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Environmental Assessment for the Atmospheric Radiation Measurement (ARM) Program: Southern Great Plains Cloud and Radiation Testbed (CART) Site

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Environmental Assessment for the Atmospheric Radiation Measurement (ARM) Program: Southern Great Plains Cloud and Radiation Testbed (CART) Site

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Executive Summary

The Atmospheric Radiation Measurement (ARM) Program is aimed at supplying improved predictive capability of climate change, particularly the prediction of cloud-climate feedback. The objective will be achieved by measuring the atmospheric radiation and physical and meteorological quantities that control solar radiation in the earth's atmosphere and using this information to test global climate and related models.

The proposed action is to construct and operate a Cloud and Radiation Testbed (CART) research site in the southern Great Plains as part of the Department of Energy's Atmospheric Radiation Measurement Program whose objective is to develop an improved predictive capability of global climate change. The purpose of this CART research site in southern Kansas and northern Oklahoma would be to collect meteorological and other scientific information to better characterize the processes controlling radiation transfer on a global scale, thereby expanding DOE's knowledge of the suspected enhanced greenhouse effect and any associated global warming.

The CART site proposed for the southern Great Plains covers an area 325 km x 275 km which is larger than the minimum conceptual design of a 200 km x 200 km square. However, due to the disbursed nature of the instrumentation located on the CART site, it would be necessary to lease only a small portion of this area in order to implement the proposed action. The proposed CART site would be comprised of a single central facility (160 acres), six auxiliary facilities (50-100 acres each), approximately 25 extended facilities (50-100 acres each), and up to six boundary facilities (50-100 acres each). Thus, of the nearly 22 million acres within the proposed CART site area, only 3,860 acres would need to be leased for these widely disbursed data collection facilities. Of the total leased acreage, about 21 acres would be secured by fenceline and the surface within the fenced areas would not be disturbed except for the placement of instruments and associated facilities. The total surface area disturbed for concrete pads to support such items as trailers, storage facilities, and housing facilities is estimated to be less than 12 acres. It is proposed to operate the CART site around-the-clock for up to 10 years with up to 36 technical staff persons. At the close of the 10 year operating period, all facilities and equipment would be removed and the land returned to its previous use.

Air quality impacts of placement and operation would be very minor since only a small amount of clearing and a small amount of leveling would be needed. State of Oklahoma regulations on fugitive dust mitigation (e.g., watering to reduce emissions) would be followed during the construction.

Noise impacts to nearby residents were evaluated for the potentially noisy 50- and 915-MHz profiler/Radio Acoustic Sounding Systems (RASSs). The noise from those instruments represent a low (for 50 MHz RASS) or high (for 915 MHz RASS) frequency tone that occurs 5-6 minutes of every 30 or 60 minutes. The results were that:

1. The 50-MHz profiler/RASS was found to be acceptable at the central facility for the proposed action and each of the alternatives. The baffled 50 MHz

profiler/RASS was found to be acceptable at the boundary sites for each of the proposed actions and for some (but not all) of the proposed alternatives.

2. The 915-MHz RASS system was found to be acceptable at all proposed sites and alternatives, including the central facility and the six boundary facilities.

Research aircraft would occasionally carry out low-level passes at 500 ft above ground level. The proposed aircraft would cause momentary speech interference for people under the flight path, a minor impact.

Water resource impacts would be very minor, with the requirement for two boundary facilities (McClain and Okmulgee County) that construction and operational activities would be carried out in specified subportions of the sites to avoid floodplain and wetlands areas.

Impacts to vegetation and wildlife would be low and temporary. No threatened or endangered species would be at risk. Land use impacts would be very low because of the limited areal requirements of the project. The project impacts to visual resources surrounding each site would be low. The only structure in the entire project that would be visible from a vantage point of greater than two miles would be the central facility's 60-m meteorological tower.

The impacts to cultural resources would be minor. The state historical preservation officers (SHPO) of Oklahoma and Kansas indicated that none of the proposed or alternative sites for facilities contains structures or sites listed in the National Register of Historic Places. The lower elevation of the Marion County (Kansas) site may contain archeological sites, but these areas would be strictly avoided.

Socioeconomics impacts would be minimal. Some minor economic benefits would occur in the vicinity of each proposed site, but these would consist of brief employment (30 days maximum) for only a few workers and the local purchase of support materials.

Because the ARM Project activities are located in isolated rural areas where there is very little activity other than farming, the cumulative impacts would be negligible. Furthermore, this project represents new effort and has no cumulative impacts with any previous DOE work or with any other federal projects.

The no action alternative would be the loss of a U.S. site, which would be detrimental to the scientific study of global warming. The loss of the U.S. site would severely limit the ability of the project to vastly improve models and to make appropriate policy decisions on global climate change.

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Acronyms and Definitions

ARM	-	Atmospheric Radiation Measurement
CART	-	Cloud and Radiation Testbed
CART site	-	a conceptual block of atmosphere and its underlying atmosphere.
CNR	-	Composite Noise Rating model
CRP	-	Conservation Reserve Program
DOE	-	Department of Energy
EA	-	Environmental Assessment
ERDAS	-	satellite analysis software package
FAA	-	Federal Aviation Administration
FEMA	-	Federal Emergency Management Agency
facilities	-	groupings of instruments
FWS	-	Fish and Wildlife Service
GCM	-	General Circulation Model
GIS	-	Geographic Information System
gpm	-	gallons per minute
IAP	-	Individual Annoyance Prediction model
locale	-	a subcontinent-sized region that is meteorologically representative of local climate.
MESONET	-	Oklahoma mesoscale meteorological network
MSS	-	satellite Multispectral Scanner images
MOA	-	military operations area
NEPA	-	National Environmental Policy Act
NOAA	-	National Oceanic and Atmospheric Administration
PNA	-	Probabilistic Noise Audibility model
RASS	-	Radio Acoustic Sounding System
SHPO	-	state historical preservation officer
USGS	-	U.S. Geological Survey
UTM	-	Universal Transverse Mercator Coordinate System

1 Description of Proposed Action and Alternatives

1.1 Purpose and Need

The recent heightened public concern about potential global warming due to an enhanced greenhouse effect has prompted the U.S. Department of Energy (DOE) to accelerate its research to improve predictions of climate change. The emphasis is on the timing and magnitude of climate change as well as on the regional characteristics of this change. The Atmospheric Radiation Measurement (ARM) Program was developed to supply an improved predictive capability, particularly prediction of cloud-climate feedback. Improved resolution and accuracy about radiative and cloud physical processes in the earth's atmosphere will be incorporated into general circulation models (GCMs) and related models used to predict climate change. The objective is to vastly improve models to study global climate change. This objective will be achieved by measuring the atmospheric radiation and physical and meteorological quantities that control solar radiation in the earth's atmosphere and by using this information to test GCMs and related models. Because of the dominant influence of clouds on radiation, the ARM Program will emphasize developing improved descriptions of clouds for modeling purposes.

A systematic examination of the number and location of independent locales required to characterize the processes controlling radiation transfer in the atmosphere on a global scale to meet the ARM objectives has been completed (Schwartz et al., 1991). The following ordered set of independent and climatologically distinct primary locales was recommended for long term (up to ten years) occupancy as ARM "Cloud and Radiation Testbed (CART)" sites:

1. United States continental
2. Tropical western Pacific
3. North slope of Alaska
4. Eastern North Pacific/Eastern North Atlantic
5. Gulf stream off eastern North America

The ARM Program is a research activity funded by the U.S. Department of Energy (DOE) in support of the National Energy Strategy and is managed by DOE as an independent field measurement program, reviewed and approved by the Office of Science Technology Policy's Committee on Earth and Environmental Sciences as part of the coordinated national initiative, the U.S. Global Change Research Program. The overall ARM Program involves substantial computational research activity at universities, companies, federal agencies, and national laboratories; indeed, the bulk of the funding supports this research, while a relatively small portion will be invested in the anticipated five sites and associated temporary facilities. The overall budget is expected to be $460 million over ten years (i.e., an average of $46 million per year); however, the actual funding for site facilities and operations is expected to be approximately $5-10 million per site over ten years.

While the types of instruments used and the activities performed will be similar for each ARM CART site, the environmental impact may vary significantly from one site to another (e.g., continental U.S. is significantly different from the tropical western Pacific Ocean, and both are significantly different from the north slope of Alaska). Program implementation will proceed incrementally. The planning for operation of the first ARM CART site is well underway, with a planned operational date of April 30, 1992. Each of the remaining CART sites is planned to become operational subsequently, at a rate of approximately one site per 18 months.

Planning for CART sites 2-5 is preliminary, and it is not yet known how the ARM concept will be applied to sites other than the first. Although the measurement concept would be the same for each of the sites, the experimental design would be different due to the very different nature of each of the CART sites. In addition, the logistics would be different. For example, a site over land would have a different measurement strategy than a site over water. There would be differences in instrument placement and operation, although the instruments would be similar at each CART site. It is quite possible that the results of measurements at this first CART site may lead to changes in the measurement plan at future sites. Consequently, additional documents meeting the requirements of the National Environmental Policy Act (NEPA) would be prepared individually for each of the CART sites as they are ready to enter the program. Because instrumentation at the other CART sites would be similar, and each of the sites are expected to have similar requirements as those for the continental U.S. CART site, the current *Environmental Assessment* (EA) would serve as a model for the other sites that follow later. This EA contains overall program-related information pertaining to the entire ARM Program and all five potential CART sites that will help to shorten future EAs.

This EA addresses potential environmental impacts associated with siting, construction, and operation of research facilities only at the ARM continental U.S. site.

1.2 Experimental Design

The heart of the ARM Program is a meteorological observatory. The ARM Program will provide experimental and computational support for a detailed study of solar and terrestrial radiative transfer and for the generalization of the results to physical scales compatible with current and future generations of GCMs. The basic experimental design for ARM incorporates four groups of facilities within a CART site. The area of the CART site is a conceptual block of atmosphere and its underlying surface. The size of the CART site is driven by the size of the smallest area (or grid) that a GCM model can mathematically represent (approximately 200 km x 200 km). The rationale for having the four groups in the CART site is the following:

1. *One central facility* (160 acres) within the CART site would contain a complete set of all instrumentation that would be used to characterize the local radiation field and meteorological conditions and the concentrations of aerosols and trace gases.

2. Approximately *6 boundary facilities* (each 50-100 acres) would contain sets of instruments similar to that of the central facility, but slightly reduced that would characterize the mesoscale atmospheric conditions that affect the CART site.

3. *Six auxiliary facilities* (each 50-100 acres) would contain a reduced subset of instruments that would be used to characterize clouds, radiation, and meteorological conditions over the central facility.

4. Approximately 25 *extended facilities* (each 50-100 acres) would contain a much reduced set of instruments that would be used to characterize surface meteorological and radiation conditions throughout the CART site.

Figure 1.1 illustrates the orientation of the various facilities within the CART site. Figure 1.2 presents a schematic diagram of the relative locations of the central facility and its supporting boundary, auxiliary, and extended facilities, all within the CART study area.

1.2.1 The Site Screening Process

The continental U.S. CART site selection was driven primarily by scientific requirements and synergism with other projects, and secondarily by operational, financial, and logistic considerations. However, the actual locations of facilities within the CART site are flexible. After first addressing candidate CART sites in the continental U.S., proposed and alternative facilities locations were identified and potential environmental impacts were addressed for the CART site. These potential impacts are presented in this EA.

1.2.2 First Level Screening

In 1991, Schwartz et al. identified locales globally by using a set of selection principles that are consistent with the objectives of the ARM project. This selection process developed a prioritized list of locales. This first level of screening identified a set of subcontinent-sized regions, termed locales, within which the broad range of physical processes that govern the quantity, structure, and radiative transfer properties of climatically important clouds is well represented. The main selection criteria used for identifying the ten CART sites are the following:

1. A broad sampling of the types, quantities, and altitudes of clouds; of energy transfer characteristics of the earth's surface; of vertical motion fields; and of temperature and humidity distributions in the atmospheric column above the CART site.

2. Quasi-uniform surface or cloud conditions across a CART site to minimize uncontrollable variables to increase the chances of interpreting causal dependencies.

3. A minimum set of logistical constraints in conducting measurements. For the selection of the first CART site logistical concerns will have a high priority to facilitate establishment and confirmation of operating procedures and instrumentation.

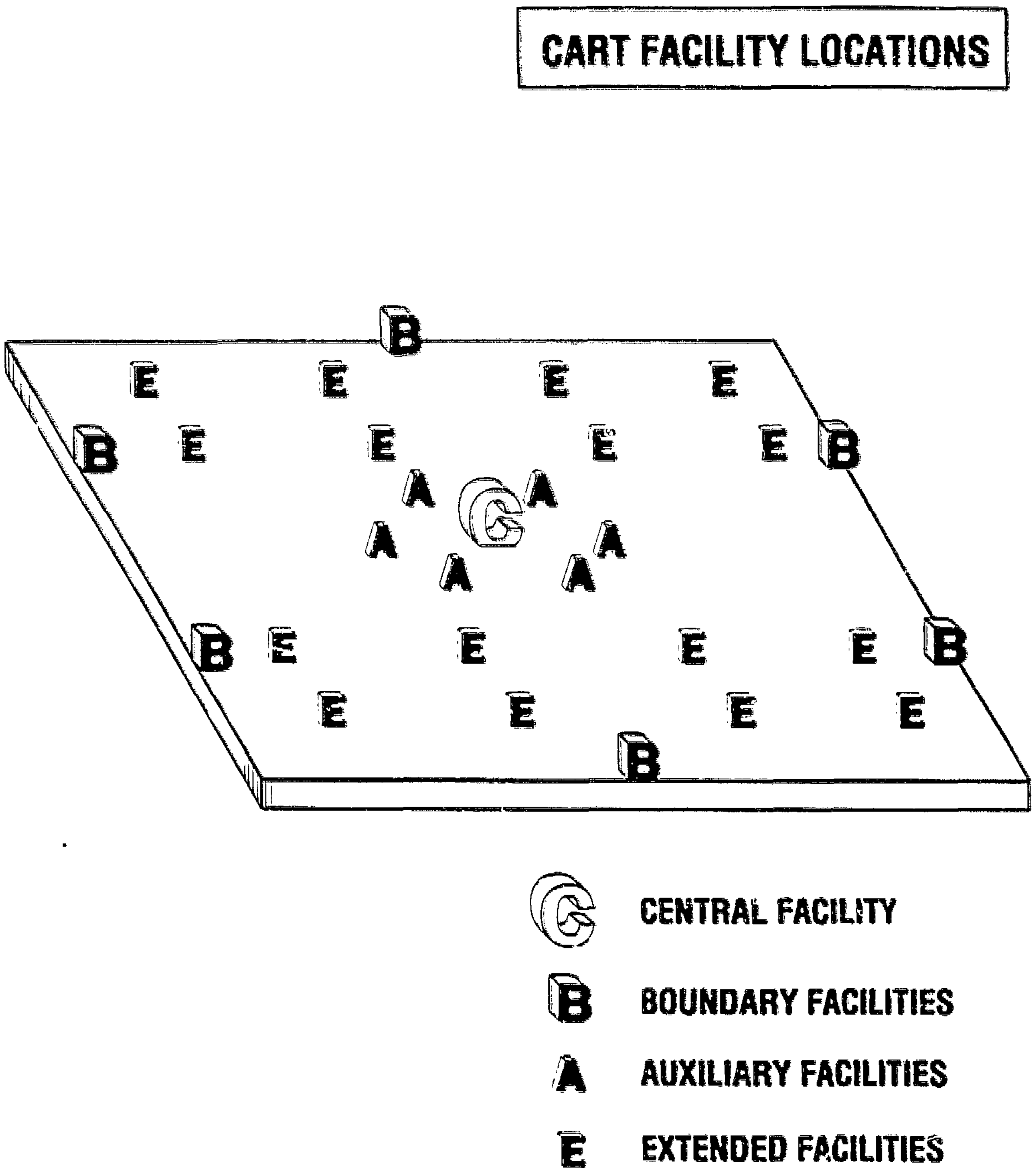

Figure 1.1 Relative Locations of CART Instrumentation Including the Central Facility and the Boundary, Extended, and Auxiliary Facilities within the CART Area

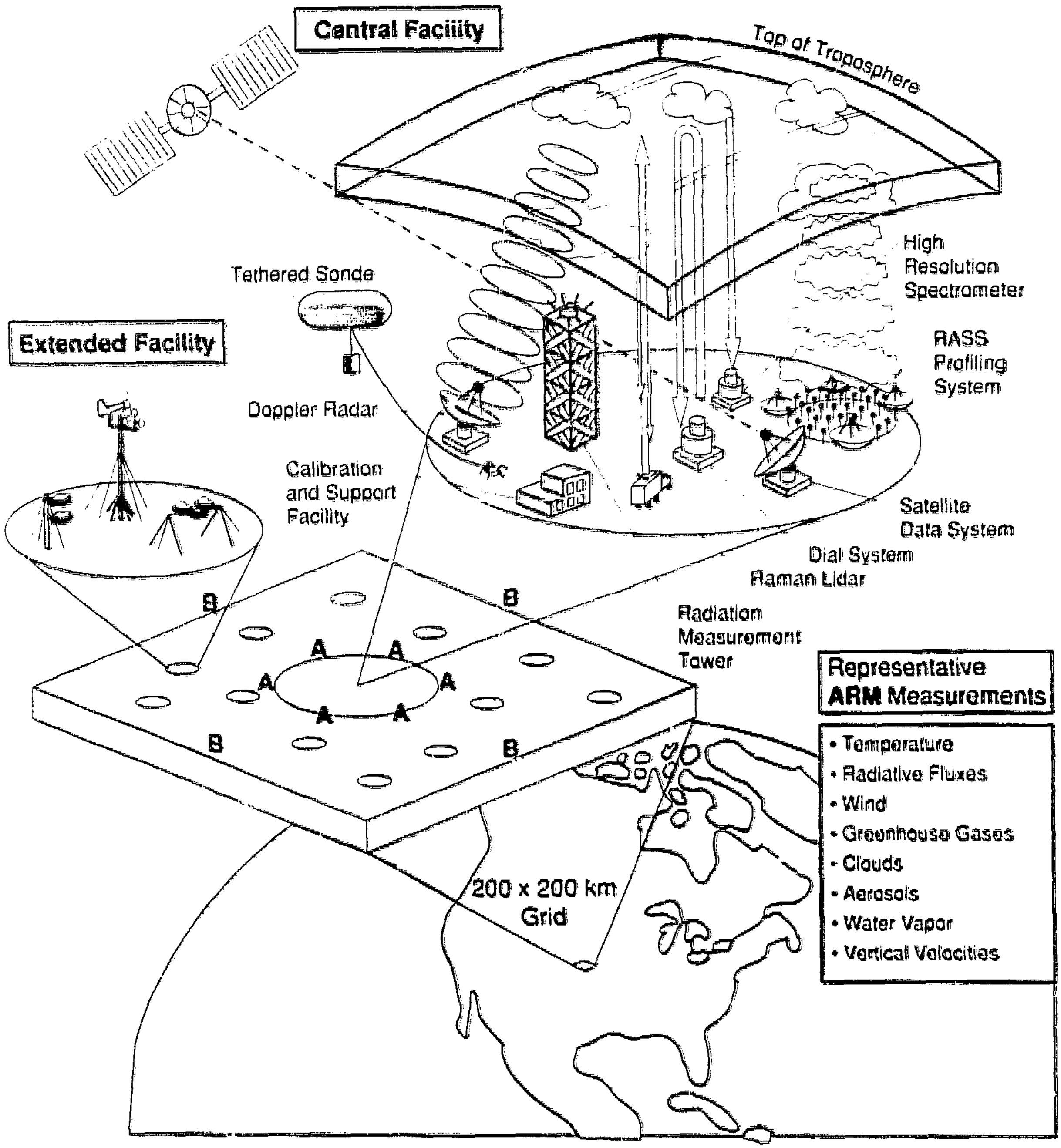

Figure 1.2 General Configuration of the ARM Measurement Grid and Representative Instrumentation for the Central Facility

4. Potential synergism relationships with other data-gathering programs. Complementary atmospheric research programs being conducted in the same general area mutually benefit from the enhanced observational networks or supplemental instrumentation available by close cooperation.

The study of Schwartz et al. (1991) identified ten possible CART sites and prioritized them. Two locales representing similar cloud conditions in eastern ocean margins were merged, leaving nine candidate locales. In preparation is a series of nine companion documents, one for each of the recommended locales. These reports focus on the specific scientific, logistical, and synergistic issues that characterize the particular locales.

The first priority was a continental locale within the U.S., with three candidate regions: the Midwest, the southern Great Plains, and the northern Great Plains. The primary reasons for choosing the continental U.S. as the first choice of the nine locales were as follows:

1. The wide range of cloud and radiation conditions supports a major portion of the ARM scientific objectives.

2. Operational procedures and interfaces with data users and interested parties can be developed and tested in the shortest possible time, at the lowest cost.

3. Instrument performance can be evaluated under a fairly wide range of environmental conditions in a setting where improvements can be made most easily, quickly, and cost effectively.

4. New instrument systems in transition from research to operation can be introduced and evaluated before they are deployed at more remote sites. This practice will avert costly redeployments.

1.2.3 Second Level Screening

All three locales within the continental U.S. offer excellent logistic attributes, good geographic homogeneity, large intra-annual variability of climate cloud type and surface flux properties, a wide variety of cloud types, and large seasonal variability in temperature and specific humidity.

The proposed action for this EA begins with the evaluation of the three locales. The scientific debate over the "best" locale with regard to the above attributes did not produce a clear candidate for the ARM continental locale. The Midwest, southern Great Plains, and northern Great Plains locales all have excellent logistic attributes; good geographic homogeneity; large intra-annual variability of climate, cloud type, and surface flux properties; a wide variety of cloud types; and large seasonal variability in temperature and specific humidity. However, the southern Great Plains locale provides the best opportunity for synergistic activity with several other major federal research programs. For example, the dense array of seven National Oceanic and Atmospheric Administration (NOAA) profilers (405 MHz microwave radars for continuous wind profile measurements) have already been installed and are operating in the southern Great Plains. The Oklahoma Climatological Survey has proposed a meteorological mesoscale network (MESONET) consisting of 109 sites in Oklahoma that will be in place by December 1992. This opportunity for synergistic activity does not mean that the existence of the ARM Program in the southern Great Plains depends upon these other programs. The ARM Program has budgeted such instrumentation where possible for its own activities, independent of other programs. Nevertheless, sharing instrumentation where possible would substantially save taxpayer dollars and would reduce potential environmental impacts by avoiding needless duplication of effort. In addition to the synergism of observations, there is a synergism in the climate, cloud, and air-surface exchange science that is potentially provided with local university and state scientific interactions. No other U.S. locale provides the desired mix of atmospheric conditions and affords proximity to as many other relevant meteorological research programs. Further, due to the fact that all three locales are so expansive in area, there would be ample opportunity to position the widely disbursed data collection facilities within this space to avoid archeological sites, floodplains, or wetlands and reduce any potential noise disturbance. Because of this and the similar climatological profiles of the three locales, none of the other locations demonstrated any environmental advantages over the southern Great Plains site.

Since the southern Great Plains has been determined to be the best choice in terms of science and co-location with other related scientific programs, the next part of the second level screening involved the actual siting of a proposed central facility and boundary facilities where the instrumentation would be placed and operated. That determination was carried out in the following steps:

1. A set of 14 Landsat Multispectral Scanner (MSS) images (Appendix A) was obtained to cover this 325-km x 275-km area. The MSS image from a typical Landsat scene has a swath of approximately 185 km x 170 km. The MSS data are widely used for vegetation inventories. The spatial resolution of MSS data is 79 m x 79 m. Detectors record the electromagnetic radiation in four bands. Bands 1 and 2 are in the visible portion of the spectrum and are useful for detecting cultural features such as roads and detailing water. Bands 3 and 4 are in the near-infrared portion of the spectrum and can be used to discriminate land/water and vegetation.

2. Towns, roads, political boundaries, water bodies, and rivers in the CART area were digitized from 1:250,000-scale U.S. Geological Survey (USGS) maps. A preliminary determination was made of candidate sections for locating the central facility and six boundary sites. Then the towns, roads, political boundaries, sections, rivers, water bodies, and NOAA profiler locations within ten miles of the proposed sites were digitized from 1:100,000-scale USGS maps.

3. The ERDAS software was used to classify the four-band spectral data from the MSS images to USGS Level I land use classes. The spectral characteristics of the data and the total county acreage from the National Resources Inventory 1982 data for cropland, rangeland, pasture land, and forests were used to

determine general land use classes. The classes determined were crop, majority crop, mixed crop and rangeland, rangeland and brush, grassy, water, dry creek beds, urban, and wooded.

4. The ground truth of the classified data was partially established when Argonne National Laboratory staff visited selected areas and reported on current land use. This information indicated that good correlation exists between the classified land use data and the current land use.

5. The land use information from the Landsat data was registered by using the Geographic Information System (GIS) system to the Universal Transverse Mercator (UTM) coordinate system and combined with the digitized vector information. Air space information was superimposed on the resulting map. Military operations areas, jet routes within a four-mile band on each side, and airfields were eliminated from consideration. Areas with no air space interference were identified for further study.

6. Representatives of the Science Team studied the GIS maps to determine general areas from which the specific proposed sites and alternative sites could be chosen for the central facility and for the six boundary facilities.

1.3 Details of the Proposed Action in Oklahoma and Kansas

The proposed action is to construct and operate a CART research site in the southern Great Plains as part of DOE's ARM Program whose objective is to develop an improved predictive capability of global climate change. The purpose of this CART research site in southern Kansas and Northern Oklahoma would be to collect meteorological and other scientific information to better characterize the processes controlling radiation transfer on a global scale, thereby expanding DOE's knowledge of the suspected enhanced greenhouse effect and any associated global warming.

The proposed action at the southern Great Plains locale includes the following steps:

1. The selection of an area for the first ARM CART research site in the southern Great Plains locale to provide routine measurements of solar radiation and meteorological conditions.

2. The construction of 1 central facility, 4-6 supporting boundary facilities, 6 supporting auxiliary sites and 25 supporting extended sites.

3. The operation of such a station for a period of up to ten years.

4. The execution of two- to three-week intensive experimental field campaigns primarily within but not limited to a 10-km radius of the central facility, for special studies aimed at supplementing work with the fixed instruments.

