A.1 to A.21. Figures A.1 to A.7 show the average weekday profiles from July 1991 through January 1992. Figures A.8 to A.14 show the average weekend profiles from July 1991 through January 1992.

4.3.2 Regional Time of Use

Shown in Figure 4.4 are the workday load profiles of the supplier, Niagara Mohawk, suitably scaled for comparison and superimposed on the Fort Drum weekday profiles of Figure 4.1. The profile labeled "NM-summer" is the average of hourly loads for 106 working days in the period May 1 through September 30, 1991. The profile labeled "NM-winter" is the average of hourly loads for 83 working days in the period October 1, 1991, through January 31, 1992.

Niagara Mohawk's local summer peaks occur at 13:00 and 20:00 hours. The evening peak coincides very nearly with Fort Drum's. The daytime peak, however, is about two hours later. Also, the Fort Drum profile drops considerably between 15:00 and 19:00 while the NM-summer profile drops very gradually. These differences are partly due to the lower use of air conditioning (in the Watertown area in general and Fort Drum in particular) and to the effects of off-post housing residents and civilian workers. The load effects of these personnel are always present on the Niagara Mohawk grid, but are only present

FIGURE 4.4. Comparison of Utility's Seasonal Average Workday Demand Profiles with Site's Monthly Profiles

on the Fort Drum grid between 06:30 and 15:30 hours. In spite of these effects, the ratio of Fort Drum's on-peak to off-peak consumption is slightly lower than for Niagara Mohawk. This is due mainly to larger-than-average exterior lighting intensities.

The NM-winter peak occurs at 18:00 hours. A daytime peak that is about 2% lower occurs at 09:30. Fort Drum has almost equal peaks at 12:30 and 18:00 hours. There is also a morning peak at 09:00 that is about 2% lower than the later peaks.

Fort Drum's consumption is considerably higher in winter than in summer at all times of the day, except near sunrise and sunset. Niagara Mohawk consumption, on the other hand, shows little seasonal variation during business hours and the seasonal variation of consumption during non-business hours is relatively small. The Niagara Mohawk loads may have seasonal lows in the spring and fall, but this cannot be determined with the summer and winter profile averaging periods.

4.3.3 Load, Demand, and Reactive Demand Growth

Figure 4.5 shows the monthly variation in on-post loads from September 1987 through January 1992. The load growth due to new loads coming on line as New Post construction projects were completed in FY 1988 is clear. The growth in excess reactive demand has been larger than the percent growth in other billed load components, which reflects the greater use of fluorescent fixtures (with inductive ballasts) in the lighting mix and the relatively large transformer standby reactive load of the New Post facilities. Note that excess reactive demand (defined as the 15-minute reactive demand minus one-third the 15-minute true-power demand) peaks in the summer when demand and consumption are lowest. Transformer standby load, expressed as a percent of total load, is highest at this time, and high-power factor loads (heating and residential and exterior lighting) are at their lowest.

4.3.4 Load Curves

Monthly histograms of electric demand for the whole base are useful for determining the electrical energy that would have to have been generated to limit the peak demand to any specified value. The relation between kWh (that

FIGURE 4.5. NMPC Monthly Billing Data (10/87 - 03/91)

must be generated) and kW shaved is plotted for July 1991 through January 1992 in Figures A.15 through A.21 (see Appendix). Figure 4.6 shows the curves for the first seven months during which PNL metering equipment was in operation.

The minimum energy (kWh) that must be generated each month is presented as a function of reduction in the monthly maximum 15-minute demand (kW). The curves are based on a control strategy that accurately forecasts each monthly peak and thus provides a specified reduction in monthly demand with the minimum possible operating time and fuel consumption and an extrapolation of the July 1991 through January 1992 load history to a full year. This information is needed to estimate savings for measures such a peak shaving by operation of existing diesel generators.

FIGURE 4.6. kWh as a Function of kW Shaved (July 1991 - January 1992)

5.0 GAS CONSUMPTION

5.1 METERING AND DATA SUMMARY

Gas is consumed in off-post dwelling units of the Army Community Housing areas and in most of the New Post family housing units as well as various AAFES reimbursable buildings. In the off-post family housing areas, each unit had an individual meter that is read every two months. FY 1990 was established as the baseline due to the information received regarding utility bills for each housing area for this time period. The following family housing areas are provided with gas service: Calcium, Eastern Boulevard, Evan Mills, Arsenal, Academy, Carthage, and West Carthage. Table 5.1 below summarizes the total therms of gas used in FY 1990 for each of the above mentioned areas, along with the price that was paid for this fuel source. The FY 1990 Army Community Housing (off-post housing) gas use of 1,377,890 therms was determined by summing the utility bill numbers over all off-post housing areas.

