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June 27,2008

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DOE CONTRACT NO. DE-AC05-06OR23100

SUBJECT: FINAL REPORT—CONFIRMATORY SURVEY FOR THE PARTIAL SITE RELEASE AT THE ABB INC. CE WINDSOR SITE, WINDSOR, CONNECTICUT
DCN 1763-SR-01-0
(DOCKET NO. 030-03754; NRC F1008; RFTA NO. 08-003)

bear *Mt.* Kouhestani:

The Oak Ridge Institute for Science and Education (ORISE) is providing, the enclosed final confirmatory survey report for the Partial Site Release areas at the ABB Incorporated, CE Windsor Site in Windsor, Connecticut. Comments provided on the draft report have been incorporated.

Please contact me at 865.576.0065 or Tim Vitkus at 865.576.5073 should you have any questions.

RECEIVED
REGION 1
20 JUL -3 AM 11: 11

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CONFIRMATORY SURVEY FOR THE PARTIAL SITE RELEASE AT THE ABB INC. CE WINDSOR SITE WINDSOR, CONNECTICUT

W. C. ADAMS

Prepared for the
U.S. Nuclear Regulatory Commission

ORISE

Oak Ridge Institute for Science and Education

Approved for public release; further dissemination unlimited.

CONFIRMATORY SURVEY FOR THE PARTIAL SITE RELEASE AT THE ABB INC. CE WINDSOR SITE WINDSOR, CONNECTICUT

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FINAL REPORT

JUNE 2008

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ABBREVIATIONS AND ACRONYMS

ε_i	instrument efficiency
ε_s	surface efficiency
ε_{total}	total efficiency
µg/L	micrograms per liter
ABB	Asea Brown Boveri Incorporated
BKG	background
CE	Combustion Engineering
cm	centimeter
cm^2	square centimeter
Co-60	cobalt-60
cpm	counts per minute
DCGL	derived concentration guideline level
DOE	U.S. Department of Energy
DP	decommissioning plan
dpm/100 cm	disintegrations per minute per 100 square centimeters
EPA	U.S. Environmental Protection Agency
FSS	final status survey
FSSP	final status survey plan
FSSR	final status survey report
FUSRAP	Formerly Utilized Sites Remedial Action Program
GM	Geiger-Muller
GPS	global positioning system
HSA	historical site assessment
IEAV	Independent Environmental Assessment and Verification Program
ISO	International Standards Organization
ITP	Intercomparison Testing Program
JHA	job hazard analysis
kg	kilogram
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum concentration level
MDC	minimum detectable concentration
MeV	million electron volts
m^2	square meter
NAD	North American Datum
NaI	sodium iodide
NIA	non-impacted area
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PSR	partial site release

ABBREVIATIONS AND ACRONYMS (CONTINUED)

R&D	research and development
SOR	sum-of-ratias
SPCS-CT	Connecticut State Plane Coordinate System
Sr-90	strontium-90
SU	survey unit
TAP	total absorption peak
Th-230	thorium-230
U-235	uranium-235
U-238	uranium-238
VSP	Visual Sampling Plan
ZnS	zinc sulfide

CONFIRMATORY SURVEY FOR THE PARTIAL SITE RELEASE AT THE ABB INC. CE WINDSOR SITE WINDSOR, CONNECTICUT

INTRODUCTION AND SITE HISTORY

Asea Brown Boveri Incorporated (ABB) has been decommissioning the Combustion Engineering (CE) Windsor Site in Windsor, Connecticut since 2001. A portion of the property has been prepared for release from Nuclear Regulatory Commission (NRC) licensure (NRC License No. 06-00217-06). This request is referred to as the ABB Partial Site Release [PSR (ABB 2007)].

The CE Windsor Site is located at 2000 Day Hill Road, Windsor, in Hartford County, Connecticut and consists of approximately 613 acres. ABB has requested the release of 365 acres of the site from licensure for unrestricted use with the remaining 248 acres being maintained under NRC regulation until completion of decommissioning activities. Site-specific derived concentration guideline levels (DCGLs), provided in the Decommissioning Plan (DP), were derived for the entire property (MACTEC 2003).

The 248 acre parcel that is to remain on the NRC license, which ABB is referring to as the "controlled area", will be contained within the PSR boundary. Access to this portion of the site will be restricted as necessary during future decommissioning activities and opemtions.

Final Status Surveys (FSS) for portions of the controlled and PSR areas have been completed and FSS Plans and Reports (FSSPs and FSSRs) have been submitted to the NRC. FSSRs for areas included in Building Complexes 2, 5, 6A, and 17, were previously submitted to and accepted by the NRC. The FSSRs for the remaining potentially impacted areas, except those previously designated as being part of the Formally Utilized Sites Remedial Action Program (FUSRAP), were included in an ABB submittal to the NRC dated September 13, 2007 (MACTEC 2007). The review of the PSR submittal indicates that portions of these building complex areas are to "...remain within the proposed controlled area under active license in order to provide staging areas, buffer zones, and access to the remaining areas for decommissioning" (ABB 2007).

The majority of the 365-acre PSR area consists of non-impacted areas along the site property boundary along with some impacted building complex areas (Building 5, 6A and 17 Complexes) and two open land area [Survey Units (SU) CE-FSS-24-01 (Southeast Parcel) and CE-FSS-26-02 (Woods north of Building 17 Complex)] that were previously part of completed decommissioning activities.

The FSSRs for these areas stated that "...there is no residual radioactivity above unrestricted release criteria in the area proposed for release". ABB also stated that "...no additional radioactive material will be used or stored in the released area. Radioactive material generated during the subsequent decommissioning process will be handled and managed in a manner to prevent cross-contamination of the released area" (ABB 2007).

The NRC's Headquarters and Region I Offices requested that the Independent Environmental Assessment and Verification Program (IEAV) of the Oak Ridge Institute for Science and Education (ORISE) perform confirmatory radiological surveys of the areas designated by ABB for Partial Site Release at the ABB, Inc. CE Windsor Site in Windsor, Connecticut. These survey activities included Buildings 5, 6A and 17 Area Complexes and SUs 24-01 and 26-02 where remediation activities had been completed and FSSRs submitted to the NRC (MACTEC 2006a and b, 2007).

SITE DESCRIPTION

The ABB CE Windsor Site is located in the Town of Windsor, approximately eight miles north of Hartford, Connecticut (Figure A-1). The site, located at 2000 Day Hill Road, consists of approximately 613 acres of which 365 acres have been designated for release (Figures A-2 and A-3). The site is located in an industrial zone with nearby property primarily being commercial, agricultural, industrial and residential areas. The northern and western portions of the property are wooded. Day Hill Road borders the southern portion of the site; tobacco fields and a sand and gravel quarry border the western side; the Windsor/Bloomfield Sanitary Landfill and Recycling Center (Landfill) and the Rainbow Reservoir portion of the Farmington River are to the north; and forested land with residential and commercial development is to the east. S1C, located within the site boundary, is a 10.6-acre area that is owned by the U.S. Government and is not part of the CE Windsor Site (MACTEC 2007).

CONFIRMATORY SURVEY AREAS

Building 5/6A Complex

The Building 5 Complex was built in the late 1950s and late 1960s as a research and development (R&D) facility in support of nuclear fuel manufacturing. The Building 5 Complex was also utilized for nuclear plant outage and field operation support. Building 6A was built in the mid 1950s as a liquid radiological waste collection and processing facility for Building 5. Later, the liquid radiological waste from the Building 5 Complex was re-routed to Building 6 and Building 6A was converted to a maintenance service facility.

For the Building 5 Complex, some soil remediation was necessary in the former hot waste trench areas; however, most samples did not have detectable concentrations of uranium or cobalt-60 (Co-60). Nine SUs were created in support of the FSS (Figure A-4), including two Class 2 and seven Class 3 SUs (MACTEC 2006a). No residual radioactivity in excess of the applicable soil radioactivity release criteria was identified during FSS.

Building 17 Complex

The Building 17 Complex was built in the late 1960s as a nuclear manufacturing facility for production of nuclear fuel for the commercial nuclear power industry. When nuclear fuel manufacturing operations ceased, Building 17 was partially decontaminated and Building 21 was released for unrestricted use and demolished. Building 17 was then renovated and utilized for nuclear fuel outage and field operation support.

For the Building 17 Complex, some soil remediation was necessary in the former nuclear fuel production area; however, most samples did not have detectable concentrations of uranium or Co-60. Eight SUs were created in support of the FSS (Figure A-5), including one Class 1, one Class 2, and six Class 3 SUs (MACTEC 2006b). No residual radioactivity in excess of the applicable soil radioactivity release criteria was identified during FSS.

Remaining Class 3 Areas within PSR

ABB has completed remediation of the remaining potentially contaminated (impacted) areas associated with commercial licensed activities within the PSR Area. The final radiological status of portions of the PSR Area outside of the Building Complex Areas that mere previously identified as having a potential to contain residual radioactivity (impacted) have been reported (MACTEC 2007). Class 3 Areas associated with the PSR Area are the Southeast Parcel (CE-FSS-24-01) which is south of the Building 3 Complex and the wooded area north of the Building 17 Complex (CE-FSS-26-02). These areas are identified on Figure A-6.

NON-IMPACTED AREAS

The 365 acre parcel to be released from NRC licensure is primarily comprised of non-impacted areas (NIA) along the Windsor Site property boundary along with some areas that were part of the decommissioning activities that have been completed. The remaining N U consist mainly of open fields or wooded areas. Based on the historical site assessment (HSA), these areas were designated as NIA and no further actions were needed for these areas. Since the NIAs were large, ORISE divided the NIAs into eight survey areas (Figure A-7).

OBJECTIVES

The objectives of the confirmatory surveys were to confirm that remedial actions had been effective in meeting established release criteria and that documentation accurately and adequately describes the final radiological conditions of the PSR Impacted Areas. Radiological surveys were also conducted within the PSR Non-Impacted Areas to ensure that those areas were correctly classified based on the HSA findings.

DOCUMENT REVIEW

ORISE personnel reviewed the HSA, the DP, the FSSP and several FSSRs in preparation for confirmatory survey activities for the PSR Areas (MACTEC 2002,2003, 2004, 2006a and b, and 2007). Information was evaluated to assure that FSS procedures were appropriate for the, radionuclides of concern and that residual activity levels satisfied the established radiological release criteria.

PROCEDURES

ORISE personnel visited the ABB site from March 24 through 27,2008 to perform visual inspections and independent measurements and sampling. The survey activities mere conducted in accordance with a site-specific confirmatory survey plan and the IEAV Survey Procedures and Quality Program Manuals (ORISE 2008a and b and ORAU 2007).

The impacted site areas within the PSR consisted of one Class 1 SU, three Class 2 SUs, and fifteen Class 3 SUs totaling approximately 60 acres. These SUs were classified in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), based on contamination potential (NRC 2000). A description of each classification is as follows:

Class 1: Land areas that have a significant potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys) that exceeds the expected $DCGL_W$.

Class 2: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$.

Class 3: Any impacted areas that are not expected to contain residual contamination, or are expected to contain levels of residual contamination at a small fraction of the $DCGL_W$.

For the confirmatory surveys, ORISE performed gamma surface scans in each of the Impacted Areas (Classes 1, 2 and 3). ORISE selected three of the impacted SUs for soil sampling to directly compare the mean activity concentration levels with the FSS results for those SUs. Judgmental gamma surface scans were performed within portions of the NIA based on site conditions and time constraints. Judgmental soil samples, based on gamma scan data and visual observations, were to be performed within the NIA if warranted Information for the ORISE survey areas is summarized in Table 1.

TABLE 1: ABB SITES SURVEY UNIT SUMMARY		
Survey Unit ID	**Size (m^2)**	**Classification**
Building 5 Complex		
CE-FSS-05-01 to 05	13,100	3
CE-FSS-05-06	6,700	2
Building 6A Complex		
CE-FSS-06-01 and 03	18,600	3
CE-FSS-06-02	1,000	2
Building 17 Complex		
CE-FSS-17-01 to 06	50,300	3
CE-FSS-17-07	3,100	2
CE-FSS-17-08	1,500	1
Southeast Parcel (south of Building 3 Complex)		
CE-FSS-24-01	101,193	3
Woods (north of Building 17 Complex)		
CE-FSS-26-02	54,628	3
Non-Impacted Areas[a]		
NIA -01	106,923	NIA
NIA-02	111,055	NIA
NIA -03	183,661	NIA
NIA -04	212,901	NIA
NIA -05	110,590	NIA
NIA -06[b]	42,246	NIA
NIA -07	70,215	NIA
NIA -08	133,140	NIA

[a]ORISE designations for Non-Impacted Areas.
[b]This non-impacted area was chosen by MACTEC as the wound reference area (MACTEC 2004). This area was not surveyed by ORISE.

REFERENCE SYSTEM

Global positioning system (GPS) coordinates were used for referencing measurement and sampling locations. The specific reference system used was North American Datum of 1927 (NAD 27) and the Connecticut State Plane Coordinate System (SPCS-CT 0600).

SURFACE SCANS

High density gamma radiation surface scans were conducted over the Class 1 SU; medium density gamma scans were conducted over all Class 2 SUs; and, low density scans were performed over all Class 3 SUs. Limited (very low density) surface scans were performed in the NIA (Refer to Table 2). Surface scans were performed using sodium iodide (NaI) scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. During some surface scans, the detectors were also coupled to GPS systems that enabled real-time gamma count rate and position data capture. Gamma scan walkover paths, for SUs where GPS systems were used, are presented in Figures A-8 through A-28. Field personnel relied on the audio output to identify and mark for further investigations any locations of elevated direct gamma radiation that might suggest the presence of residual contamination.

TABLE 2: GAMMA SCAN DENSITY/PERCENTAGE (%) FOR ABB CLASSIFICATION		
Class 1	High Density	50 to 100 %
Class 2	Medium Density	10 to 50 %
Class 3	Low Density	5 to 10 %
Non-Impacted Areas	Very Low Density	Up to 5 %

SOIL SAMPLING

ORISE judgmentally selected a Class 1 or Class 2 survey unit from each of the building complexes for soil sampling. A random sampling approach was used to design the confirmatory soil sampling plans for these selected SUs (EPA 2002). The ABB final survey data provided the information for determining the number of random confirmatory soil samples necessary to verify the mean concentrations. Specifically, the inputs used were the respective DCGLs for the primary radionuclides—total uranium and Co-60 and the observed maximum variability (standard deviation) for each area.

Random surface (0 to 15 cm) soil samples were collected from 14 locations within each of the selected impacted site areas. The number of samples collected was adequate to estimate the mean activity concentration level across these impacted site areas. A one-minute static gamma count rate measurement was also performed at each soil sample location. The software Visual Sample Plan v.4.6 (VSP) was used to generate the random locations. Figures A-29 through A-31 show the random soil sample locations.

At the discretion of the NRC site representative, a judgmental soil sample was collected from a soil pile within SU 24 (Figure A-32; S0043). ORISE also collected a sediment sample from the eastern portion of the Great Pond (Figure A-32; S0044).

SURFACE WATER SAMPLING

At the discretion of the NRC site representative, two surface water samples were collected from judgmentally selected locations. One water sample was collected from along the eastern shore of the Great Pond and the other sample was collected from the eastern portion of Goodwin Pond (Figure A-32; W0001 and W0003). Also at the discretion of the NRC site representative, a background surface water sample was colleated at a location upstream of the site within Farmington River (Figure not provided; W0002).

ADDITIONAL RADIOLOGICAL SURVEYS

At the request of the NRC site representative, ORISE performed limited alpha and beta surface activity measurements on several remaining structural surfaces (that included limited portions of roadways, parking lots, door entrance ways, and drainage culverts). These additional surveys were at the discretion of the NRC site representative and were performed within portions of the impacted areas based on past history, site conditions and time constraints.

Judgmentally-selected direct measurements for total alpha and total beta activity were performed at seven locations along the southern portion of the site. Particular attention was given to cracks and joints in the surfaces, exposed concrete surfaces, and other locations where material may have accumulated. Locations of elevated direct radiation were marked for further investigation. Direct measurements for alpha and beta radiation were performed using zinc sulfide (ZnS) scintillation and Geiger-Mueller (GM) detectors. All detectors were coupled to ratemeters or ratemeter-scalers with audible indicators; a GPS unit was used to mark the measurement locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to the ORISE laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2008c). Direct measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Soil and water samples were analyzed by gamma spectroscopy for U-235, U-238 and Co-60. The spectra were also reviewed for other identifiable photopeaks. To determine total uranium soil results, ORISE used the site-derived multiplier of 31 times the U-235 concentration to determine the total uranium soil values (MACTEC 2004). Soil sample results were reported in units of picocuries per gram (pCi/g); water sample results were reported in units of picocuries per liter (pCi/L) for Co-60 and units of microgram per liter (µg/L) for total uranium.

The soil data generated were compared with the NRC-approved soil DCGLs established for the ABB, Inc, site and with the FSS data provided for the specific SUs that received confirmatory surveys. The sum-of-ratios (SORs) were also calculated in accordance with the equation:

$$\frac{Conc._{Total\,Uranium}}{DCGL_{Total\,Uranium}} + \frac{Conc._{Co-60}}{DCGL_{Co-60}} < 1$$

Surface water results were compared with U.S. Environmental Protection Agency (EPA) drinking water standards (EPA 2000). Direct measurement results were compared with applicable NRC surface activity guidelines (NRC 1987). For the NIAs, any indication of residual contamination above average background levels (as determined by MACTEC during previous survey activities) for site contaminants resulted in the ORISE recommendation that those areas be reevaluated and/or reclassified.

FINDINGS AND RESULTS

The results for each confirmatory component are discussed on the following pages.

DOCUMENT REVIEW

ORISE's review of MACTEC's project documentation indicated that the procedures and methods implemented for the FSS were appropriate and that the resultant data were acceptable.

SURFACE SCANS

Gamma radiation surface scans did not identify any locations of elevated direct radiation due to site contaminants. Area gamma scan count rates generally ranged from approximately 3,000 to 9,000 counts per minute (cpm) with the variability in the ambient gamma radiation levels consistent with the localized area topography and geology and the respective gamma detectors that were used during the survey activities. Gamma scan results are illusttated in Figures **A-8** through **A-28** for each area where the GPS units were used; for SUs were GPS data tracking was not available, gamma scan ranges were from 4,000 to 9,000 cpm. Gamma scan rate data is provided as the gross, observed count rates.