1.3.1 Site Selection

On the basis of the ARM Program documents entitled *Identification, Recommendation, and Justification of Potential Locales for ARM Sites* (Schwartz et al., 1991) and *Locale Specific Report: Southern Great Plains* (Barr and Sisterson, 1991), the CART site has been located within an area roughly defined by the latitude, longitude coordinates 38 deg 30 min, 99 deg 30 min; 38 deg 30 min, 95 deg 15 min; 34 deg 15 min, 99 deg 30 min; and 34 deg 15 min, 95 deg 15 min. Figure 1.3 illustrates this 325-km x 275-km area covering the northern part of Oklahoma and the southern part of Kansas. This area encompasses not only seven of the NOAA high-density profilers but also many of the Oklahoma MESONET sites. Although this area is larger than the conceptual 200-km x 200-km GCM grid, its size does not increase the required number of facilities to characterize the CART site area, nor does it reduce the effectiveness of the measurement strategy. In fact, co-location with existing instruments is expected to increase the effectiveness of the measurement strategy. Thus, the ability to capture significant meteorological phenomena within a GCM grid has not been compromised by assuming a larger conceptual CART area.

A GIS is being used to identify candidate areas for each of the facilities within the CART site area. Scientific considerations and the recognition of the benefits of the NOAA high-density profiler network in Kansas and Oklahoma require the central facility to be as close as possible to the center of the CART site. The selection of the central facility's 160-acre parcel and the boundary facilities' 50- to 100-acre parcels is therefore critical. The locations of the remaining auxiliary and extended facilities are not as critical.

The GIS also included information about controlled air space over the CART site, such as military operating areas (MOAs), because there will be aircraft operations involved with the ARM Program. Also included was analyzed Landsat data that allowed land use categories to be identified in the CART site area. Scientific siting criteria included the avoidance of wetlands, urban areas, forests, and significant changes in elevation. The Landsat analysis identified crop and pasture lands as the dominant land use categories in this area for locations of facilities. These screening procedures were used to identify candidate sites for the central and boundary facilities. Similar screening for the remaining extended and auxiliary facilities will take place at a later date. Scientific investigations using preliminary data from the central facility will be used to identify land use categories that need to be characterized by measurements taken at the auxiliary and extended facilities. The central facility at this first CART site is planned to be operational by April 30, 1992.

The locations of all facilities must fall within the conceptual CART site boundaries. Figure 1.4 provides a sketch of the instruments that are planned for use at the central, boundary, extended, and auxiliary facilities. The planned layout of the central facility (160 acres) is given in Fig. 1.5; the boundary layer facility (50-100 acres) is shown in Fig. 1.6; the auxiliary facility (50-100 acres) is given in Fig. 1.7; and the extended facility (50-100 acres) is shown in Fig. 1.8.

The actual locations of facilities within those boundaries, however, are flexible. Scientific considerations of the program, which include land use, siting criteria for instruments, aircraft operations, and synergism with other programs, indicate one proposed site and at least two alternatives for each of the central and boundary facilities have been identified for formal NEPA

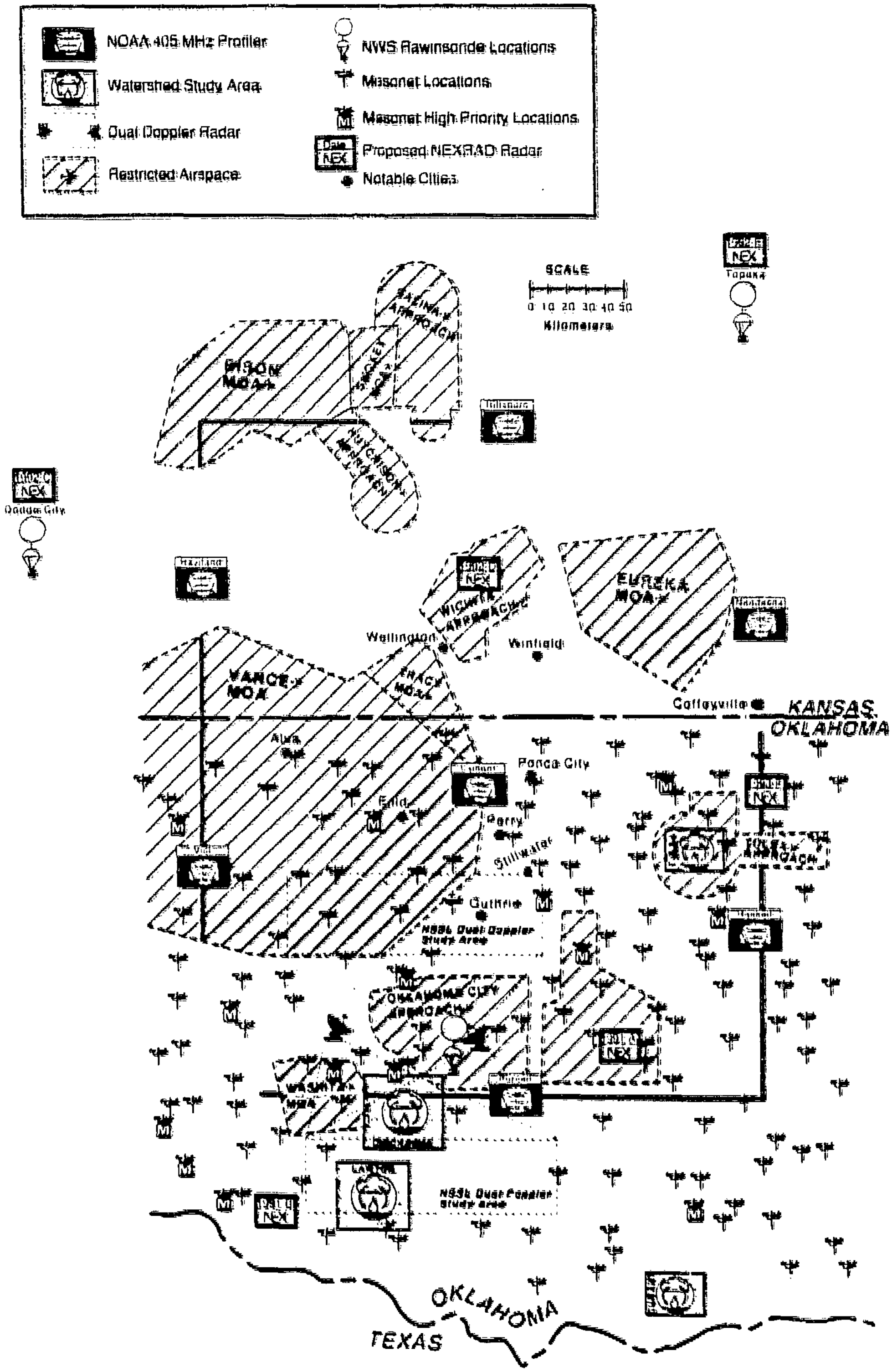

Figure 1.3 The Location of the 325-km x 275-km CART Experimental Area within the Southern Great Plains (Oklahoma and Kansas)

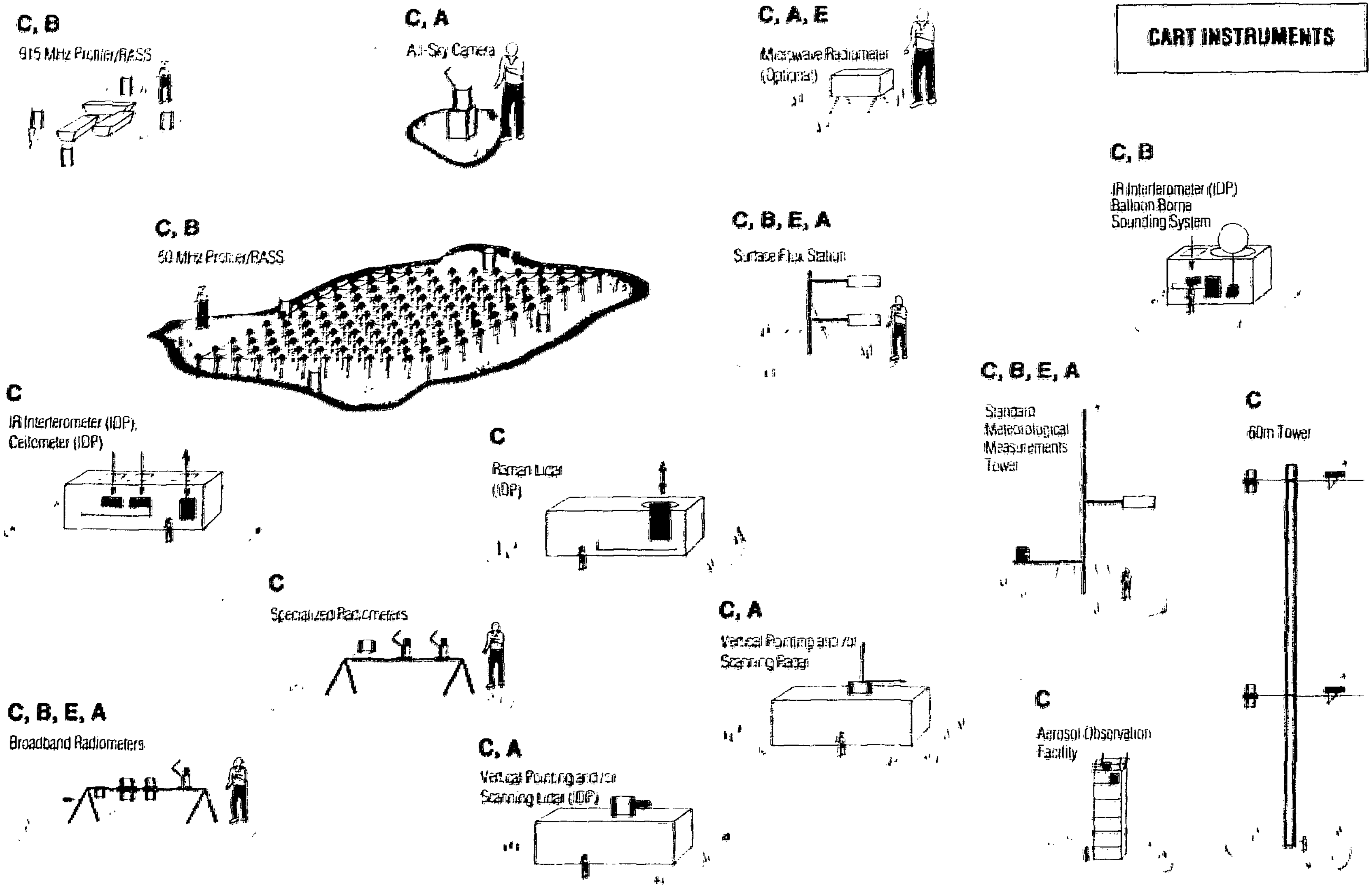

Figure 1.4 Distribution of CART Instrumentation among the Central, Boundary, Extended, and Auxiliary Facilities

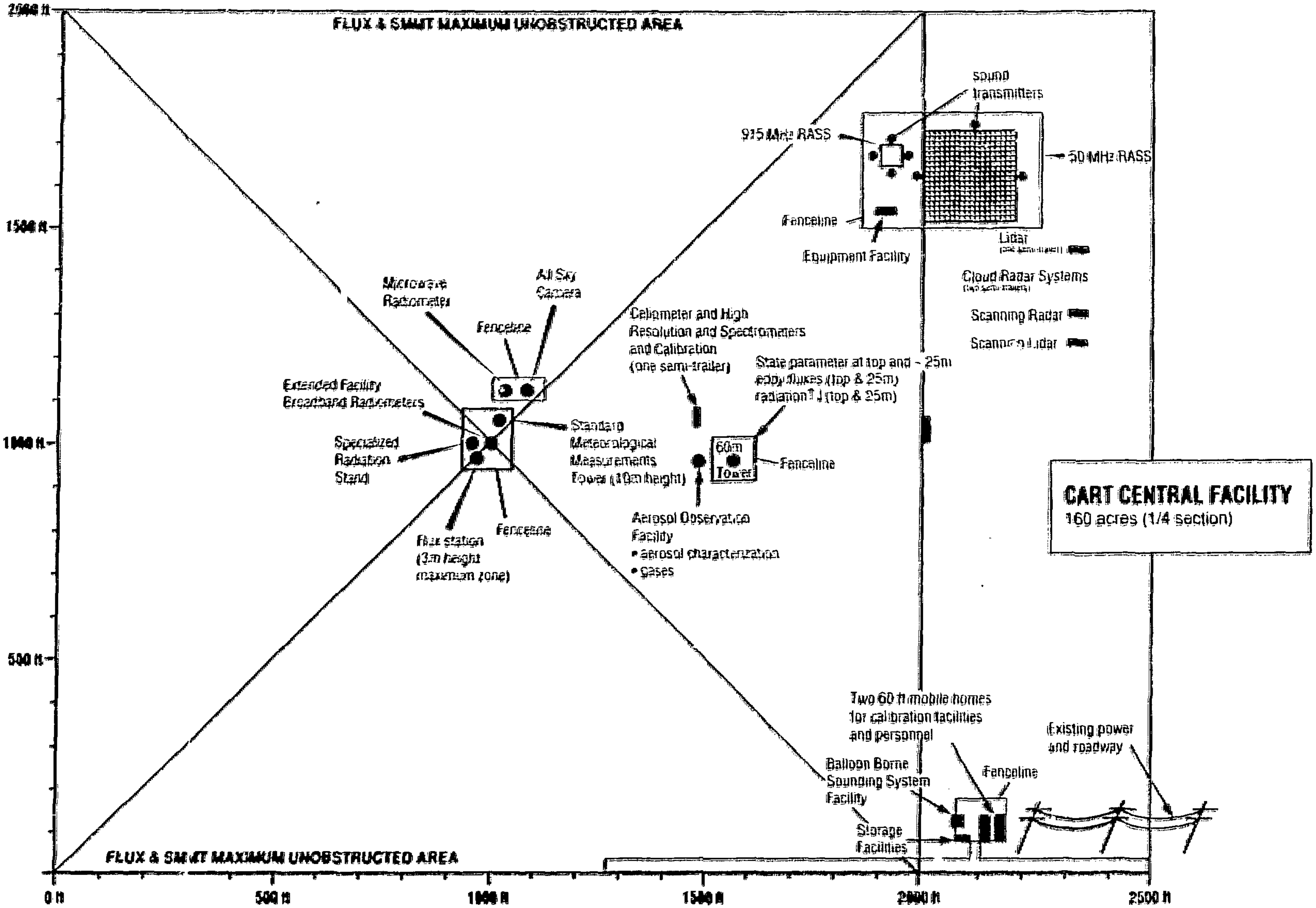

Figure 1.5 Relative Orientation of Instrumentation within the 160-Acre CART Central Facility

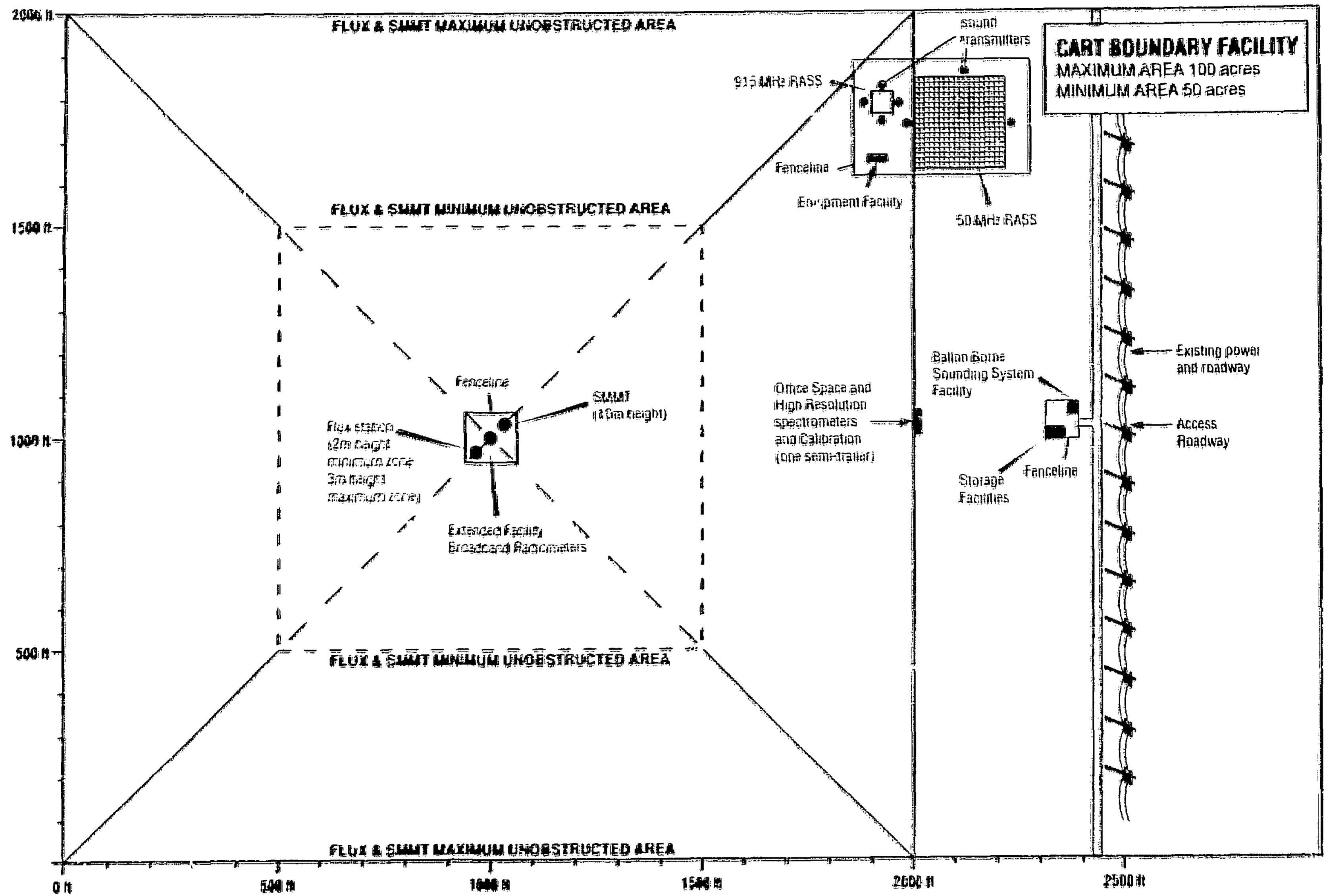

Figure 1.6 Relative Orientation of Instrumentation within a CART Boundary Facility

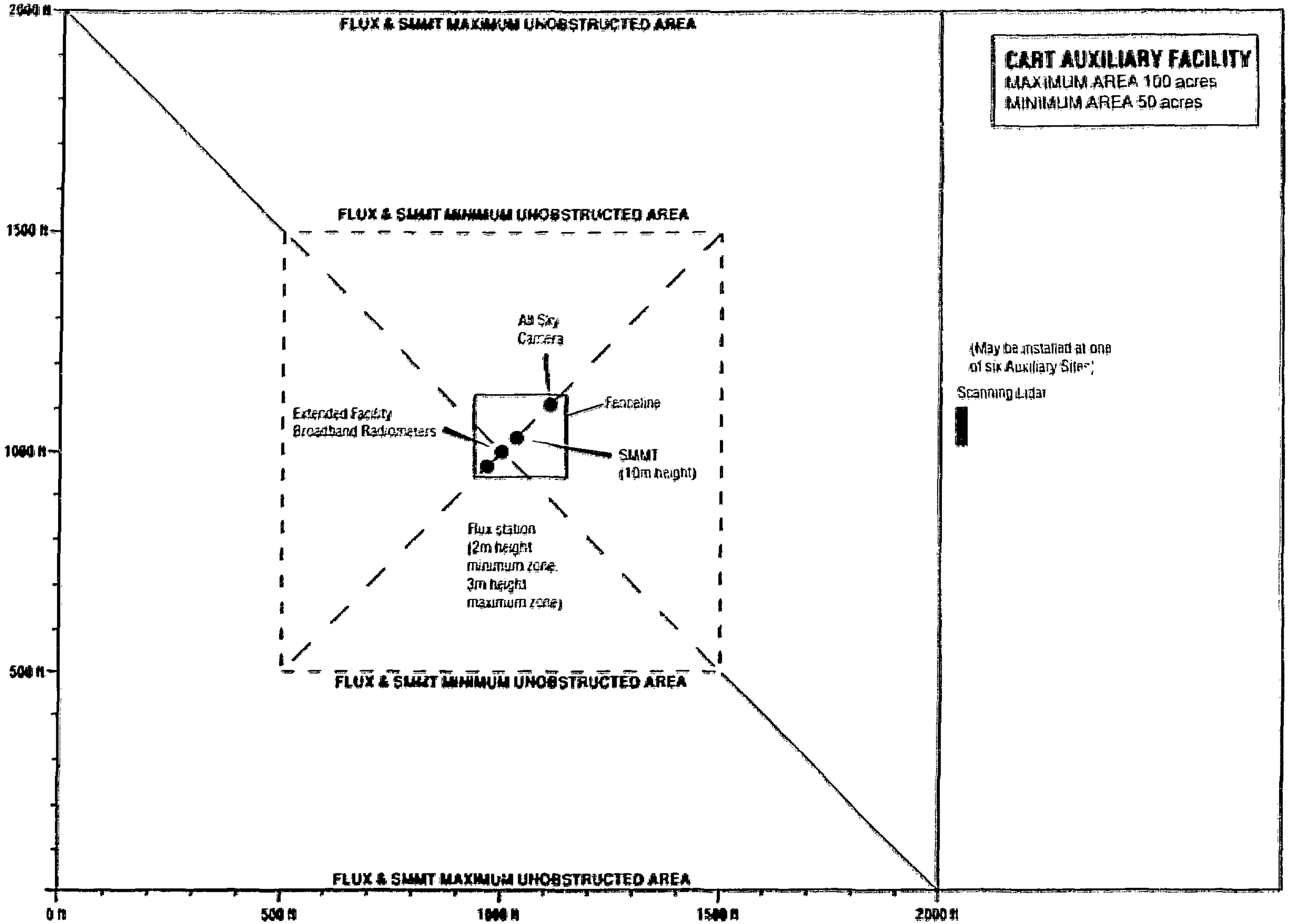

Figure 1.7 Relative Orientation of Instrumentation within a CART Auxiliary Facility

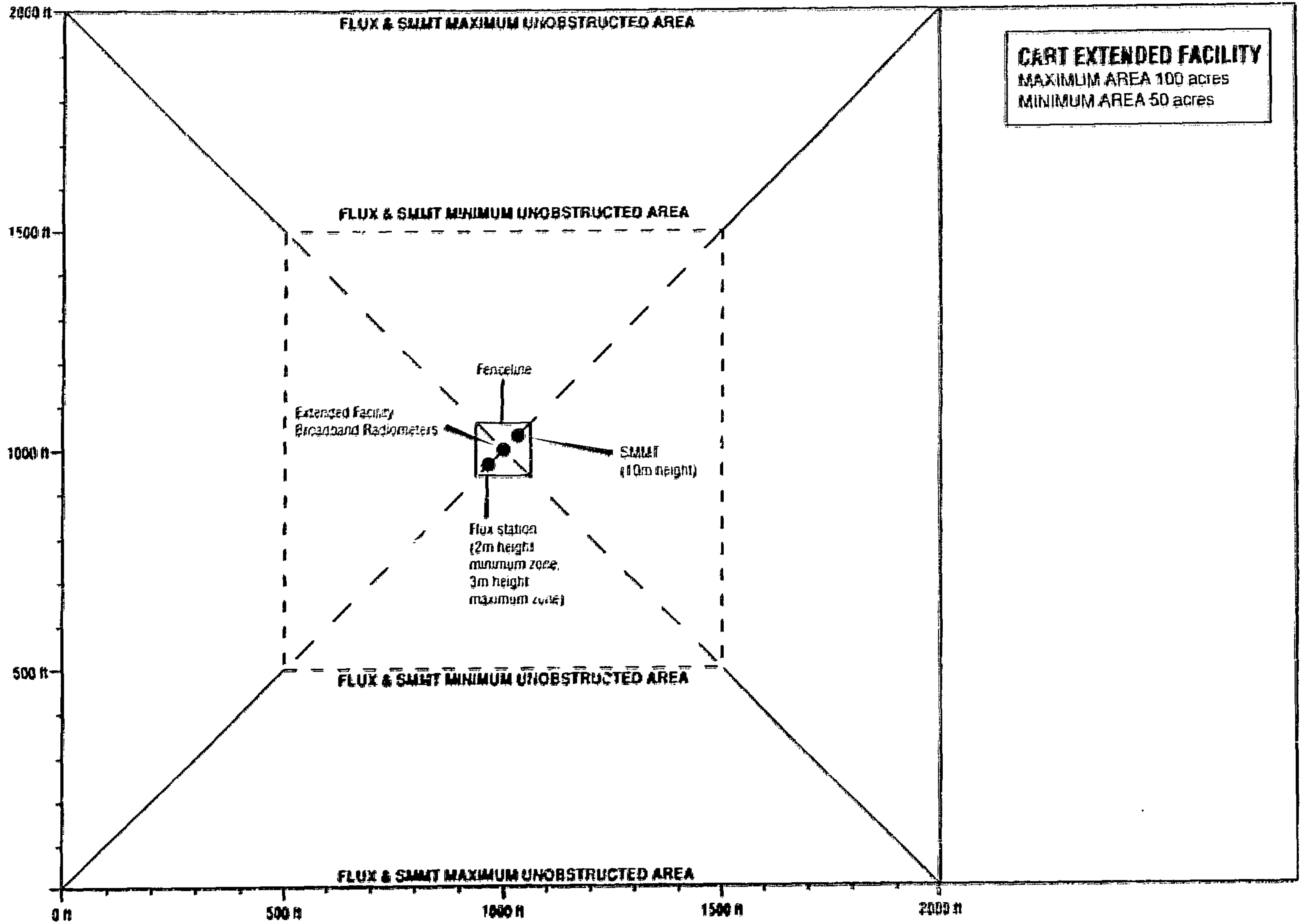

Figure 1.8 Relative Orientation of Instrumentation within a CART Extended Facility

screening in this EA. Figures 1.9-1.15 provide sketches of the locations of the central and the six boundary facilities, including one proposed site for each of these facilities and at least two alternatives for each of those locations. The proposed central facility site is in Oklahoma. Three of the proposed boundary facilities are in Oklahoma, and three are in Kansas. Table 1.1 presents the legal descriptions of these sites. Each of the proposed sites and alternatives fit within a quarter section except for the proposed site for the two of the boundary facilities (McClain and Marion County). As indicated in Figs. 1.10 and 1.14, the proposed site is divided into two parts: Part A contains all instruments except the 50-MHz RASS (Radio Acoustic Sounding System) which is located in Part B.