The other areas that use natural gas are on the New Post (New Post commercial buildings and on-post housing). Using the FY 1990 base year, information was found regarding various metered areas. Included were the Directorate of Engineering and Housing (DEH) areas, AAFES (bowling alley, mini-mall, Burger King, Branch Exchange, etc.), Fort Drum recreation center, dining areas, Jones O&M, and hotel, as well as the gas main. The metering data that were available from this source had nine months of data shown (October 1989 to June 1990). Analyses of these data indicate 2,479,301 therms

TABLE 5.1. Off-Post Army Community Housing Gas Usage

<u>Building Type</u>	<u>Description</u>	<u>1990\$ of Gas</u>	<u>Annual Therms</u>
HGAC	Academy	63,706	105,658
HGAR	Arsenal	151,987	254,976
HGEB	Eastern Blvd	126,567	211,151
HGCA, HGCB	Calcium A and B	158,682	249,503
HGCR	Carthage	84,987	141,142
HGWC	West Carthage	74,822	123,947
HGEM	Evan Mills	<u>185,716</u>	<u>291,513</u>
Totals		846,467	1,377,890

were used on the New Post, including the New Post commercial and on-post housing sections of Table 5.2. The meter records do not include data on the Dry Hill or the Reserves areas, which were beyond the scope of the project.

5.2 ENERGY-USE BREAKDOWN

Natural gas consumption for Fort Drum is accounted for in Table 5.2. All natural gas consumption for the Fort Drum site as well as the off-post housing areas is included. Each building type is listed individually as well as grouped by site areas. The consumption is apportioned within each building type to each of its primary end uses. Also included for each end use is the number and square footage of buildings within each type that use gas for that end use.

The following contains additional information relevant to understanding Table 5.2. The BRKG (Burger King), JONES (Jones Power Plant), and NBNK (commercial bank) building types are individual private facilities that were not considered in our Energy Resource Opportunity (ERO) analysis of gas usage. Their consumption values are listed as totals only to account for all major gas consumption. The gas consumption for the off-post housing areas is based almost entirely on metered (billed) gas data. The corresponding on-post housing gas consumption is based on estimates of similar use. The gas-metered consumption data for the HGEM (Evans Mills) appeared to be incomplete for a full year. The values were based on averages of the other off-post housing areas.

TABLE 5.2. Fort Drum Gas Consumption

BUILDING H E A T I N G			H O T W A T E R			F O O D P R E P			TOTAL	
TYPE	SQFT	# BLDG	THERMS	SQFT	# BLDG	THERMS	SQFT	# BLDG	THERMS	THERMS
NEW POST COMMERCIAL:										
NCLB	36,398	2	7,280	36,398	2	9,100	49,708	3	10,936	27,315
NDGR	14,800	2	28,120	10,220	1	2,560	10,220	1	3,580	34,260
NHOT	0	0	0	54,123	1	15,154	0	0	0	15,154
NMES	0	0	0		0	0	87,367	6	35,821	35,821
NREC	66,845	3	36,765	66,845	3	26,738	23,800	1	809	64,312
BRKG			no end use split							21,298
JNES			no end use split							21,634
NBNK			no end use split							1,090
NEW POST COMMERCIAL SUB TOTAL										220,884
ON POST HOUSING:										
HGRH	310,110	232	176,763	310,110	232	49,618	310,110	232	6,202	232,583
HGRE	260,134	188	148,276	260,134	188	41,621	260,134	188	5,203	195,101
HGBO	147,954	89	84,334	147,954	89	23,673	147,954	89	2,959	110,966
HGLI	320,116	218	182,466	320,116	218	51,219	320,116	218	6,402	240,087
HGCL	268,808	182	153,221	268,808	182	43,009	268,808	182	5,376	201,606
HGSL	239,730	188	136,646	239,730	188	38,357	239,730	188	4,795	179,798
HGAD	246,763	193	140,655	246,763	193	39,482	246,763	193	4,935	185,072
HGSU	399,898	312	227,942	399,898	312	63,984	399,898	312	7,998	299,924
HGYO	207,637	162	118,353	207,637	162	33,222	207,637	162	4,153	155,728
HGWI	114,708	80	65,384	114,708	80	18,353	114,708	80	2,294	86,031
HGCA	238,154	150	135,748	238,154	150	38,105	238,154	150	4,763	178,616
HGPA	103,979	75	59,268	103,979	75	16,637	103,979	75	2,080	77,984
HGSA	153,232	100	87,342	153,232	100	24,517	153,232	100	3,065	114,924
ON POST HOUSING SUB TOTAL										2,258,417
OFF POST HOUSING:										
HGAC	163,360	120	71,352	163,360	120	26,138	163,360	120	8,168	105,658
HGAR	382,684	256	174,612	382,684	256	61,229	382,684	256	19,134	254,976
HGEB	338,352	224	140,097	338,352	224	54,136	338,352	224	16,918	211,151
HGCA	225,774	150	93,563	225,774	150	36,124	0	0	0	129,687
HGCB	208,590	150	86,442	208,590	150	33,374	0	0	0	119,816
HGCR	189,526	126	101,342	189,526	126	30,324	189,526	126	9,476	141,142
HGWC	176,262	122	86,932	176,262	122	28,202	176,262	122	8,813	123,947
HGEM	440,366	300	199,036	440,366	300	70,459	440,366	300	22,018	291,513
OFF POST HOUSING SUB TOTAL										1,377,890
SITE TOTAL										3,857,191