SURFACE SOIL SAMPLE GAMMA COUNT RATES

A summary of the gross static gamma count rates, at each of the soil sample locations, for each of the sampled SUs is provided in Table 3.

**TABLE 3:
SUMMARY RESULTS FOR STATIC GAMMA MEASUREMENTS
AT SOIL SAMPLE LOCATIONS**

Survey Unit	Minimum Gross Count Rate (cpm)	Maximum Gross Count Rate (cpm)	Average Gross Count Rate (cpm)
SU 05-06	5,100	7,700	6,400
SU 06-02	5,700	7,100	6,300
SU 17-08	5,600	11,600	6,500

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

The summary data for the three SU which were sampled are presented in Table 4 below. The data for the radionuclide concentrations in individual samples and the sum-of-ratios are provided in Table B-1.

TABLE 4: SUMMARY RESULTS FOR RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES		
Survey Unit	**Co-60 (pCi/g)**	**Total Uranium (pCi/g)**
SU 05-06	-0.03 to 0.04	-1.9 to 9.3
Mean Concentration	*0.01*	*3.1*
SU 06-02	-0.05 to 0.02	-1.4 to 5.5
Mean Concentration	*-0.02*	*1.8*
SU 17-08	-0.03 to 0.05	-6.0 to 11.3
Mean Concentration	*0.00*	*2.9*

RADIONUCLIDE CONCENTRATIONS IN WATER SAMPLES

The data for the three water samples are presented in Table 5 below.

TABLE 5: RADIONUCLIDE CONCENTRATIONS IN SURFACEWATER SAMPLES		
Sample ID[a]	***Co-60* (pCi/L)**	**Total Uranium (µg/L)**
W0001	4.9 ± 2.5[b]	0.10 ± 0.33
W0002 (Background)	0.6 ± 4.6	0.11 ± 0.56
W0003	2.1 ± 3.0	0.21 ± 0.30

[a]Refer to Figure A-32. Figure location not provided for Sample ID W0002.
[b]Uncertainties are total propagated uncertainties, based on the 95% confidence interval.

Additional Radiological Survey Results

Alpha and beta direct surface activity measurements were performed at seven locations on the southern portion of the ABB site. Total net alpha activity measurements ranged from -15 to 260 dpm/100 cm^2; total net beta surface activity measurements ranged from -570 to 2,100 dpm/100 cm^2. The alpha surface activity measurements determined that a localized area of residual elevated alpha surface activity was present on the concrete steps at the Building 4-23 entrance. Due to the elevated alpha surface activity level determined at Location 6, ABB, MACTEC and NRC personnel were notified and MACTEC personnel were to perform additional radiological investigations at this location. Surface activity levels are presented in Table B-2.

COMPARISON OF RESULTS WITH RELEASE CRITERIA

The primary radionuclides of concern are total uranium (U-234, U-235 and U-238) and Co-60. The applicable site-specific soil DCGLs for the radionuclides of concern are provided in Table 6 and have been approved by the NRC (MACTEC 2007). To demonstrate compliance with the Table 6 criteria, each radionuclide concentration should be less than its respective DCGL—with consideration for small areas of elevated activity—as well as application of the unity rule. The unity rule requires that the sum of the concentration of each contaminant divided by the respective guideline be less than one.

TABLE 6: ABB SOIL DERIVED CONCENTRATION GUIDELINE LEVELS (DCGLS)	
Radionuclide	**Soil Guidelines (pCi/g)**
Co-60	5
Total Uranium	557[b]

[a]ABB soil DCGLs are from MACTEC's FSSR Volume I, Text, Figures and Tables (MACTEC 2007).
[b]Total uranium DCGL regardless of enrichment (MACTEC 2004).

Radionuclide concentrations in soil samples were directly compared with the Total Uranium and Co-60 DCGLs. All individual sample results and the SORs were less than the release criteria.

Furthermore, the verification mean concentrations across the survey areas, provided in Table 4, were compared directly with the mean concentrations from the site's FSS results for each survey unit. The MACTEC site mean concentrations were as follows (Table 7):

TABLE 7:
SUMMARY RESULTS FOR MACTEC'S RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

Survey Unit	Co-60 (pCi/g)	Total Uranium (pCi/g)
SU 05-06	-0.112 to 0.094	-0.666 to 9.176
Mean Concentration	*0.014*	*3.5*
SU 06-02	-0.076 to 0.091	0.688 to 7.161
Mean Concentration	*0.021*	*2.976*
SU 17-08	-0.170 to 0.076	-0.305 to 16.895
Mean Concentration	*0.007*	*5.094*

The calculated site mean concentrations and the confirmatory mean concentrations are comparable. These data validated the site's FSS results. Additionally, the independent surveys validated area classifications.

The EPA drinking water maximum concentration levels (MCLs) are 100 pCi/L for Co-60 and 30 µg/L for total uranium (EPA 2000). All of the water samples were below the respective drinking water MCLs.

The applicable NRC surface activity guidelines are 5,000 βγ dpm/100 cm^2, average and 15,000 βγ dpm/100 cm^2, maximum for Co-60; and, 5,000 a dpm/100 cm^2, average and 15,000 α dpm/100 cm^2, maximum for uranium (NRC 1987). All direct measurements were well below the NRC surface activity guidelines.

SUMMARY

The Oak Ridge Institute for Science and Education performed confirmatory survey activities for 27 site areas at the ABB Inc. CE Windsor Site in Windsor, Connecticut. These activities included the review and assessment of the final status survey reports and during the period March 24 through 27,2008 independent confirmatory measurements and sampling were performed. The ORISE results confirmed MACTEC's and ABB's conclusions regarding each area's classification, final radiological status, and that the release limits have been satisfied.

The total uranium and cobalt-60 concentrations in the water samples were well below the EPA drinking water MCLs.

Alpha and beta surface activity level measurements determined that a localized area of residual elevated alpha surface activity was present on the concrete steps at the Building 4-23 entrance. However, the elevated alpha surface activity was well below the NRC guidelines for uranium.

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APPENDIX A

FIGURES

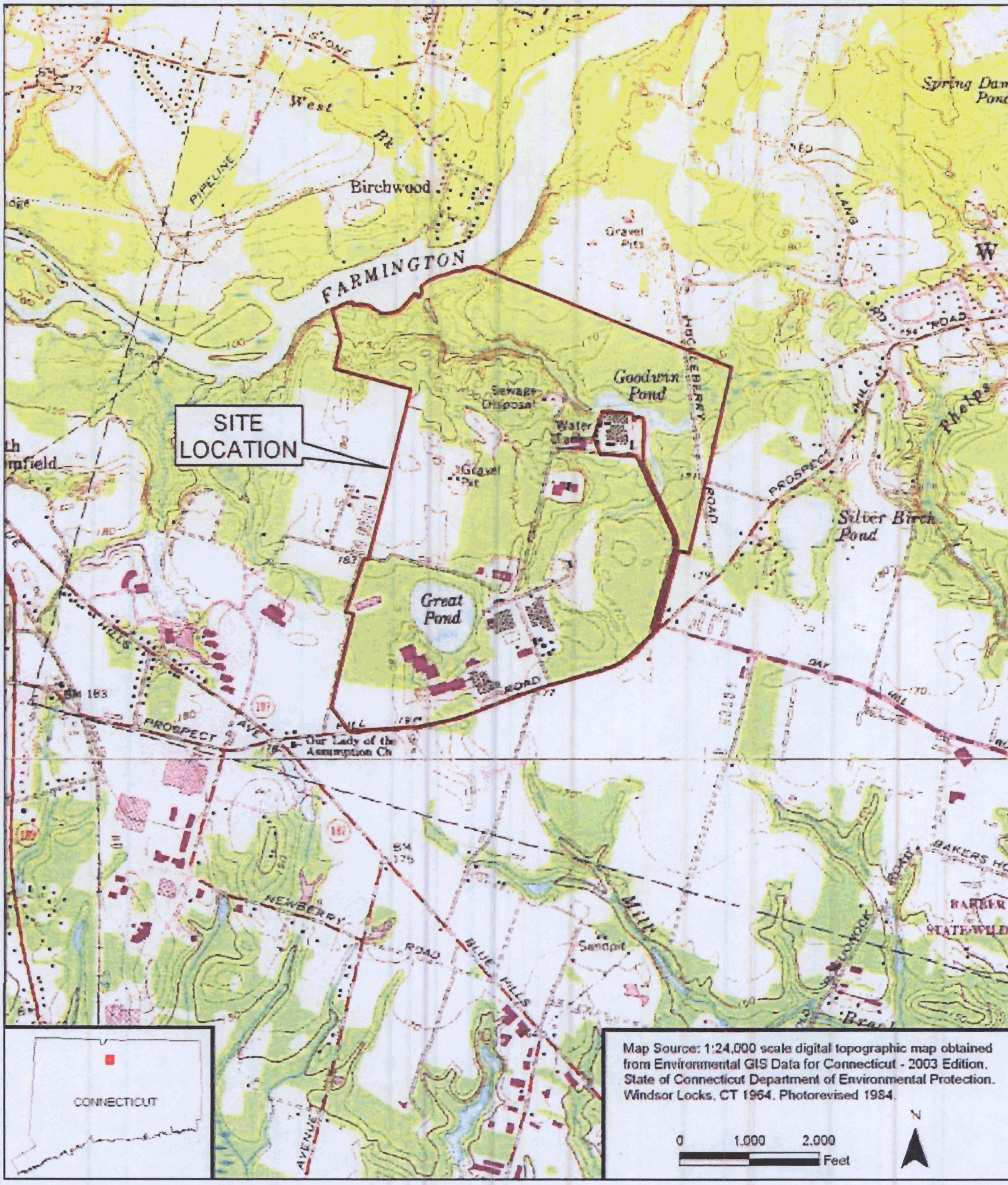


FIGURE A - 1: SITE LOCATION MAP–
ABB CE WINDSOR SITE, WINDSOR, CONNECTICUT

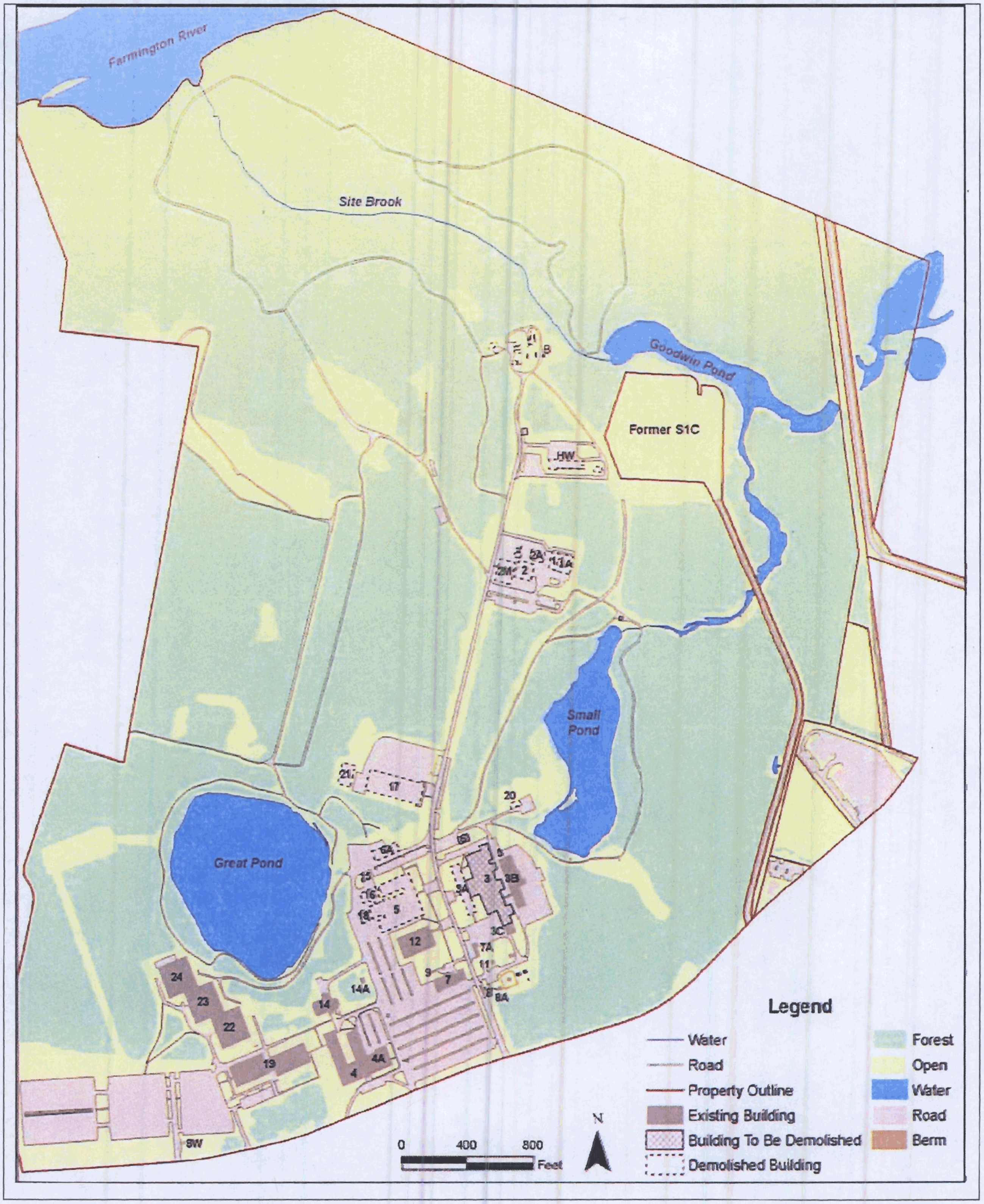


FIGURE A - 2: ABB CE WINDSOR SITE – SITE OVERVIEW

ID	Easting	Northing
1	606019.38	386042.61
2	606142.20	385588.65
3	606047.03	385195.14
4	607147.83	384907.92
5	606526.85	382452.41
6	606471.18	382467.14
7	606207.99	381687.83
8	606311.35	381656.57
9	606002.10	380310.24
10	606244.42	379868.21
11	607320.61	380045.78
12	607817.49	380149.16
13	608963.75	380585.11
14	609936.67	380857.79
15	610076.28	380917.22
16	610204.98	380897.59
17	610674.96	381439.66
18	610977.99	382562.66
19	611134.11	382547.79
20	611745.93	385219.79
21	608133.92	386865.51