The proposed activities at the four types of facilities would be encompassed within about 3,860 acres (central facility, 160 acres; auxiliary facilities, 6 x 100 acres; extended facilities, 25 x 100 acres; and boundary facilities, 6 x 100 acres). The actual disturbance to the surface of the 3,860 acres would be minimal. Nearly all of the land at the various facilities is required to provide the instruments with unobstructed wind flow in all directions. The actual surface area to be secured by fencing at all of the sites (Appendix B) totals about 21 acres, and the surface within the fenced area would not be disturbed except for actual instrument placement. The actual total surface area disturbed for concrete pads for trailers, storage facilities, housing facilities, etc., is estimated to be less than 12 acres. The remaining portion of the area in each of these facilities (e.g., the remaining 160 - 1.8 = 158.2 acres of the central facility) would not be disturbed and continue with its same land use. All surfaces areas disturbed by activities would be returned to agricultural use and/or pasture use as part of decommissioning of the CART site, or they would be provided to the land owner, a university, or an interested state or federal agency for possible continued operation. At that time, however, another assessment of impacts would be provided for appropriate approval for continued operation. If no parties are interested, then all structures would be removed and all graded or impacted surfaces would be reseeded at the request of the property owner.

Activities at the CART site would continue 24 hours per day, 365 days per year, for up to 10 years. Up to 36 technical staff persons would be required to operate the southern Great Plains CART site. The central facility would be the only location where the continuous on-site presence of 6 CART personnel maximum (and 6 alternates) would be required over a 24 hour period. Up to 2 personnel (and 2 alternates) would be required to be at each of the boundary facilities for daily activities. The site would attract visiting scientists and officials for short periods during the lifetime of the site.

The main science or experimental activities include the collection and computer processing of data received by the in-place instrumentation. Once the facilities are in place the activities and routine operations revolve around the collection of solar and meteorological data. There will be no destructive field sampling that will affect the environment of the central, boundary, auxiliary, or extended facilities. Furthermore, operations will not include the creation of any chemicals or hazardous waste.

The proposed action includes the following major activities:

1. The temporary acquisition of areas for placement of the central, auxiliary, extended, and boundary facilities.

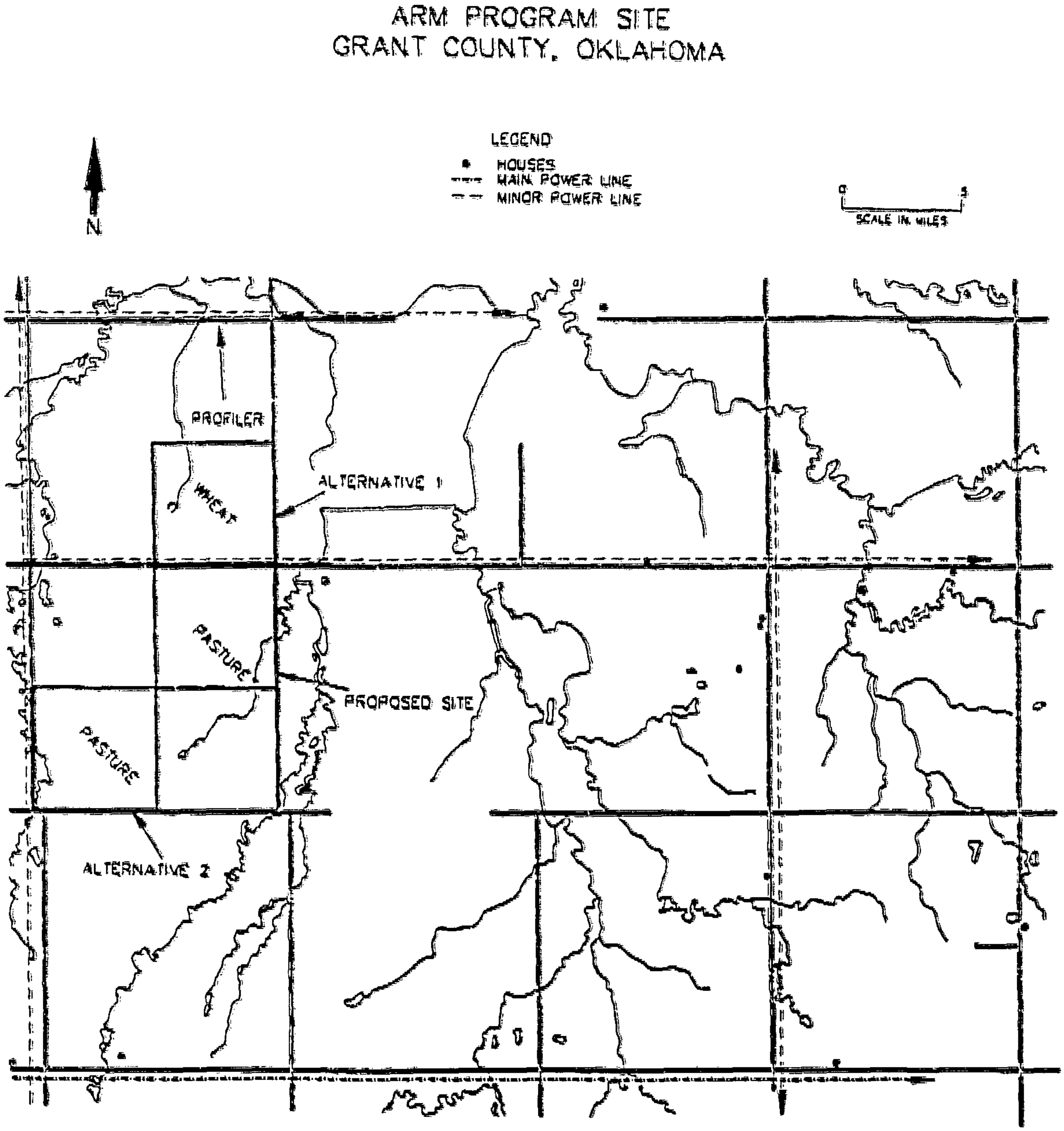

Figure 1.9 Siting of Central Facility in Grant County -- Proposed Site and Alternatives 1 and 2

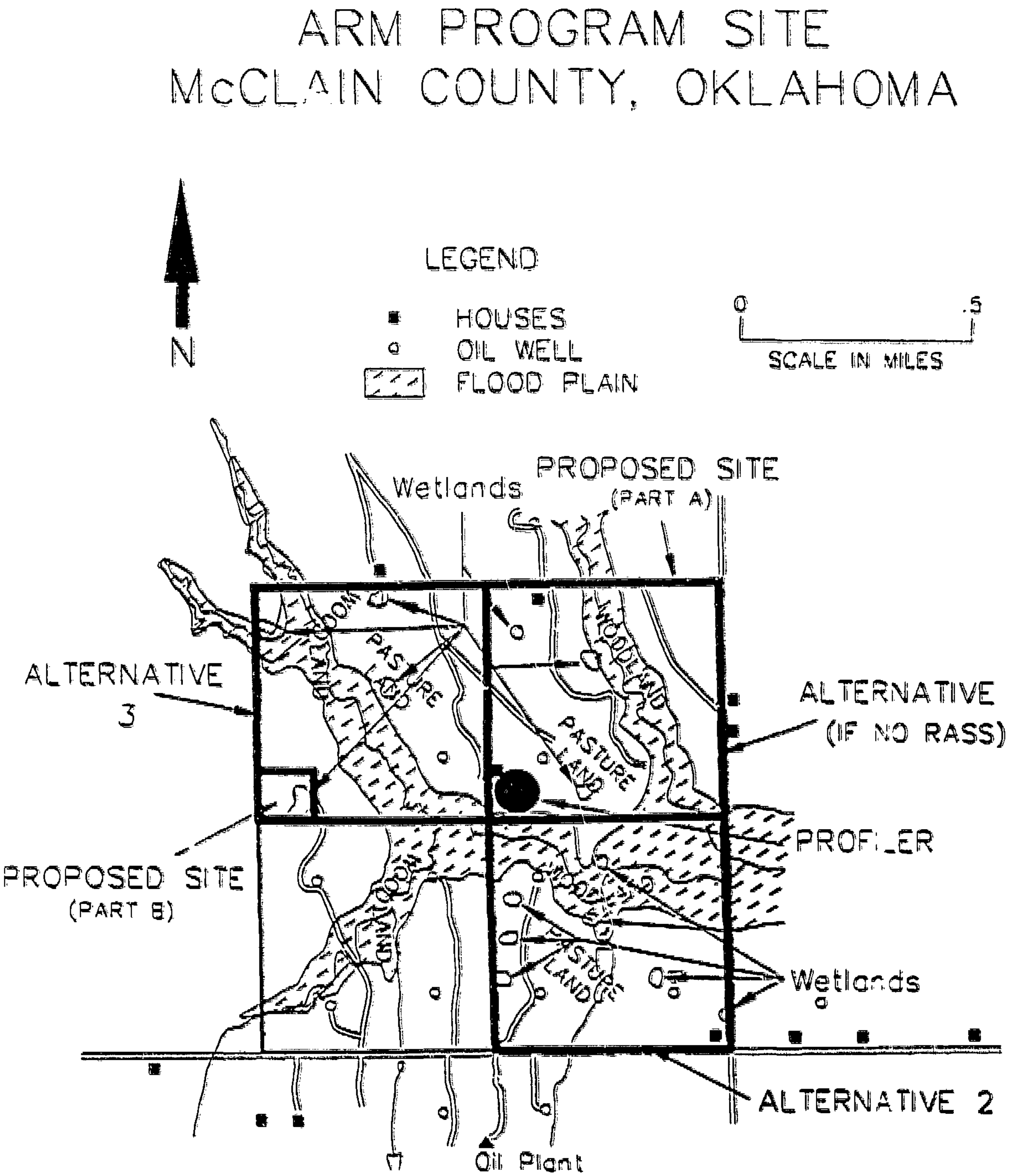

Figure 1.10 Siting of Boundary Facility in McClain County -- Proposed Site and Alternatives 1, 2, and 3

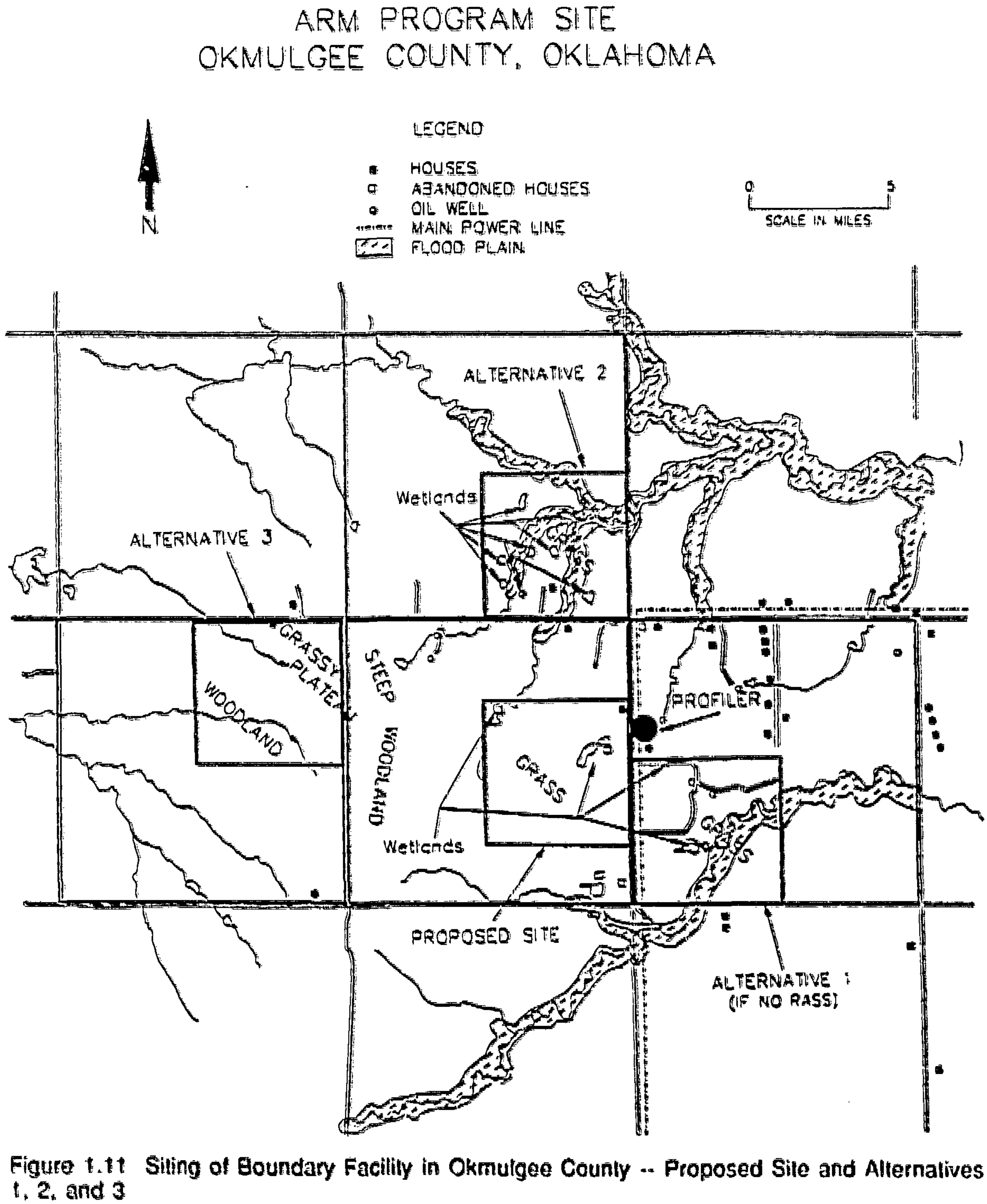

Figure 1.11 Siting of Boundary Facility in Okmulgee County -- Proposed Site and Alternatives 1, 2, and 3

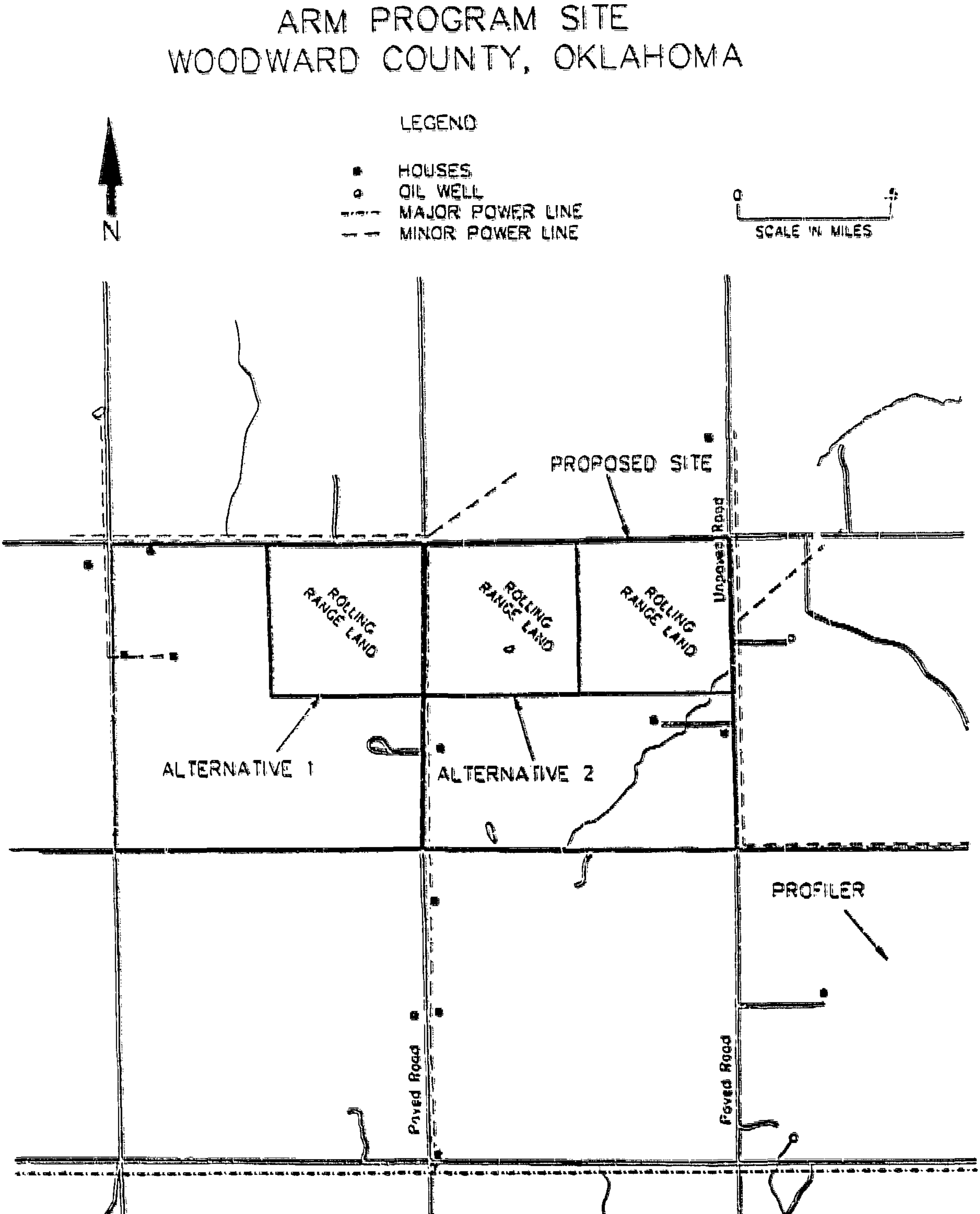

Figure 1.12 Siting of Boundary Facility in Woodward County -- Proposed Site and Alternatives 1 and 2

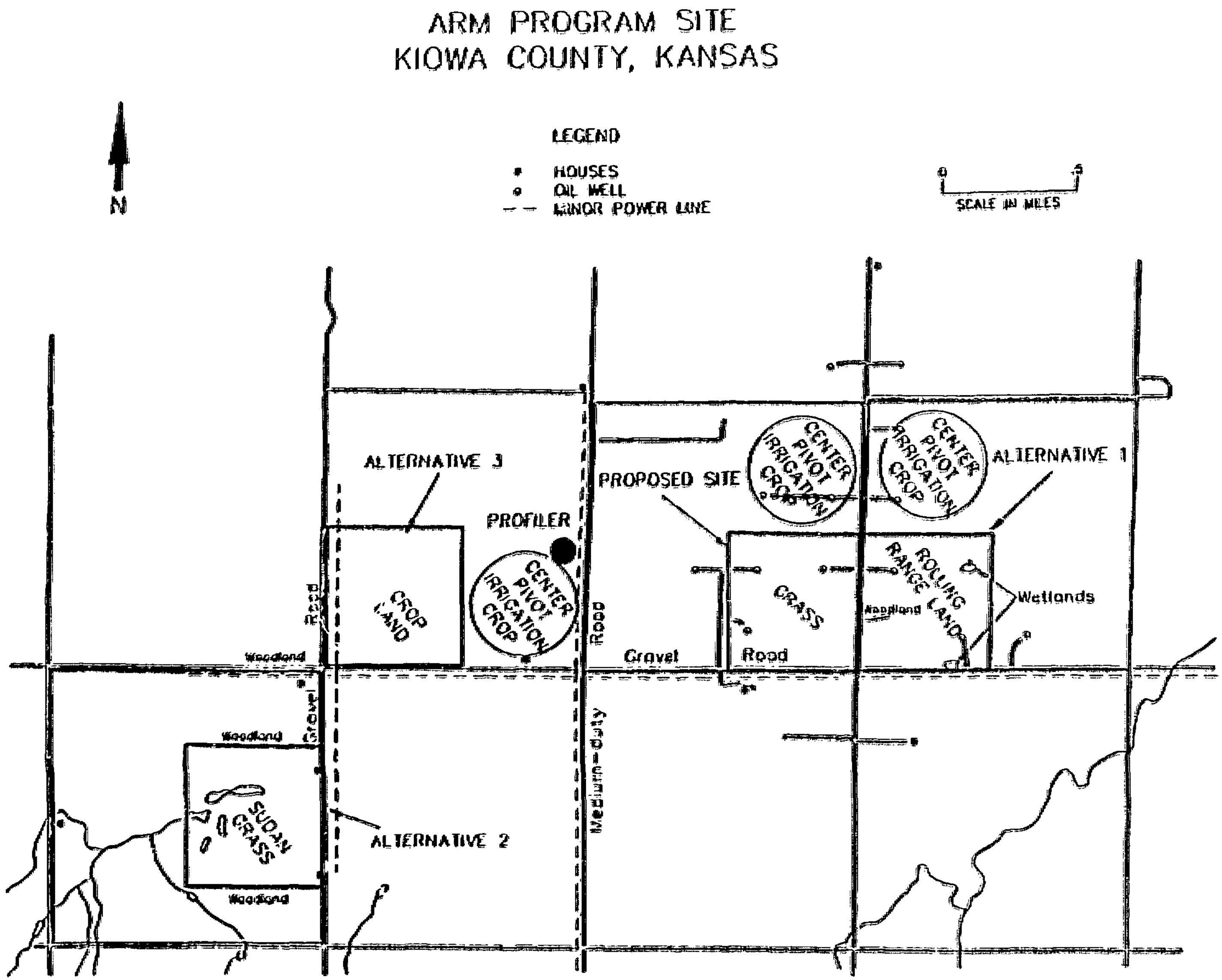

Figure 1.13 Siting of Boundary Facility in Kiowa County -- Proposed Site and Alternatives 1, 2, and 3

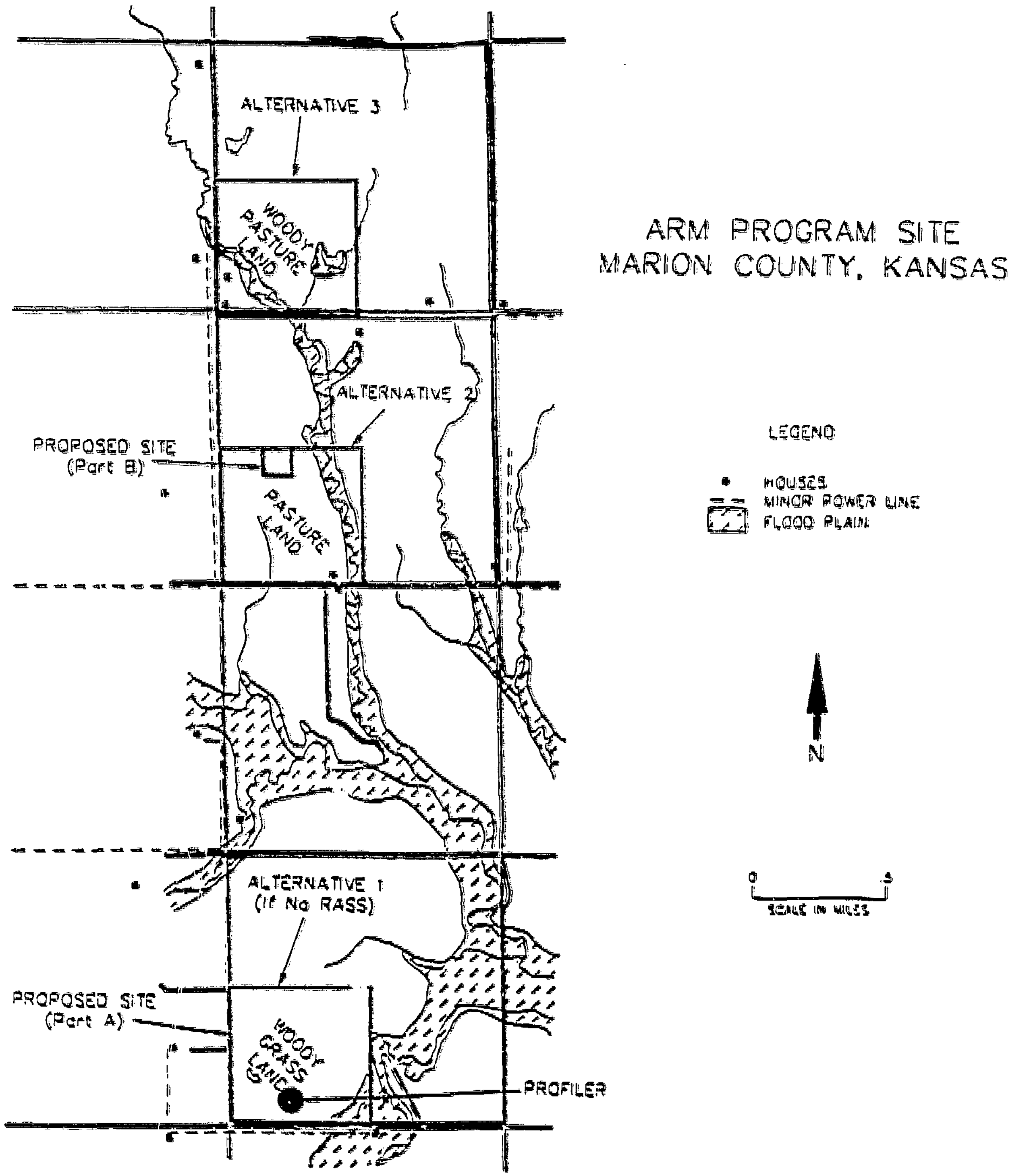

Figure 1.14 Siting of Boundary Facility in Marion County -- Proposed Site and Alternatives 1, 2, and 3