6.0 OIL CONSUMPTION

6.1 METERING AND DATA SUMMARY

Oil delivery records were received from Fort Drum and were summarized only for those buildings that were not to be demolished. The Old Post, including SAGE and the battle simulation building, were included in this analysis. The building demolition list was useful in determining which buildings would be included in the overall analysis. Virtually all of the buildings scheduled for demolition were heated with coal.

There was a small discrepancy between the oil delivery records and the documents that indicated which buildings were provided with oil burning equipment. Some of this discrepancy could be due to the fact that some buildings use very little oil and do not have deliveries often.

6.2 ENERGY-USE BREAKDOWN

Consumption of #2 fuel oil at Fort Drum is accounted for in Table 6.1. All #2 fuel oil consumption for the Fort Drum site and Off-Post housing areas is included. Each building type is listed individually as well as grouped by site area. The consumption by building type is divided between primary end uses. In addition, each end use is the number and square footage of buildings within each type that use oil for that end use.

Oil consumption for the Old Post commercial buildings is based on actual oil deliveries to a majority of these buildings. This building count does not include those buildings scheduled for demolition. The consumption values shown are based on typical oil deliveries for buildings not to be demolished. This calculation was considered a reasonable accounting of typical oil use at Fort Drum. For comparison, the calculated value is within 5% of the total delivered value reported by the Fort.

TABLE 6.1. Fort Drum Oil Consumption

BUILDING TYPE	H E A T I N G		H O T W A T E R		G E N E R A T O R		T O T A L	
	SQFT	# BLDG	GALLONS	SQFT	# BLDG	GALLONS	SQFT	GALLONS
OLD POST COMMERCIAL:								
OADM	634,848	221	411,645	218,664	43	31,508	0	443,153
OASS	113,050	29	94,480	47,369	9	6,826	0	101,305
OBAM	85,139	1	44,164	85,139	1	25,149	0	69,313
OBAR	1,033,309	198	536,010	997,036	182	251,414	0	787,424
OCLB	33,249	4	27,069	0	0	0	0	27,069
OCLD	45,319	1	11,101	0	0	0	0	11,101
OCOM	27,625	6	16,519	0	0	0	0	16,519
ODGR	35,857	9	28,934	0	0	0	0	28,934
OHAN	32,540	1	23,444	0	0	0	0	23,444
OHOT	7,728	1	4,510	7,728	1	1,782	0	6,292
OHSP	18,480	1	19,039	18,480	1	4,527	0	23,566
OLAU	13,427	2	8,029	4,160	1	599	0	8,629
OMED	56,401	15	35,759	48,003	11	10,375	0	46,134
OMES	101,012	39	82,236	48,882	19	14,439	0	96,675
OMTH	18,901	7	8,170	0	0	0	0	8,170
OOTH	12,635	10	10,742	0	0	0	0	10,742
OREC	55,463	9	37,162	36,735	3	9,263	0	46,425
OSHP	334,218	37	288,949	95,947	5	39,402	0	328,351
OSIM	13,726	1	11,471	13,726	1	1,681	0	13,152
OWAR	402,098	102	118,775	67,245	15	3,876	0	122,651
ON POST COMMERCIAL SUB TOTAL								2,219,349
OFF POST COMMERCIAL:								
SAGE	208,532	1	126,201	208,532	1	24,038	208,532	172,794
ON POST HOUSING:								
HGLE	36,556	15	15,539	0	0	0	0	15,539
SITE TOTAL								2,407,383