Coordinates are CT State Plane NAD 27 with Units of US Survey Feet

FIGURE A - 3: BOUNDARY OF PARTIAL SITE RELEASE AREA

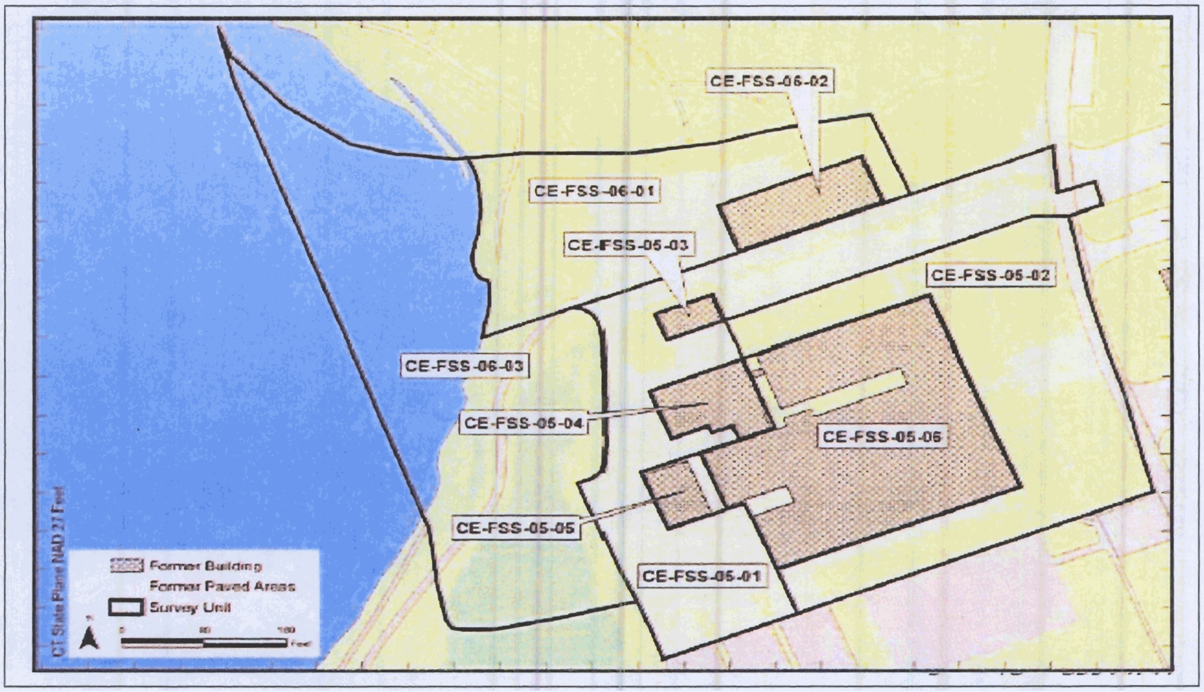


FIGURE A - 4: BUILDING 5 AND 6A COMPLEX

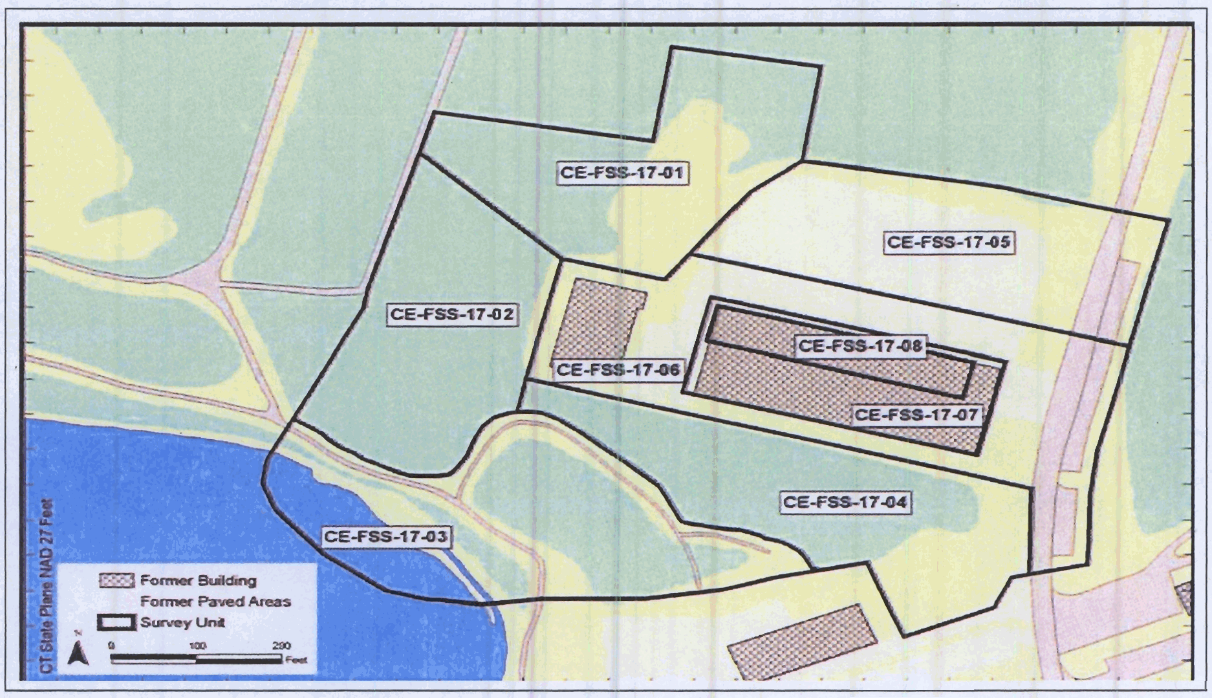


FIGURE A - 5: BUILDING 17 COMPLEX

FIGURE A - 6: LOCATION OF SUs CS FSS-24-01 AND CE FSS-26-02

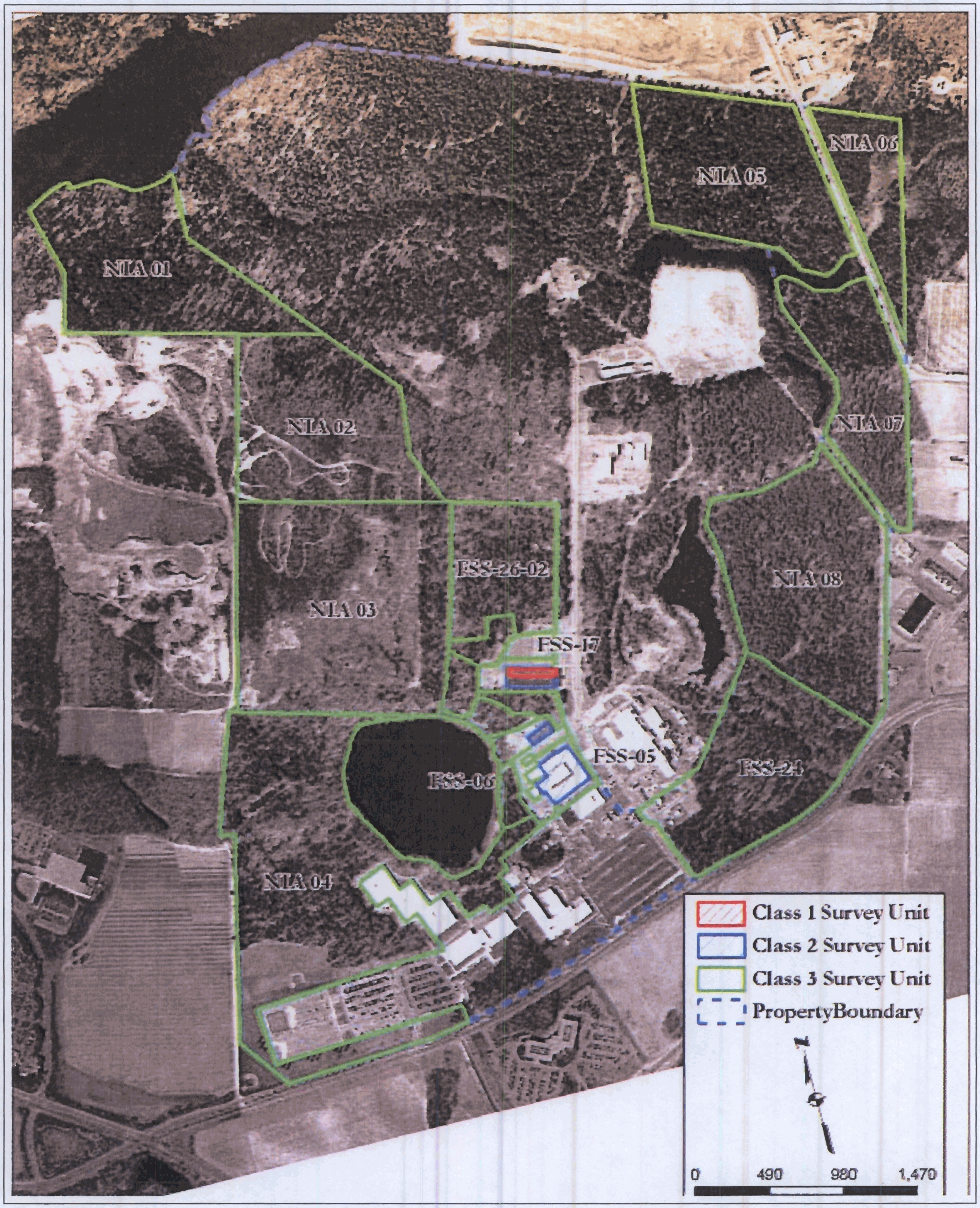


FIGURE A - 7: LOCATIONS OF NON-IMPACTED AREAS AS DESIGNATED BY ORISE