ARM PROGRAM SITE
MONTGOMERY COUNTY, KANSAS

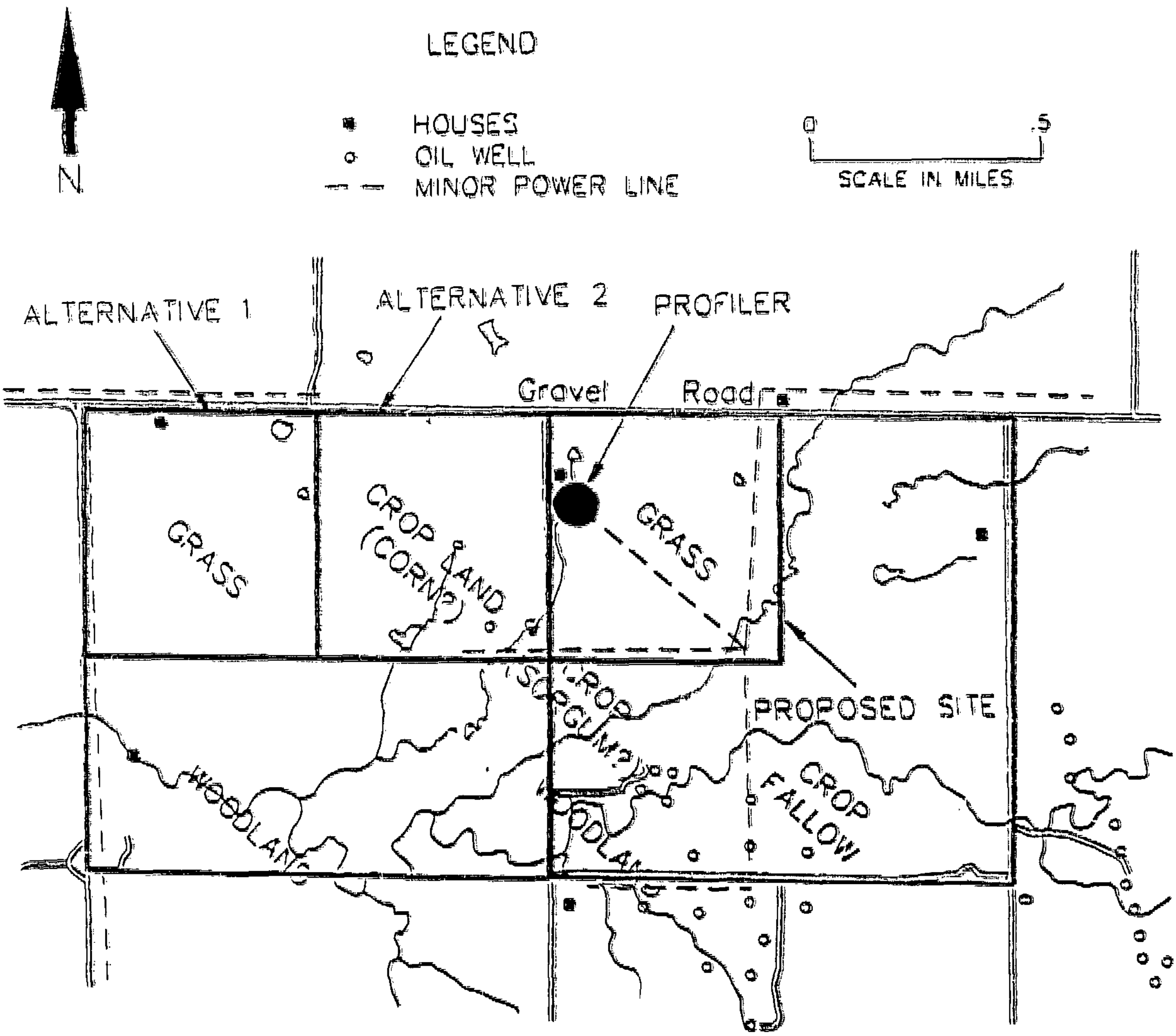

Figure 1.15 Siting of Boundary Facility in Montgomery County -- Proposed Site and Alternatives 1 and 2

Table 1.1 Legal Descriptions of the Proposed and Alternative Sites for the Central Facility and Six Boundary Facilities

Facility, Location	Proposed Site	Alternative 1	Alternative 2	Alternative 3
Central Facility, Lamont Grant County, Oklahoma	NE 14 Section 35 T-25N, R-3W	SE 1/4 Section 26 T-25N, R-3W	SW 1/4 Section 35 T-25N, R-3W	- - -
Boundary Facility, Purcell McClain County, Oklahoma	NE 1/4 Section 21 plus a 1.75 acre parcel in the SW corner of Alt. 3 T-6N, R-3W	NE 1/4 Section 21 T-6N, R-3W (if no 50 MHz RASS)	SE 1/4 Section 21 T- 6N, R-3W	NW 1/4 Section 21 T- 6N, R-3W
Boundary Facility, Haskell Okmulgee County, Oklahoma	N 1/2 of SE 1/4 Section 2, and S 1/2 of NE 1/4 Section 2 T-15N, R-14E	SW 1/4 Section 1 T-15N, R-14E (if no 50 MHz RASS)	SE 1/4 Section 35 T-16N, R-14E	NE 1/4 Section 3 T-15N, R-14E
Boundary Facility, Vici Woodward County, Oklahoma	NE 1/4 Section 33 T-20N, R-20W	NE 1/4 Section 32 T-20N, R-20W	NW 1/4 Section 33 T-20N, R-20W	- - -
Boundary Facility, Haviland Kiowa County, Kansas	SE 1/4 Section 32 T-27S, R-16W	SW 1/4 Section 33 T-27S, R-16W	SE 1/4 Section 1 T-28S, R-17W	SW 1/4 Section 31 T-27S, R-16W
Boundary Facility, Hillsboro Marion County, Kansas	SW 1/4 Section 14 T-20S, R-1E	SW 1/4 Section 2 T-20S, R-1E	SW 1/4 Section 35 T-19S, R-1E	- - -
Boundary Facility, Neodesha Montgomery County, Kansas	NW 1/4 Section 2 T-31S, R-16E	NW 1/4 Section 3 T-31S, R-16E	NE 1/4 Section 2 T-31S, R-16E	- - -

2. The temporary rental or purchase of one or more small, trailer-like buildings to house the data acquisition systems and office work space, the placement of small sheds to store supplies, the placement of cement pads to provide a level base for several semi-trailers that would be used to house larger instruments, and the placement of instruments and towers and anchoring. Such actions involve some clearing of land.

3. Continuous, around-the-clock operation of instruments for as long as ten years.

4. Routine (mostly but not limited to daytime) overflight with airborne sensors by aircraft (one aircraft for a period of 4-6 hours approximately 2-3 days a month) measuring cloud microphysical properties and solar radiation. Low-level flights, below FAA (Federal Aviation Administration) minimums, would not be required.

In addition to these main activities, in one or more two- to three-week intensive experimental field campaigns, special studies would supplement the measurements at the fixed sites. These intensive periods would be carried out mainly at the central facility, but they could involve any of the facilities. During this period, the data collection rate from instruments would be increased. Activities would include labor-intensive measurements of meteorological variables such as eddy correlation to benchmark surface flux measurements of heat, moisture, and momentum. Prototype meteorological measurement instrumentation would be field tested. Because these activities are only temporary, no permanent structures would be required.

Aircraft operations activities during intensive experimental field campaigns would involve up to 6 research aircraft to provide solar radiance and meteorological observations. The aircraft would range in size from light, single or twin propeller driven, to small, twin jet engine driven, to large, multiple turbo propeller driven. The jet aircraft would provide observations at the upper troposphere levels (30,000-50,000 ft), the larger aircraft at the middle troposphere levels (1,500-30,000 ft), and the light aircraft at the lowest troposphere levels (500-10,000 ft). Aircraft flight patterns would consist of horizontal transects at three levels: typically, the middle of the boundary layer, the middle of the troposphere, and at the top of the troposphere. There would also be vertical profiling (spirals) from the boundary layer to the top of the troposphere. During intensive experimental field campaigns, up to 4-6 aircraft may be airborne simultaneously for approximately 4-6 hours. Aircraft activity during intensive periods would mostly be (but not limited to) within a 50 km radius of the central facility. For the flights 500 ft above ground level, light aircraft such as twin-engine propeller planes would be used and, occasionally, an aircraft such as a P3-Orion (four-engine turbo propeller) might be used if the flight path would cover a sparsely populated area. The flight legs at 500 ft would mostly be (but not limited to) 20 km legs centered over the central facility. On one or two occasions per year, a single criss-cross pattern over the entire CART site at 500 ft may be required and light-aircraft would be used for this purpose. All aircraft operations will be conducted according to all applicable FAA regulations. Aircraft coordination is under way with Vance Air Force Base (for use of Vance Military Operations Area 1-B), FAA Kansas City Control Center, and Tinker Air Force Base.

The auxiliary and extended sites have not been determined at this time because the scientific criteria for their choice depends on field measurements acquired during the first few months of operation of the central facility. However, very minor impacts can be expected from these sites due to the low level of activity there and much reduced set of instruments that may have an impact on nearby residents. The siting of the extended and auxiliary sites is quite flexible and would be chosen, based not only on scientific considerations, but also within the following environmental guidelines. All of these sites would be chosen to avoid areas with wetlands or floodplains; areas with the presence of any archeological sites or structures listed in the National Register of Historic Places or areas that have state-listed archeological sites or structures; areas with existing or planned land use controls or zoning that would prohibit the placement and operation of such meteorological and radiation measurement instrumentation; areas of known habitats of threatened and endangered species or state-listed species; and areas with nearby visual resources that contain unique vistas, trails, national parks, etc. The area within the CART boundary, in which such environmental criteria can be met, is very large and does not exclude any general area where placement may be considered.

Once the choice of auxiliary and extended facilities has been made by the ARM scientists based on scientific as well as the avoidance of impacts evaluated in the NEPA process, then those choices along with a brief description of NEPA-related issues will be sent to the appropriate state (Oklahoma or Kansas) for confirmation. Once such confirmation has been received by the ARM project, and any required permits obtained (if needed), then work at those sites may be initiated. It is likely that the choice of sites will be done in sequence, and so not all sites will go through this state review process at the same time. In addition, due to the unobtrusive activities planned at these sites, it is expected that this review process will go smoothly. Letters to the states and their reply will become part of addenda to this EA.

1.3.2 Instruments

The instruments can be categorized into several groups. In almost all cases, instruments would be remote sensors that continuously investigate the atmosphere in the vertical direction. These instruments provide near-real-time data for evaluation of instrument performance, model testing, and comparison with models. A sketch of the instruments currently planned for use at the central, boundary, auxiliary, and extended sites is given in Fig. 1.4. A more complete description of instruments is given in Appendix C.

1.3.2.1 Radiation Sensors

The various types of passive radiance-measuring instruments observe the sun's incoming and outgoing shortwave (light) and longwave (heat) radiation and the earth's heat emissions. Radiation sensors would be used at all facilities. The high resolution radiation sensors to be used at the central and boundary facilities are housed in a standard semi-trailer (7 ft x 40 ft).

1.3.2.2 Standard Meteorological Instruments

Sensors of temperature, relative humidity, pressure, rain amount, and wind speed and direction provide direct measurement of the atmosphere. They are usually mounted on a small, guyed tripod that is used to raise the sensors to the measurement height of 10 m. Direct measurement of heat flux and moisture flux at heights of 1-2 m above the surface require a small pole-and-guy system. Soil temperature is measured by a small thermocouple buried at levels typically less than 1.5 m below the surface. Standard meteorological instruments would be used at all facilities.

1.3.2.3 Profilers/RASS

Profiling instrumentation can use sound waves, microwaves, or lasers to probe (by tr... ting and receiving energy signals) the atmosphere from above the surface to 16 km. Wind pr... s use low-level microwave energy at frequencies of 50 and 915 MHz. The energy used does not interfere with human health or wildlife. An environmental assessment of the NOAA 405-MHz microwave profilers is available for reference (*Environmental Assessment -- Wind Profiler Demonstration Program*; SRI International, 1986). The profilers provide continuous wind profile information up to 10-15 km. A profiler may be outfitted with a Radio Acoustic Sounding System (RASS), which probes the atmosphere to produce vertical profiles of virtual temperature. The RASS associated with the 50 MHz profiler provides about 79 dB unweighted sound pressure level at about 133 meters from the source, at a frequency of between 50-100 Hz. The RASS associated with the 915 MHz profiler provides about 57 dB unweighted sound pressure level at 100 meters from the source, at a frequency of between 1,500-2,000 Hz. Sound-reducing baffles and absorption packages can significantly reduce the horizontally-propagated audible noise from the RASS associated with the 915-MHz profiler. A 50-MHz profiler/RASS that can be engineered by the manufacturer to reduce noise will also be considered in this assessment, and will be referred to as the "baffled 50-MHz profiler." The baffled 50 MHz profiler/RASS has about a 10 dB lower sound power level (at the source) then the unbaffled 50 MHz profiler/RASS. Profilers with associated RASS would be used only at the central and boundary facilities. The proposed action calls for a baffled 915-MHz profiler/RASS and a baffled 50-MHz profiler/RASS at each of the boundary facilities. At the central facility, there is proposed a 915-MHz profiler/RASS and an unbaffled 50-MHz profiler/RASS. The profiler/RASSs would be sited as distant as possible to homes in order to avoid impacts to nearby residents. Equipment to operate the profiler and RASS systems would be located in a standard semi-trailer.

1.3.2.4 Radars and Lidars

Lidars are lasers used to probe the atmosphere to provide wind profile information up to 15 km. A few of the proposed lidars are not eye-safe. All non-eye safe lidars would be required to have a secondary radar system, with a wider beam width than the laser, to automatically activate a shutdown switch for the laser when any object enters its path both on the surface or in the air. Lidars would be used *only* at the central facility and possibly at one auxiliary facility. Should a lidar be used at an auxiliary facility, it will be of the eye safe type, or have a secondary safety radar system as described above or will be manned during operational periods. Passive microwave radars would be used to probe the atmosphere for humidity at the central and auxiliary facilities. Ceilometers, eye-safe lidars used to measure the height of the base of clouds, would be used only at the central and auxiliary facilities. The larger lidar and radar systems would be housed separately in standard semi-trailers.

1.3.2.5 Rawinsondes

Rawinsondes are helium-filled balloons used to carry small meteorological instrument packages up to 20 km in the earth's atmosphere. This type of balloon-borne system is used routinely for measurement of wind speed, direction, temperature, humidity, and pressure as a function of altitude by the National Weather Service for its daily weather forecasts. Rawinsondes would be used only at the central and boundary facilities. Rawinsonde systems are contained in an 8-ft x 10-ft trailer.

The balloon-borne system is equipped with a parachute to slow the decent rate of the instrument package after the balloon breaks at high altitudes to less than 5 m/s. The instrument package will be labeled with information that identifies the instrument and provides an 800 phone number to call for further information.

1.3.2.6 Platforms and Facilities

A 60-m tower would be erected only at the central facility to provide standard meteorological and radiation measurements. Also at the central facility, normal office work space would be provided by leasing a 60-ft mobile home or the equivalent. A calibration facility for solar instrumentation would require the leasing of a second 60-ft mobile home or the equivalent. Several small storage garages (approximately 15 ft x 30 ft at the central facility and 10 ft x 10 ft at each of the boundary facilities) and a small loading dock would be required to unload and store supplies. Utilities (power, water, phone, well and septic, etc.) would be required to operate computers and instrumentation and for personnel at the central facility. Siting considerations include close proximity to existing commercial power lines so that connecting lines could be run to individual instruments. Every effort would be made to keep power lines short and confined to existing rights-of-way where possible.

In lieu of the office trailer, an abandoned farm house exists on the quarter section of the proposed central facility site. If found to be structurally sound, repairs to the house may be more economically beneficial than leasing a trailer. The use of the house, since already in place, would reduce the potential impact by one large trailer to the central facility.

Power requirements at the boundary, extended, and auxiliary facilities would be much lower than required at the central facility. Commercial power is preferred, but solar power/battery backup systems are considered a viable option for instruments at the extended and auxiliary facilities. Although routine visits would be required for maintenance, no permanent on-site presence would be required at the extended, auxiliary, and boundary facilities. However, boundary facilities would require the daily presence of personnel to launch rawinsonde balloons. Trailer space will be made available for a place of shelter, a phone and desk, and bottled water at the boundary facility. One portable toilet will be supplied for sanitation reasons.

Some of the instruments are large and cannot be hand-carried to the actual placement location. A small truck will be required for installation and removal of equipment. Because of the scientific concerns about maintaining existing surface characteristics, portable mats laid down and picked up as a temporary path for vehicle traffic which minimize impact to surfaces may be used during instrument installation and removal. Instruments in the field would be approached on foot or by a small all-terrain vehicle for all routine maintenance of installed equipment.

Fences will be used to protect instruments from wildlife and inadvertent entry by humans. All fences will be labeled with appropriate warnings and/or information.

The placement of instrumentation at the central, boundary, auxiliary, and extended facilities involves only a small amount of construction activity that could lead to surface disturbances. In fact, the actual area involved in surface disturbances at each of these sites is very small. Appendix B lists for each facility (1) actual areas of surface disturbances, (2) the space actually occupied by an instrument or facility, and (3) the fenced area. For example, from Table B.5, the central facility covers 160 acres, but only 1.83 acres of that amount would actually be disturbed. The remaining portion of the area in each of these facilities (e.g., the remaining 160 - 1.8 = 158.2 acres of the central facility) would not be disturbed and continue with its same land use. An inspection of Fig. 1.4 reveals the relative sizes of the instruments and/or facilities to be used. The larger facilities are the two 10-ft x 60-ft mobile homes (or portable buildings) brought to the site and anchored there. One of the mobile homes provides space for the computers, a small laboratory for on-site equipment repairs, and office space for 3-5 personnel. The other mobile home provides calibration space for the solar radiation instruments. A smaller shed and dock (15 ft x 30 ft at the central facility and 10 ft x 15 ft at the boundary facilities) and about 6 semi-trailers (7 ft x 40 ft) are also required.

The largest clearing required is for the 50-MHz profiler system. The procedure for placement of this instrument, semi-trailers, and mobile trailers is to level an area (which is already nearly level), remove the vegetation from that area by surface scraping, apply two 6-mil-thick plastic sheets at right angles over the scraped ground, place about 3 in. of gravel on top of the plastic, and place the profiler or trailer on top of that. Tie-downs would be used to hold mobile homes and trailers securely in place. At the central facility, mobile homes would be transported to the site, or portable buildings would be brought to the site on a semi-trailer truck. The portable buildings and/or storage sheds could be made of fiberglass that has been preconstructed or molded or comprised of 2-3 small mobile trailers or portable buildings. For the storage sheds, the base would be a cement pad that exceeds the ground contact area of the building. Only one small tractor (for grading) would probably be used along with a gravel dump truck and a cement mixer. These pieces of equipment would move from one part of a site to another as one job is completed. A water truck would be used to minimize the fugitive dust.

At the central facility, utilities (water, power, telephone, etc.) would be required, as would power and telephone at each of the boundary, auxiliary, and extended sites. Solar power is currently expected to power the instruments at the auxiliary and extended facilities (up to 31 sites in total). Some of the instruments require power and semi-trailers for housing. These include the Raman lidar, the scanning lidar, the infrared interferometer, the ceilometer, and the balloon-borne sounding system. A sketch of these systems and the relative sizes of semi-trailers needed to house them is provided in Fig. 1.4.

The decommissioning plan, after the ARM field work is completed, is to restore each of the disturbed areas to its previous usage. If, after the ten years of study are completed, the decision is made to maintain the equipment at the sites longer (perhaps supervised by a university, for example), a re-evaluation of environmental impacts (on the basis of the ten-year experience) would be made through a new environmental assessment to evaluate the impacts of any further experimental effort. Presently, decommissioning of the sites is expected at the end of the ten-year experimental study.

1.4 No Action Alternative

The no action alternative implies no work done on the ARM project installing and operating meteorological instrumentation at any of the three U.S. locales. In particular, the no action alternative means that there would be no construction or operation of any instrumentation in Oklahoma or Kansas. No construction or operational air emissions, no noise impacts, no impacts to visual resources, no socioeconomic impacts, no impacts to cultural resources, etc. above current baseline levels, would occur. The current affected environment remains the same.

2 Affected Environment

This chapter will describe the affected environment at the central facility and the six boundary facilities. Nine key environmental areas will be evaluated: (1) soils and geology; (2) water resources; (3) air quality; (4) noise; (5) biotic resources; (6) land use; (7) visual resources; (8) cultural resources; and (9) socioeconomics. The focus will be on information that is required for later assessment of the impacts of the proposed action and its alternatives in Chapter 3.

2.1 Soils and Geology

2.1.1 Grant County, Oklahoma, Central Facility

At the proposed site in Grant County, the soil is predominantly Kirkland silt loam, with 1-3% slopes. Alternative 1 has a mixture of Grainola silty clay loam, Renfrow silty clay loam, and Kirkland silty loam. Alternative 2 has mainly a mixture of Kirkland silty loam and Renfrow silty clay loam . These soil types are in the Renfrow Grainola association (a group of soils commonly found together); i.e., they are deep or moderately deep, very gently sloping to gently sloping, well drained, nonalkali soils that have a loamy surface layer over a clayey subsoil, usually found on uplands. Due to the fact that these soils have a low permeability as an absorption field, a large septic tank field that services large facilities with many people are not permitted. The geology of Grant County is fairly simple. Outcropping rocks consist of Permian sandstones and shales that were deposited near the shoreline of shallow seas that once covered much of western Oklahoma. In many parts of the county, these rocks are mantled by unconsolidated alluvium laid down by modern rivers and streams.

2.1.2 McClain County, Oklahoma, Boundary Facility

At the proposed and alternative McClain County boundary sites, the soils are predominantly Lela clay and Port silt loam. The general soil/relief/drainage type is Nash-Lucien-Grant, which refers to well drained soils that are loamy throughout, formed in residuum from sandstone on uplands. Such an area has fair potential for residential or other urban use. Slopes in excess of 8% and bedrock of a depth of less than 40 in. limit the development of some facilities.

2.1.3 Okmulgee County, Oklahoma, Boundary Facility

The proposed site, at Okmulgee County, is mainly a mixture of Collinsville-Talihina complex (with 10-30% slopes) and Bates-Collinsville fine, sandy loams (with 1-5% slopes). Alternative 1 has a combination mainly of the Bates-Collinsville fine sandy loam and the Hector complex (5-30% slopes). Alternative 2 has mostly Hector-Hartsells fine sandy loams. Alternative 3 has predominantly soil of the Hector complex (5-30% slopes), which is soil that is loamy, siliceous, and thermic. The more clayey soils tend to have more movement and tend to shrink and fill more during summertime and wintertime than loamy soil. These tendencies would have an impact for large facilities. The geological formations that are at the surface or immediately beneath the soil in Okmulgee County are of sedimentary origin. Except for Recent alluvium and Quaternary terrace deposits, these formations belong to the Pennsylvanian system. The Pennsylvanian formations consist mainly of sandstone and shale.

2.1.4 Woodward County, Oklahoma, Boundary Facility

The predominant soil type for the proposed boundary site and both alternative sites in Woodward County is Pratt fine sandy loam. The Pratt association is made up of deep sandy soils that have formed under native grass. Sand sagebrush is common, and a few trees occur in some areas. The deep, brown, sandy Pratt soils are on undulating to low dunelike topography in the uplands. They have a surface layer of brown fine sand or loamy fine sand and a subsoil of yellowish-brown loamy fine sand. The soil absorbs moisture well.

2.1.5 Kiowa County, Kansas, Boundary Facility

The main soil type at the Kiowa County proposed boundary site and the alternatives is the Pratt loamy fine sand. The Pratt-Attica association consists of deep, undulating and rolling, well drained soils that have a sandy or loamy subsoil and are on uplands.

2.1.6 Marion County, Kansas, Boundary Facility

Each of the Marion County boundary alternatives is in the Goessel-Rosehill association, implying that the soil area is moderately deep or deep, is nearly level and gently sloping, is moderately well drained, has a clayey subsoil, and is on uplands. The main soil at the proposed site and Alternative 1 is Irwin silty clay loam. Alternative 2 has Irwin silty clay loam and Wells loam. The Irwin series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old alluvium. The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in old alluvium or in residuum from noncalcareous sandstone.

2.1.7 Montgomery County, Kansas, Boundary Facility

The Montgomery County boundary facility site is part of the Verdigris-Osage-Lanton association with nearly level, moderately well drained to poorly drained, silty and clayey soils on bottom land. The main soil type for the proposed site and the alternatives is the Bates-Collinsville complex (1-4% slopes), which consists of gently sloping, well drained soils that are on the tops of ridges in the uplands. The Bates soil is suitable as a site for dwellings without basements and for local roads and streets. However, Collinsville soil is not suitable as a site for dwellings and local roads and streets, because the depth to rock is a severe limitation.

2.2 Water Resources

2.2.1 Surface Water Quality

2.2.1.1 Grant County, Oklahoma, Central Facility

The proposed site of the Central Facility is in the basin of the Salt Fork of the Arkansas River. A total of 529,250 acre-feet of water is available. Many areas of Grant County have an inadequate water supply for domestic and livestock use. Rural water systems presently serve much of Grant County. Water for these systems and for limited irrigation is available under some of the bottom land soils. In some areas, the water is too high in salt and mineral contents for domestic use. Farm ponds furnish much of the water for livestock.

The area of north central Oklahoma in which Grant County is located is part of the Enid quadrangle, which is within the Arkansas River basin. The nearby Salt Fork of the Arkansas River is one of several rivers and tributaries that make up the drainage network for most of the region. Restrictions have been imposed on the use of water from major streams in the area for public water supplies and some types of industrial and agricultural uses because of excessive concentrations of sulfate, sodium, and chloride. These constituents come mainly from gypsum and salt-bearing formations west of the area.

2.2.1.2 McClain County, Oklahoma, Boundary Facility

The proposed McClain County boundary facility is near Finn Creek, which is a tributary of the Middle Washita River Stream System Basin. A total of 227,320 acre-feet of water is available.

2.2.1.3 Okmulgee County, Oklahoma, Boundary Facility

The proposed Okmulgee County boundary facility is near Duck Creek and Snake Creek, which are tributaries of the Middle Arkansas River Stream System Basin. The total water available has not been determined. Rainfall is about 38 in. per year, with about 60% of the average annual rainfall occurring during the growing season, from April to September.

2.2.1.4 Woodward County, Oklahoma, Boundary Facility

The proposed Woodward County boundary facility is near the South Persimmon Creek, which is a tributary of the Upper North Canadian River Stream System. In all, 24,400 acre-feet of water is available. Surface water quality (for municipal use) is rated poor, with more than 1,000 mg/L of dissolved solids in nearby Brent Creek.

2.2.1.5 Kiowa County, Kansas, Boundary Facility

The area of the proposed and alternative sites in Kiowa County, which is the upper Arkansas drainage basin, is drained by Rattlesnake Creek and its tributaries. Annual precipitation is about 23 in., and of this, 16 in. fall in April through September.

2.2.1.6 Marion County, Kansas, Boundary Facility

The Cottonwood River and its tributaries drain about two-thirds of Marion County from northwest to southeast. Areas along the southern part of the county (where the boundary facility would be located) are drained by Middle Emma Creek, East Emma Creek, Sand Creek, and Turkey Creek, which flow south. Sources of surface water are ponds, springs, lakes, and perennial streams.

2.2.1.7 Montgomery County, Kansas, Boundary Facility

Most of Montgomery County is drained by the Verdigris and Elk Rivers and their tributaries. These streams flow in the southerly direction. The water for use on farms is drawn from wells, ponds, streams, and rural water district supply lines. The water for towns generally is drawn from streams and lakes.

2.2.2 Groundwater Quality

2.2.2.1 Grant County, Oklahoma, Central Facility

The proposed Grant County sites are in the Vamoosa aquifer, which is composed of fine- to coarse-grained sandstone irregularly imbedded with shale and limestone. Wells in the aquifer generally yield 25-50 gallons per minute (gpm). The chemical characteristics of groundwater in that area differ considerably within short distances. The water in the area is typically hard or very hard and locally contains sulfate and chloride in excess of 250 mg/L. The total dissolved solids concentrations in the groundwater in the Vamoosa aquifer are 500-1,000 mg/L.

2.2.2.2 McClain County, Oklahoma, Boundary Facility

The chemical quality of the groundwater in McClain County is generally good, with dissolved solids contents of less than 500 mg/L, which is satisfactory for most uses. An undesirable constituent or excessive hardness may make the water unsuitable for some purposes. However, the yield is expected to be less than 25 gpm.