7.0 PROPANE CONSUMPTION

7.1 METERING AND DATA SUMMARY

The information received from Fort Drum dealing with propane was limited. There were two pages summarizing propane use for the Army Community Housing area, but this information was found to be too variable between FY 1989 and FY 1990 to be used for this analysis. Therefore, another approach was taken. After the EUI development was complete, the results obtained from the gas information were used to calculate total consumption for propane. The gas values were obtained from related buildings in the Army Community Housing sector. The housing groups calculated in this manner were Clayton, Copenhagen, Gouverneur, Lowville, and Philadelphia. Observed discrepancies could have been due to the fact that propane is delivered into a storage tank, and this delivery is assumed to be the consumption of the building. The total calculated propane use from the baseline information was 651,964 gallons.

7.2 ENERGY-USE BREAKDOWN

Propane consumption for Fort Drum is shown in Table 7.1. All propane consumption for the Old Post and the off-post housing areas is included. The small amount of propane used in newer areas was not assessed. Each building type is listed individually and by site areas. The consumption is apportioned within each building type to each of its primary end-uses. Also included with each end-use is the number and square footage of buildings that use propane.

Propane consumption in the housing units for each area is based on gas consumption for similar units in similar areas. The total housing propane consumption is reconciled to the total supplied by Fort Drum.

TABLE 7.1. Fort Drum Propane Consumption

BLDG TYPE	H E A T I N G			H O T W A T E R			C O O K I N G			TOTAL
	SQFT	# BLDG	GALLONS	SQFT	# BLDG	GALLONS	SQFT	# BLDG	GALLONS	YEARLY GALLONS
OLD POST COMMERCIAL:										
OBAM	0	0	0	0	0	0	85,139	1	4,484	4,484
OCLB	0	0	0	0	0	0	33,249	4	14,347	14,347
OMES	0	0	0	52,130	20	22,495	101,012	39	43,589	66,084
OWAR	0	0	0	30,850	13	2,600	0	0	0	2,600
OLD POST COMMERCIAL SUB TOTAL										87,515
OFF POST HOUSING:										
HGCL	152,032	100	72,015	152,032	100	25,605	152,032	100	4,002	125,622
HGCO	94,125	75	44,586	94,125	75	15,853	94,125	75	4,454	64,964
HGGN	136,652	96	64,730	136,652	96	23,015	136,652	96	7,192	97,937
HGGC	110,549	75	52,365	110,549	75	18,619	110,549	75	5,414	76,428
HGLO	84,304	56	39,933	84,304	56	14,199	84,304	56	1,342	65,478
HGPH	234,808	150	111,221	234,808	150	39,547	234,808	150	12,458	193,186
OFF POST HOUSING SUB TOTAL										564,149
SITE TOTAL										651,664

8.0 COAL CONSUMPTION

8.1 METERING AND DATA SUMMARY

The coal consumption at Fort Drum was not analyzed, because most of the buildings that use coal are on the building demolition list. Efforts to analyze these structures would not be beneficial. According to information received from the Fort, most of the coal-fired buildings are to be demolished by 1995, and none are scheduled to be converted to natural gas. According to Fort information, coal is received from the supplier at a central stockpile and then delivered, as needed, to small bins adjacent to each building that uses coal. All of these buildings are located on the Old Post.

8.2 ENERGY-USE BREAKDOWN

Coal use at Fort Drum is declining and is currently at very low levels. By 1995, coal will not be used as a primary fuel at Fort Drum. Most of the facilities using coal are scheduled for demolition. Table 8.1 is included to report the number of facilities currently operating with coal equipment. The assessment does not include these facilities.