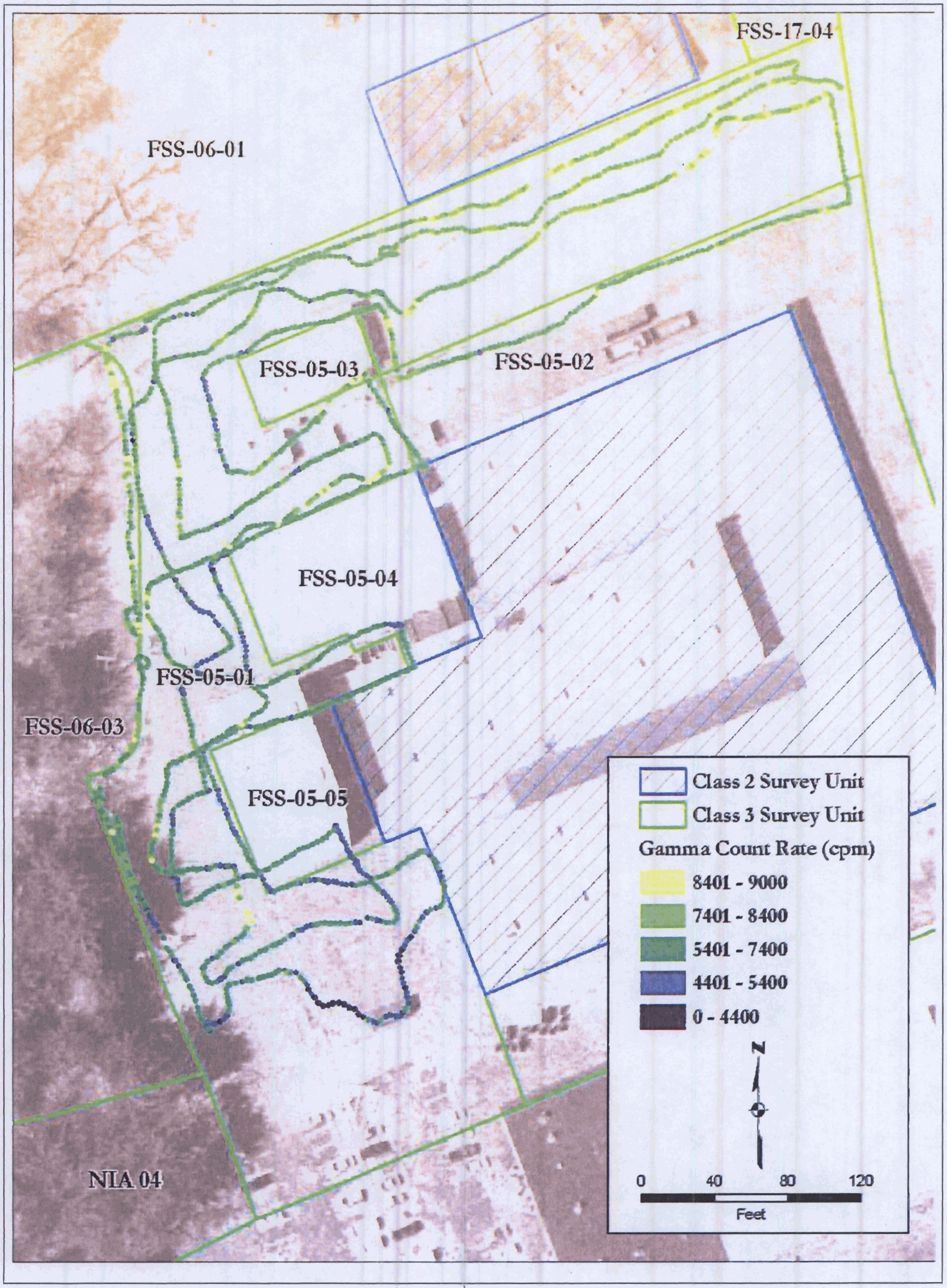


FIGURE A - 8: SURVEY UNIT FSS-05-01 – GAMMA SCANS

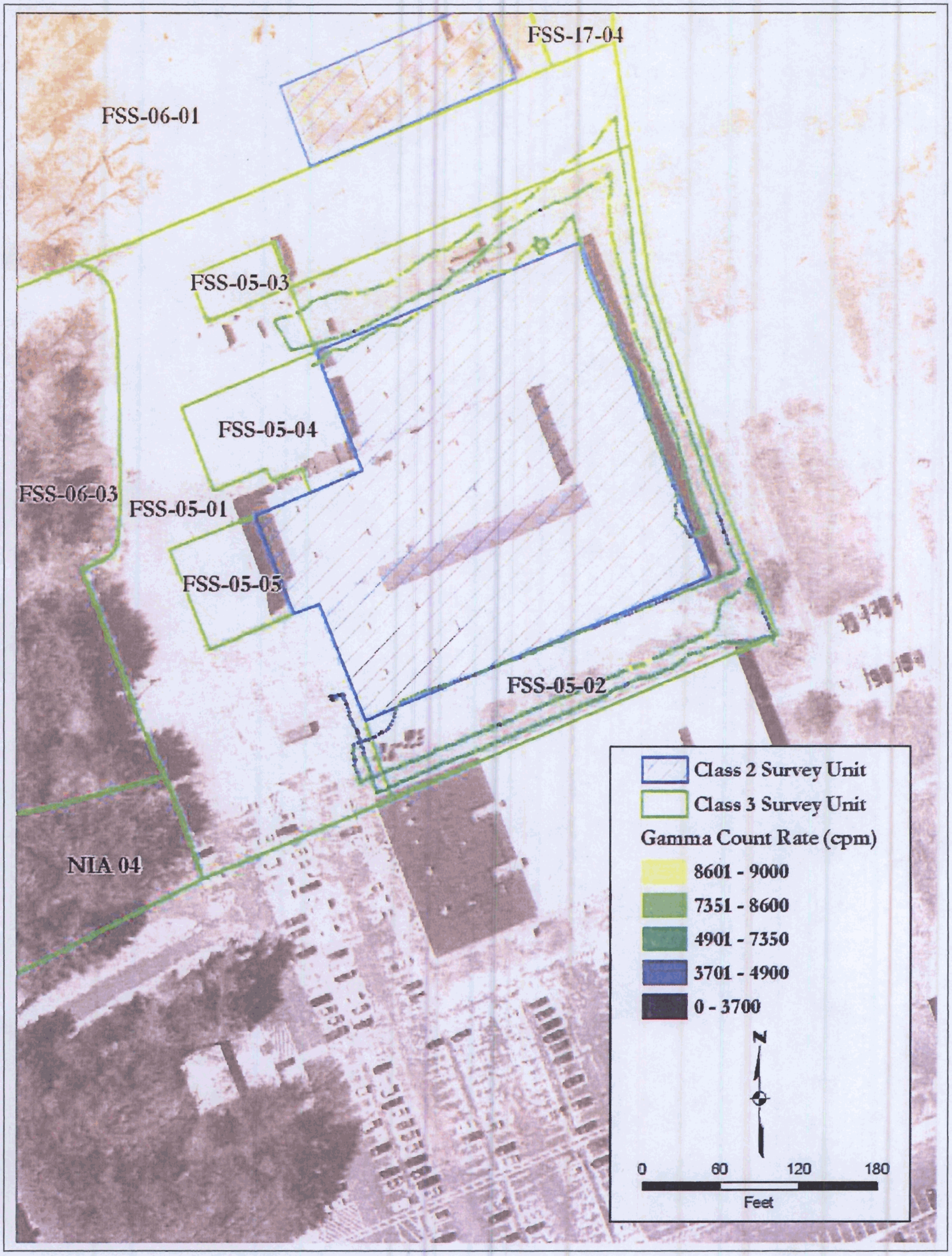


FIGURE A - 9: SURVEY UNIT FSS-05-02 – GAMMA SCANS

FIGURE A - 10: SURVEY UNIT FSS-05-03 – GAMMA SCANS

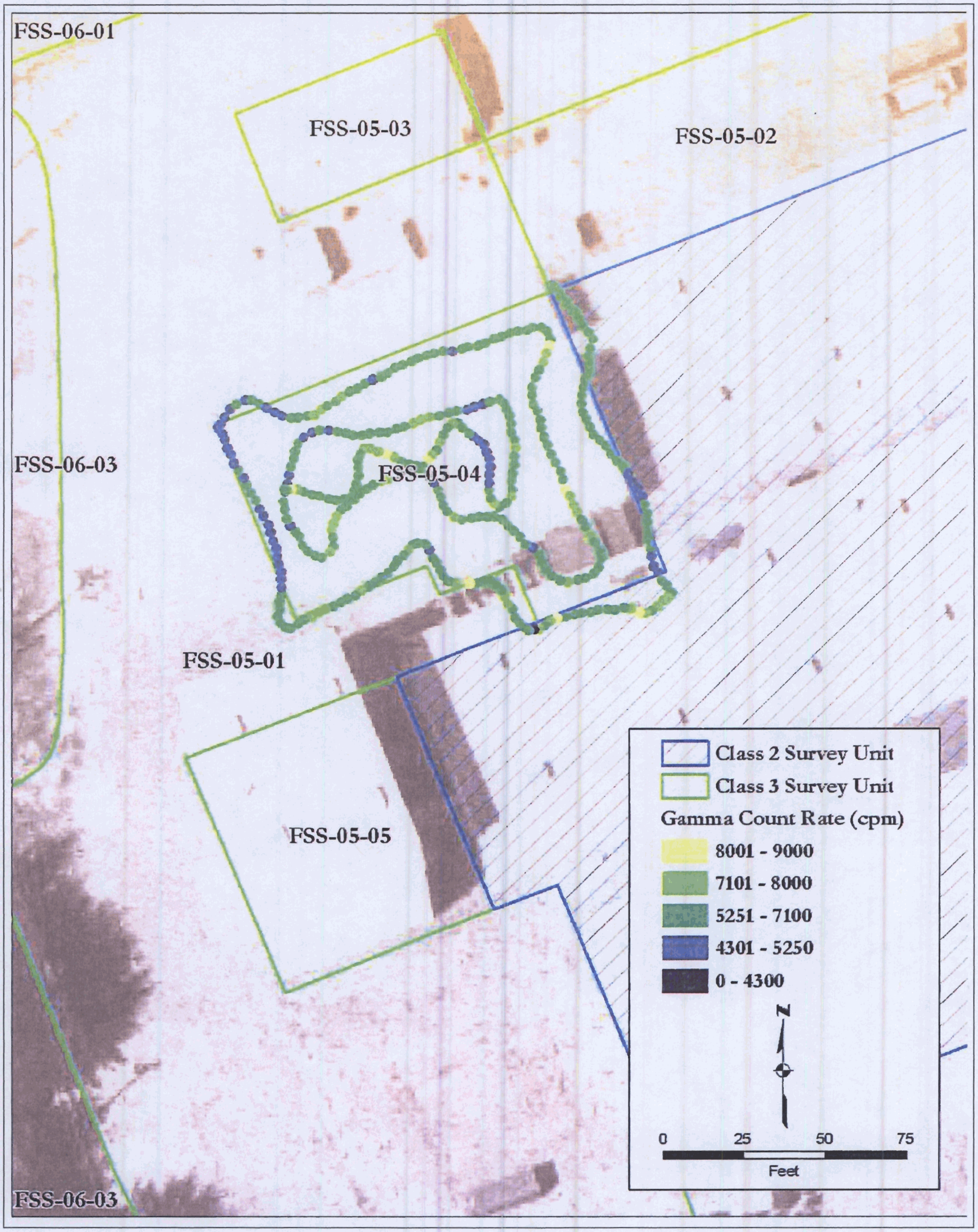


FIGURE A - 11. SURVEY UNIT FSS-05-04– GAMMA SCANS

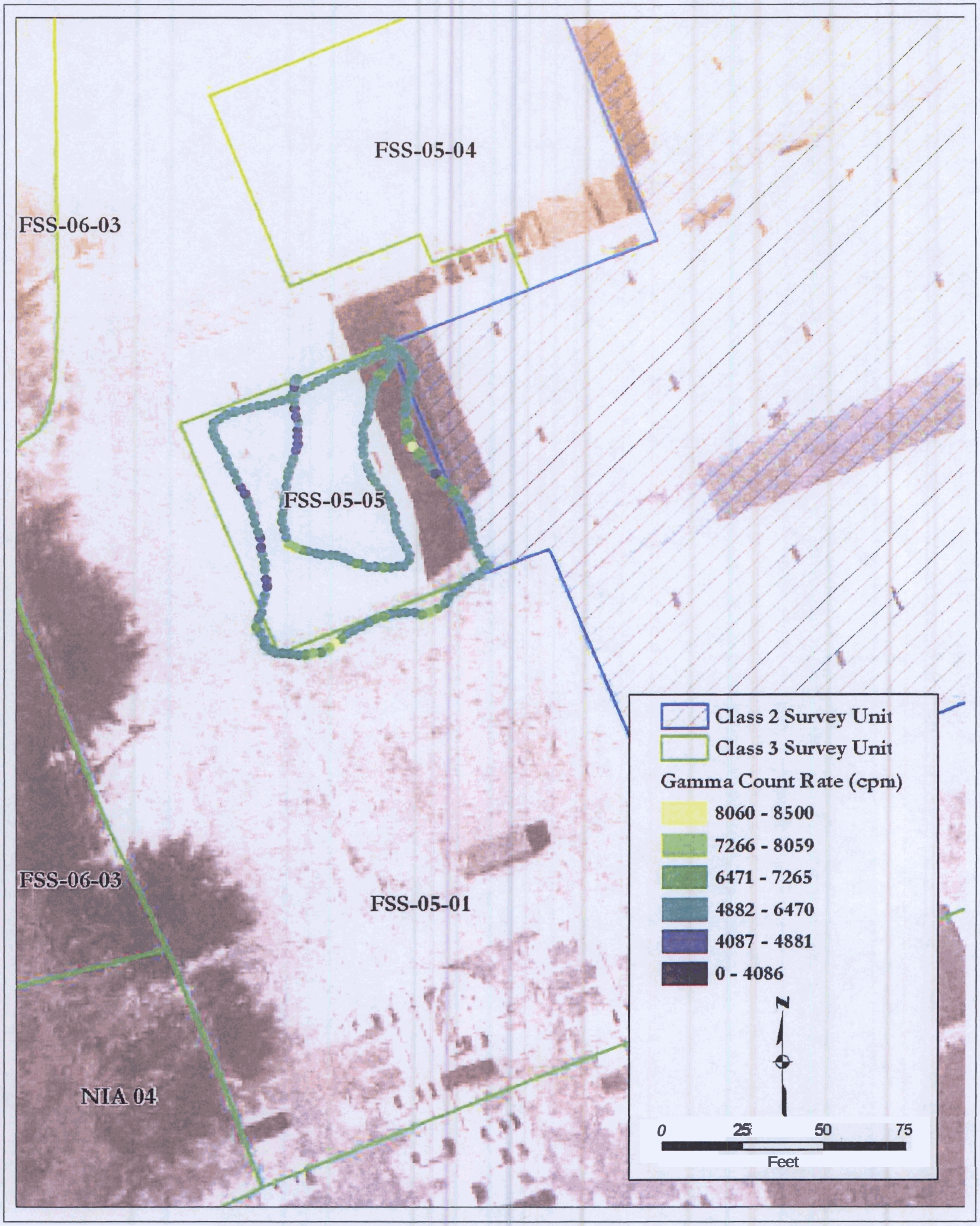


FIGURE A - 12: SURVEY UNIT FSS-05-05 – GAMMA SCANS

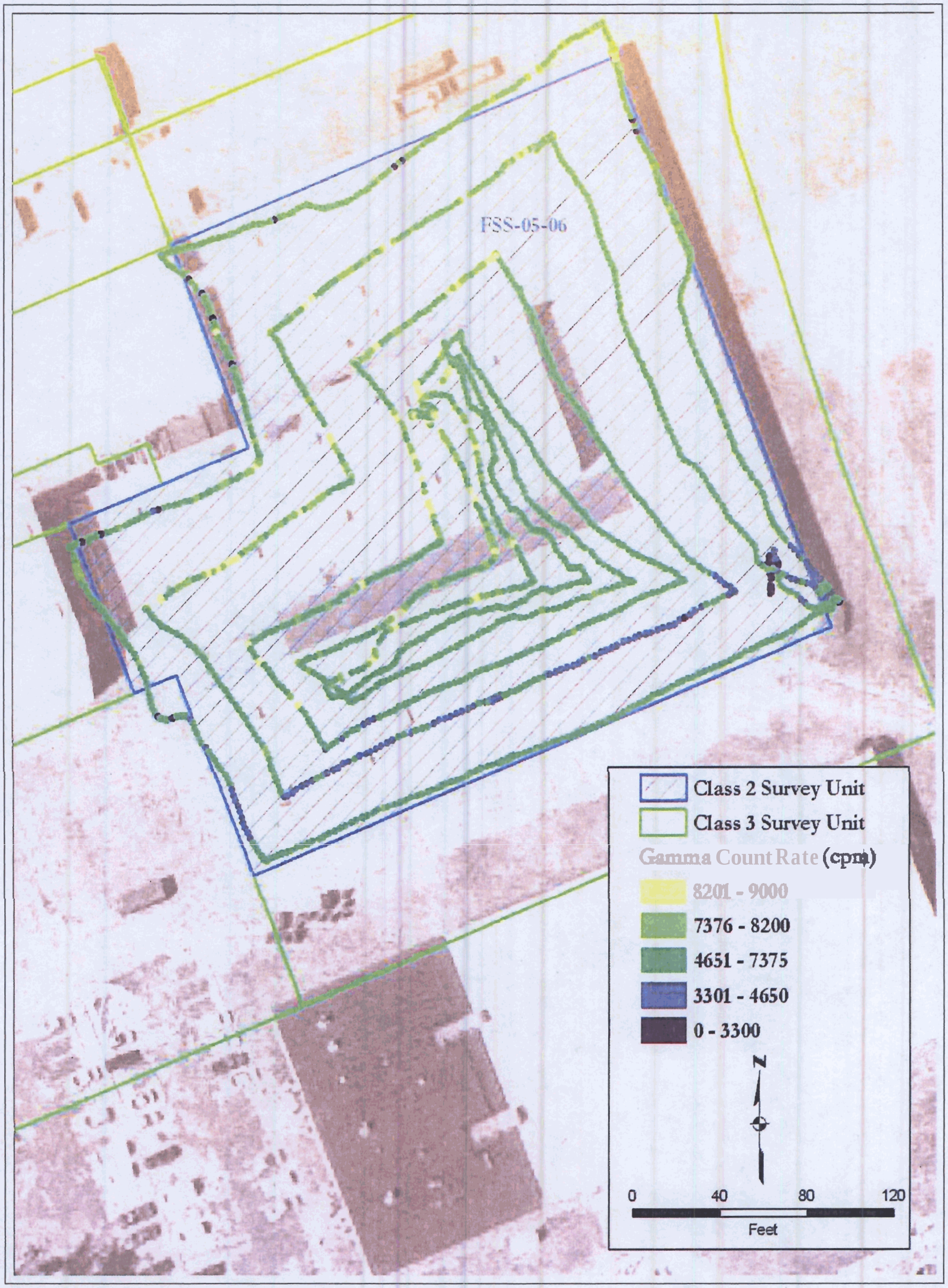