2.2.2.3 Okmulgee County, Oklahoma, Boundary Facility

This area of Okmulgee County proposed for siting the boundary facility is generally unfavorable for groundwater supplies. The area is underlain by shale, siltstone, and sandstone of Pennsylvanian age and by terrace deposits. Most wells in the shale, siltstone, and sandstone yield only a fraction of a gallon per minute to a few gallons per minute. Wells here yield limited amounts of water of poor quality.

2.2.2.4 Woodward County, Oklahoma, Boundary Facility

Groundwater in the Woodward County area is derived almost entirely from the precipitation falling directly on the area. Of an annual precipitation from 21-28 in., about 1.7-2.2 in. is available annually to recharge the groundwater reservoir. A well in the area of the boundary facility could yield 25-150 gpm. Water in this area is derived mostly from the thin sand and gravel of some alluvial and terrace deposits, the Ogallala Formation, and some parts of the Whitehorse Group. The chemical quality of the groundwater in these areas is generally good, with total dissolved solids contents typically less than 500 mg/L.

2.2.2.5 Kiowa County, Kansas, Boundary Facility

Water in sufficient quantity for irrigation is available in the northern part of the county, where the proposed site alternatives are located. The use of irrigation systems has increased significantly in the county over the past 20 years. Domestic and livestock water generally is obtained from wells. A well dug in 1981 about two miles from the proposed sites encountered groundwater 40 ft from the surface. A 123-ft well yielded 1,400 gpm (Kraxner, 1991). Water in that general area is chemically suitable for irrigation (Fader and Stullken, 1978).

2.2.2.6 Marion County, Kansas, Boundary Facility

Groundwater in Marion County is generally of poor quality and low yield. Wells that yield 100-500 gpm are in the central part of the county. (The boundary facility is in the west central part of the county.) Wells in the rest of the county yield 10-100 gpm. About 2,600 acres of cropland are irrigated. Water for several irrigation systems comes from wells. A few systems depend on water from streams, but the water supply from streams is limited, and water often is not available when it is needed. In places, the supply of water from wells is inadequate for domestic and livestock use. Rural water districts have been formed, and three of these are presently in use.

2.2.2.7 Montgomery County, Kansas, Boundary Facility

The proposed site and the alternatives in Montgomery County overlie Chanute Shale and Drum Limestone. Sandstone beds in the Chanute Shale are an important consolidated-rock aquifer that yields small to moderate supplies of water to wells from sandstone beds at depths of as much as 400 ft Drum Limestone generally yields little or no water to wells except in the shallow zone of weathering. A well in the area near the proposed sites yields water with a dissolved solids content of 183 mg/L (O'Connor, 1974). Kansas drinking water standards for dissolved solids are 500 mg/L.

2.2.3 Wetlands

Marshes, swamps, ponds, and bogs are used by migratory birds, fish, and aquatic plant life. Wetlands have the following benefits (Federal Interagency Committee, 1989):

1. Protection of wildlife. Wetlands support 30% of federally protected threatened and endangered species. Wetlands can be shallower, less turbulent areas for fish to hatch; they are a safe refuge for amphibians and reptiles. Wetlands are the few fertile, moist areas during winter for migratory birds and are crucial waterfowl nesting spots.

2. Control of flooding. Wetlands act as holding tanks during heavy rains and snow melts.

3. Purification of water. Wetlands filter sediments and pollutants before water flows to nearby streams, lakes and rivers.

4. Boosting of groundwater supplies. Wetlands help purify and replenish water supplies by recharging aquifers and filtering out sediment and disease-causing bacteria.

Wetlands are protected by the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.). Any soil disturbance in a designated wetland area is construed as depositing fill in the waters of the United States, and wetlands are considered part of the waters of the United States. Any proposed digging activity in a wetlands area requires application for a Section 404 permit or a waiver of a permit from the U.S. Army Corps of Engineers.

Each central facility site and the six boundary facility sites (proposed sites and alternatives) were evaluated with regard to wetland sites. Documents reviewed were (1) Soil Conservation Service wetlands maps, (2) U.S. Fish and Wildlife Service National Wetlands Inventory Program maps and (3) data obtained from the U.S. Army Corps of Engineers in Tulsa (for the northern Oklahoma and southern Kansas sites). All letters documenting the findings of the various agencies cited throughout Section 2 are provided in Appendix D.

2.2.3.1 Grant County, Oklahoma, Central Facility

The U.S. Fish and Wildlife Service investigated the presence of wetlands in the proposed and alternative quarter sections of Grant County and found no wetlands. Furthermore, the U.S. Soil Conservation Service wetlands maps indicated that there are no wetlands at these sites.

2.2.3.2 McClain County, Oklahoma, Boundary Facility

The evaluation by the U.S. Fish and Wildlife Service and the McClain County Soil Conservation Service indicated that all of the alternatives for the McClain County boundary facility have protected wetlands in the quarter sections. No wetlands appear to be in the proposed site. The wetland area is illustrated in Fig. 1.10. The creek oriented north-south needs to be protected to a distance of about 90 yards on each shore. The creek oriented east-west has a wider area of protection toward the east side. In the case of the McClain County boundary facility, the wetland area coincides with the floodplain area to be discussed in Section 2.2.4.

A letter from the U.S. Fish and Wildlife Service concerning the wetlands at this boundary facility recommends that impacts to wetlands and stream areas (the floodplain) be avoided by locating facilities in upland sites.

2.2.3.3 Okmulgee County, Oklahoma, Boundary Facility

While the U.S. Soil Conservation Service wetlands maps indicated that there were no wetlands at these sites, the U.S Fish and Wildlife Service determined that there are wetlands in the alternative sites 1 and 2 quarter sections in Okmulgee County.

A letter from the U.S. Fish and Wildlife Service concerning the wetlands at this boundary facility recommends that impacts to wetlands and stream areas (the floodplain) be avoided by locating facilities in upland sites.

2.2.3.4 Woodward County, Oklahoma, Boundary Facility

The U.S. Fish and Wildlife Service investigated the presence of wetlands in the proposed and alternative quarter sections of Woodward County and found no wetlands of concern. Furthermore, the U.S. Soil Conservation Service wetlands maps indicated that there are no wetlands at these sites.

2.2.3.5 Kiowa County, Kansas, Boundary Facility

The U.S. Fish and Wildlife Service investigated the presence of wetlands in the proposed and alternative quarter sections of Kiowa County and found no wetlands of concern.

2.2.3.6 Marion County, Kansas, Boundary Facility

No wetlands information was available for this site since the county has not been mapped for wetlands.

2.2.3.7 Montgomery County, Kansas, Boundary Facility

No wetlands information was available for this site since the county has not been mapped for wetlands.

2.2.4 Floodplains

Floodplain/floodway areas are delineated by the Federal Emergency Management Agency (FEMA) for the creeks and bodies of water in each county. Floodplain data were obtained from the U.S. Army Corps of Engineers in Tulsa for the northern Oklahoma and southern Kansas sites. Each county in Oklahoma also sent verification information on floodplains for the proposed site and the alternatives in that county. The 100-year floodplain maps used for this EA are defined by FEMA and represent the regulatory floodplain for non-critical facilities to be observed by federal agencies, according to Executive Order 11988 (Floodplain Management, May 24, 1977). In an area marked as part of a 100-year floodplain, the probability of a flood is 1% per year. The floodplains would be avoided for placement of any instrumentation.

2.2.4.1 Grant County, Oklahoma, Central Facility

A review by the Grant County Conservation District and the U.S. Army Corps of Engineers in Tulsa revealed that no floodplains are in the area of the proposed site and its alternatives in Grant County.

2.2.4.2 McClain County, Oklahoma, Boundary Facility

A review by the McClain County Conservation District and the U.S. Army Corps of Engineers in Tulsa revealed that the proposed site and each of the alternative quarter sections in McClain County is partially encompassed by floodplain areas (see Fig. 1.10).

2.2.4.3 Okmulgee County, Oklahoma, Boundary Facility

A review by the Okmulgee County Conservation District and the U.S. Army Corps of Engineers in Tulsa revealed that the quarter sections representing alternatives 1 and 2 in Okmulgee County partially encompass floodplain areas (see Fig. 1.11).

2.2.4.4 Woodward County, Oklahoma, Boundary Facility

A review by the Woodward County Conservation District and the U.S. Army Corps of Engineers in Tulsa revealed that no floodplains are in the area of the proposed site and its alternatives in Woodward County.

2.2.4.5 Kiowa County, Kansas, Boundary Facility

Kiowa County does not participate in the flood insurance program of the Federal Emergency Management Agency. As a result, the presence of a flood plain in the area of this project is very unlikely.

2.2.4.6 Marion County, Kansas, Boundary Facility

A review by the U.S. Army Corps of Engineers in Tulsa revealed that the proposed and alternative quarter sections in Marion County partially encompasses the floodplain (see Fig. 1.13).

2.2.4.7 Montgomery County, Kansas, Boundary Facility

A review by the U.S. Army Corps of Engineers in Tulsa revealed that no floodplains are in the area of the proposed site and its alternatives in Montgomery County.

2.3 Air Quality

The states of Oklahoma and Kansas accept the National Ambient Air Quality Standards for the following six criteria air pollutants: sulfur dioxide, carbon monoxide, nitrogen oxides, particulate matter, lead, and ozone. Each state has a limited monitoring network within the state to monitor compliance in areas that may be exceeding one or more standards.

The proposed central facility in Grant County, Oklahoma, and the three proposed boundary sites in Oklahoma are in attainment areas for all air pollutants. Most of the state of Oklahoma is an attainment area for all pollutants except for pockets near the larger cities, largely because of automobile exhaust. The entire state is an attainment area except that (1) for ozone, an exceedance exists in Farn, Tulsa, and Skiatook, and (2) for sulfur dioxide, an exceedance exists in Ponca City. The state generally places sampling stations where it expects that exceedances of the criteria pollutants might occur. No sampling station exists in any of the four Oklahoma counties of interest because significant industrialization and/or automobile traffic are absent.

All three of the boundary sites in Kansas are in attainment areas for all pollutants. That is to be expected because none of the three areas is near a large city or a highly industrial area. Only the Kansas City area (in the northeast corner of the state) is a nonattainment area for carbon monoxide. The Wichita area is a nonattainment area for ozone. Otherwise the remaining portion of Kansas is an attainment area with respect to each of the criteria pollutants.

2.4 Noise

The ambient background (environmental residual) noise level at the proposed central facility and each of the six proposed boundary facilities is expected to be low because industrial and transportation activities are minimal at these rural sites. Background noise measurements were made by Argonne National Laboratory staff for this EA at the nearest residence for each of the proposed sites, at the two alternatives for the central facility site, and at two of the six proposed boundary sites (Okmulgee County and Montgomery County). Measurements were made in the evening or nighttime, when human activity was at a minimum and surface winds were lowest. The methodology used to measure the ambient noise levels at the sites is described in Appendix E.

The ambient noise measurements in the full 1/3-octave band spectrum were acquired and are summarized in Appendix E. All references to the 100-Hz frequency band and the 2,000-Hz frequency band will be taken to be the 1/3-octave band frequencies for which 100-Hz and 2,000-Hz are the center frequencies, respectively. A detailed study of the noise in the 100-Hz and 2,000-Hz frequency bands was also carried out, with results also presented in Appendix E. Emphasis is placed on these frequency bands because the 50-MHz and 915-MHz profiler/RASSs emit potentially annoying tones at those frequencies. Measured noise levels are compared with the threshold of hearing, which is defined as the lowest level that can be detected by the human ear. For the 100-Hz frequency band, the threshold of hearing is 30 dB and for 2,000-Hz frequency band the threshold of hearing is 2 dB (Robinson and Whittle, 1964). A brief discussion of measured or expected noise levels at each site is presented here. The expected impacts from the noise of the RASSs will be discussed in Section 3.4.

Table 2.1 gives the distance between the proposed/alternative sites and the nearest residence for the central facility and each of the 6 boundary facilities. A zero in the table indicates that the nearest residence is actually on the plot of land that is represented by the proposed/alternative quarter section or immediately adjacent to it. Background ambient noise levels are of interest for these nearest residences because the potential impacts would be greatest there. Field measurements carried out for this EA focused on those nearest residences.

2.4.1 Grant County, Oklahoma, Central Facility

Background noise measurements were made in November and December 1991 at the residences nearest the location of the proposed site and each of the two alternatives in Grant County, as sketched in Fig. 1.9. The area around the proposed central facility is in an isolated rural area with farmhouses located within about a mile of each other. Most of the area is either cropland or pasture with some trees. Billings, Oklahoma, the nearest town, is about four miles to the south. Transportation traffic is rare during the evening and nighttime, and no industrial activity is present in the area. Ambient noise levels are very low. Measurements at the 100-Hz frequency

Table 2.1 Distance of Closest Residence to Each of the Proposed and Alternative Sites (miles)

Facility	Proposed Site	Alt. 1	Alt. 2	Alt. 3
Grant County, OK	1.7	1.5	1.5	---
McClain County, OK	0	0	0	0
Okmulgee County, OK	0	0	0	0
Woodward County, OK	0.1	0.1	0.1	---
Kiowa County, KS	0.1	0.2	0.0	0.1
Marion County, KS	0	0	0	0
Montgomery County, KS	0	0	0	---

band revealed values of about 30 dB, which is equal to the threshold of hearing. The ambient residual noise level for the 2,000-Hz frequency band is 8 dB, which is 6 dB higher than the threshold of hearing for this frequency band.

2.4.2 McClain County, Oklahoma, Boundary Facility

No background noise measurements were made at the McClain County sites. However, the background (environmental residual) noise levels are expected to be slightly higher than those measured in Grant, Montgomery, and Okmulgee Counties, due to the fact that there is some industrial activity present. An oil plant runs continuously and the noise from that plant can be heard at the nearest residences during the nighttime and sometimes during the day. Figure 1.10 presents a sketch of the McClain County boundary sites and the residences nearest them, including the oil plant. The area around this boundary facility is isolated and rural. Residences are located close to the proposed site and Alternatives 1 and 2. Transportation traffic is rare during the evening and nighttime. Most of the area is either cropland or pasture land with some trees. By using the ambient noise data acquired at Grant, Montgomery, and Okmulgee Counties of 30 dB at the 100-Hz frequency band and 8 dB at the 2,000-Hz frequency band, any projected impacts from the profiler/RASSs will be overestimated since the background noise level at this site is expected to be higher than at either Grant or Okmulgee Counties (due to the background noise from the oil plant).

2.4.3 Okmulgee County, Oklahoma, Boundary Facility

Background noise measurements were made in December 1991 adjacent to the residences nearest the location of the proposed site and each of the three alternatives in Okmulgee County. These locations are identified in Fig. 1.11. The area around this proposed boundary facility is rural, with residences located near to the north, east, and south of the site. Fewer homes are in the areas of the alternatives than at the proposed site. However, residences are near all of the sites. Transportation traffic is rare during the evening and nighttime, and no industrial activity is present. Most of the area is either cropland or pasture land with some trees. Measurements at the 100-Hz frequency band revealed values about 30 dB, which is barely audible. The ambient level at the 2,000-Hz frequency band is 10 dB, about 8 dB greater than the threshold of hearing.

2.4.4 Woodward County, Oklahoma, Boundary Facility

No background noise measurements were made at the Woodward County sites. The proposed site and the two alternatives are sketched in Fig. 1.12. Background noise levels are expected to be very low at this site because the area has no nearby industrial activity and little transportation activity. The background noise levels are expected to be similar to those measured in Grant, Montgomery, and Okmulgee Counties because the land use and density of houses are similar. Figure 1.12 presents a sketch of the location of the residences nearest the three sites under consideration. The area around this proposed boundary facility is rural. Residences are located nearby to the north, west, and south of the site and alternatives. Transportation traffic is rare during the evening and nighttime, and no industrial activity is present in the area. Most of the area is rolling rangeland. Ambient noise data acquired at Grant, Montgomery, and Okmulgee Counties suggest that the ambient noise level in the 100-Hz frequency band should be about 30 dB. The ambient level at 2,000-Hz is expected to be about 8 dB.

2.4.5 Kiowa County, Kansas, Boundary Facility

No background noise measurements were made at the Kiowa County sites. Background noise levels are expected to be very low at these sites because the area has no nearby industrial activity and little transportation activity. However, the background noise levels are expected to be similar to those measured in Grant, Montgomery, and Okmulgee Counties. Figure 1.13 presents a sketch of the location of the Kiowa County proposed and alternative sites and the residences nearest them. The area around this boundary facility is rural. Only a few residences are located near the proposed site and alternatives. Transportation traffic is rare during the evening and nighttime, and no industrial activity is present in the area. Most of the area is cropland, rolling rangeland, and grassland. Ambient noise data acquired at Grant, Montgomery, and Okmulgee Counties suggest that the ambient noise level in the 100-Hz frequency band should be about 30 dB. The ambient level in the 2,000-Hz frequency band is expected to be about 8 dB.

2.4.6 Marion County, Kansas, Boundary Facility

No background noise measurements were made at the Marion County sites. Background noise levels are expected to be very low at the proposed and alternative sites because the area has no nearby industrial activity and little transportation activity. However, the background noise levels are expected to be similar to those measured in Grant, Montgomery, and Okmulgee Counties. Figure 1.14 presents a sketch of the Marion County boundary sites and the residences nearest them. The area around this boundary facility is rural. Residences are located near the proposed site and alternatives. Transportation traffic is rare during the evening and nighttime, and no industrial activity is present in the area. Most of the area is woody pasture or woody grassland. Ambient noise data acquired at Grant, Montgomery, and Okmulgee Counties suggest that the ambient noise level in the 100-Hz frequency band should be about 30 dB. The ambient level at the 2,000-Hz frequency band is expected to be about 8 dB.

2.4.7 Montgomery County, Kansas, Boundary Facility

Background noise measurements were made at the Montgomery County sites. Background (environmental residual) noise levels were very low at the proposed and alternative sites because this area has no nearby industrial activity and little transportation activity. Figure 1.15 presents a sketch of the Montgomery County boundary sites and the residences nearest to them. The area around this boundary facility is rural. A few residences are located close to the proposed site and the alternatives. Transportation traffic is rare during the evening and nighttime, and no industrial activity is present in the area. Most of the area is cropland or grassland. The ambient noise level at the 100-Hz frequency band is measured to be 30 dB. The ambient level at 2,000-Hz was measured to be 6 dB.

2.5 Biotic Resources

In terms of areal requirements, the ARM Program's CART site (325 km x 275 km) supports several diverse habitats and biotic communities. In general terms, the ecosystems of Kansas and Oklahoma consist chiefly of grasslands, woodlands, and some shrublands. These ecosystems are not clearly defined and often overlap or mix. The grassland ecosystem dominates the land within the boundaries of the CART site. Grassland types found within the confines of the CART site include tallgrass, shortgrass, mixed, and sandsage prairie (Jones et al., 1985). Woodland ecosystems occur most frequently in the eastern regions of both states and along water courses. The Northern Floodplain Forest type, featuring cottonwoods and willows, can be found in scattered tracts within the CART site boundaries. Oak-hickory forests occur in Okmulgee (Oklahoma) and Montgomery (Kansas) Counties, near the CART site's eastern boundary. Shrubland ecosystems are confined to the western reaches of Oklahoma and can be found in Woodward County.

Many animal species thrive within the ecosystems defined by the CART site. Common species found in the seven counties containing the proposed sites include badger, beaver, black-tailed jackrabbit, coyote, deer, fox, house mouse, opossum, quail, and red-eared turtle.

2.5.1 Vegetation and Wildlife

2.5.1.1 Grant County, Oklahoma, Central Facility

Originally mixed-grass prairie, most of the land in Grant County is cultivated or dedicated to livestock production. The mixed-grass prairie ecosystem is characterized by tallgrass, shortgrass, and intermediate-height species, (Jones et al., 1985). Tallgrass varieties occurring in the county (USDA, 1985) include big bluestem (*Andropogon gerardi*), switchgrass (*Panicum virgatum*), and indiangrass (*Sorghastrum nutans*). Blue grama (*Bouteloua gracilis*), is a shortgrass species that grows in Grant County. Native trees and shrubs, though relatively sparse in this county, include blackjack oak (*Quercus marilandica*), cottonwood, green ash, and American elm. Eastern red cedar (*Juniperus virginiana*), Russian olive, and Austrian pine have been introduced in the county for use in windbreaks. Windbreaks shield livestock, buildings, gardens, and fruit trees from the effects of high wind and snow.

The Oklahoma Natural Heritage Inventory, a component of the Oklahoma Biological Survey, identified 54 animal species likely to occur in Grant County. The badger, beaver, bull snake, eastern cottontail rabbit, Great Plains toad, house mouse, and yellow mud turtle were among the common species identified (Butler, 1991). Common bird species include the mourning dove, barn owl, belted kingfisher, and American crow (Peterson, 1980).

2.5.1.2 McClain County, Oklahoma, Boundary Facility

Oak savannah and mixed-grass prairie can be found in McClain County. Post oak (*Quercus stellata*) and blackjack oak dominate the woodland regions of the savannah (Jones et al., 1985). Species of vegetation inhabiting the county include big bluestem, blue grama, silver bluestem, and indiangrass.

Wildlife species occurring in the county include beaver, bobcat, coyote, fox squirrel, raccoon, red-tailed hawk, redwing blackbird, and two types (timber and western diamondback) of rattlesnake. Over 75 species of vertebrates occur in the county (Butler, 1991).

2.5.1.3 Okmulgee County, Oklahoma, Boundary Facility

The Oak-Hickory Woodlands ecosystem, which includes prairie grasslands, is prevalent in Okmulgee County. The hardwood forests in such an ecosystem are dominated by oak-hickory (*Quercus-Carya*) species (Jones et al., 1985). Bermuda grass (*Cynodon dactylon*), Korean lespedeza (*Lespedeza stipulacae*), broomsedge bluestem (*Andropogon virginicus*), and sudan grass are among the vegetation types found in the county (USDA, 1968).

The bull snake, collared lizard, deer mouse, gray squirrel, mink, plains pocket gopher, prairie king snake, red fox, and opossum represent some of the animal species occurring in

Okmulgee County (Butler, 1991). Bird species found in the county include the brown-headed cowbird, northern mockingbird, European starling, and house sparrow (Peterson, 1980).

2.5.1.4 Woodward County, Oklahoma, Boundary Facility

Woodward County is located in an area of vast mixed-grass prairie, broken up occasionally by sandsage prairie. Native grasses in the mixed-grass prairie consist primarily of bluestem species. Sand sagebrush (*Artimisia filifolia*) is the dominant grass species in the sandsage prairie (Jones et al., 1985). Native trees that can be found along streams and in some upland areas include blackjack oak, cottonwood, elm, hackberry, and willow (USDA, 1963). Eastern red cedar, ponderosa pine, sycamore, and Siberian elm have been used in windbreaks.

The least shrew, northern grasshopper mouse, and spotted ground squirrel are most likely to occur in the regions of Woodward County that support a sandsage prairie ecosystem. Other species occurring in the county include the big brown bat, bobcat, common snapping turtle, coyote, Great Plains toad, raccoon, and river otter (Butler, 1991).

2.5.1.5 Kiowa County, Kansas, Boundary Facility

Vegetation species occurring in Kiowa County are typical of the mixed-grass ecosystem that is prevalent in western Kansas. Broomweed, goldenrod, indiangrass, switchgrass, wheatgrass, and several varieties of bluestem grass are native to the county (USDA, 1986). American elm, black walnut, black willow, cottonwood, green ash, and Russian mulberry grow in scattered, relatively narrow tracts, usually along rivers and streams. For windbreaks, eastern red cedar and Siberian elm are the most commonly used species. Buckbrush, dogwood, plum, and prairie rose are examples of the county's native shrubs.

Various kinds of wildlife are attracted to the mixed-grass vegetation commonly found in Kiowa County. Larger mammals occurring in the rangeland habitat include, coyotes, mule deer, and pronghorn (Jones et al., 1985). Bobwhite quail, meadowlark, mourning dove, pheasant, and field sparrow represent some of the bird species found in the county.

2.5.1.6 Marion County, Kansas, Boundary Facility

Noncrop vegetation in Marion County consists chiefly of tallgrass prairie species. Big bluestem, little bluestem, indiangrass, and switchgrass can be found in areas where managed grazing but no overgrazing has occurred. Buffalograss, blue grama, and sideoats grama are common in overgrazed areas (USDA, 1983). Native wooded areas of the county occur along upland drainages and along rivers and streams. Common species include American elm, black walnut, black willow, box elder, honey locust, Kentucky coffee tree, and silver maple. Windbreaks usually consist of eastern red cedar and Siberian elm.

The tallgrass habitat found in Marion County supports a variety of animal life, including the bobwhite quail, cottontail rabbit, field sparrow, meadowlark, and pheasant. White-tailed deer, wild turkey, opossum, owl, raccoon, and squirrel frequent the county's woodlands. The badger, jackrabbit, killdeer, and prairie chicken are attracted to Marion County's rangeland (USDA, 1983).

2.5.1.7 Montgomery County, Kansas, Boundary Facility

Montgomery County, located in a region referred to as Cross Timbers, contains both oak savannah and tallgrass prairie ecosystems (Jones et al., 1985). Approximately 40% of the county consists of various types of cropland (USDA, 1980). Big bluestem, goldenrod, indiangrass, ragweed, switchgrass, and wheatgrass are but a few of the native vegetation species occurring in the county. Woodland areas occupy approximately 10% of the land in the county. Species native to upland regions include ash, hackberry, blackjack oak, and post oak. Black walnut, hickory, red oak, pin oak, white oak, pecan, sycamore, and maple are common along rivers and streambeds.

Wildlife occurring in the wooded habitats of Montgomery County include white-tailed deer, opossum, squirrels, owls, hawks, and woodpeckers. Killdeer, jackrabbits, hawks, and dickcissels can be found in the county's rangeland habitat (USDA, 1980). Cottontail rabbit, meadowlark, field sparrow, and red fox frequent the tallgrass prairie.

2.5.2 Threatened and Endangered Species

Consultation with the Kansas and Oklahoma offices of the U.S. Fish and Wildlife Service (FWS) revealed that several federally listed threatened and endangered species have been seen or may occur in the seven counties under consideration for the ARM Program's central and boundary facilities (see Table 2.2). In Oklahoma, the piping plover (*Charadrius melodus*) and least tern (*Sterna antillarum*) are seasonal migrants associated with unvegetated wetlands and streams (Gill, 1991a). Their habitat exists in all four of the Oklahoma counties containing proposed and alternative sites. The bald eagle (*Haliaeetus leucocephalus*) can occur in river and lake habitats (usually in winter) that exist in the Oklahoma counties examined in this assessment. While the peregrine falcon (*Falco peregrinus*) is an uncommon migrant to Oklahoma, its habitat (water bodies, wetlands, cropland, and grasslands) occurs in each of the four counties. The prairie mole cricket (*Gryllotalpa major*), currently under consideration for threatened status, has been seen in McClain and Okmulgee Counties (Forsythe, 1991b). No federally listed plants occur in the Oklahoma counties containing the proposed central or boundary sites.