TABLE 8.1. Fort Drum Coal Consumption

BLDG	H E A T / D H W		TOTAL
TYPE	SQFT	# BLDG	YEARLY
			TONS
OLD POST COMMERCIAL:			
OADM	53,499	32 NA	NA
OBAR	318,626	68 NA	NA
OASS	21,430	5 NA	NA
OMED	11,624	4 NA	NA
OMES	81,970	32 NA	NA
OOTH	80	1 NA	NA
OMTH	6,714	1 NA	NA
OWAR	264,505	92 NA	NA
TOTALS	758,448	235	98 NA

9.0 PURCHASED THERMAL CAPACITY CONSUMPTION

9.1 METERING AND DATA SUMMARY

The thermal energy consumption by Fort Drum is metered and billed by the supplier, J. A. Jones. J. A. Jones uses a Btu meter, consisting of a supply water flow meter and supply and return-water temperature sensors, to measure and bill for energy supplied to the thermal distribution loop. There are daily logs of flow rate (gpm) and supply and return temperatures and pressures for the high-temperature water supplied to Fort Drum. J. A. Jones also supplied a monthly summary of consumption and billing information.

Line loss for the HTHW system was calculated by PNL. This calculation was based on flow rate and temperature data provided by J. A. Jones for the month of August 1991. Line-loss calculations were made assuming "no-load" on the system between the hours of 12 midnight to 5 a.m. During these hours the metered load was assumed to be the line loss. Representative hours were analyzed in this time period for 13 days in August and the results averaged to arrive at an average summer line-loss value of 18.14 MBtu/hr.

The Jones plant operates on two temperature/pressure schedules during the year; therefore, a ratio of summer-to-winter line loss was used to estimate an average winter line-loss value. This ratio was calculated from the Fort Drum HTHW report that noted the design estimate of seasonal loss. The average winter line-loss value was calculated to be 21.75 MBtu/hr. The winter and summer line-loss values were prorated to arrive at a total line loss of 177,274 MBtu/yr.

At least two other sources of line loss estimates exist for Fort Drum. The first is an FY 1991 estimate by Gordon Green of Fort Drum; his estimate for yearly total line loss was 164,000 MBtu/yr. The second estimate is from the design documentation from the Fort Drum HTHW report and is reported as 171,983 MBtu/yr. Discrepancies in line-loss estimates are relatively minor and considered within the accuracy range of the metered data received from J. A. Jones.

9.2 ENERGY-USE BREAKDOWN

Only one source of purchased thermal capacity exists at the Fort. This capacity is supplied to the New Post distribution system as part of the Jones Power Plant heat rejection system. A capacity of 458,000 MBtu is typically delivered to the New Post in a year. See Table 9.1 for a breakdown of the capacity between buildings and losses.

The one central thermal distribution system at Fort Drum serves the majority of the facilities on the New Post and is supplied by the Jones generating plant located on the site. The energy use is apportioned by end use and building type with associated square footage and building counts. It includes all buildings known to be served by the system. Any other fuel or electricity use associated with these buildings is accounted for in the individual electric and other fuel sections. Losses from the distribution lines are about 39% of the total thermal energy leaving the Jones Plant. Since the thermal capacity is purchased from a private generation source, there is no value to the Fort associated with combustion and stack losses at the central distribution plant.

TABLE 9.1. Fort Drum Hot Water Distribution Consumption

BUILDING TYPE	H E A T I N G			H O T W A T E R			V E H. W A S H		TOTAL MBTU	
	SQFT	# BLDG	MBTU	SQFT	# BLDG	MBTU	SQFT	# BLDG		
NEW POST COMMERCIAL:										
NADM	714,269	52	53,570	714,269	52	10,714	0	0	0	64,284
NBAR	1,102,549	30	71,666	1,102,549	30	27,564	0	0	0	99,229
NCLB	13,310	1	1,131	13,310	1	546	0	0	0	1,677
NASS	39,920	4	1,597	39,920	4	519	0	0	0	2,116
NDGR	95,020	3	5,701	95,020	3	285	0	0	0	5,986
NMED	104,227	3	10,423	104,227	3	3,023	0	0	0	13,445
NMES	87,367	6	7,863	87,367	6	3,582	0	0	0	11,445
NOTH	5,900	1	236	5,900	1	89	0	0	0	325
NREC	185,090	6	12,031	185,090	3	5,553	0	0	0	17,584
NSHP	462,158	13	25,419	462,158	13	6,932	462,158	13	7,857	40,208
NGRO	82,800	1	6,210	82,800	1	1,242	0	0	0	7,452
NSMA	195,670	1	10,762	195,670	1	2,935	195,670	1	3,326	17,023
LOSS										177,274
SYSTEM TOTAL										458,048

10.0 BIBLIOGRAPHY

REGIONAL EUI SOURCES

Characterization of Niagara Mohawk Power Corporation's Commercial Class: Equipment Saturations, Conservation Measures, and Decision Making Profile. 1988. Xenergy Inc.