FIGURE A - 13: SURVEY UNIT FSS-05-06 – GAMMA SCANS

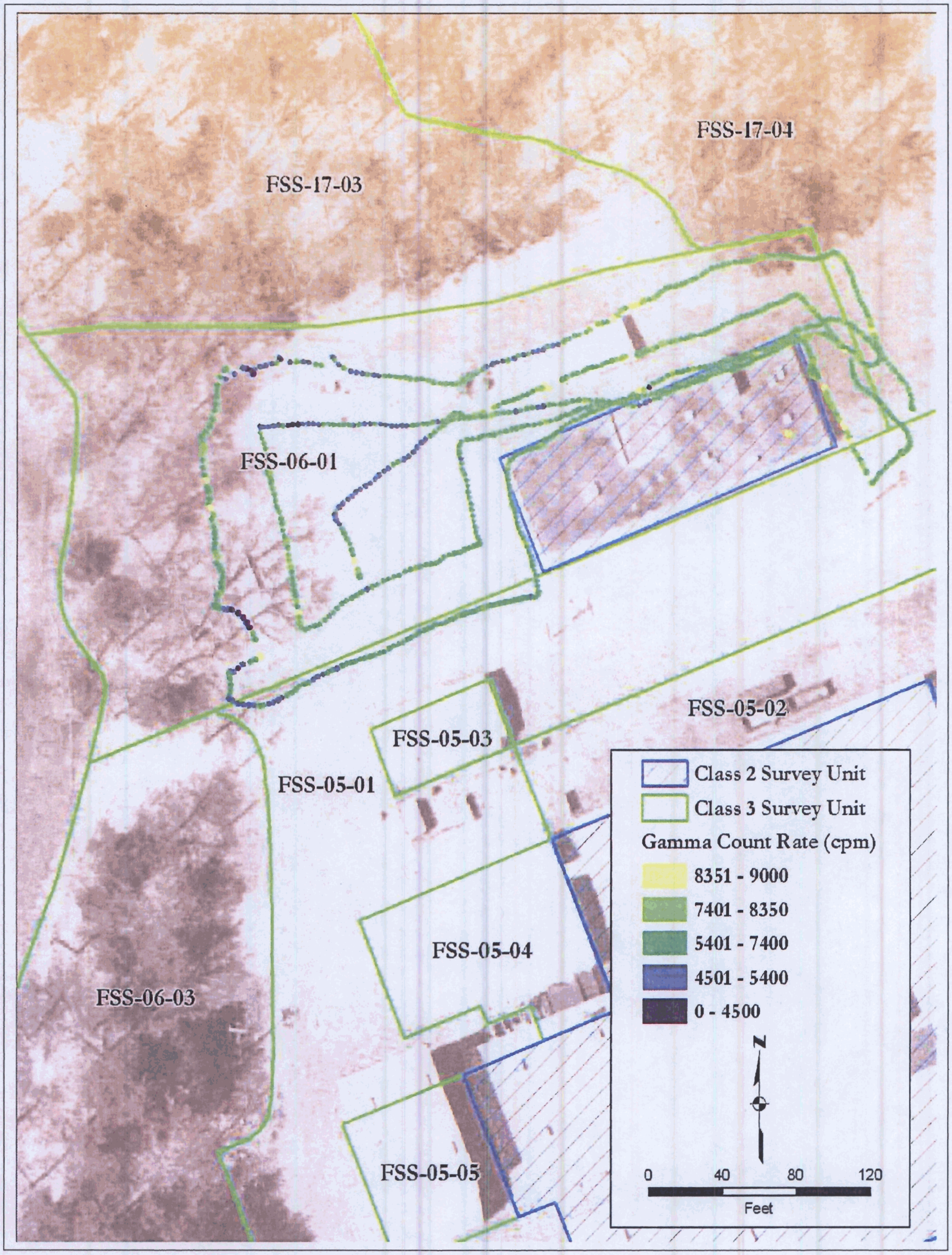


FIGURE A-14: SURVEY UNIT FSS-06-01 – GAMMA SCANS

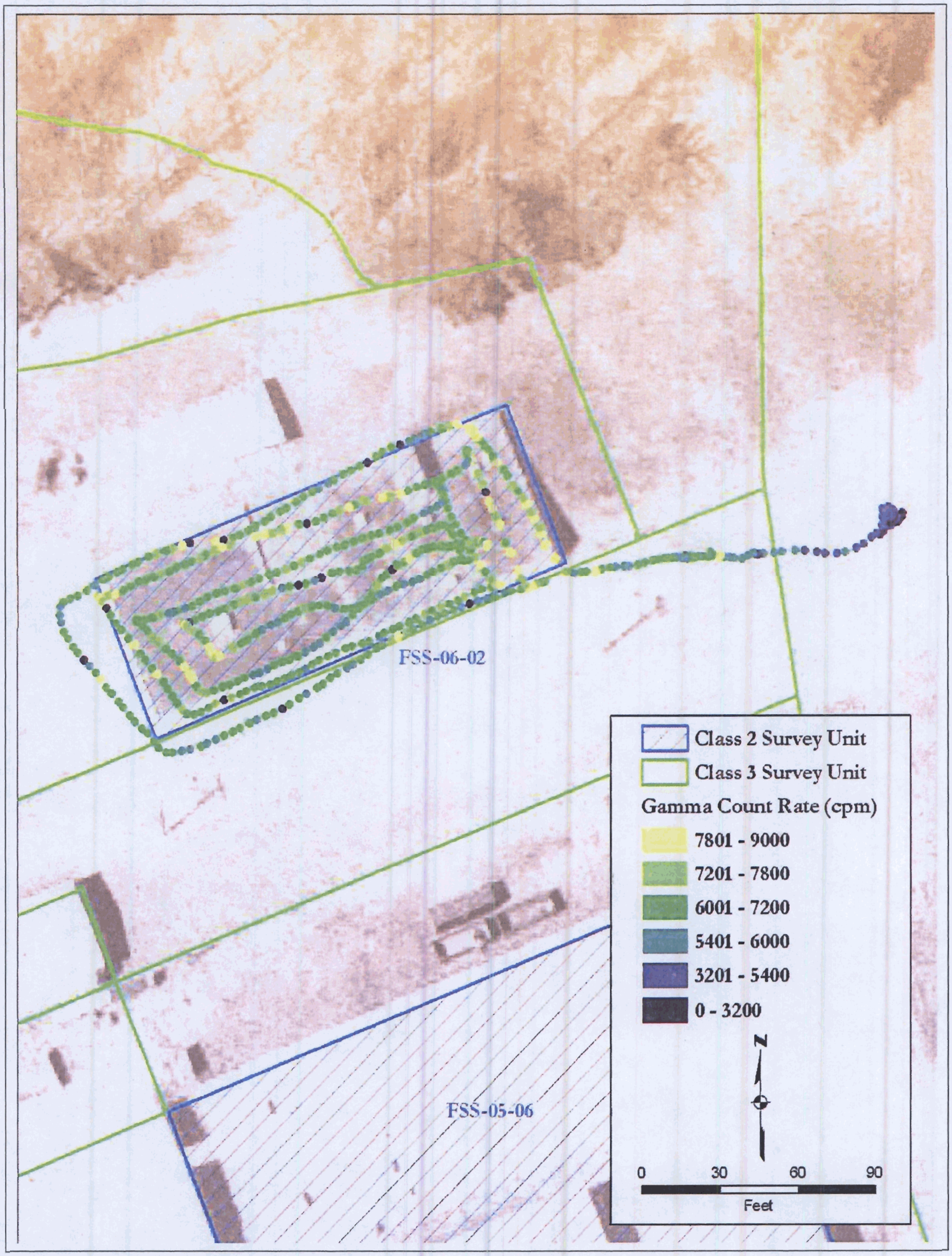


FIGURE A - 15: SURVEY UNIT FSS-06-02 – GAMMA SCANS

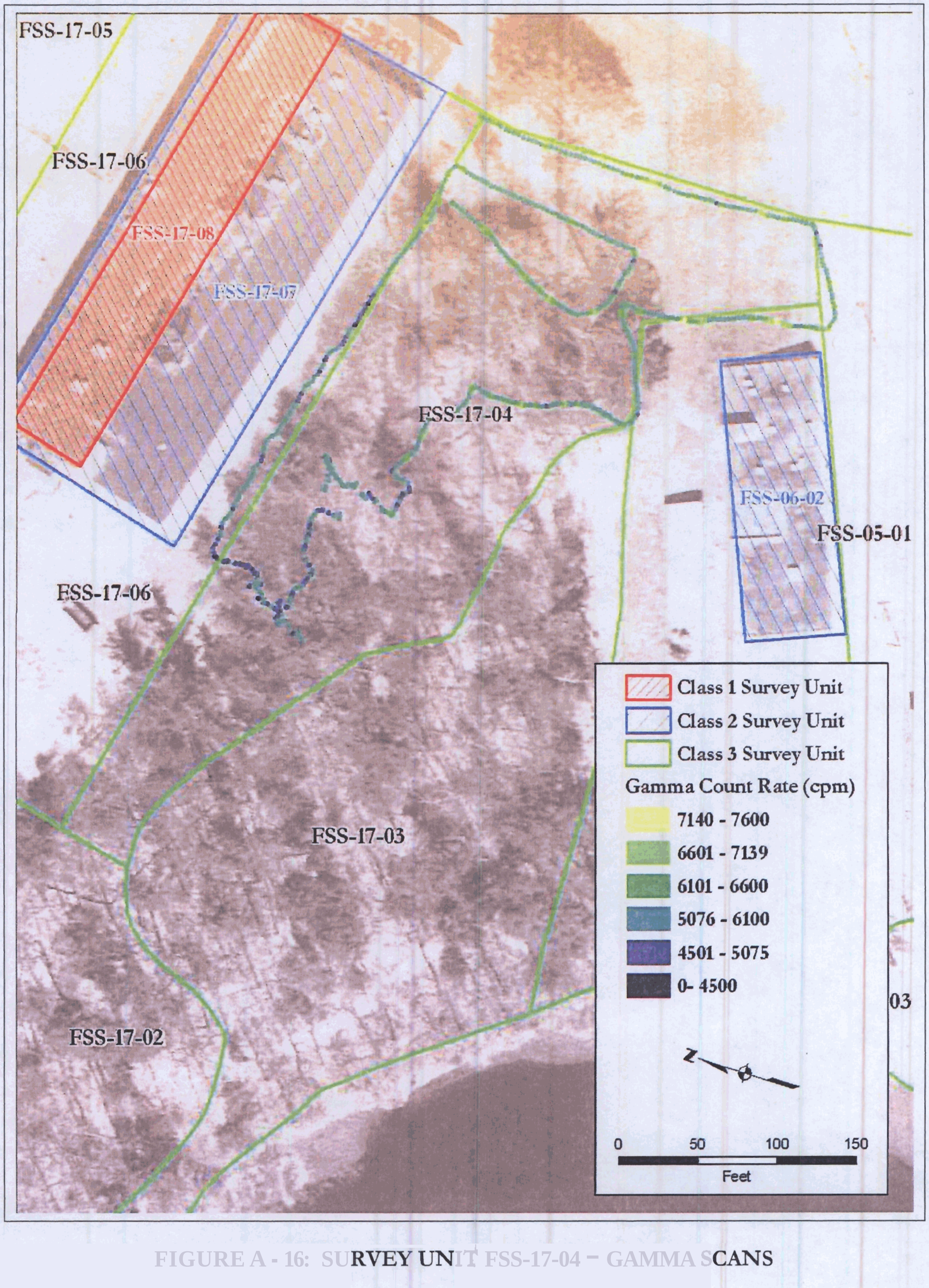


FIGURE A - 16: SURVEY UNIT FSS-17-04 – GAMMA SCANS

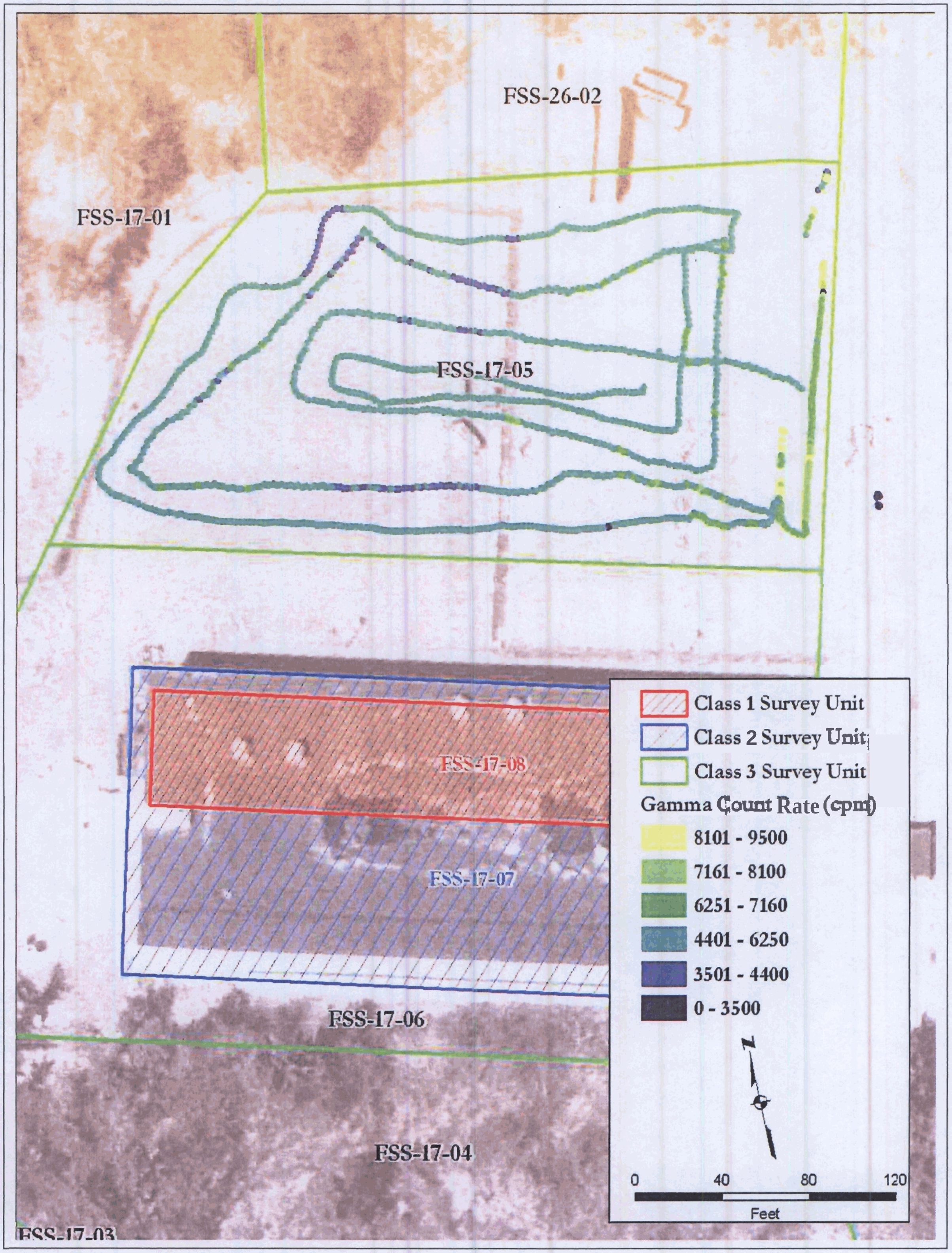


FIGURE A - 17: SURVEY UNIT FSS-17-05 – GAMMA SCANS