The three counties in Kansas (Kiowa, Marion, Montgomery) that contain proposed and alternative boundary facility sites provide potential habitats for eight federally listed threatened or endangered animal species. Six of these species (bald eagle, whooping crane, peregrine falcon, least tern, piping plover, prairie mole cricket) are among those that potentially occur in the four Oklahoma counties identified. The black-footed ferret (*Mustela nigripes*) is associated with prairie dog towns that can occur in Kiowa County. However, the Kansas office of FWS indicated that no sightings of the black-footed ferret have ever been reported in the county (FWS, 1992). The

Table 2.2 Federally Listed Threatened and Endangered Species Occurring or Potentially Occurring in the Counties Containing Central or Boundary Facility Sites

State	Scientific Name	Common Name	Status
Oklahoma[a]	*Falco peregrinus*	Peregrine falcon	Endangered
	Haliaeetus leucocephalus	Bald eagle	Endangered
	Grus americana	Whooping crane	Endangered
	Sterna antillarum	Least tern	Endangered
	Charadrius melodus	Piping plover	Threatened
	Gryllotalpa major	Prairie mole cricket	Threatened
Kansas[b]	*Falco peregrinus*	Peregrine falcon	Endangered
	Haliaeetus leucocephalus	Bald eagle	Endangered
	Grus americana	Whooping crane	Endangered
	Sterna antillarum	Least tern	Endangered
	Mustela nigripes	Black-footed ferret	Endangered
	Charadrius melodus	Piping plover	Threatened
	Noturus placidus	Neosho madtom	Threatened
	Gryllotalpa major	Prairie mole cricket	Threatened

[a] Source: U.S. Fish and Wildlife Service Oklahoma Office.
[b] Source: U.S. Fish and Wildlife Service Kansas State Office.

Neosho madtom (*Noturus placidus*), a small catfish favoring shallow gravel bottoms, can be found in the Cottonwood River, which flows through a portion of Marion County (Gill, 1991a). No federally listed plant species were reported in Kiowa, Marion, or Montgomery Counties.

No official surveys for federally listed threatened and endangered plant or animal species have been conducted in any of the quarter sections that would contain the central or a boundary facility. A listing of FWS Candidate 1 and 2 species that can occur in the seven counties containing the proposed site and its alternatives appears in Appendix F. Candidate 1 species have the potential for an official federal listing by FWS; Candidate 2 species are those for which the FWS is collecting data in order to determine their biological status.

2.6 Land Use

Land use in the seven counties containing the proposed action and its alternatives is dominated by agriculture, particularly cropland, pasturage, and rangeland. Farmland accounts for over 90% of the land in Grant (Oklahoma) and Marion (Kansas) Counties. Urban land uses account for less than 5% of the land in each of the seven counties. None of the proposed and alternative facility sites is governed by zoning regulations or other land use controls. Most of the counties containing the proposed and alternative facility sites have yet to develop comprehensive plans or future land use maps. Only the Grant County and McClain County (Oklahoma) sites are located within ten miles of a major transportation artery (Interstate 35). None of the proposed and alternative facility sites are located in or near areas of existing or proposed residential development. Existing land use maps of the area immediately surrounding each proposed boundary facility (and the alternatives) appear in Appendix G. Table 2.3 summarizes the proportion of agricultural land and woodland in each of the counties containing a proposed or alternative facility.

2.6.1 Grant County, Oklahoma, Central Facility

The proposed and alternative sites for the project's central facility are located in the extreme southeastern corner of Grant County, Oklahoma, in the northern part of the state, approximately seven miles southeast of the small town of Lamont (pop. 454). Billings (pop. 555), in neighboring Garfield County, is located five miles to the southeast. The Salt Fork of the Arkansas River winds in an east-west orientation approximately three miles to the north of the proposed and

Table 2.3 Agriculture in Counties Containing Proposed and Alternative Facility Sites in 1987

County (State)	Land Area (acres)	Land in Farms (%)	Land in Woodland (%)
Grant (Oklahoma)[a]	642,739	90.7	0.5
McClain (Oklahoma)[a]	372,179	72.9	2.5
Okmulgee (Oklahoma)[a]	446,425	55.9	6.0
Woodward (Oklahoma)[a]	794,848	86.1	0.6
Kiowa (Kansas)[b]	462,572	84.8	0.01
Marion (Kansas)[b]	604,243	95.6	2.5
Montgomery (Kansas)[b]	413,292	79.2	10.0

[a] Source: USBC, 1987a.
[b] Source: USBC, 1987b.

alternative sites. The sites can be reached by county section roads, most of which are unpaved. Major transportation arteries in the area include U.S. Highway 60, running east-west six miles north of the proposed facility site, and Interstate 35, a north-south route located approximately eight miles east.

Agriculture is the dominant land use in Grant County. Over 90% of the land is dedicated to farming. Agricultural uses include cropland and rangeland for pasturage. Wheat accounted for most of the cultivated crop in recent years. USDA-designated prime farmland accounts for 71% (457,000 acres) of the soils found in the county (USDA, 1985). The county has not yet developed a comprehensive plan, and no zoning controls exist in the immediate vicinity of the proposed site and its alternatives (Shaffer, 1991).

Land use in the immediate vicinity of the proposed and alternative sites for the central facility is almost exclusively agricultural (see Fig. 2.1), consisting of cropland, pasture, and rangeland. Over 75% of the soils in the quarter sections containing the proposed and alternative sites are considered prime. Small woodland tracts can be found a few miles north of the proposed facility site, along the Salt Fork of the Arkansas River.

2.6.2 McClain County, Oklahoma, Boundary Facility

The proposed and alternative sites for the McClain County boundary facility are located in the south central portion of the county, amid rolling and hilly topography, approximately 35 miles south of Oklahoma City and 8 miles southwest of Purcell. Interstate 35 runs north-south through Purcell, and the Canadian River flows another mile east of the interstate. The sites can be accessed by county section roads that are typically unpaved.

Agriculture is the major land use in McClain County. Almost 73% of the land is in farmland (USDA, 1979). Abandoned cropland used for grazing and rangeland account for most of the remaining land in the county. Crops produced within the county include wheat, sorghum, cotton, soybeans, and peanuts (USBC, 1987a). No zoning controls exist for the portion of the county containing the proposed and alternative sites.

Land use in the immediate vicinity of the proposed and alternative sites comprises pasture and rangeland, scattered tracts of woods, and an occasional cultivated field (see Appendix G). Evidence of past activity related to oil extraction operations exists on a parcel of land approximately two miles south and west of the proposed site, and an oil derrick is located on the south side of state Highway 24, two miles southeast of the proposed site. A pipeline that runs northwest-southeast passes within a few meters of the southwestern corner of the quarter section containing Alternative 1. Another pipeline, having a north-south orientation, passes within 0.75 miles of the eastern edge of the quarter section containing the proposed site. NOAA profiler equipment is located in the quarter section containing the proposed facility site.

2.6.3 Okmulgee County, Oklahoma, Boundary Facility

The proposed boundary site and its alternatives are located on gently rolling terrain in the northeast corner of Okmulgee County, 6 miles west of Haskell, Oklahoma, and approximately 20 miles south of Tulsa. The Arkansas River is located approximately 8 miles north of the proposed and alternative sites. It also passes 7 miles to the east. The sites can be reached from county section roads, most of which are unpaved.

Agriculture and woodlands are the prevalent land uses in the county. Wheat, soybeans, sorghum, alfalfa, small grains, and livestock are the primary products (USBC, 1987a). No zoning restrictions apply to the land in or around the proposed site or its alternatives.

The land in the immediate vicinity of the proposed site is dominated by woodland, rangeland, pasture, and some cultivated crops (see Appendix G). A large area of woodland stretches to the north and west of the proposed and alternative sites. Single-family residences are scattered throughout the area surrounding the proposed and alternative sites. An electrical power transmission line running in a northwest-southeast direction, passes approximately 1.5 mi north of the proposed site. A pipeline with a northwest-southeast orientation runs approximately two miles south of the proposed site. NOAA profiler equipment is located in the quarter section immediately east of the proposed site.

2.6.4 Woodward County, Oklahoma, Boundary Facility

The proposed and alternative sites for the Woodward County boundary facility are located in an area of rolling rangeland on the southern edge of the county, two miles northwest of the town of Vici, in the northwestern part of Oklahoma. The Dewey County line is 0.25 miles south of the proposed site. The Canadian River flows approximately ten miles south. The proposed and alternative sites can be accessed from U.S. Highway 60, 1.5 miles south, or state Highway 34, 1.5 miles east.

Agriculture dominates land use in the county, with 86% of the county's land area dedicated to farming. The county's principal agricultural products include wheat, sorghum, alfalfa and small grains, sheep, poultry, and cattle (USBC, 1987a). Recreational opportunities in the county can be found in Boiling Springs State Park, located approximately 20 miles north of the proposed facility. No zoning restrictions exist for the portion of the county containing the proposed and alternative sites.

Rangeland and pasture are the dominant land uses in the immediate vicinity of the proposed and alternative sites (see Appendix G). Some scattered wooded tracts lie within a mile of the proposed site, and larger areas of woodland are within 1-3 miles southwest and northeast of the proposed site. Some prime soil is in the quarter section containing Alternative 2. A pipeline running east-west is located approximately 2.5 miles south of the quarter sections containing the proposed and alternative sites.

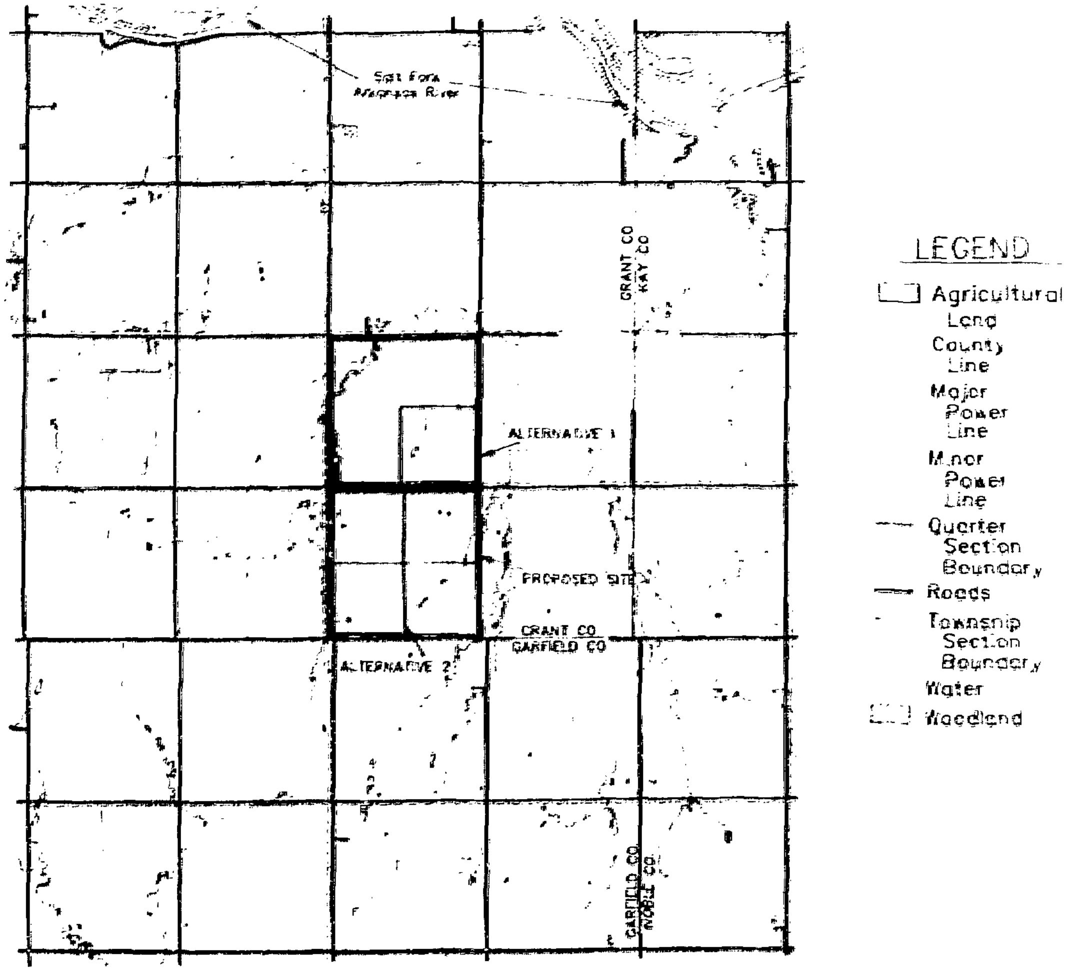

Figure 2.1 Existing Land Use in the Immediate Vicinity of the Proposed Action And its Alternatives (Central Facility, Grant County, Oklahoma)

2.6.5 Kiowa County, Kansas, Boundary Facility

Located in south central Kansas, the proposed and alternative boundary facility sites sit on relatively flat terrain in the northeast corner of Kiowa County, Kansas. The town of Haviland is located two miles south of the proposed facility site. U.S. Highway 54 runs through Haviland in a westerly direction toward the town of Greensburg, approximately ten miles to the west of the proposed and alternative sites. The Rock Island and Pacific Railroad line runs just north of and parallel to U.S. Highway 54. The Pratt Sandhills State Wildlife Area is in Pratt County, directly across Kiowa County's eastern border. The proposed and alternative sites can be reached from county section roads.

As the dominant land use in Kiowa County, agriculture accounts for almost 85% of the land (USBC, 1987b). Agricultural uses include cropland and rangeland for pasturage. Wheat, sorghum, corn, soybeans, and alfalfa are the chief crops produced, and beef cattle, hogs, and pigs account for most of the livestock produced. Nearly 42% (193,000 acres) of the county is considered prime farmland (USDA, 1986). The Kiowa County State Park is located immediately northwest of Greensburg. The county has not yet developed a comprehensive plan, and no zoning controls exist in the parcels containing the proposed facility and its alternatives.

Center-pivot-irrigated cropland, pasture, rangeland, scattered tree lines, Conservation Reserve Program (CRP) native grass, and urban areas (Haviland) make up the land use in the immediate vicinity of the proposed and alternative sites (see Appendix G). No prime soil is in the parcels containing the proposed and alternative sites. A pipeline running from the southwest to the northeast passes under the quarter section containing the proposed site and under the northwest corner of the quarter section containing Alternative 1. Another pipeline is located 0.5 miles north of the proposed and Alternative 1 site.

2.6.6 Marion County, Kansas, Boundary Facility

The proposed boundary facility is comprised of two parcels of land in southwestern Marion County, Kansas, in an area of gently to moderately sloping topography. The larger parcel (100 acres) is located four miles south of the town of Lehigh (see Appendix G). The smaller parcel (1.75 acres), which would contain the RASS, is located approximately two miles south of Lehigh. The city of Hillsboro is four miles to the east of the proposed site. An Atchison, Topeka, and Santa Fe rail line enters Lehigh from the west, passes within 0.5 miles of Alternative 2, and continues east into Hillsboro and Marion. The South Cottonwood River flows approximately one mile north of the proposed site. The proposed and alternative sites can be reached from U.S. Highway 56, which runs east-west 0.5 miles south of Lehigh, and from state Highway 15, a north-south route that passes two miles to the west of the proposed and alternative sites.

Over 95% of Marion County's land is dedicated to agricultural land uses (USBC, 1987b). Approximately 60% (680) of the 1,119 farms in Marion County produced beef and dairy cattle in 1987. Crops produced in the county included wheat, sorghum, corn, soybeans, oats, and alfalfa. Over 75% (465,000 acres) of Marion County soils are considered prime (USDA, 1983). Recreational land uses in the county include Marion Lake and the Marion Lake State Wildlife Area.

located approximately ten miles northeast of the proposed site. The county recently adopted a resolution to form a planning and zoning commission and begin the process of developing a comprehensive plan in the spring of 1992. Presently, no existing zoning regulations affect the proposed and alternative sites.

Land use in the immediate vicinity of the proposed and alternative facility sites consists of pasture, rangeland, scattered trees, and urban areas (Lehigh and Hillsboro). Almost all of the land reserved for the proposed and alternative sites is considered prime. NOAA profiler equipment is located in the southern end of the quarter section containing the proposed site.

2.6.7 Montgomery County, Kansas, Boundary Facility

Montgomery County, Kansas, is located in the southeastern portion of the state, directly north of the Oklahoma state line. The proposed and alternative boundary facility sites are located in the northeastern part of the county, in quarter sections directly south of the Wilson County (Kansas) border. The city of Neodesha is located approximately 3 miles northwest of the proposed and alternative sites, and Cherryvale lies approximately 8 miles southeast. Coffeyville, the county's largest city, is located 23 miles south of the proposed and alternative sites. The Verdigris River flows 1.5 miles west of the proposed site. The St. Louis-San Francisco rail line, which runs in a southeasterly direction from Neodesha to Cherryvale, passes within 1.5 miles of the proposed and alternative sites. The Missouri-Pacific rail line passes approximately 2 miles to the west of the proposed site and heads north into Neodesha. The proposed and alternative sites can be accessed by state Highway 96, 3 miles to the west of the sites, and from state Highway 37, which runs east from Neodesha before it turns south and passes within 2 miles of the proposed site.

Agriculture dominates land use in Montgomery County. Almost 80% of the county is comprised of farms (USBC, 1987b). Principal crops include alfalfa, sorghum, soybeans, and wheat. Over 700 of the county's 974 farms sold cattle and calves in 1987. Recreational land uses in the county include Elk City Lake, Elk City State Park, and the Elk City State Wildlife Area, a contiguous network of recreational areas located approximately 10 miles southwest of the proposed and alternative sites. Big Hill State Wildlife Area and Big Hill Lake are located approximately 12 miles southeast of the proposed site. The county has no comprehensive plan or zoning body. No land use controls apply to the area surrounding the proposed site and its alternatives.

Land use in the immediate vicinity of the proposed and alternative sites (see Appendix G) consists of cropland, pasture, rangeland, scattered tracts of woods, and an urban area (Neodesha). Approximately 20% of the land reserved for the proposed facility is considered prime (SCS, 1991). NOAA profiler equipment is located on the western edge of the quarter section containing the proposed facility site.

2.7 Visual Resources

An inventory of the visual resources of an area is necessary to determine the inherent qualities of the landscape and to establish levels of intrusion that a given action or project may introduce to sensitive receptor areas. Examples of sensitive receptor areas include residential developments, major roads, schools, parks, natural areas and trails, unique landforms (bluffs, overhangs, ledges, etc.), and shorelines. Components of a landscape include vegetation, landform, water, and man-made structures (USDA, 1985). Landscapes can be categorized (high, medium, low) for visual diversity according to such criteria as vegetation type, height, color and distribution pattern; water clarity and shoreline definition; landform type and height; and the compatibility of man-made structures with the existing landscape. A landscape set on a mountain ridge that towers over a valley containing a clear, meandering stream and is surrounded by meadow grasses and woodlands, with no visible man-made structures, would have high visual diversity.

Viewing proximity zones, which are measurements of distance between a viewer and an object, establish parameters for analysis of visual resources. The foreground proximity zone ranges from 0 to 1/4 mile; the middleground zone ranges from 1/4 to 2 miles; and the background zone consists of views from between 2 and 5 miles (and beyond).

Most of the sites containing the proposed and alternative facilities are located in areas of relatively low to medium visual diversity.

2.7.1 Grant County, Oklahoma, Central Facility

The proposed and alternative facilities are located in an area of low visual diversity. The topography is gently rolling to flat, with few hills or distinctly contrasting landforms visible. The vegetation pattern is characteristic of the cropland and rangeland that dominates the county. There is some diversity in height but little in color. Trees and shrubs are scattered across the horizon, and no water features are visible in the any of the viewing proximity zones surrounding the proposed site. The primary sensitive viewers consist of residents in homes and farmsteads scattered throughout a five-mile radius around the proposed site. The nearest town (Billings) is five miles away. No unique views or vistas are apparent in the vicinity of the proposed facility. Photographs of the proposed action that were taken from within the foreground and middleground viewing proximity zones appear in Appendix H.

2.7.2 McClain County, Oklahoma, Boundary Facility

The McClain County proposed and alternative sites are set in an area of medium visual diversity. The local topography is dominated by low, rounded hills and several drainages (Finn, Wildcat, and Wolf creeks) of the Washita River. Some of these drainages are steep, in contrast to the surrounding rolling landforms. Some uncommon viewpoints and vistas are located on the highest points of the hills near the proposed and alternative sites. Several man-made structures (communication, water, and oil industry towers) are visible from viewpoints surrounding the proposed site. Travelers on state Highway 24 and residents of the homes and farmsteads scattered in a five-mile radius around the proposed site would be the primary sensitive viewers.

Appendix H contains foreground and middleground views of the proposed facility. The middleground views were taken from state Highway 24, at a point approximately two miles east-northeast of the proposed site.

2.7.3 Okmulgee County, Oklahoma, Boundary Facility

The topography in the immediate vicinity of the Okmulgee County proposed and alternative sites is gently rolling. Wooded hills rise to the west. Landform and vegetation are generally uniform, with little diversity in height and color. No major water features are visible in the area surrounding the proposed site. Several towers from an electrical power transmission line that runs approximately two miles northeast of the proposed site are visible from points around the proposed and alternative sites. An NOAA meteorological tower, located in the section containing the proposed site, is visible from only a few points beyond the foreground viewing proximity zone. The primary sensitive viewers would be the residents of the scattered homes and farmsteads surrounding the proposed and alternative sites.

2.7.4 Woodward County, Oklahoma, Boundary Facility

The landscape of the area containing the proposed and alternative sites in Woodward County consists of gently rolling topography dominated by rangeland and pasture vegetation that has some variation in type, height, and color. Variety in landform is limited, and no water features are visually obvious. Sensitive viewers would include residents of Vici (approximately two miles southeast of proposed site), travelers on state Highway 34 and U.S. Highway 60, and people in the scattered residences and farmsteads that surround the proposed and alternative sites.

2.7.5 Kiowa County, Kansas, Boundary Facility

The landscape surrounding the proposed and alternative sites in Kiowa County can be described in terms of low visual diversity. Although some variety exists in vegetation type, size, and color, landforms are uniform, and no water bodies of particular visual interest are in the area. A meteorological tower operated by the NOAA is located within 1.5 miles of the proposed site, and a communications tower rises above the southern edge of Haviland. Both structures are visible from viewpoints surrounding the proposed and alternative sites. Travelers on U.S. Highway 54 (two miles south of proposed site) and residents of Haviland would be the primary sensitive viewers.

2.7.6 Marion County, Kansas, Boundary Facility

The landscape containing the proposed and alternative sites in Marion County is dominated by rolling topography of limited variation and an agricultural vegetative cover of medium diversity in type, height, and color. Tree lines and isolated trees can be found in randomly scattered patterns throughout the area surrounding the proposed site. Steep inclines associated with Stony Brook (immediately south of the proposed site) and the South Cottonwood River (approximately one mile north) may offer visual diversity. Marion Lake and the contiguous Marion Lake State Wildlife Area are beyond background viewing range. A NOAA meteorological tower, located in the section containing the proposed facility, is visible in the foreground and middleground viewing proximity zone. The primary sensitive viewers would include travelers along U.S. Highway 56 and residents of Lehigh and Hillsboro.

2.7.7 Montgomery County, Kansas, Boundary Facility

The landscape setting of the area containing the proposed and alternative sites in Montgomery County has some visual diversity. The vegetation cover, predominantly agricultural, varies only slightly in color and height. The gently rolling topography of the region, though mostly uniform, is interrupted by the steep drainages of the nearby (1.5 miles west) Verdigris River. The areas with the highest potential for viewing diversity, Elk City State Park, Elk City State Wildlife Area, and Big Hill Lake, are located beyond the proposed site's background viewing range. An NOAA meteorological tower is located in the section containing the proposed site and is visible within the foreground and middleground viewing proximity zones. Primary sensitive viewers would include residents of Neodesha and travelers along state Highway 37 (two miles east).

2.8 Cultural Resources

Archeological, cultural, and historical resources are protected under the National Historic Preservation Act (16 U.S.C. 470 et seq.); Executive Order 11593, *Protection and Enhancement of the Cultural Environment*; the Archeological and Historic Preservation Act of 1974 (16 U.S.C. 469-469c); the Archeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470ll); and the Historic Sites, Buildings and Antiquities Act (16 U.S.C. 461-467). Federal agencies must provide an opportunity for comment and consultation with the appropriate state historic preservation officer (SHPO) when an action has the potential to affect cultural sites.

The Oklahoma and Kansas State Historic Preservation Offices have determined that no archeological sites or historic structures listed on the National Register of Historic Places or the respective state inventories exist in the areas that would be affected by the proposed site or its alternatives (Pankrantz, 1991; Gettys and Brooks, 1991). A list of structures and sites appearing on the National Register of Historic Places that are located in the counties containing the proposed central and boundary sites is presented Appendix I.

2.8.1 Grant County, Oklahoma, Central Facility

The Oklahoma SHPO determined that no archeological surveys would be necessary for the central facility sites and that no archeological sites or historic structures listed on the National Register of Historic Places or state inventories exist in the quarter sections in Grant County containing the proposed site or its alternative sites (see Appendix D).

2.8.2 McClain County, Oklahoma, Boundary Facility

The SHPO reported a potential for prehistoric archeological resources at the McClain County boundary facility site and subsequently conducted an archeological survey of the site and its alternatives. The state archeologist reported no prehistoric materials and concluded that no historic features would be disturbed during construction and operation of the proposed boundary facility. No archeological sites or historic structures listed on the National Register of Historic Places or state inventories are located in the parcels of land containing the proposed site or its alternative sites.

2.8.3 Okmulgee County, Oklahoma, Boundary Facility

The SHPO determined that no archeological surveys would be necessary for the proposed boundary facility or its alternatives in Okmulgee County and that no archeological sites or historic structures listed on the National Register of Historic Places or state inventories exist in the quarter sections containing the proposed site or the alternative sites.

2.8.4 Woodward County, Oklahoma, Boundary Facility

Oklahoma's SHPO determined that no archeological surveys would be necessary for the proposed boundary facility or its alternative sites in Woodward County. No archeological sites or historic structures listed on the National Register of Historic Places or state inventories exist in the quarter sections containing the proposed site or the alternative sites.

2.8.5 Kiowa County, Kansas, Boundary Facility

The Kansas SHPO indicated that no archeological surveys are necessary for the proposed site or its alternative sites in Kiowa County. None of the quarter sections containing these sites have archeological sites or historic structures listed on the National Register of Historic Places or state inventories.

2.8.6 Marion County, Kansas, Boundary Facility

The Kansas SHPO reported that the lower elevations along Stony Brook in the Marion County proposed boundary facility site have the potential for archeological resources. No archeological sites or structures appearing on the National Register of Historic Places or state inventories were found in parcels containing the proposed site or its alternative sites.