Commercial Energy Demand Modelling Systems (CEDMS). 1986. Jerry Jackson Assoc.

Household Energy Consumption and Expenditure 1987 (RECS). 1987. Energy Information Administration.

New York State Energy Office (NYSEO) Commercial End Use Data Base for Niagara Mohawk Utility District. 1987. NYSEO.

New York State Energy Office (NYSEO) Residential End Use Data Base for Niagara Mohawk Utility District. 1986. NYSEO.

Nonresidential Building Energy Consumption Survey: Commercial Buildings Consumption and Expenditure 1986 (CBECS). 1986. Energy Information Administration.

Study of Energy End Use and Conservation Potential in Selected Segments of the Commercial Class. 1987. Xenergy Inc.

"Supplement 3B to Long Range Forecast 3 for the Twin Year Period 1988-1997." 1988. Filing Companies: Massachusetts Electric, New England Power Co., Yankee Atomic Electric Co., New England Hydro-Transmission Electric Co.

The Potential for Electricity Conservation in New York State. 1988. American Council for an Energy Efficient Economy (ACEEE).

OTHER SOURCES

End Use Energy Consumption for Restaurants, Warehouses, Hotels/Motels, and Miscellaneous Buildings. 1987. Xenergy Inc.

Lessons Learned: A Review of Utility Experience with Conservation and Load Management Programs for Commercial and Industrial Customers. 1990. New York State Energy Research and Development Authority.

Low-Cost Energy Savings in State Buildings, A Report on Energy Audits Conducted in State Buildings. 1985. New York State Energy Office.

New Commercial Office Building End Use Energy Study. 1985. Synergetic Resources Corporation.

The Achievable Conservation Potential in New York State from Utility Demand-Side Management Programs. 1990. New York State Energy Research and Development Authority.

APPENDIX

FORT DRUM ELECTRIC METERING FIGURES

APPENDIX

FORT DRUM ELECTRIC METERING FIGURES

Figures A.1 through A.14 show the average weekday and weekend load profiles for each month from July 1991 through January 1992.

Figures A.15 through A.21 show the relation between minimum monthly energy (kWh) generated during weekday peaks and demand reduction (kW-mo) that could have been obtained for the months of July 1991 through January 1992. Results are based on 15-minute continuous time-series data monitored at the substations.

FIGURE A.1. Fort Drum Substation Metering July 1991
Average Weekday Profile

FIGURE A.2. Fort Drum Substation Metering August 1991
Average Weekday Profile

FIGURE A.3. Fort Drum Substation Metering September 1991
Average Weekday Profile

FIGURE A.4. Fort Drum Substation Metering October 1991
Average Weekday Profile

FIGURE A.5. Fort Drum Substation Metering November 1991
Average Weekday Profile

FIGURE A.6. Fort Drum Substation Metering December 1991
Average Weekday Profile

FIGURE A.7. Fort Drum Substation Metering January 1992
Average Weekday Profile

FIGURE A.8. Fort Drum Substation Metering July 1991 Average Weekend Profile

FIGURE A.9. Fort Drum Substation Metering August 1991 Average Weekend Profile

FIGURE A.10. Fort Drum Substation Metering September 1991
Average Weekend Profile

FIGURE A.11. Fort Drum Substation Metering October 1991
Average Weekend Profile

FIGURE A.12. Fort Drum Substation Metering November 1991
Average Weekend Profile

FIGURE A.13. Fort Drum Substation Metering December 1991
Average Weekend Profile

FIGURE A.14. Fort Drum Substation Metering January 1992
Average Weekend Profile

FIGURE A.15. kWh as a Function of kW Shaved, July 1991

FIGURE A.16. kWh as a Function of kW Shaved, August 1991

FIGURE A.17. kWh as a Function of kW Shaved, September 1991

FIGURE A.18. kWh as a Function of kW Shaved, October 1991

FIGURE A.19. kWh as a Function of kW Shaved, November 1991

FIGURE A.20. kWh as a Function of kW Shaved, December 1991

FIGURE A.21. kWh as a Function of kW Shaved, January 1992

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