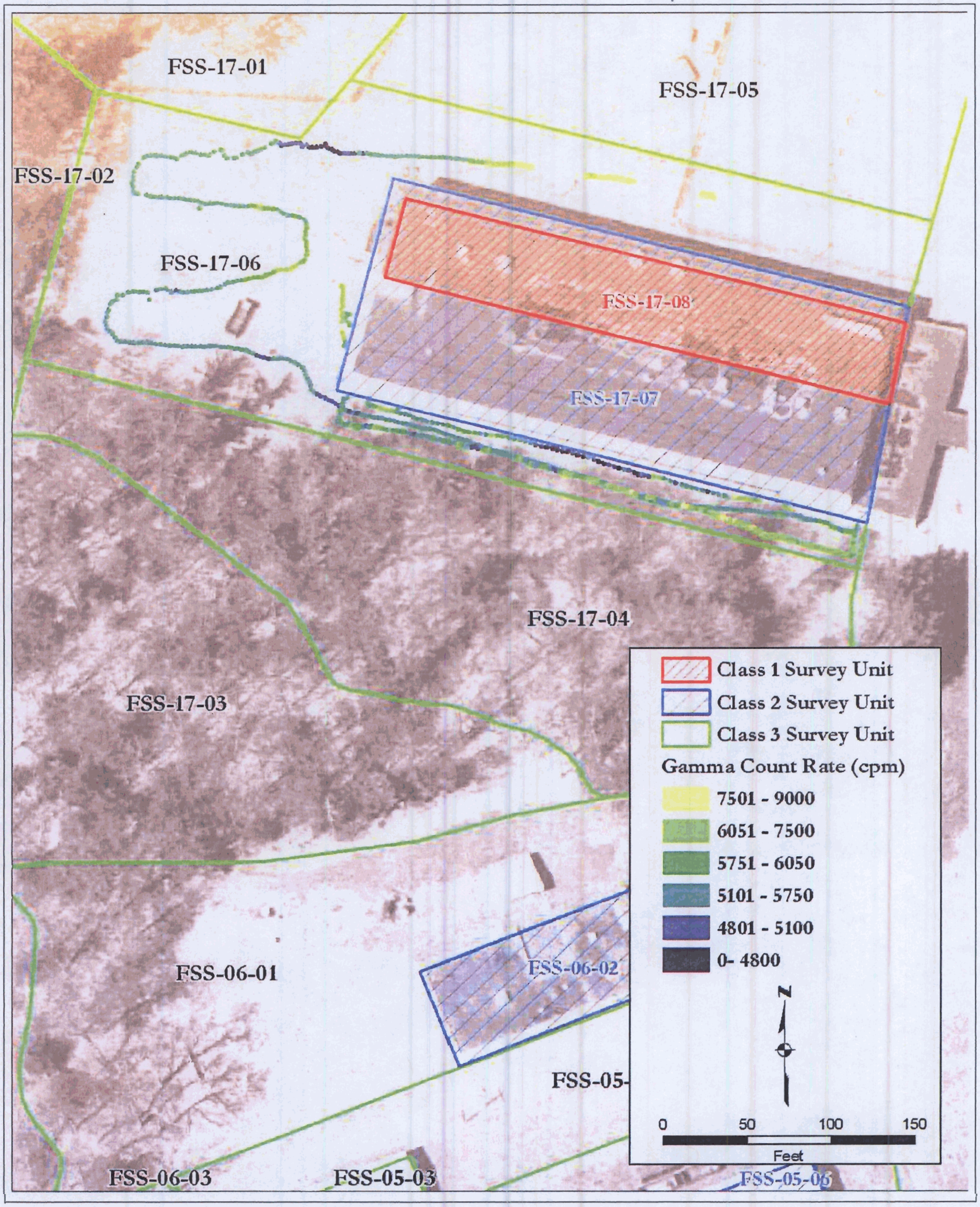


FIGURE A - 18: SURVEY UNIT FSS-17-06 – GAMMA SCANS

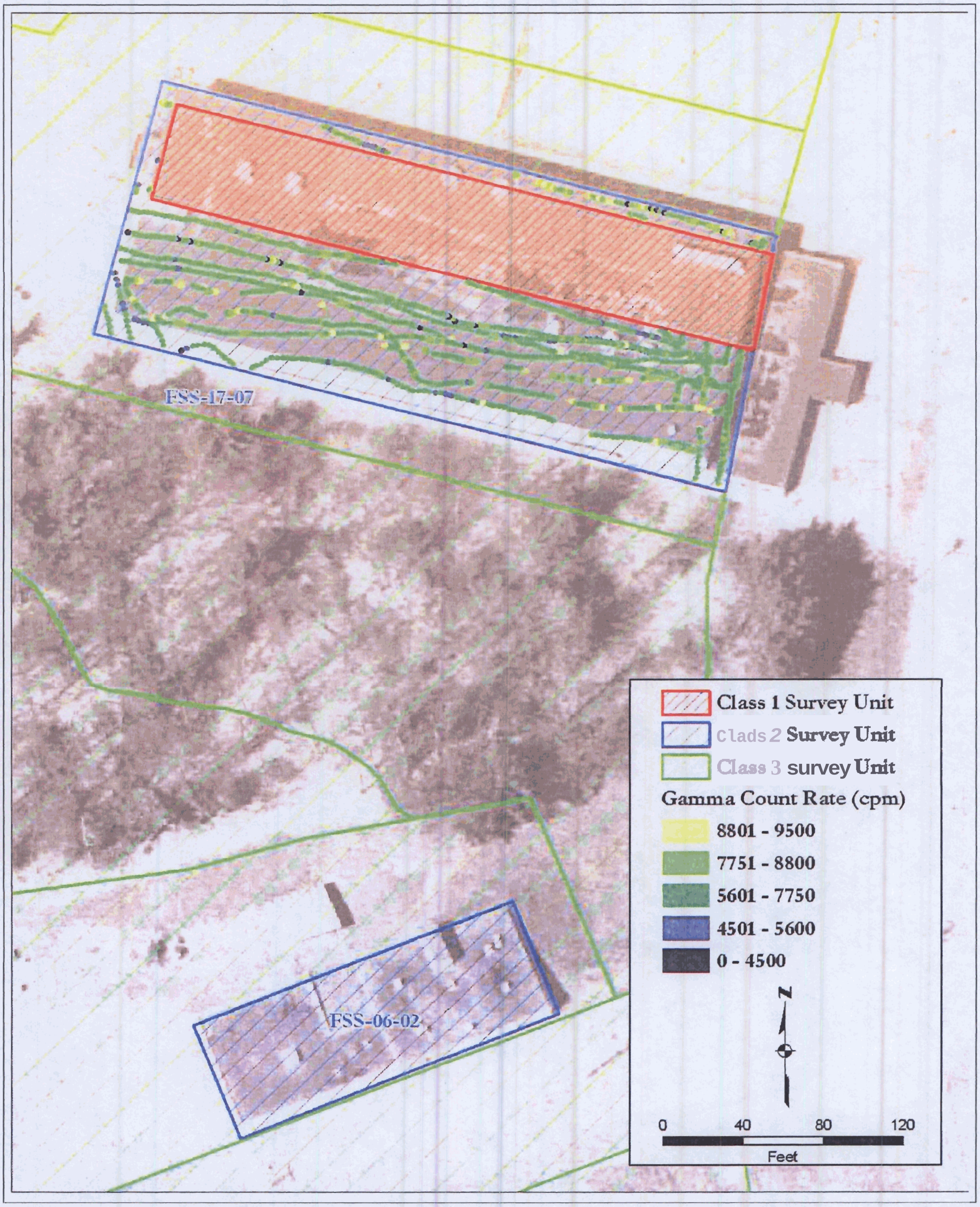


FIGURE A - 19: SURVEY UNIT FSS-17-07 – GAMMA SCANS

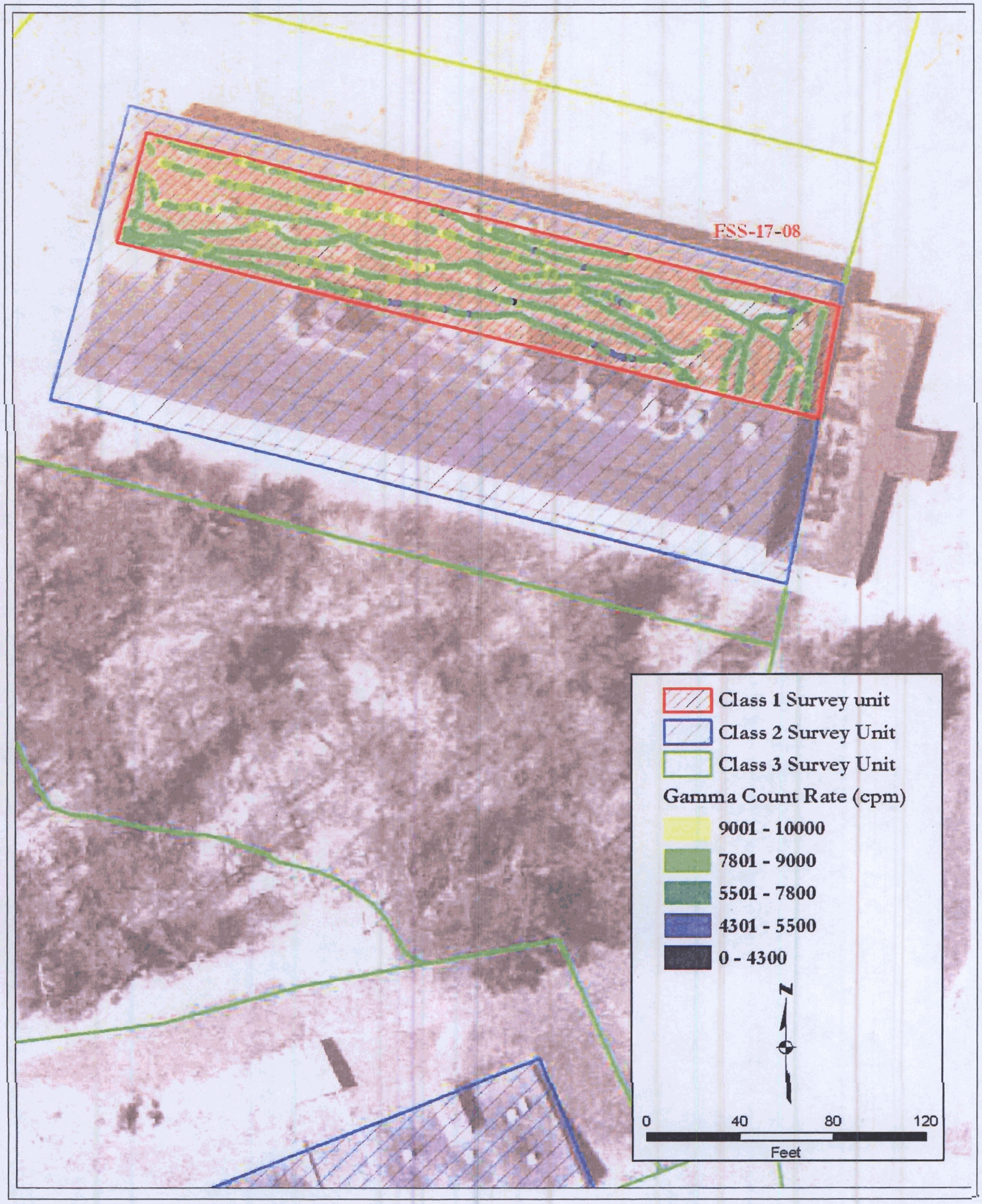


FIGURE A - 20: SURVEY UNIT FSS-17-08 – GAMMA SCANS

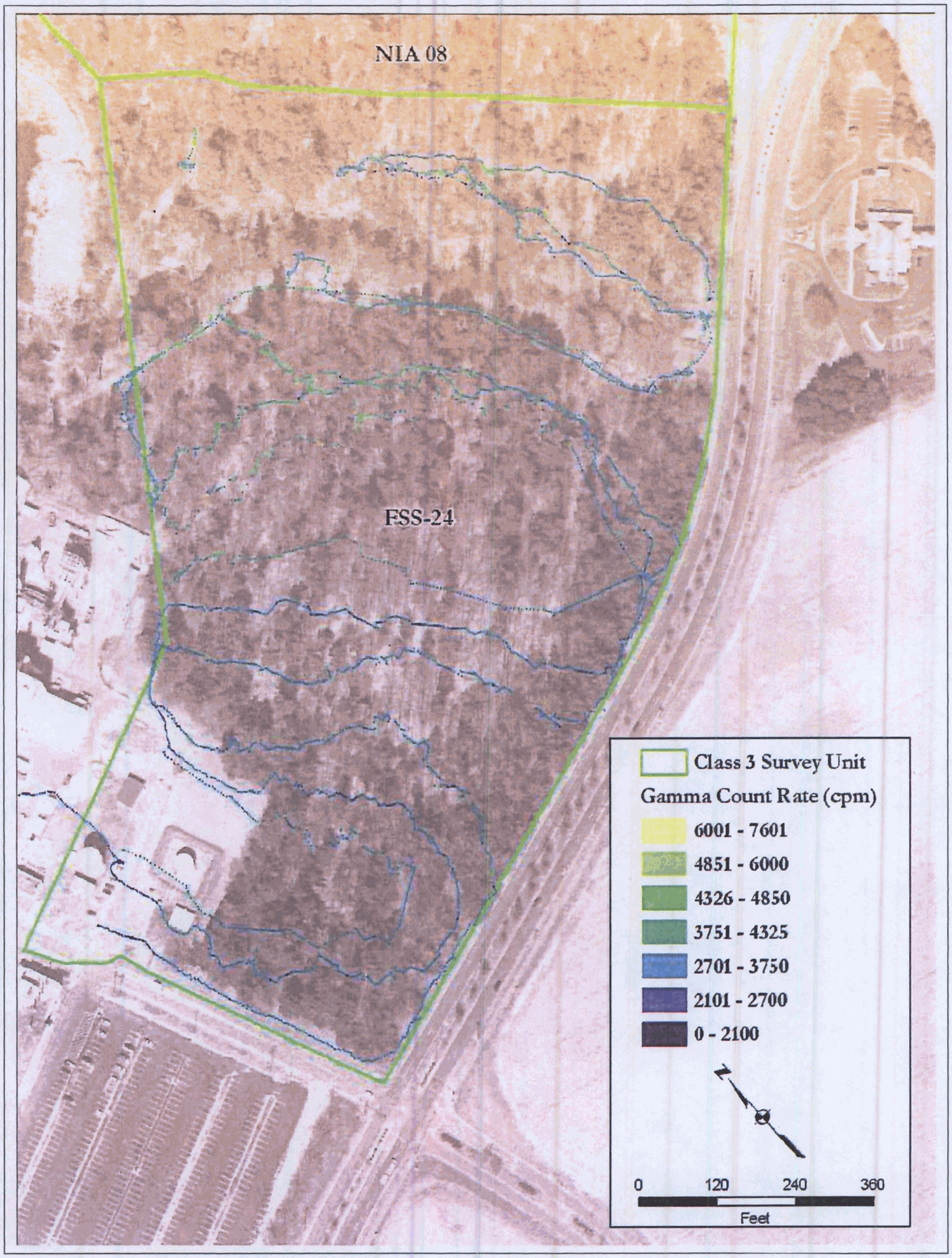


FIGURE A - 21: SURVEY.UNIT FSS-24 – GAMMA SCANS

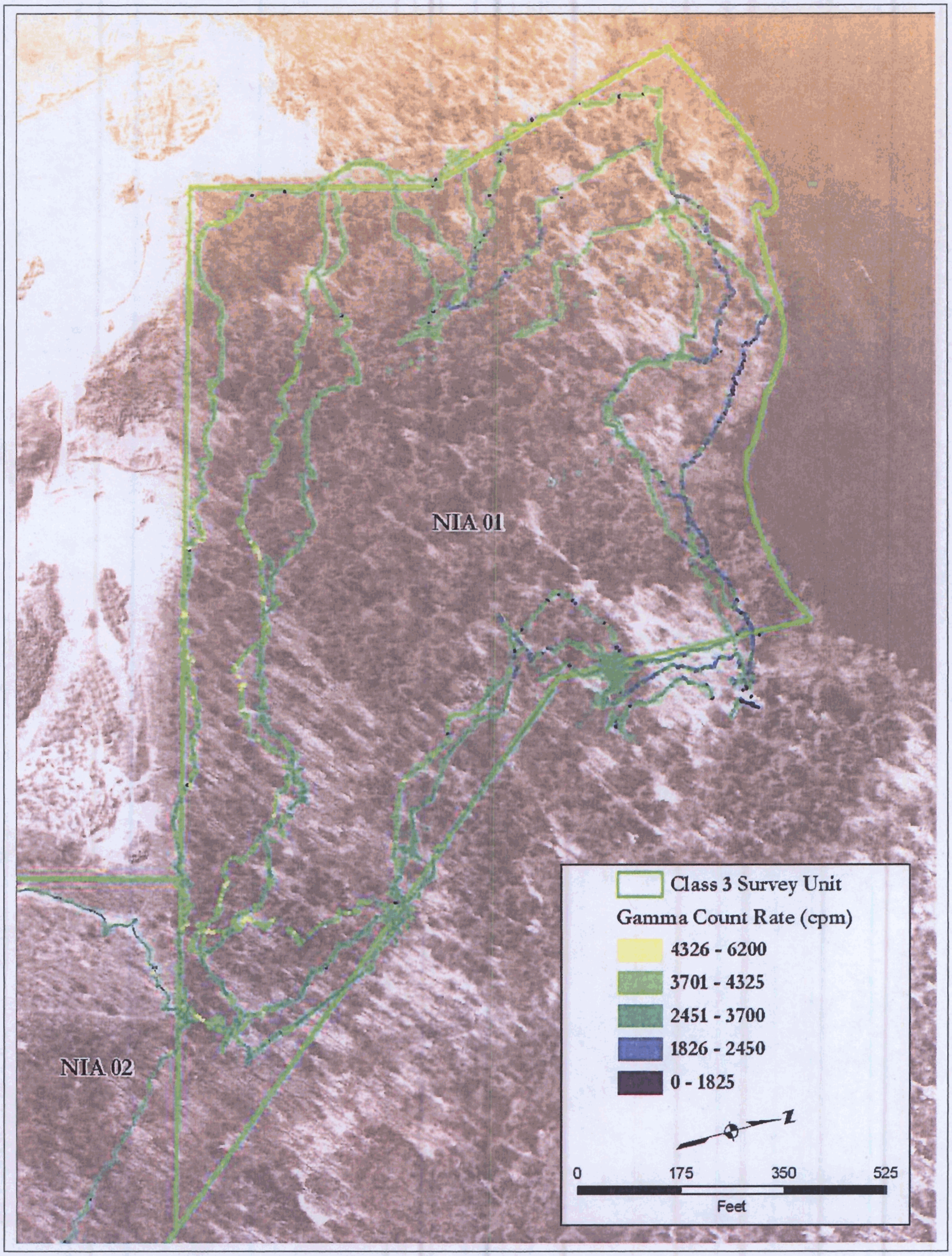


FIGURE A - 22: SURVEY UNIT NIA-01– GAMMA SCANS