2.8.7 Montgomery County, Kansas, Boundary Facility

The Kansas SHPO determined that no archeological surveys would be necessary for the proposed facility site (and its alternatives) in Montgomery County and that no archeological sites or historic structures listed on the National Register of Historic Places or state inventories are located in the quarter sections containing the proposed site or its alternative sites.

2.9 Socioeconomics

The seven counties examined in this analysis are predominantly rural. Except for the proposed and alternative boundary facility sites in Montgomery County (Kansas), none of the sites are located within ten miles of a town or city exceeding 5,000 people. Population in the seven counties for 1990 (see Table 2.4) ranged from 4,046 in Kiowa County (Kansas) to 42,281 in Montgomery County (Kansas). All of the counties except McClain County (Oklahoma) experienced population declines between 1980 and 1990. The most current (August 1991) labor force and unemployment data were used for this analysis. The unemployment rates in the seven counties (see Table 2.5) as of August 1991 ranged from 3.3% in Kiowa County to 9.0% in Okmulgee County (Oklahoma). All of the counties under examination for this study have exhibited trends of increasing unemployment over 1990 totals.

Table 2.4 Population and Growth Rates in Counties Containing Proposed and Alternative Facility Sites, 1980-1990

County (State)	1980 Population[a]	1990 Population[b]	Change 1980-1990 (%)
Grant (Oklahoma)	6,518	5,689	-12.7
McClain (Oklahoma)	3,291	22,795	12.3
Okmulgee (Oklahoma)	39,169	36,490	-6.8
Woodward (Oklahoma)	21,172	18,976	-10.3
Kiowa (Kansas)	4,046	3,660	-9.5
Marion (Kansas)	13,522	12,888	-4.6
Montgomery (Kansas)	42,281	38,816	-8.1

[a] Source: USBC, 1988.
[b] Source: USBC, 1990a; USBC, 1990b.

Table 2.5 Labor Force and Unemployment in Counties Containing Proposed and Alternative Facility Sites, August 1991 (BLS, 1991)[a]

County (State)	Labor Force	Unemployment Rate (%) 1990	August 1991
Grant (Oklahoma)	2,996	3.3	4.1
McClain (Oklahoma)	11,016	5.3	5.7
Okmulgee (Oklahoma)	14,369	8.2	9.0
Woodward (Oklahoma)	9,780	4.8	6.6
Total Oklahoma	-	5.5	6.2
Kiowa (Kansas)	1,852	2.1	3.3
Marion (Kansas)	6,186	3.2	3.6
Montgomery (Kansas)	18,284	5.9	6.7
Total Kansas	-	4.4	4.8

[a] Data for August 1991 were the most current data available as of December 1991.

2.9.1 Grant County, Oklahoma, Central Facility

Grant County occupies 1,000 square miles and had a 1990 population of 5,689 (USBC, 1990a). With a 1990 population density of 5.7 people per square mile, this predominantly rural county experienced a 12.7% decline in its population between 1980 and 1990 (USBC, 1990a). Medford, the county seat, is located approximately 20 miles northwest of the proposed facility site and had a 1990 population of 1,172. Cities and towns near the proposed facility and their 1990 populations include Billings (5 miles south in Kay County), 555; Lamont (7 miles northwest), 454; and Tonkawa (11 miles northeast in Kay County), 3,127. The largest city within 50 miles of the proposed facility site is Enid (population 45,308), in nearby Garfield County.

In August 1991, a labor force of 2,996 was reported in Grant County (BLS, 1991). The unemployment rate in Grant County for the same period was 4.1%. The unemployment rate in the state of Oklahoma during August of 1991 was 6.2%.

2.9.2 McClain County, Oklahoma, Boundary Facility

McClain County, which is predominantly rural, experienced a 12.3% increase in population during the 1980s. Its 1990 population was 22,795 (USBC, 1990a). The county covers an area of 569 square miles and had a population density of 40 people per square mile in 1990. Purcell, the county seat, is located eight miles northeast of the proposed facility site and had 4,760 residents in 1990. Cities and towns within 15 miles of the proposed facility site include Purcell; Lindsay (approximately 10 miles southwest in Garvin County), with a 1990 population of

2,947; Maysville (approximately 12 miles southeast in Garvin County), with a 1990 population of 1,203; and Wayne (approximately 12 miles east-southeast), with a 1990 population of 519.

In August of 1991, 11,016 people were employed in McClain County, and the unemployment rate was 5.7% (BLS, 1991).

2.9.3 Okmulgee County, Oklahoma, Boundary Facility

Okmulgee County had a 1990 population of 36,490 and a population density of 52.5 people per square mile (USBC, 1990a). Its population declined by 6.8% during the 1980s. The city of Okmulgee, located approximately 15 miles southwest of the proposed facility site, serves as the county seat. Its 1990 population was 13,441. In addition to Okmulgee, cities and towns within 15 miles of the proposed facility site and their 1990 populations include Haskell (6 miles east in Muskogee County), 2,143; Bixby (approximately 11 miles northwest in Tulsa County), 5,501; and Coweta (approximately 12 miles northeast in Wagoner County), 6,159.

The labor force in Okmulgee County was 14,369 in August 1991 (BLS, 1991). During the same month, the county experienced an unemployment rate of 9.0%.

2.9.4 Woodward County, Oklahoma, Boundary Facility

Woodward County, with a 1990 population of 18,976 (USBC, 1990a), is the largest (1,242 square miles) of the seven counties considered in this study. Its predominantly rural population declined by 10.3% during the 1980s. Population density in the county was 15.3 people per square mile in 1990. The city of Woodward, located approximately 18 miles north of the proposed facility site, serves as the county seat. The city had 12,340 residents in 1990. Vici, with a 1990 population of 751, is the nearest town (2 miles southeast) to the proposed facility site. No towns or cities within 15 miles of the proposed site have populations of more than 500.

Over 9,700 people were employed in Woodward County in August 1991, when the unemployment rate was 6.6% (BLS, 1991).

2.9.5 Kiowa County, Kansas, Boundary Facility

Kiowa County had 4,046 residents in 1990 (USBC, 1990b). The population of this rural county declined during the 1980s by 9.5%. With a total area of 722 square miles, the county had a population density of 5.1 people per square mile in 1990. The county seat is Greensburg, located approximately 11 miles southwest of the proposed site. The town had 1,792 people in 1990. The city or town closest to the proposed facility is Haviland (1.5 miles south), with a 1990 population of 624. Combined, these two urban areas make up almost 60% of the entire population in the county.

Kiowa County had a labor force of 1,852 and an unemployment rate of 3.3% in August 1991 (BLS, 1991). The state of Kansas experienced an unemployment rate of 4.8% during the same month.

2.9.6 Marion County, Kansas, Boundary Facility

Predominantly rural, Marion County had a 1990 population of 13,522 (USBC, 1990b). The county covers 943 square miles and had 13.7 people per square mile in 1990 Located approximately 14 miles east of the proposed site, the county seat of Marion had a 1990 population of 1,906. Cities and towns within ten miles of the proposed site, along with their 1990 populations, include Lehigh (two miles northwest), 180; Hillsboro (four miles east), 2,704; and Canton, in McPherson County (seven miles northwest), 794.

In August of 1991, 6,186 people were employed in Marion County, and the unemployment rate was 3.6% (BLS, 1991).

2.9.7 Montgomery County, Kansas, Boundary Facility

Montgomery County had a 1990 population of 42,281 (USBC, 1991b). Occupying 645 square miles and mostly rural, the county had a 1990 population density of 60.2 people per square mile. The largest city in the county is Coffeyville (approximately 25 miles south of proposed site), with a 1990 population of almost 12,917. Independence, the county seat, is located approximately 9 miles southwest of the proposed site and had 9,942 residents in 1990. In addition to Independence, cities and towns within 15 miles of the proposed site include Neodesha (2.5 miles northwest in Wilson County), with a 1990 population of 2,834, and Cherryvale (7 miles southeast), with 2,464 people in 1990.

In August 1991, Montgomery County had a labor force of 18,284 and an unemployment rate of 6.7% (BLS, 1991).

3 Environmental Impacts of Proposed Action and Alternatives

This chapter will provide an evaluation of the potential environmental impacts at the proposed and alternate sites of the central facility and the six boundary facilities resulting from ARM program activities in Oklahoma and Kansas. The impacts covering nine key environmental areas will be presented: (1) soils and geology; (2) water resources; (3) air quality; (4) noise; (5) biotic resources; (6) land use; (7) visual resources; (8) cultural resources; and (9) socioeconomics. The discussion of environmental impacts will be based on current baseline environmental conditions (at the various facilities) and the resulting impacts of the activities involved in the ARM program. Impacts are evaluated for both the construction phase and the operation phase.

3.1 Soils and Geology

3.1.1 Construction

Only small areas would be cleared and graded (i.e., less than 0.3 acres at a time, with a total of about 1.8 and 1.5 acres for the central and boundary facilities, respectively) and only minor excavation would be required to install the meteorological and radiation measurement equipment and facilities (mobile homes or portable buildings, storage sheds, and semi-trailers). As a result, there would be no effects on local geology and mineral resources at any of the sites (central facility, boundary facility, auxiliary facility, and extended sites). The local terrain would be modified slightly, since the site selection requirements are focused on nearly level areas as a scientific criterion. No loss of or permanent damage to soil is expected; even the removed topsoil would be stockpiled or moved to adjacent land to ensure its protection, if requested by the owner. Very minor effects from soil erosion are expected, due to the small area that would be disturbed.

As identified in Appendix B, most of the areas to be disturbed would be covered with plastic sheeting and gravel, while other areas would be cleared, and a concrete pad would be placed. The effects of this type of treatment and even installation of the concrete padding would not be permanent, and the entire site would be returned to the original land use at the conclusion of the ten-year project.

3.1.2 Operation

There would be only minimal predicted impact during the operation phase of the project. Soil erosion would be minimal due to the small surface area and the nature of the facility. The problem with the more clayey soils that tend to have more movement and tend to shrink and fill more during summertime and wintertime than loamy soil (as mentioned in Chapter 2) would have an impact for large facilities but not for the instruments and small trailers proposed for the ARM Program.

3.2 Water Resources

3.2.1 Surface Water

3.2.1.1 Construction

The placement and operation of the meteorological and radiation measurement instruments would avoid contact with any creeks or rivers. No impacts are likely to any of the sites, including auxiliary and extended sites, during the construction phase of the project. Water requirements for construction would be minor and would be met by water tank trucks for dust control and bottled water and a portable toilet for personnel during construction.

3.2.1.2 Operation

No impacts are likely to the surface waters at any of the sites, including auxiliary and extended sites, during the operation phase of the project. As discussed in Chapter 1, only the central facility would be permanently staffed, and would therefore require both potable water and a septic system. The site is sufficiently near commercial water mains, and these would be used. The potential problems associated the low permeability of the soils as an absorption field at the central facility (mentioned in Chapter 2), would not present a problem for the ARM program, in terms of surface water, since the proposed septic tank is small (designed for up to 6 people). The septic field would be installed in compliance with local regulations. In the event that additional burden is placed on the septic system from visiting scientists or other personnel on a temporary basis, sanitary capacity at the central facility would be supplemented with portable toilets of the type used at the boundary facilities.

3.2.2 Groundwater

3.2.2.1 Construction

The placement of the meteorological and radiation measuring equipment and facilities involves only minor excavation and would, at most, lead to penetration of the ground by only 5-6 ft. This level of minor excavation is unlikely to affect potable groundwater since depth to groundwater in this area is typically greater than 50 ft.

3.2.2.2 Operation

As discussed in Chapter 1, the proposed action for the ARM program calls for a small septic tank at the central facility. The problems associated the soils low permeability as an absorption field at the central facility (mentioned in Chapter 2), would not present a problem for the

ARM program, in terms of groundwater, since the proposed septic tank is small (designed for up to 6 people). The septic field would be installed in compliance with local regulations. There will be no chemical wastes produced, and therefore no potential for impact to the groundwater.

3.2.3 Wetlands

3.2.3.1 Construction

As indicated in Chapter 2, wetlands are present at all of the alternative sites in McClain County and at alternative sites 1 and 2 in Okmulgee. The presence of wetlands at Marion and Montgomery Counties, does not appear likely since these areas have not been mapped for wetlands and mapping usually takes place for areas that are likely wetlands candidates. For those sites for which wetlands have been identified, no construction or contact with any wetland area is needed or would be made as part of this ARM experimental effort. Since the disturbed area required for a boundary facility is only 1.5 acres within an entire quarter section (160 acres, of which 50-100 acres bound the needed area), ample room is available away from the wetland area for equipment placement.

Auxiliary and extended sites have significantly less equipment and facilities, but they still have the same environmental requirements for siting. One of the criteria for choosing the auxiliary and extended facility sites is the avoidance of wetlands. Consequently, by that criterion, no impacts are likely to any of the wetlands at any of the sites during the construction phase of the project.

3.2.3.2 Operation

No impacts are likely to any of the wetlands at any of the sites during the operation phase of the project. Since the placement of equipment will be away from the wetland areas, there would be no activity at any of the wetland sites. Furthermore, since the facilities would be constructed away from the wetland areas (even auxiliary and extended sites), operations take place away from the wetland areas and these areas would be avoided.

3.2.4 Floodplains

3.2.4.1 Construction

Evaluation of the floodplain information for the central and boundary facilities revealed that floodplains exist for the McClain County (Purcell, Oklahoma) boundary facility (the proposed site and Alternatives 1, 2 and 3), the Okmulgee County (Haskell, Oklahoma) boundary facility site (proposed site and Alternatives 1, 2 and 3), and the Marion County (Hillsboro, Kansas) boundary facility site (proposed site and Alternatives 1 and 2). Floodplain information on Kiowa County has not been developed by any agency. Figures 1.10 and 1.11 show the areas affected by the floodplain for these facilities. Since only 1.5 acres need to be disturbed in these quarter sections of 160 acres (160 acres, of which 50-100 acres are needed for the boundary facility), ample room remains for placement of the instrumentation within those quarter sections, away from the floodplain areas. These floodplain areas, identified in Fig. 1.10, 1.11 and 1.14, would be avoided during the construction activities. In that sense, each of the proposed action and alternative sites is acceptable from the viewpoint of floodplain impacts. In summary, given that designated floodplain areas in the proposed and alternative Okmulgee and McClain County boundary sites would be avoided, each of the sites is acceptable.

The criteria for choosing the auxiliary and extended sites also require the avoidance of floodplain areas. No sites susceptible to flooding or ponding would be chosen. Consequently, no impacts are likely to any of the floodplain areas at any of the sites, including auxiliary and extended sites, during the construction phase of the project.

3.2.4.2 Operation

No impacts are likely to any of the floodplain areas at any of the sites, including auxiliary and extended sites, during the operation phase of the project. Since the facilities would be constructed away from the floodplain areas, operations would take place away from the floodplain areas and these areas would be avoided.

3.3 Air Quality

3.3.1 Construction

The placement of instrumentation at the central, boundary, auxiliary, and extended facilities involves only a small amount of construction activity that could lead to air emissions. In fact, the actual area involved in surface disturbances at each of these sites is no more than 1.8 acres and only one small tractor (for grading) would probably be used along with a gravel dump truck and a cement mixer. Since a water truck would be used to minimize the fugitive dust through the use of a spray system, only a negligible amount of air emissions would occur upon placement of these instruments and facilities. No air quality permit would be required for the ARM Program field work from either the state of Kansas or the state of Oklahoma. However, the state of Oklahoma requires that fugitive dust emissions be controlled even if the source is not permitted by its regulations. This requirement is part of Regulation 3.1, entitled "Pertaining to the Control of Smoke, Visible Emissions, and Particulates" of the Oklahoma Air Pollution Control Rules and Regulations (State of Oklahoma, 1990). The water truck would serve the purpose of fugitive dust emissions control, with an expected 50% reduction in fugitive emissions due to periodic watering.

3.3.2 Operation

Actual operation of the instruments over the ten-year period from all sites would lead to no air pollutant emissions. Only exhaust from the vehicles of the workers at the site would be added to the air. Air quality regulations would be maintained on the basis of this very low level of activity.

The decommissioning plan, after the ARM field work is completed, is to restore each of the disturbed areas to its original land use. Decommissioning first involves the removal of pads, piers, and all structures from each of the sites. The next step is the replacement of topsoil and then the replanting, as appropriate, the crop that was there originally. Air emissions from decommissioning would also be small (on the order of the emissions from the construction phase) as equipment is removed and vegetation is restored. A water truck would be used to serve the purpose of fugitive dust emissions control, with an expected 50% reduction in fugitive emissions due to periodic watering.

3.4 Noise Impacts

3.4.1 Construction

During the construction phase, noise impacts at the central and boundary facilities should be minor because the noise-making equipment includes, at most, one tractor and one gravel dump truck. These two pieces of equipment would level the ground and/or foundation for the placement of equipment and/or trailers. When one instrument has been positioned at a site, construction equipment would move to another location within the site for placement of another instrument or facility. Impacts of noise from these pieces of equipment and from the automobiles of the workers traveling to and from the site would be negligible. One of the initial actions would be placement of most of the mobile homes (one each for the 50-MHz and 915-MHz profiler/RASSs) and semi-trailers. Various other instruments and semi-trailers would be placed intermittently during the first year.

3.4.2 Operation

During the operational phase, the noise sources of potentially significant intensity are: (1) the baffled 50-MHz, unbaffled 50-MHz, and 915-MHz profiler/RASSs; and (2) the research aircraft "routine flyovers" and "special intensive campaigns." The impacts from the profiler/RASSs will be discussed first, followed by the impacts from the aircraft.

3.4.3 Profiler/RASS Operation

The profiler/RASSs can have significant impacts if they are sited too close to nearby residences. The unbaffled 50-MHz and the 915-MHz profiler/RASSs are being proposed for the central facility, while the baffled 50-MHz and the 915-MHz profiler/RASSs are being proposed for the boundary facilities. Both 50-MHz profiler/RASSs (baffled and unbaffled) emit a tone like a continuous foghorn (at a frequency of about 100 Hz) for a period of 5 min. once per half hour from up to three transducers positioned about 50 m apart. The 915-MHz profiler/RASS emits a continuous tonal sound in the 2,000-Hz frequency band for 5-6 min. every 30 or 60 min. The 915-MHz profiler/RASS has four transducers that emit sound simultaneously. Information provided by personnel involved in the operation of such profiler/RASSs elsewhere in the U.S. indicates that these instruments can lead to annoyance to residents too close to the source.

In order to assess the potential impacts from the placement of the profiler/RASSs, sound pressure levels at the residences from the baffled 50-MHz, unbaffled 50-MHz, and 915-MHz profiler/RASSs are required. In order to determine the sound pressure levels at the residences, the following three pieces of information were needed:

1. The location of the residences from each of the proposed and alternative profiler/RASS locations, for the central and boundary facilities,

2. The background noise levels at the central and boundary facilities, and

3. The source noise level of the baffled 50-MHz, unbaffled 50-MHz, and 915-MHz profiler/RASSs.

Appendix E provides the information required in (1) above. Noise data were collected in a two phase noise study that involved the measurement of the background ambient noise levels at the central facility and the boundary facilities, and the measurement of the noise emission of the unbaffled 50-MHz profiler/RASS. Furthermore, noise data were available to determine the source noise level of the baffled 50-MHz profiler/RASS (given the unbaffled 50-MHz profiler/RASS noise level) and the 915-MHz profiler/RASS. This combination of noise data (available and collected) provides enough information to meet the requirements of both items (2) and (3) above. Appendix E provides a detailed description of both phases of the noise measurement study, including a brief discussion of noise terminology.

Concerning the background ambient noise measurements acquired at the central facility and the boundary facilities, the data were all quite similar, with corresponding background levels of noise of about 30 dB in the 100-Hz frequency band and about 8 dB in the 2,000-Hz frequency band. Note that all references to the 100-Hz frequency band and the 2,000-Hz frequency band will be taken to mean the 1/3-octave band frequencies for which 100-Hz and 2,000-Hz are the center frequencies, respectively.

The brief discussion of the second phase of the noise study (the measurement of the noise emission of the unbaffled 50-MHz profiler/RASS) will be presented here, with a more detailed discussion in Appendix E. Sound around an unbaffled 50-MHz profiler/RASS that was in operation (with two transducers operating simultaneously) was measured in Coffeyville, Kansas, in December 1991. Measurements at a distance of 133 m from the centroid of the two-speaker system showed a sound pressure level of 78 dB in the 100-Hz frequency band. Using the Edison Electric Institute *Environmental Noise Guide* (EEI, 1984), which provides empirical formulas that take into account environmental attenuation with distance from a noise source, the sound power level of the source was estimated to be 129 dB, at the centroid of the 50-MHz profiler/RASS. Since the actual 50-MHz profiler/RASS that would be used would have three speakers instead of a two, the sound pressure level is increased by 2 dB to 131 dB (see Appendix E).

Radian Corporation personnel (Vik, 1991) carried out similar measurements for a 915-MHz profiler/RASS in Austin, Texas. The measurements by Radian Corp. (the Manufacturer) were taken at a wide range of distances. The measurement taken at 10 m from the centroid of the four speakers of the 915-MHz profiler/RASS (76 dB in the 2,000-Hz frequency band) was used to determine the corresponding sound power level at the centroid of the 915-MHz profiler/RASS, which was estimated as 104 dB (using the Edison Electric Institute *Environmental Noise Guide's* empirical formulas).

The baffled 50-MHz profiler/RASS was not measured directly, but the sound power level was estimated by Radian Corp. personnel to be at least 10 dB less than the unbaffled 50-MHz profiler/RASS, and was therefore taken as 121 dB (at 100-Hz frequency band). Table 3.1 summarizes the sound power level of the three profiler/RASSs.

With the knowledge of the distances of the nearest residence from each of the proposed and alternative sites, and the sound emission levels of the three profiler/RASSs, the propagation of sound from each profiler/RASS to the nearest residence was predicted using the empirical formulas from the Edison Electric Institute *Environmental Noise Guide* (EEI, 1984), yielding the sound pressure levels at the various residences. Predictions of sound pressure level as a function of downwind distance were made. For example, for a generic siting of an unbaffled 50-MHz profiler/RASS, this means that at one mile, the sound pressure level in the 100-Hz frequency band would be 53 dB, and that at 1.25 miles, it would be 50 dB. These predictions were made with the assumption of standard day conditions (15°C, 70% relative humidity) and no wind (calm). Figure 3.1 shows how the sound pressure level decays with distance for the three profiler/RASSs of interest.

Once the background ambient noise levels and the potential sound pressure levels at the various residences were determined, the issue of human impact was analyzed to determine at what locations there would be no annoyance of residents. Two models were used to predict human annoyance due to noise.

A model of community annoyance, the modified Composite Noise Rating (CNR) method (EEI, 1984), is the most accepted method used in the power industry for continuous fixed noise sources. These profiler/RASSs qualify as continuous sound sources, and the methodology is applicable under EEI guidelines. The method is based on empirical data of community reactions to fixed industrial-plant noise sources. The modified CNR method was used in this EA to determine acceptable residence distances from these profiler/RASSs. Data used in the method include the following:

1. The sound pressure level of the intrusive noise at the location of the residence and the residual environmental ambient noise levels.

Table 3.1 Sound Power Level of the Various Profiler/RASSs

Profiler/RASS	Frequency Band (Hz)	Sound Power Level (dB)
Baffled 50-MHz	100	121
(Unbaffled) 50-MHz	100	131
915-MHz	2,000	104

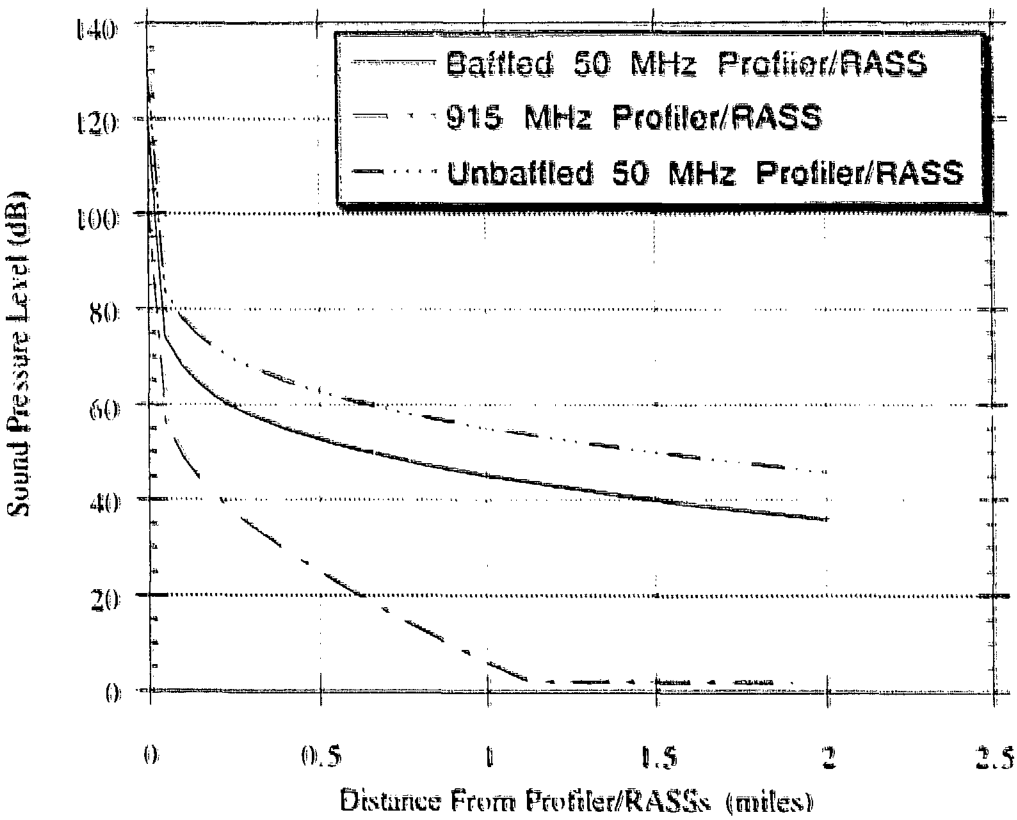

Figure 3.1 Decay of Sound Pressure Level in Distance for the Profiler/RASSs

2. The character of the noise source [i.e., whether it is of very low frequency, its tonal character, and also its intermittency (the ratio of source "on" time to a reference time of, say, 1 h)]. Included also are seasonal (winter, summer), operational, and other temporal factors (daytime or nighttime only).