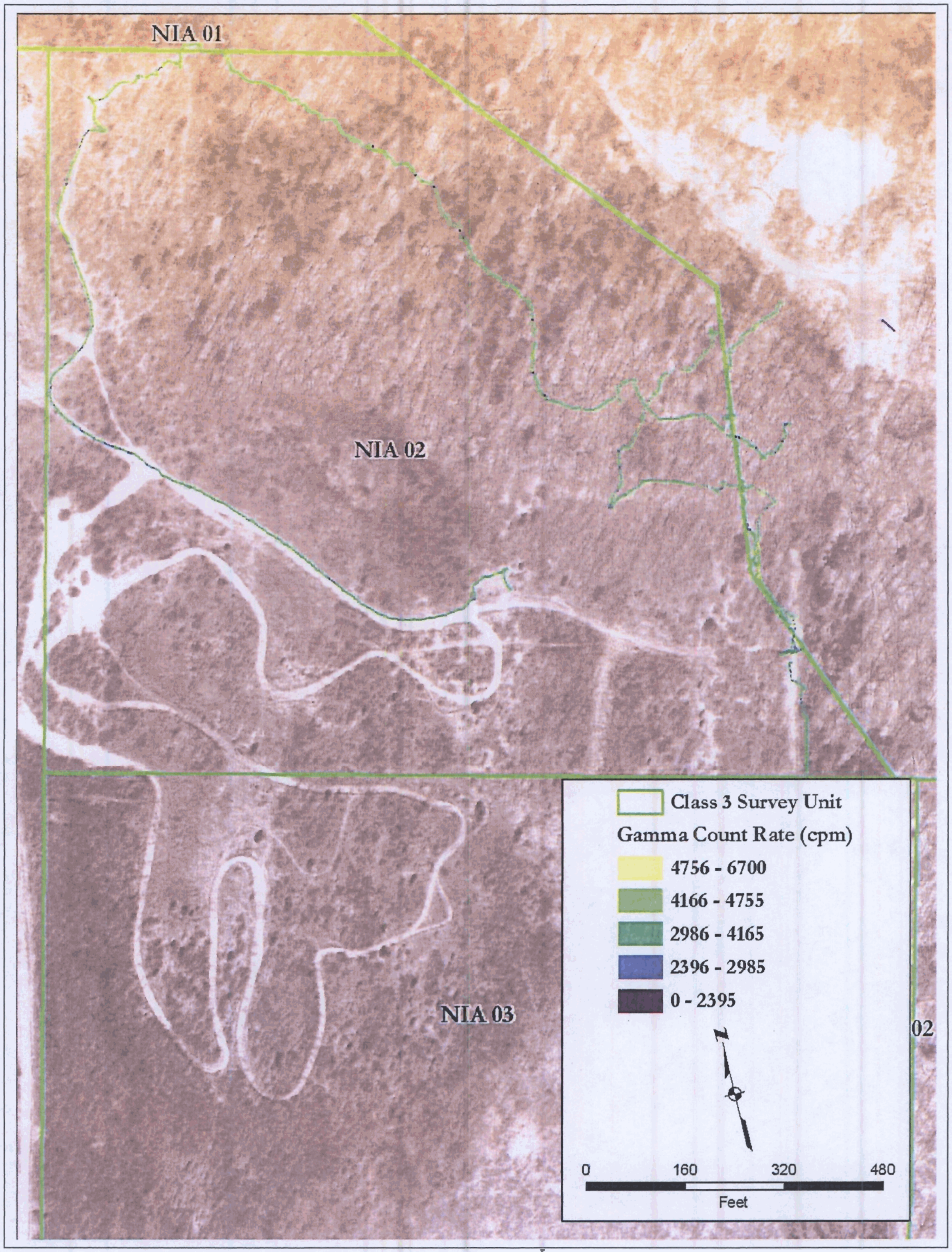


FIGURE A - 23: SURVEY UNIT NIA-02 – GAMMA SCANS

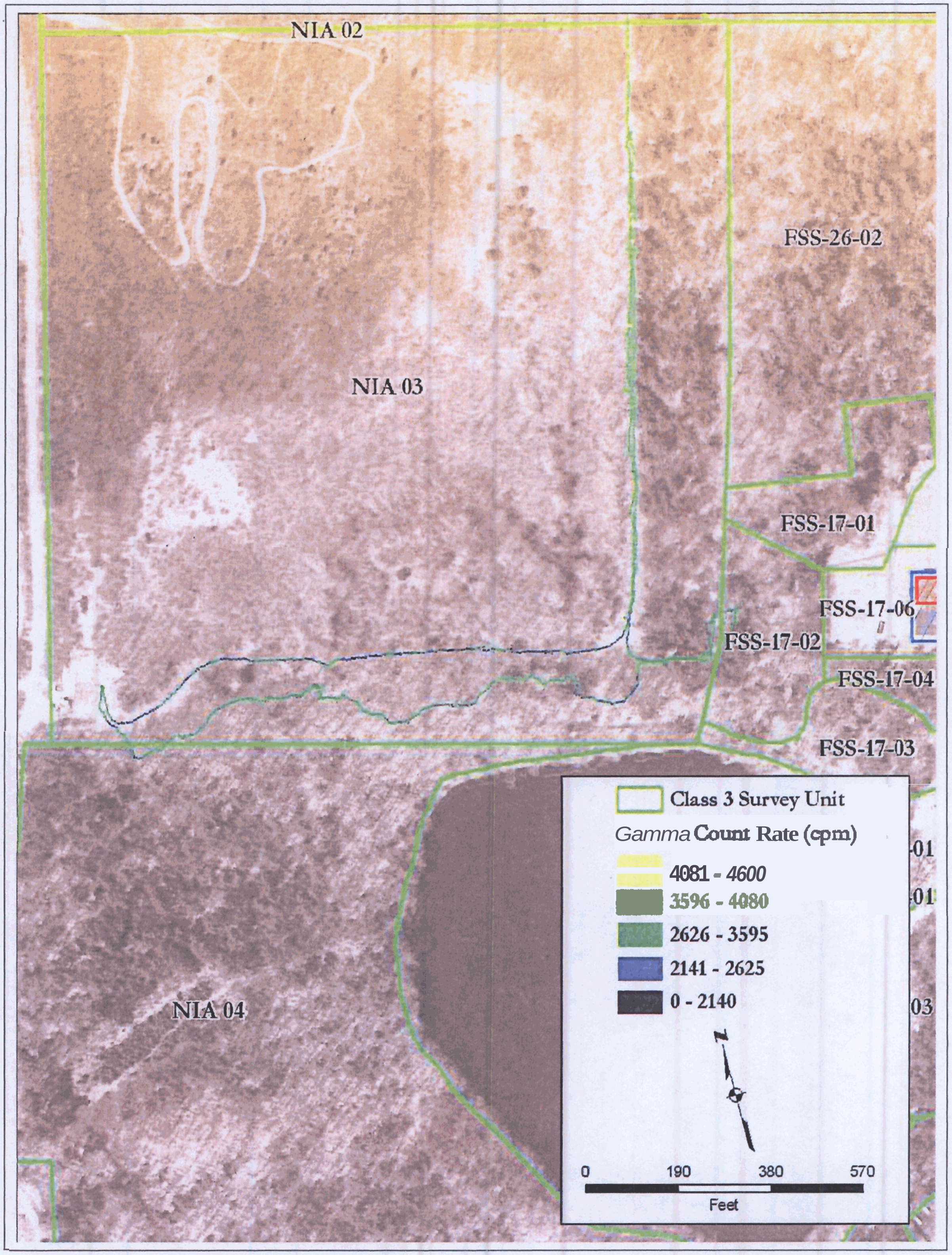


FIGURE A - 24: SURVEY UNIT NIA-03 – GAMMA SCANS

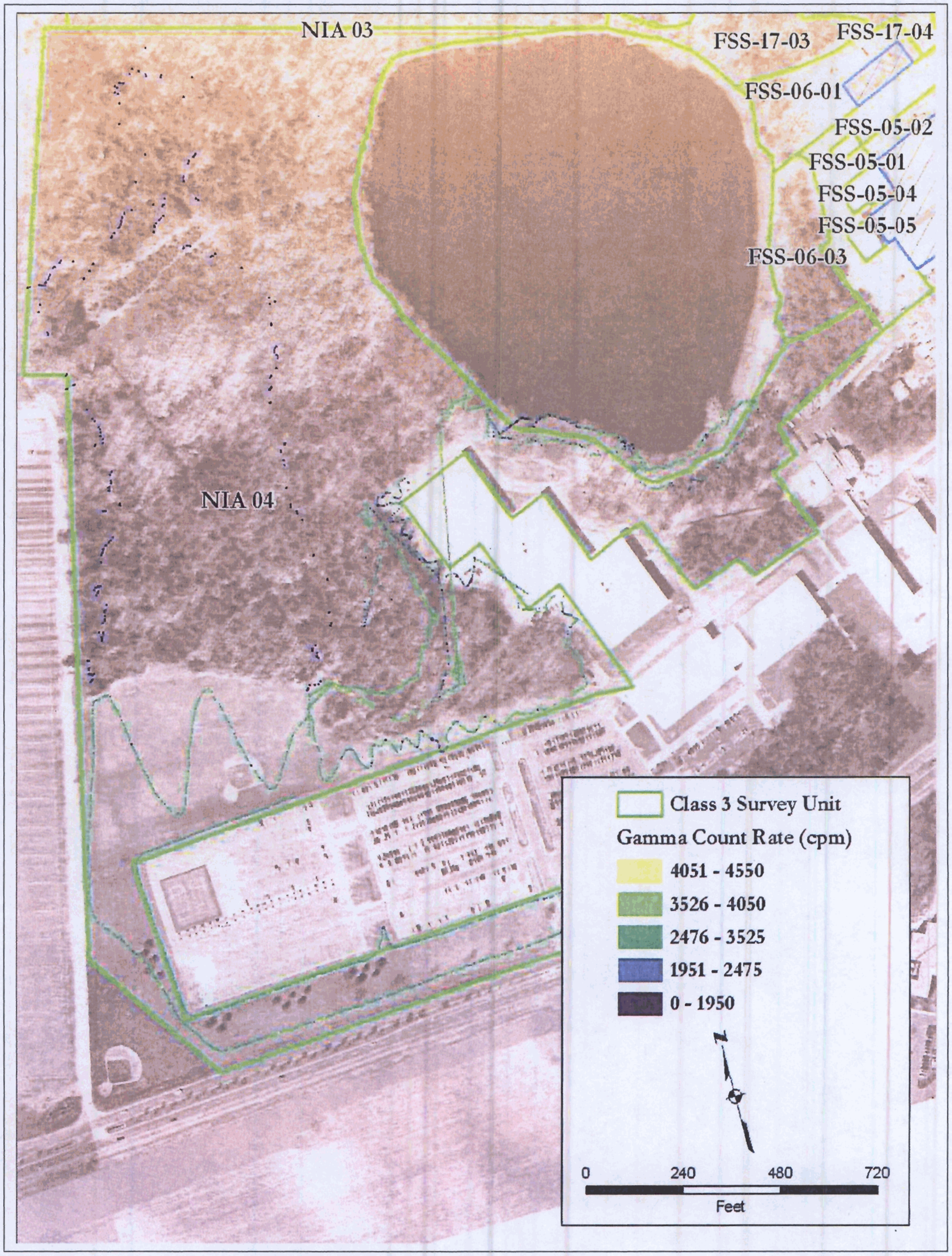


FIGURE A - 25: SURVEY UNIT NIA-04 – GAMMA SCANS

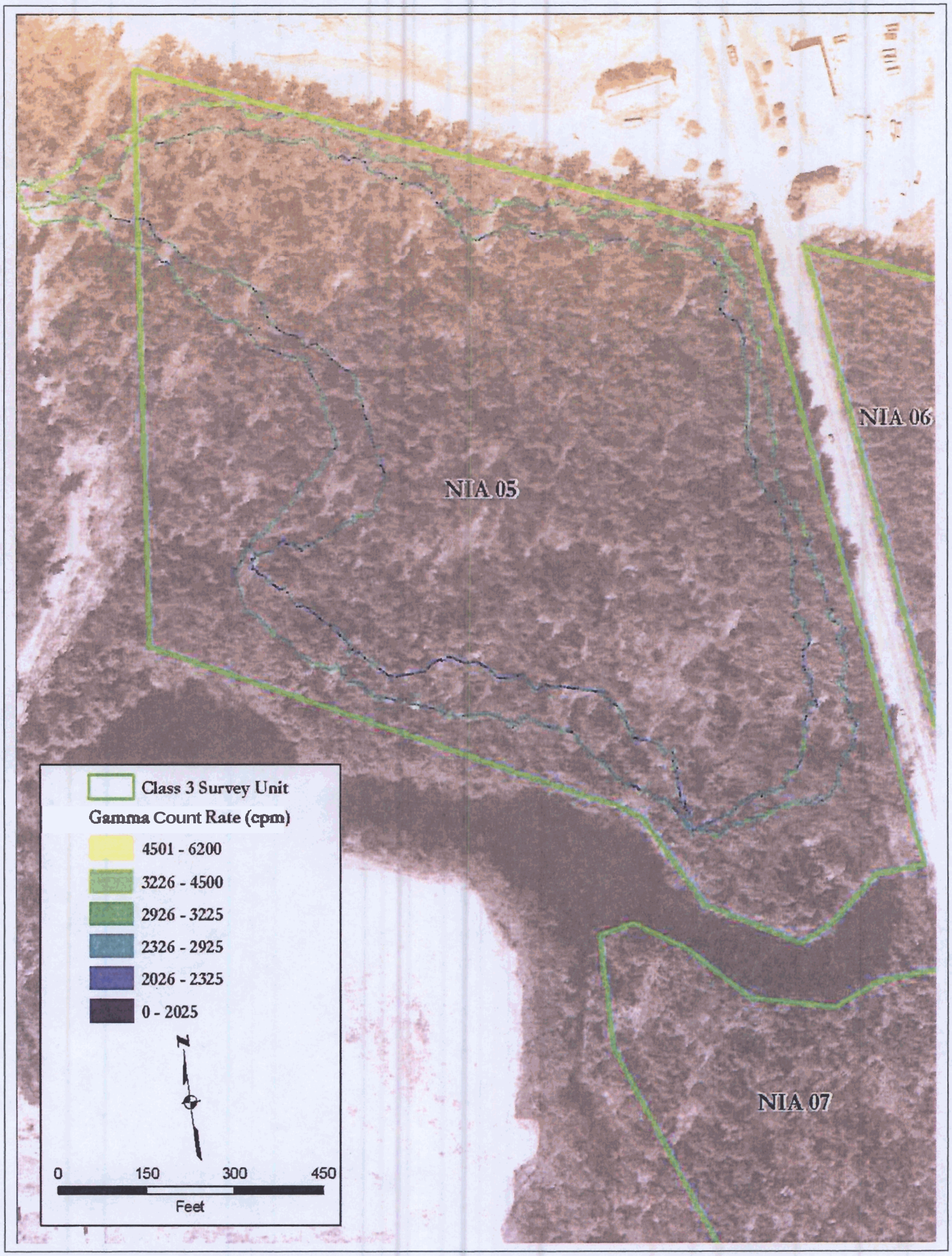


FIGURE A - 26: SURVEY UNIT NIA-05 – GAMMA SCANS

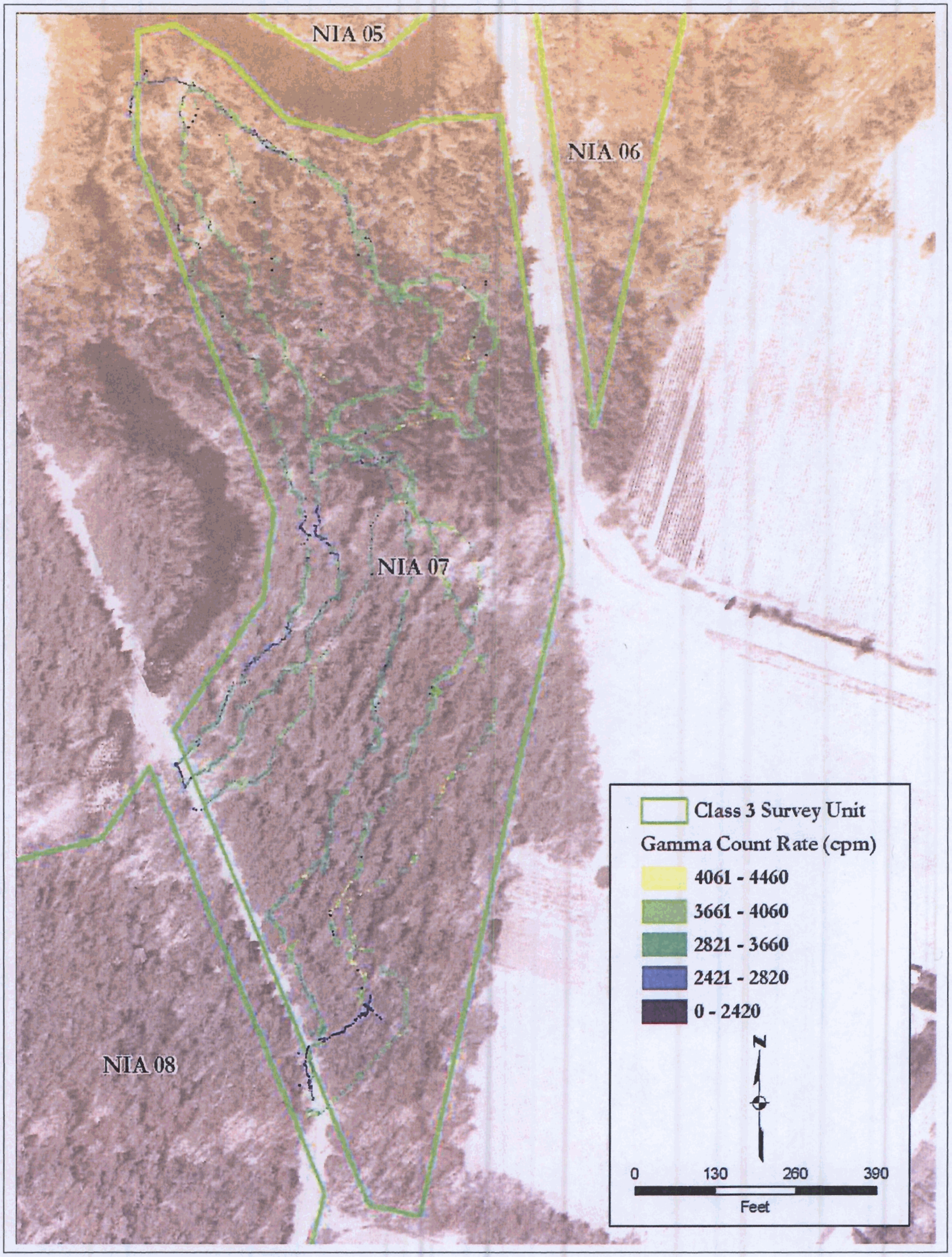
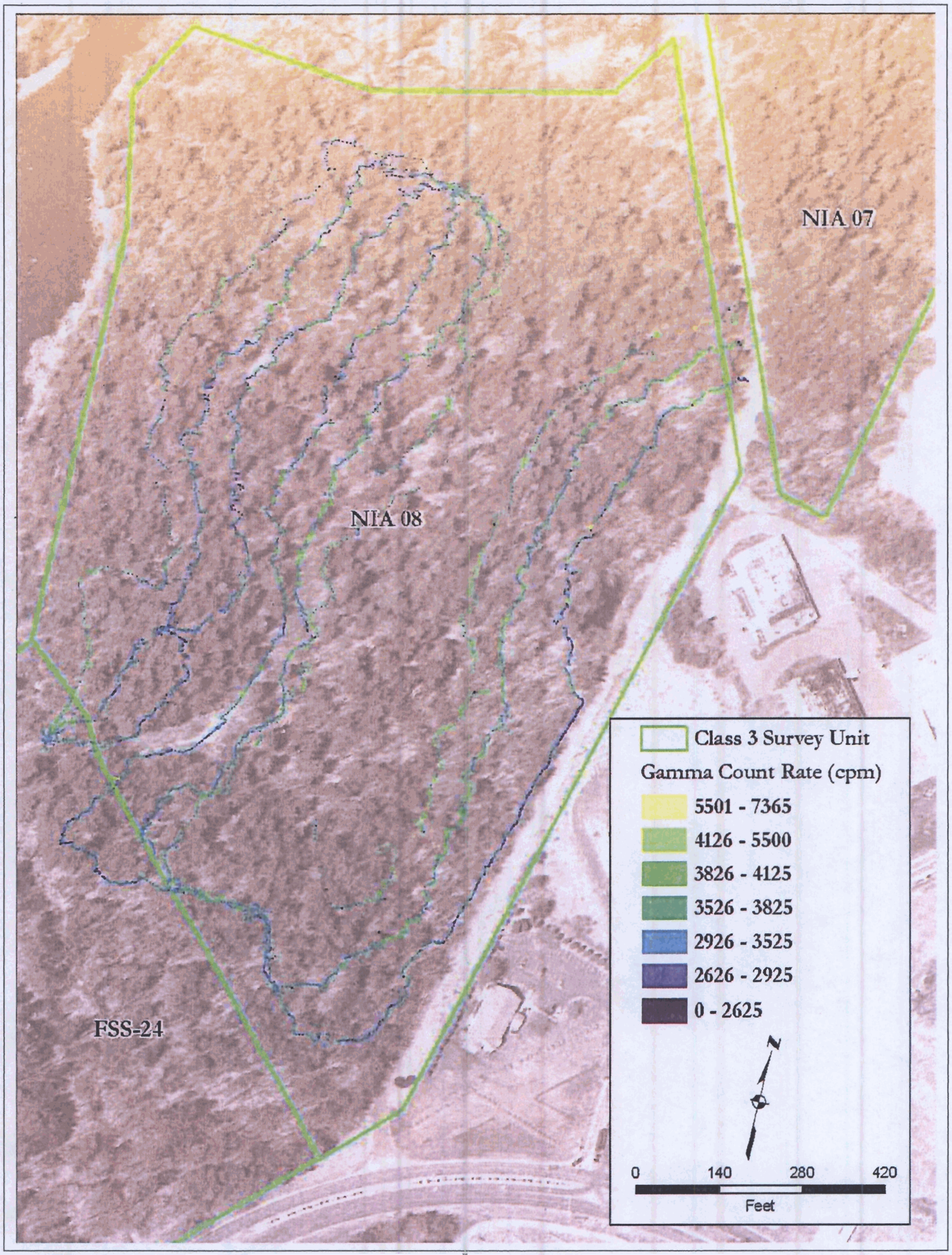


FIGURE A - 27: SURVEY UNIT NIA-07 – GAMMA SCANS



IGURE A - 28: SURVEY UNIT NIA-08 – GAMMA SCANS

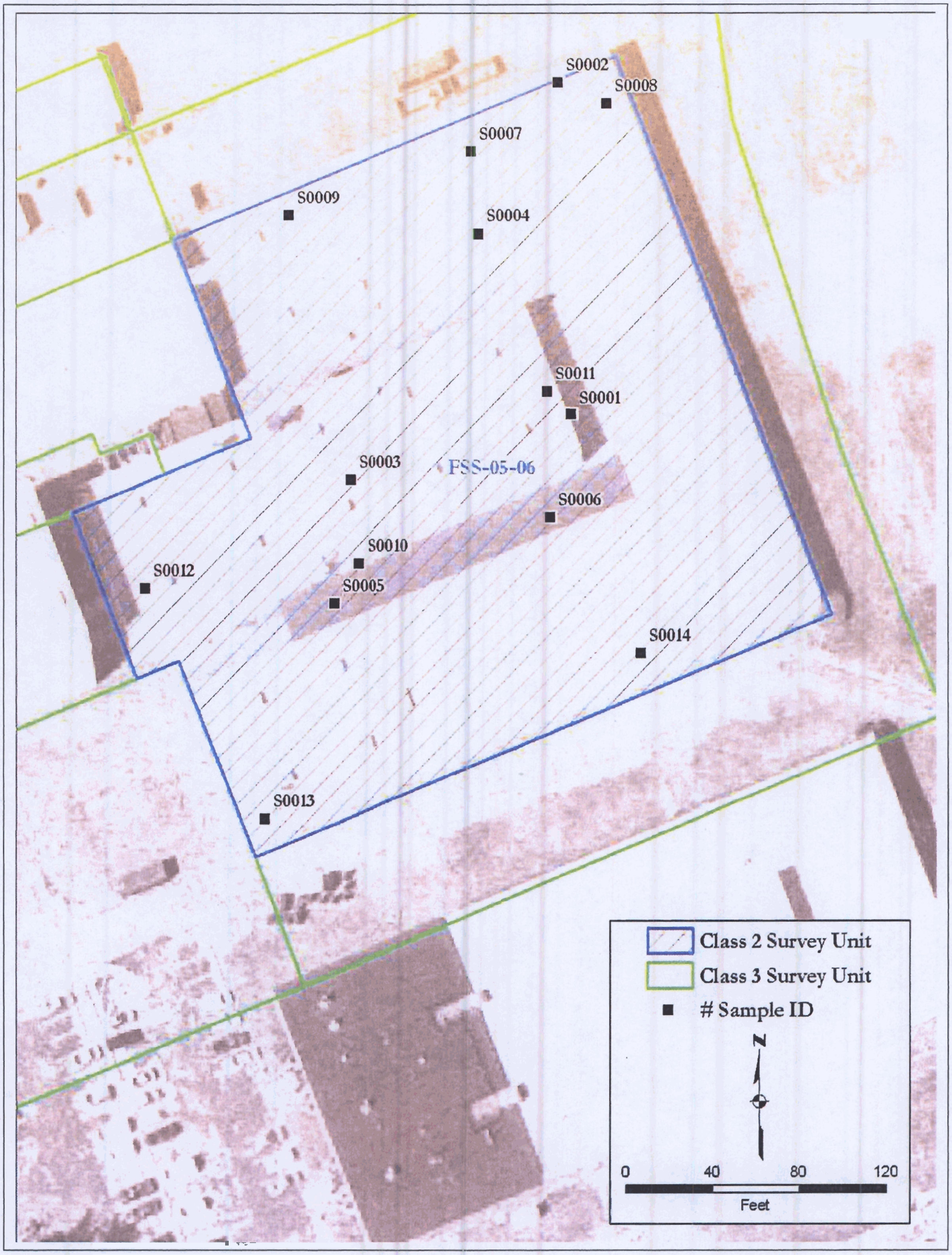


FIGURE A - 29: SURVEY UNIT FSS-05-06 – SOIL SAMPLE LOCATIONS

FIGURE A - 30: SURVEY UNIT FSS-06-02 – SOIL SAMPLE LOCATIONS

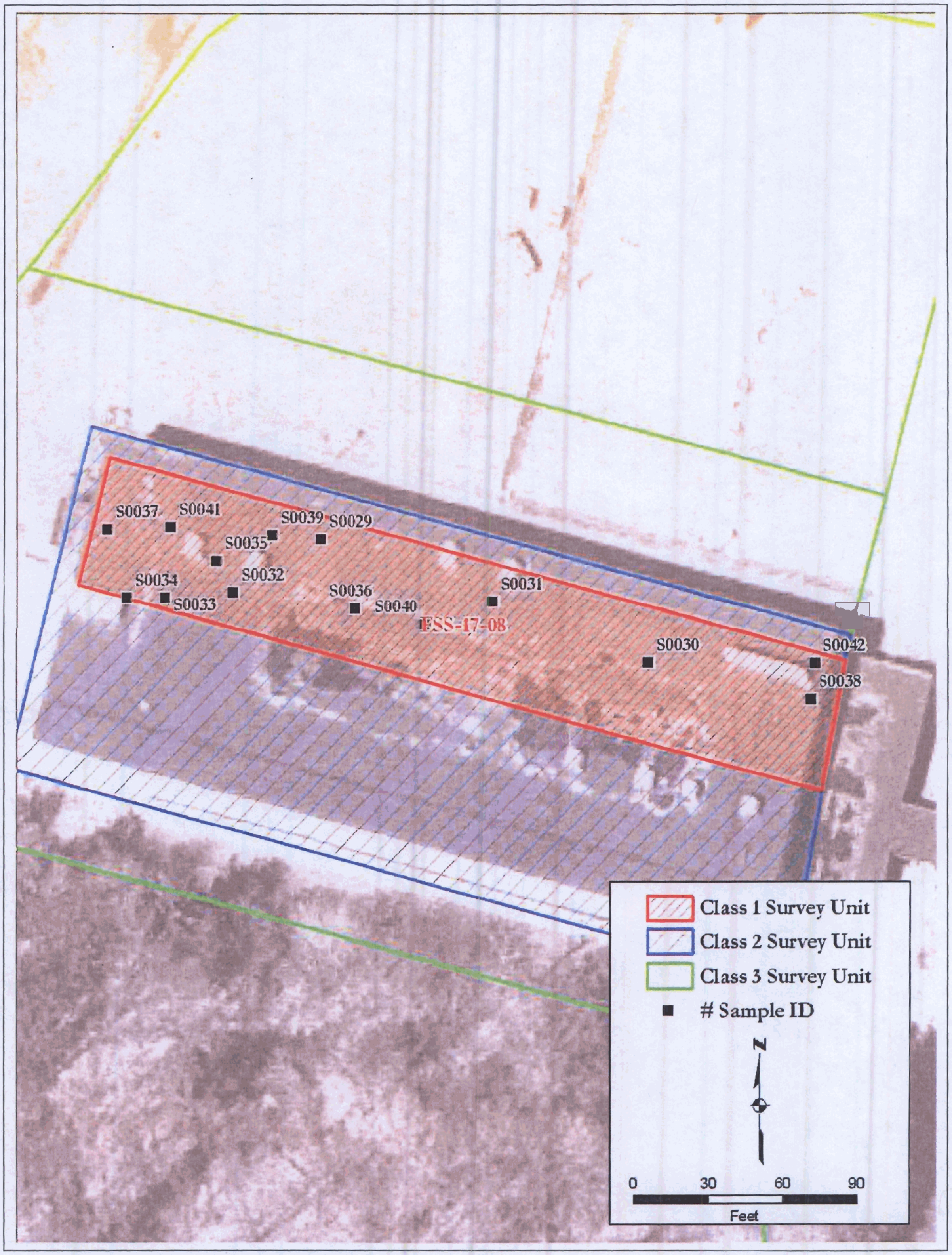


FIGURE A - 31: SURVEY UNIT FSS-17-08 – SOIL SAMPLE LOCATIONS

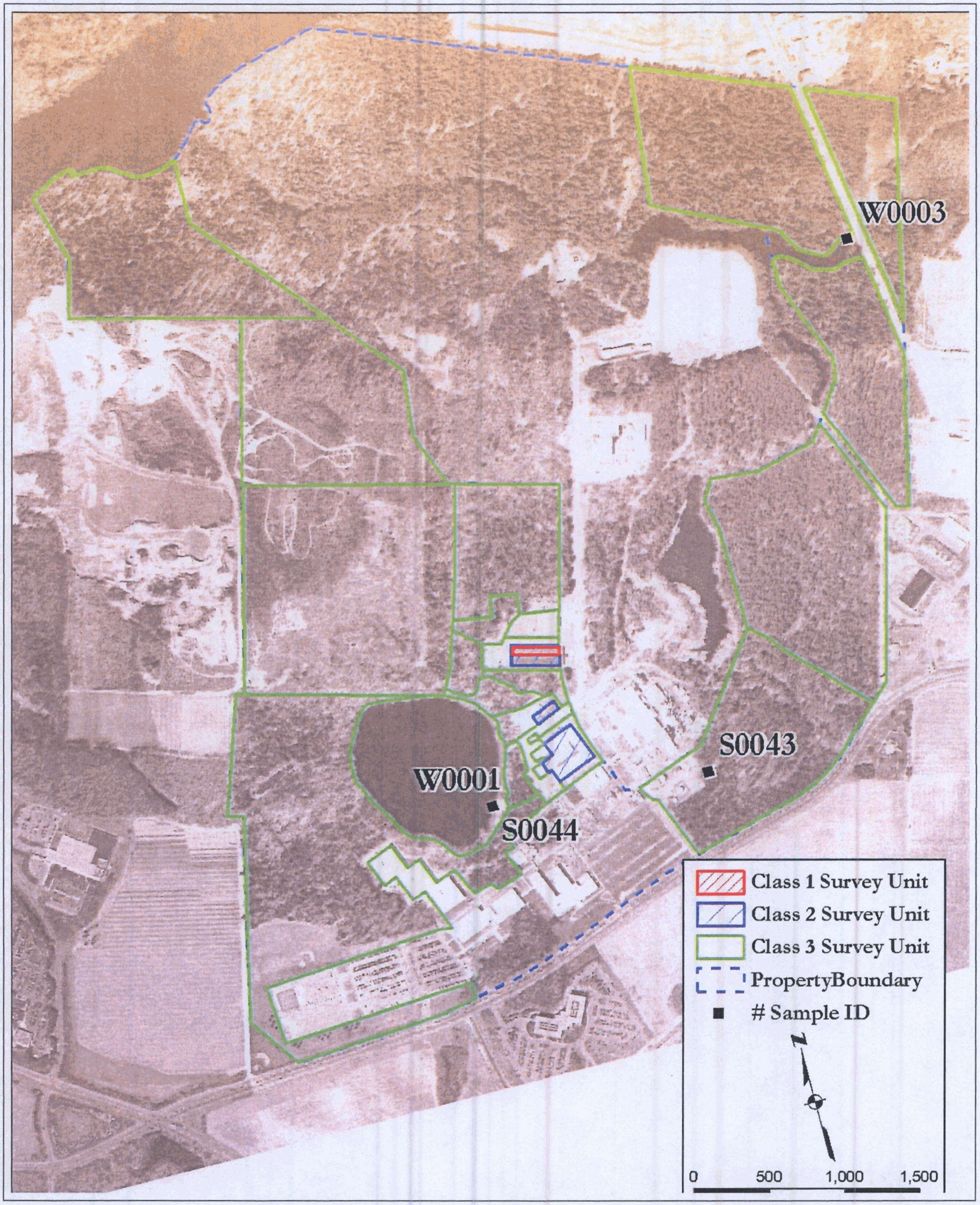


FIGURE A - 32: WATER, SEDIMENT, AND JUDGMENTAL SOIL SAMPLE LOCATIONS

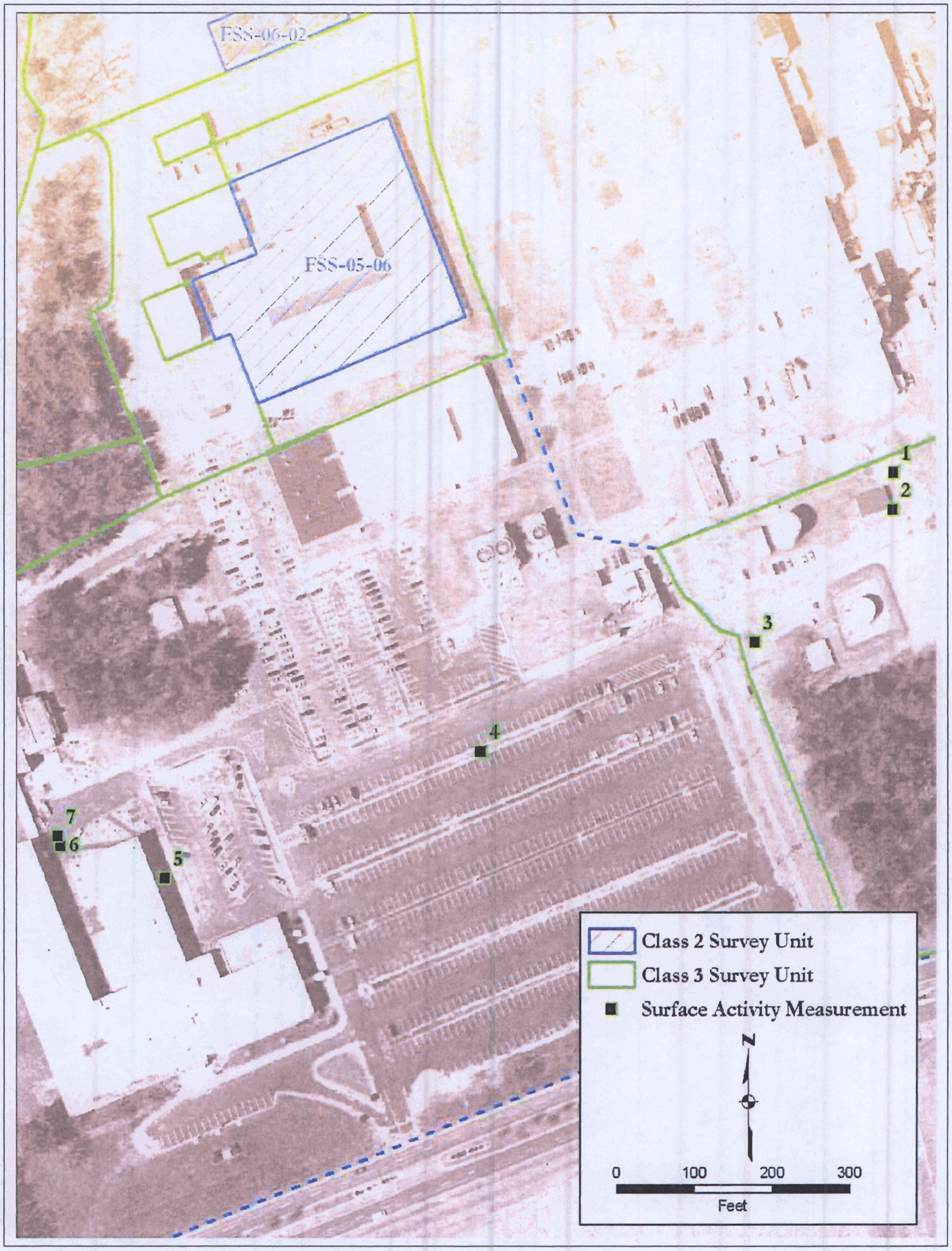


FIGURE A - 33: SURFACE ACTIVITY MEASUREMENT LOCATIONS

APPENDIX B

TABLES

TABLE B - 1: RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES ABB CE WINDSOR SITE WINDSOR, CONNECTICUT				
Sample ID/Area[a]	Coordinate (North, East)	Radionuclide Concentration (pCi/g)		SOR
		Co-60	Total Uranium	
Survey Unit 05-06				
S0001	381546 , 608549	0.02 ± 0.06[b]	6.6 ± 6.6	0.02
S0002	381694 , 608542	0.02 ± 0.06	1.0 ± 7.7	0.01
S0003	381517 , 608447	0.02 ± 0.04	2.6 ± 3.2	0.01
S0004	381626 , 608506	0.02 ± 0.05	3.8 ± 3.6	0.01
S0005	381462 , 608439	0.01 ± 0.04	1.8 ± 4.4	0.00
S0006	381500 , 608539	-0.02 ± 0.06	-1.9 ± 6.0	-0.01
S0007	381663 , 608503	0.00 ± 0.04	3.5 ± 3.8	0.01
S0008	381684 , 608565	0.04 ± 0.04	3.9 ± 5.0	0.01
S0009	381635 , 608418	0.02 ± 0.04	0.1 ± 4.8	0.00
S0010	381480 , 608450	-0.01 ± 0.04	2.8 ± 4.0	0.00
S0011	381556 , 608537	0.02 ± 0.06	9.3 ± 7.3	0.02
S0012	381469 , 608352	-0.03 ± 0.04	1.4 ± 3.6	0.00
S0013	381366 , 608407	0.03 ± 0.06	1.6 ± 6.3	0.01
S0014	381436 , 608581	0.01 ± 0.05	6.7 ± 6.2	0.01
Survey Unit 06-02				
S0015	381806 , 608375	0.02 ± 0.04	0.2 ± 4.5	0.00
S0016	381787 , 608387	-0.02 ± 0.07	1.8 ± 7.5	0.00
S0017	381778 , 608379	-0.01 ± 0.06	0.2 ± 6.4	0.00
S0018	381827 , 608424	0.02 ± 0.06	-1.1 ± 7.3	0.00
S0019	381784 , 608402	-0.01 ± 0.05	3.5 ± 4.2	0.00
S0020	381803 , 608385	-0.03 ± 0.05	3.2 ± 3.7	0.00
S0021	381820 , 608383	0.00 ± 0.06	-1.4 ± 6.5	0.00
S0022	381818 , 608347	-0.02 ± 0.06	5.5 ± 4.6	0.01
S0023	381835 , 608381	-0.02 ± 0.06	5.5 ± 4.6	0.01
S0024	381786 , 608390	0.00 ± 0.06	0.2 ± 6.8	0.00

Sample ID/Area[a]	Coordinate (North, East)	Radionuclide Concentration (pCi/g)		SOR
		Co-60	Total Uranium	
Survey Unit 06-02 (continued)				
S0025	381808 , 608424	-0.03 ± 0.06	3.2 ± 7.2	0.00
S0026	381837 , 608432	-0.05 ± 0.05	1.7 ± 4.3	-0.01
S0027	381824 , 608480	-0.03 ± 0.04	3.0 ± 3.7	0.00
S0028	381829 ,608443	-0.03 ± 0.04	0.0 ± 4.3	-0.01
Survey Unit 17-08				
S0029	382271,608414	0.01 ± 0.06	2.1 ± 6.6	0.01
S0030	382223 ,608546	0.00 ± 0.06	-1.4 ± 6.9	0.00
S0031	382246,608484	-0.03 ± b.06	2.0 ± 6.7	0.00
S0032	382250 , 608379	0.04 ± 0.04	2.5 ± 4.5	0.01
S0033	382248 , 608352	-0.02 ± 0.06	10.1 ± 6.1	0.01
S0034	382248 , 608336	0.05 ± 0.06	11.3 ± 6.5	0.03
S0035	382262 , 608372	0.00 ± 0.05	-6.0 ± 6.0	-0.01
S0036	382244 , 608428	-0.01 ± 0.05	2.3 ± 4.9	0.00
S0037	382274 , 608328	0.00 ± 0.05	4.7 ± 3.8	0.01
S0038	382209 , 608612	-0.03 ± 0.07	0.2 ± 7.6	-0.01
S0039	382272 , 608395	0.04 ± 0.04	-0.9 ± 4.4	0.01
S0040	382238 , 608456	0.01 ± 0.05	2.1 ± 5.7	0.01
S0041	382275 , 608354	0.02 ± 0.06	8.6 ± 7.8	0.02
S0042	382223 , 608614	-0.01 ± 0.08	3.4 ± 4.0	0.00
Judgmental Soil Sample				
S0043	381164 , 609386	-0.02 ± 0.04	3.2 ± 3.7	0.00
Sediment Sample				
S0044	381305 , 607944	-0.03 ± 0.05	1.9 ± 6.2	0.00

[a]Refer to Figures 29 through 32.
[b]Uncertainties are total propagated uncertainties, based on the 95% confidence interval.

TABLE B - 2: SURFACE ACTIVITY LEVELS ABB CE WINDSOR SITE WINDSOR, CONNECTICUT				
Measurement Location[a]	Coordinate (North, East)	Surface Material	Total Activity (dpm/100 cm^2)	
			Alpha	Beta
1	381276 , 609228	Concrete Drain	48	2,100
2	381211 , 609218	Asphalt	-15	-140
3	381147 , 609123	Pavement	45	-570
4	380928 , 608690	Parking Lot	33	210
5	380773 , 608272	Window Ledge	-15	-140
6	380821 , 608136	Concrete Steps	180	500
6 Duplicate	380821 , 608136	Concrete Steps	260	---[b]
7	380821 , 608145	Concrete Drain	21	-71

[a]Refer to Figure 33.
[b]Measurement not performed.

APPENDIX C

MAJOR INSTRUMENTATION

APPENDIX C
MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

SCANNING AND MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

Scanning Instrument/Detector combination

Gamma

Victoreen NaI Scintillation Detector Model 489-55, Crystal. 3.2 cm x 3.8 cm
(Victoreen, Cleveland, OH)
coupled to:
Ludlum Ratemeter-scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to:
Trimble GeoXH Receiver and Data Logger
(Trimble Navigation Limited, Sunnyvale, CA)

Direct Measurement Instrument/Detector Combinations

Alpha

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
Eberline AC3-7 ZnS Scintillation Detector, Physical Area: 74 cm^2
(Eberline Instrument Corporation, Santa Fe, NM)

Beta

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
Eberline Geiger-Mueller Detector Model HP-260, Physical Area: 20 cm^2
(Eberline, Santa Fe, NM)

Direct Measurement Instrument/Detector Combinations (continued)

<u>Gamma</u>

Victoreen NaI Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 an
(Victoreen, Cleveland, OH)
coupled to:
Ludlum Ratemeter-scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to:
Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA

LABORATORY ANALYTICAL INSTRUMENTATION

Alpha Spectrometry System
Tennelec Model 256
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors
(Canberra, Meriden, CT) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

Alpha Spectrometry System
Canberra Model 7401VR
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDSSO-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

LABORATORY ANALYTICAL INSTRUMENTATION (Continued)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(AMETEK/ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-30-P4, 30% Eff.
(AMETEK/ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX D
SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

The proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current job hazard analyses (JHA). Additionally, upon arrival on site, a walk-down of the site was performed to identify hazards present and a pre-job integrated safety management checklist was completed and discussed with field personnel. All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to the National Institute of Standards and Technology (NIST).

Analytical and field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual (January 2008)
- Laboratory Procedures Manual (March 2008)
- Quality Program Manual (November 2007)

The procedures contained in these manuals were developed to meet the requirements of 10 CFR 830 Subpart A, *Quality Assurance Requirements*, Department of Energy Order 414.1C *Quality Assurance*, and the U.S. Nuclear Regulatory Commission *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.

- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.

- Periodic internal and external audits.

CALIBRATION PROCEDURES

Detectors used for assessing surface activity were calibrated in accordance with ISO-7503[1] recommendations. Total alpha and total beta efficiencies (ε_{total}) were determined for each instrument/detector combination and consisted of the product of the 2π instrument efficiency (ε_i) and surface efficiency (ε_s): $\varepsilon_{total} = \varepsilon_i \times \varepsilon_s$.

Th-230 was selected as the alpha calibration source. The 2π alpha ε_i factor for the ZnS detector used to collect direct measurements was 0.36. ISO-7503 recommends an ε_s of 0.25 for all alpha energies. The total alpha efficiency was 0.09.

Tc-99 was selected as the beta calibration source. The 2π beta ε_i factor for the GM detector used to collect direct measurements was 0.28. ISO-7603 recommends an ε_s of 0.25 for maximum beta energies less than 0.4 MeV (the maximum beta energy of Co-60 is 0.314 MeV). The total beta efficiency was 0.07.

SURVEY PROCEDURES

Surface Scans

A NaI scintillation detector was used to scan for elevated gamma radiation. Identification of elevated radiation levels was based on increases in the audible signal from the recording and/or indicating instrument. Additionally, the detectors were coupled to GPS units with data loggers enabling real-time recording in one-second intervals of b o d geographic position and the gamma

[1] International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.16 MeV) and alpha-emitters. August 1,1988.

count rate. Position and gamma count rate data files were transferred to a computer system, positions differentially corrected, and the results plotted on geo-referenced aerial photographs. Positional accuracy was within 0.5 meters at the 95th percentile.

The scan minimum detectable concentrations (MDC) for the NaI scintillation detectors were 188 pCi/g for Total Uranium (assuming 75% enriched uranium as conservative) and 5.8 pCi/g for Co-60 as provided in NUREG-1507. An audible increase in the activity rate was investigated by ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

Surface Activity Measurements

Measurements of total alpha and total beta surface activity levels were performed using hand-held ZnS and GM detectors coupled to portable ratemeter-scalers. Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the count rate by the total static efficiency ($\varepsilon_i \times \varepsilon_s$) and correcting for the physical area of the detector. ORISE did not determine construction material-specific background for each surface type encounter& for determining net count rates. Instead, ORISE took the conservative approach and did not subtract material specific backgrounds in determining surface activity levels.

The *a priori* MDC for surface activity measurements was calculated using the following equation:

$$MDC = \frac{3 + (4.65\sqrt{B})}{Tx\varepsilon_{Tot}xG}$$

Where:

B	=	background [total counts) in time interval, T
T	=	count time (min) used for field instruments
ε_{Tot}	=	total efficiency = ε_i x ε_s
ε_i	=	instrument efficiency
ε_s	=	source efficiency
G	=	geometry (physical detector area cm^2/100)

The *a priori* alpha static MDC was approximately 87 dpm/100 cm^2 using the total efficiency of 0.09 and an instrument background of 31 counts in five minutes. The physical surface area assessed by the gas proportional detector used was 74 cm^2. The *a priori* beta static MDC was approximately 2,500 dpm/100 cm^2 using the total efficiency of 0.07 and an instrument background of 50 cpm. The physical surface area assessed by the GM detector used was 20 cm^2.

Soil Sampling

Approximately 0.5 to 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ORISE survey procedures.

Surface Water Sampling

Approximately 1 L of surface water was collected at each sample location. Collected samplks were placed in a plastic container, sealed, and labeled in accordance with ORISE survey procedures.

RADIOLOGICAL ANALYSIS

Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Water samples were filtered and acidified as needed. Net material weights and volumes were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All total absorption peaks (TAP) associated with the radionuclides of concern were reviewed for consistency of activity. TAPs used for determining the activities of radionuclides of concern and the typical associated MDCs for a one-hour soil gamma spectroscopy count time and a 16-hour water gamma spectroscopy count time were:

Radionuclide	TAP (MeV)	SOIL MDC (pCi/g)	WATER MDC (pCi/L)
Co-60	1.173	0.06	7.2
U-235	0.143	0.08	6.0
U-238	0.063	0.87	85

Spectra were also reviewed for other identifiable TAPs

Alpha Spectroscopy

Water samples were acidified and homogenized and taken to dryness using a pyrosulfate fusion. Barium sulfate precipitate was redissolved and the specific elements of interest—isotopic uranium were individually separated by extraction chromatography using Eichrom resins and re-precipitated with a cerium fluoride carrier. The precipitate was then analyzed using ion implanted detectors (Canberra), alpha spectrometers (Tennelec and Canberra), and a multichannel analyzer (Nuclear Data).

An alpha spectroscopy detector system calculates an MDC for each individual isotope per sample based on the detector background, counting efficiency, yield, and quantity. An MDC is printed out with each sample results. The typical MDC for a 1000-minute count time was 0.4 pCi/L.

DETECTION LIMITS

Detection limits, referred to as minimum detectable concentrations, were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\ (BKG)^{1/2})$]. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.