3. Subjective factors such as previous exposure history of the community to that noise source and community attitude.

The details of the modified CNR analysis are given in Appendix E. A CNR rating of "C" (which represents an average community response between "no reaction, although noise is generally noticeable" and "sporadic complaints") is the common criteria for an indication of no significant impact. The minimum distance between the various profiler/RASSs and the nearest residence in order to avoid a CNR rating greater than "C" is presented in Table 3.2. For example, the nearest residence at the central facility for the proposed site and the two alternative sites was found to be 1.9 miles, and therefore the (unbaffled) 50-MHz profiler/RASS and the 915-MHz profiler/RASS are acceptable. At all of the boundary facilities, the proposed sites and some of the alternative sites have a nearest residence greater than 0.54 miles away, and therefore the baffled 50-MHz profiler/RASS and the 915-MHz profiler/RASS are acceptable.

A model of individual (rather than community) annoyance was also used to supplement the results of the modified CNR method. This model is the psychoacoustic method of Fidell (1987, 1988). This model was used as a supplement to the modified CNR findings, in order to verify that sites found to be acceptable by the CNR model would also be acceptable by this model. The Fidell model, a new and different type of computer model, was applied to the issue of siting the profiler/RASSs. While the modified CNR method applies to a *community* of people located at the residential location of interest, and its predictions refer to likely reactions of the community, the more objective Fidell approach to evaluating annoyance is for an *individual* resident and is based, in part, on certain psychological attitudes of that individual resident. Analyses that focus on a

Table 3.2 Minimum Distance between Profiler/RASSs and Nearest Residences, as Predicted by the Modified CNR Method

Profiler/RASS	Minimum Distance to Avoid Adverse Impacts (miles)
Baffled 50-MH	0.54
(Unbaffled) 50-MHz	1.30
915-MHz	0.30

particular individual, require the input of individual characteristics that affect that person's reaction to noise. Among the variables required in this Fidell model are the following:

1. The "affected state" of the individual (the individual's view of the project as unfavorable, neutral, or favorable).

2. The individual's level of concentration on ongoing activities, being focused on the disturbance, on neither the task at hand or on the disturbance, or only on the task at hand.

The above two variables, in combination with the sound pressure level of the profiler/RASSs and the background ambient sound pressure level, can be used to predict the probability of an individual's annoyance. The Fidell method results supported the findings of the modified CNR method (see Appendix E for details).

The overall results of the modified CNR method are presented in Table 3.3, with a detailed discussion in Appendix E. Table 3.3 shows the acceptable (A) and unacceptable (U) sites for locating the profiler/RASSs. This table uses the modified CNR method, and gives the limiting predictions for the cases studied here. The analyses and predictions made indicate that at the proposed sites, the proposed action (which is a combination of profiler/RASSs, including (1) for the central facility, an unbaffled 50-MHz profiler/RASS along with a 915-MHz profiler/RASS, and (2) for each of the boundary facilities, a baffled 50-MHz profiler/RASS and a 915-MHz profiler/RASS) does not produce any significant noise impacts.

It is important to note, that the analyses do not account for wind and temperature gradients that are usual in the atmosphere. If the wind is blowing from the resident to the source, noise levels should be much lower than predicted above or perhaps even inaudible, depending upon the distance between noise source and residence. On the other hand, if the wind is blowing toward a nearby residence from a profiler/RASS, the effect of wind and temperature gradients may lead to the temporary increases in noise levels. Downwind propagation of noise due to refraction of noise due to inversion conditions (especially at night) do occur and may lead to occasional increases in noise levels far from the source, but these increases are very transitory (at a fixed location downwind) due to the strongly time-varying nature of the air flow. Variations in noise levels due to wind and temperature gradients cannot be precisely predicted at this time because data on vertical temperature and wind profiles are not available for these sites. Predictions made here for periods of no wind and standard daytime conditions provide the best single estimates, but nonetheless they have a large standard deviation.

Finally, the modified CNR method is a comprehensive approach to community response due to a continuous noise source, and therefore includes the times when community members are attempting sleep. The Fidell method, which was used to support the findings of the modified CNR method, was run for a variety of conditions, including an attempt to model the annoyance of an individual during the nighttime (see Appendix E).

Table 3.3 Acceptable (A) and Unacceptable (U) Sites for the Profiler/RASSs According to the Criteria of the Modified CNR Method for Acceptability of Noise Impacts

Facility (County, State)	Proposed Site	Alternative 1	Alternative 2	Alternative 3
Unbaffled 50-MHz Profiler/RASS				
Central (Grant Co., Okla.)	A	A	A	-
Baffled 50-MHz Profiler/RASS				
Boundary (McClain Co., Okla.)	A	-	U	A
Boundary (Okmulgee Co., Okla.)	A	-	U	A
Boundary (Woodward Co., Okla.)	A	A	A	-
Boundary (Kiowa Co., Kans.)	A	A	U	A
Boundary (Marion Co., Kans.)	A	-	U	U
Boundary (Montgomery Co., Kans.)	A	U	U	-
915-MHz Profiler/RASS				
Central (Grant Co., Okla.)	A	A	A	-
Boundary (McClain Co., Okla.)	A	-	A	A
Boundary (Okmulgee Co., Okla.)	A	-	A	A
Boundary (Woodward Co., Okla.)	A	A	A	-
Boundary (Kiowa Co., Kans.)	A	A	A	A
Boundary (Marion Co., Kans.)	A	-	A	A
Boundary (Montgomery Co., Kans.)	A	A	A	-

3.4.4 Aircraft Operation

The "routine flyovers" and "special intensive campaigns" of the research aircraft have the potential for causing annoyance for people on the ground if the flights are too low and/or directly over nearby residences. Five aircraft (the P-3 Orion, the GI Gulfstream, the King Air C-90, the DeHavilland Twin Otter DHC-6, and the Cessna) are candidate type aircraft that have been proposed to fly special research missions at the central and boundary facilities. An evaluation of the impacts of these flights would largely be with respect to noise on the ground. The situation leading to the greatest noise impact would be the 2-3 intensive measurement periods per year. One or two of the above aircraft type would fly at 500 feet above ground level for either several 20 km legs over the central facility location or two 425 km legs that criss-cross over the entire CART site. Such flight paths would be chosen to avoid towns and homes as much as possible. This section evaluates potential impacts of these flyovers. Two noise metrics were used as indicators of potential impact due to aircraft operations, using the NOISEMAP 6.0 model (Horonjeff et al., 1974)). Although the jet aircraft will not be used at 500 ft, all five aircraft were (for completeness) compared at an altitude of 500 ft, and for the purpose of this analysis, flight paths were assumed to be directly over a residence (worst case scenario). In addition, flight paths at various transverse distances from a residence (500, 1000 and 2500 ft) were also considered.

First, the day-night average sound level (L_{dn}), was used to predict the community effects of long-term exposure to environmental noise. Noise levels below 65 dB L_{dn} are considered to be compatible with residential land use. The most commonly used measure of aggregate community response is the percentage of people in a populated community who are "highly annoyed" by the noise (NAS 1977; Schultz 1978, U.S. EPA 1982). Table 3.4 gives estimates of this percentage of high annoyance in a populated community as a function of L_{dn}.

Table 3.5 gives the predicted L_{dn} levels for the various aircraft using the NOISEMAP model. None of the predicted L_{dn} values exceed 65 dB, which is the level considered to be compatible with residential land use. Furthermore, the only aircraft that predicts any percent of the community as highly annoyed is the P-3 Orion, which has the potential for highly annoying 1-2 % of the people when the aircraft is flying within an offset of about 500 ft. It is important to keep in mind that the flight paths may vary, so it would not be a direct overflight every time. No nighttime flyovers would occur at low altitudes. Any nighttime flights would take place at 1000 feet or higher and noise impacts at those heights would be negligible for the light aircraft (including the P-3 Orion) being considered. Each of the aircraft lead to values less than 65 dBL_{dn} .

The second metric by which the impact of aircraft operations was measured was the L_{max} value, which is the maximum A-weighted sound level occurring during a single aircraft operation. The L_{max} value is used to assess the level of speech interference during the flyover at 500 ft. Table 3.6 shows the voice effort required for direct speech communication as a function of L_{max} value and the distance between the individuals communicating.

The L_{max} values predicted by the NOISEMAP model are presented in Table 3.7. If one number is to be used from Table 3.6, an L_{max} value of 65 dB is generally considered as the threshold for speech interference. As can be seen, any direct overhead flight would produce some

Table 3.4 Highly Annoyed Percentage of a Populated Community (U.S. EPA 1982)

L_{dn} Level (dB)	Percent of Community Highly Annoyed
45	1
50	2
55	5
60	9
65	15
70	25
75	37
80	53
85	73

Table 3.5 L_{dn} Level for the Various Aircraft at Different Offset Distances

Aircraft	L_{dn} Level (dB) for Various Perpendicular Horizontal Offsets			
	0 ft	500 ft	1000 ft	2500 ft
P-3 Orion	48.5	45.9	42.0	34.2
G1 Gulfstream	31.3	28.6	24.0	13.6
King Air C-90	30.6	27.9	23.3	12.9
Twin Otter DHC-6	38.9	36.2	31.8	21.9
Cessna	33.3	30.4	25.5	14.6

Table 3.6 Voice Effort Required for Direct Speech Communication as a Function of Maximum Intrusive Noise Level (L_{max}) and Distance between Individuals

Distance between Talker and Listener (ft)	L_{max} (dB) Requiring Increased Voice Effort[a]			
	Normal	Raised	Very Loud	Shouting
0.5	81	87	93	99
1	75	81	87	93
2	69	75	81	87
4	63	69	7[illegible]	81
6	59	65	71	77
12	53	59	65	71

[a] L_{max} is the greatest A-weighted sound level of intruding (aircraft) noise.

Sources: Beranek 1947, 1971, 1988; Kryter 1984; Newman and Beattie 1985; Webster 1969a,b.

Table 3.7 L_{max} Level for the Various Aircraft at Different Offset Distances

Aircraft	L_{max} Level (dB) for Various Perpendicular Horizontal Offsets			
	0 ft	500 ft	1000 ft	2500 ft
P-3 Orion	93.3	89.9	84.8	75.2
G1 Gulfstream	76.5	73.3	68.7	59.8
King Air C-90	76.5	73.3	68.7	59.8
Twin Otter DHC-6	82.2	79.0	74.6	66.2
Cessna	72.8	69.4	64.4	55.1

speech interference. However, since only one event per day would occur during intensive periods, the interference events are of short duration (10-20 seconds), and there are no schools or hospitals nearby the flight path, impacts would be small.

Finally, each of these aircraft fly slowly during their low-level flights (about 120-150 knots). The possibility of a startle effect is negligible because at these slow speeds, people on the ground would have adequate warning that an aircraft will pass by. Startle effects are of concern for military aircraft such as high-speed F-15 and F-16 military jets flying training exercises in low-level routes. It may be concluded that only a once per day speech interference would occur for people under the flight path. One may say, in summary, that the impacts from the operation of the research aircraft appear to be small and very infrequent whichever aircraft is used for the research flights.

3.5 Biotic Resources

The primary impacts of the proposed action on biotic resources would occur during construction of facility access roads, concrete trailer pads, parking areas, the RASS, and equipment anchoring piers.

3.5.1 Vegetation and Wildlife

Adverse impacts to vegetation would be limited to areas excavated for power lines and trailer pads; augured for equipment piers and fence posts; and graded for parking areas, RASS deployment, and access roads. Access roads (driveways) to the central facility and each of the boundary facilities, which would be built perpendicular to an existing section road and would be only long enough to clear utility easements along the existing road, would be approximately 30 ft long and 15 ft wide (0.01 acres). These driveways would lead to the mobile homes, rawinsonde, and storage area at the central facility and to the rawinsonde and storage areas at the boundary facilities. No roads or graded paths would be built to access individual equipment at any of the central, boundary, auxiliary, or extended facilities. Sacrificed vegetation would primarily consist of grasses and some other herbaceous species. However, the impacts of construction activities to vegetation are likely to be low because the areal requirements for piers, pads, equipment, and parking areas are small (see Appendix B). The U.S. Department of Energy would provide a qualified biologist to conduct a pedestrian survey of those areas to be disturbed before construction begins.

The impacts to vegetation during project operations would be minor, consisting of slight disturbances caused by technicians walking to and from equipment. At the end of the project's ten-year life span, all equipment, fencing, concrete pads, and piers would be removed from the respective sites. All graded areas would be revegetated at the request of the property owner. Consequently, overall impacts to local vegetation would be temporary and minimal.

Adverse impacts of the proposed action to local wildlife would be minor and temporary. The highest frequency of wildlife mortality is likely to occur during construction, when burrowing and less mobile species would be at risk. However, the project's areal requirements are so low that impacts to such species are likely to be negligible. A potential for mortality exists among avian species (collisions) once project structures have been erected, but mitigative measures such as installation of fluorescent guy wire sleeves would be implemented. Additionally, a blinking light would be mounted on the 60 meter meteorological tower to reduce the possibility of avian collisions. Further, the vertical noise source would be placed as far as technically feasible away from the tower to minimize any attractive influence on birds. These mitigative measures have been discussed with the Department of Interior, Fish and Wildlife Service (FWS) (on January 2, 1992, with Ms. Karolee Owens of the Tulsa Field Office) in response to the FWS letter of December 23, 1992 (see page D-14), and are considered to be an acceptable solution by FWS to their previous concerns. All instrumentation would be fenced, reducing the risk of contact for most nonavian wildlife. Overall impacts to wildlife are expected to be minimal and short term, and all project-related structures would be removed upon the project's termination.

3.5.1.1 Effects of Noise on Birds

A potential impact on birds including both breeding birds and migratory birds in flight is the sound from the 50-MHz and 915-MHz RASS systems. The 50-MHz RASS emits noise at 100-Hz, and the 915-MHz RASS emits noise at 2,000-Hz, each at a single tonal frequency for a period of 5-6 min. every 30 or 60 min. of RASS operation. The range of maximum sensitivity of hearing of birds is at 1,000-5,000 Hz. Some species can hear sounds from frequencies of less than 100 Hz up to about 29,000 Hz. For example, starlings, owls, and pigeons can hear sounds at frequencies as low as 100 Hz. Because hearing may play an important role in bird migration, the RASS noise could disorient a bird as it flies in the sound field. However the sound field, originating from the ground level, attenuates rather rapidly with distance (by 6 dB for each doubling of the distance). In addition, the birds may simply avoid the sound field. Some birds may be attracted to a sound source, while other birds may be repelled. Birds have been known to fly into a tall antenna or a tall tower with attached guy wires. Mortalities could occur if birds are attracted to such a sound source. For the ARM study, the sound is emitted from transducers at the ground. Two or three transducers would be needed for the 50-MHz RASS and four transducers for the 915-MHz RASS. At the central facility, a 60-m tower would be present, but that tower would be located at least 100 m from the RASS systems.

Another possibility is that breeding birds could be disturbed by the sound and could fail to use available breeding habitat. On the other hand, birds could become habituated to the sound. Physiological responses and reduced hatching and fledging success have resulted from exposure to noise; such data were obtained experimentally and relate to aircraft flyovers. The literature on sound effects on birds is sparse, and expectations of bird behavior cannot be quantified at this time. Most of the existing literature involves impacts of aircraft flyovers.

In summary, the impacts of the two RASS systems on birds are expected to be negligible because the 60-m tower is relatively short, and most migrating birds fly higher than the height of the tower. The source of noise is at the ground, and the sound attenuates rather rapidly in the vertical direction. Further, as discussed in Section 3.5.1, additional mitigative measures would be taken based upon guidance received from the FWS to reduce any impacts on birds.

3.5.1.2 Impacts of Noise on Domesticated Animals

Noise elicits behavioral and physical reactions in domestic livestock similar to those of wildlife species. Impacts to any given species of livestock would be influenced by noise characteristics, duration, hearing ability of the animal, and familiarization of the animals to the sound source. Manci et al. (1988) summarized studies on the effects of elevated noise levels to livestock. The observed adverse impacts included startle reactions, reduced feed consumption, reduced egg production, reduced milk yield and release, influences on hormonal systems, and increases in heart and respiratory rates. Most of these effects have been observed for noise levels above 90 dB. The RASS systems emit noise for 5 min. every half hour, and the impacts of that noise are very localized. For the unbaffled 50-MHz RASS system, the distance to the 90-dB noise level is about 40 m; the distance is 13 m for the baffled 50-MHz RASS system. For the 915-MHz RASS system, the distance to the 90-dB noise level is about 2 m. Many of the proposed sites for the central and boundary facilities are in pasture land or rangeland; e.g., the proposed site and alternative 2 for the central facility. The domesticated animals are already somewhat acclimated to disturbances because cars and farm vehicles pass them periodically. The presence of the RASS systems would add proportionately to the annoyance currently experienced by the domesticated animals in the near vicinity of the RASS system. The baffled 50-MHz RASS system (planned for use at the boundary facilities) would be surrounded by a fence that would include a circle of 13-m radius; the 915-MHz RASS system also has a fence that includes the 2-m-radius 90-dB contour. The unbaffled 50-MHz RASS system (for the central facility) is surrounded by a fence, but the fence is not large enough to cover a 40-m circle. That small area (outside the fence but inside the 40-m circle) should not cause a problem because livestock are mobile, and such animals will probably become acclimated to the noise in time.

3.5.2 Threatened and Endangered Species

The Kansas State Office of the FWS has determined that the proposed and alternative boundary facility sites in Montgomery (Neodesha, Kansas) and Marion (Hillsboro, Kansas) counties would not adversely affect federally listed endangered and threatened species (Gill, 1991b). The proposed and alternative boundary facility sites in Kiowa County (Haviland, Kansas) are in an area where migrating whooping crane and black-footed ferret may occur. However, neither the wetland habitat that supports whooping cranes nor the prairie dog town rangeland habitat of the black-footed ferret occurs within the immediate vicinity of the proposed facility or its alternatives.

The Ecological Services branch of the FWS office in Tulsa indicated that the project was not expected to affect any federally listed endangered or threatened species in Oklahoma (Forsythe, 1991). The Natural Heritage Inventory of the Oklahoma Biological Survey reported no records of rare or significant species at or in the vicinity of the proposed and alternative sites (Butler, 1991).

3.6 Land Use

The proposed action is not expected to adversely affect existing or future land use. The proposed central facility and each of the proposed boundary facilities are located in rural settings, resulting in no adverse impacts to residential, commercial, or industrial land use patterns. None of the proposed facilities would violate existing land use plans or zoning controls. Pipelines that pass under or near proposed or alternative sites would not be affected. The impacts of the proposed action on prime farmland are also expected to be minimal, since fewer than three acres would be disturbed or occupied by instruments at the central facility, and less than two acres would be disturbed or occupied by instruments at the boundary facilities (see Appendix B). At each auxiliary and extended facility, less than 0.5 acres of land would be disturbed or occupied by instruments. Upon completion of the project, all land within the borders of each facility that would be utilized for equipment and structures would be returned to agricultural use and all graded areas would be seeded or kept in place, according to the wishes of property owners.

Land outside the perimeters of the proposed site's facilities would be affected only during construction, when roads around the facilities would experience a slight increase in traffic. Many of these roads are unpaved, but the slight increase in traffic during construction is expected to have negligible impacts. During operations, impacts to land outside the perimeters of these facilities would be negligible.

No additional adverse impacts to land use are anticipated with the alternative facilities, since their close proximity to the proposed facilities would result in almost identical impacts.

3.7 Visual Resources

Visual impacts to the scenic environment surrounding the proposed central and boundary facilities (and their alternatives) during construction and operation are expected to be low. As described in Section 2, the landscapes surrounding the central facility and several of the boundary facilities are relatively uniform, lacking a wide variety in landform, vegetation, and color. No unique viewsheds would be adversely affected.

The tallest structure in the entire project, the central facility's 60-m meteorological tower, would be visible for several miles from viewpoints surrounding the proposed facility and its alternatives. However, two communications towers are already visible on the western horizon from viewpoints in the vicinity of both the proposed central facility and its alternatives. Consequently, the 60-m tower's impact on visual resources would be minimal. The central facility would also contain a 10-m walk-up tower that would be visible from several middleground (distances of 1/4-2 miles) viewpoints, but its intrusion onto the landscape would be negligible.

Within each boundary facility, only a 10-m tower is likely to be visible from within the middleground viewing range. Several of the boundary facilities (and their alternatives) would be located in township sections containing National Oceanic and Atmospheric Administration (NOAA) wind profiler network equipment. Such equipment includes a 10-m meteorological tower for detecting wind speed and direction. The presence of an NOAA tower in the existing landscape reduces the visual impacts of the boundary facility tower. Background views (2-5 miles) would not be affected by the boundary facilities.

No visually sensitive receptor areas such as residential developments, parks, schools, trails, state forests, or recreational facilities would be visually affected by the proposed facilities or their respective alternatives. The Marion Lake State Wildlife Area, located approximately ten miles northeast of the proposed Marion County (Hillsboro, Kansas) boundary facility, and the Pratt Sandhills State Wildlife Area, located almost seven miles northeast of the proposed Kiowa County (Haviland, Kansas) boundary facility, would not be affected by the proposed action or its alternatives. The Elk City State Park and State Wildlife Area of Montgomery County (Neodesha, Kansas) are located too far away (ten miles) from the proposed or alternative sites to be affected.

3.8 Cultural Resources

The Oklahoma SHPO and the Kansas SHPO have confirmed that the proposed action would have no adverse impacts on cultural resources (Gettys and Brooks, 1991; Pankratz, 1991). The proposed boundary facility and its alternatives in McClain County (Purcell, Oklahoma) were located in a region that holds a potential for prehistoric sites, but a survey of the proposed site, conducted on December 17 by the Oklahoma Archeological Survey, revealed no evidence of prehistoric sites (Gettys and Brooks, 1991b). The Kansas SHPO indicated that the lower elevations of Stony Brook, located in the quarter section containing the proposed boundary facility site in Marion County (Hillsboro, Kansas) might hold prehistoric sites. However, the facility would be located in an area of higher elevation, away from the sensitive parcels.

If archeological remains are encountered during project construction activity at any of the proposed facilities, the appropriate SHPO would be contacted immediately. The U.S. Department of Energy would have a qualified expert present during construction to make such determinations. Operations in the various facilities would not impact cultural resources.

3.9 Socioeconomics

No adverse social or economic impacts would result from the proposed action or its alternatives. Some short-term economic benefits would result during the construction phase of the project, but these would be limited to brief periods of employment and to local purchases of building materials. Although the precise number of workers required for construction has not yet been established, the size of the work crew is expected to be approximately 10-20 (including ARM Program personnel installing the actual instruments) for the central facility and 3-5 for each boundary facility. Construction activity at the central facility is expected to require no more than 30 days, while construction of the boundary facilities would be completed in approximately two weeks.

Some minor economic benefits would result from employment at the central and boundary facilities once operations begin. The central facility would employ six people per day, while each boundary facility would employ two persons per day.

3.10 Health Effects on Site Personnel

Each of the site workers would be specially trained not only in instrument service and maintenance but also in environmental, safety, and health issues. As part of the ARM Program Safety Plan for operations at the southern Great Plains CART site, DOE would provide documented training in all aspects of equipment, office, and laboratory safety to all personnel hired for site operations.

With regard to the potential impacts of electromagnetic radiation, all radars (microwave) and lidars (laser light) are located in semi-trailers. Those trailers are specially designed to have sheet metal skins and are grounded. This treatment shields the electromagnetic radiation by reducing or eliminating the radiation from the power sources that run the instruments. All non-eye safe lasers would have safety precautions that automatically shut off the power to the laser light if any obstacle comes into the potential path of the laser light.

The possibility for accidents affecting workers and the public are extremely low. The lidars would be eye-safe and the remaining equipment pose no special danger during construction or operation. The public will be kept from entering the instrumented areas by the fences around that equipment and by warning signs on the property rented by DOE.

3.11 Waste Treatment and Disposal

Only the central facility would be occupied on a regular basis. The boundary, auxiliary, and extended sites would be visited periodically for maintenance and the acquisition of the collected data. For the central facility, a septic tank system would be installed; otherwise all other solid waste would be transported from the site by a commercial firm. No hazardous waste would be created at any of the sites.

3.12 Unavoidable Adverse Impacts

The issue to be addressed in this section is whether there are any unavoidable adverse impacts that could lead to the need for an environmental impact statement. Considering that mitigation has been built into the proposed action (including baffled profiler/RASSs at the boundary sites), there are no unavoidable adverse impacts that could lead to the need for an environmental impact study. There are, however, some small impacts such as very occasional speech interference due to occasional aircraft flyovers, possible (but low probability of) birds striking the meteorological tower, very transient noise at residences due to noise refraction through nighttime inversions, a small amount of fugitive dust emitted during construction, and a small amount of prime farmland used for project activities (only for the life of the project). These impacts are very minor, however.

3.13 Comparison of Alternatives

Aside from noise impacts, there is little difference among the alternatives, largely because of their close proximity to each other. The proximity of homes to some of the sites has led to potentially important noise impacts (according to the modified CNR criterion), even with the baffled 50-MHz RASS system. The potentially impacted boundary facility sites are the Alternative 1 site for Montgomery County, the Alternative 2 sites in McClain, Okmulgee, Kiowa, and Marion Counties, and the Alternative 3 site for Marion County. These sites would have much greater noise impacts than the other boundary site candidates and would not be used.

On the basis of the avoidance of construction and operation in the wetlands subareas of the McClain County candidate sites and in the floodplain subareas of the McClain and Okmulgee County sites, all candidates are equally preferable. The placement and monitoring of instruments could be carried out satisfactorily within subareas of the McClain and Okmulgee County, Oklahoma, candidate sites.

Potential impacts to land use, cultural resources, visual resources, and socioeconomics are similar under any scenario. For visual resource impacts, several of the proposed sites that already contain NOAA profiler equipment (McClain, Marion, and Montgomery Counties) may be preferable to their respective alternatives.

The no action alternative would lead to no environmental impacts at or near the specific proposed and alternative sites identified. However, there are negative implications for the U.S. as a whole of no ARM field studies of this type in the U.S. First, all scientific information which would be gained by such a field effort would be lost. Global climate models would not be improved leading to considerable uncertainties in the magnitude of the global warming phenomenon; in addition, the validity of the global climate models used for both scientific and policy analysis would remain questionable. Consequences of the use of poor or unvalidated modeling tools could lead to a poor projection of the future magnitude of suspected global warming for the world (and U.S. in particular) and faulty policy solutions. The cost of poor policy could be very large and have very negative impacts to the long-term future of the U.S. Second, if no action is translated into requiring the choice of a site outside the U.S., there would be imposing logistical constraints, greatly increased costs, and most importantly, data that would be of less scientific value.

3.14 Cumulative Impacts

The potential for cumulative impacts has been examined with a finding that there are no cumulative impacts that are of any importance. The CART facilities at each of the central, boundary, auxiliary, and extended sites are located in isolated rural areas where there is very little activity other than farming. The ARM Project work represents a new effort and has no cumulative impacts with any previous DOE work or with any other federal projects, other than the 405-MHz profiler network at 5 of the boundary sites (as mentioned earlier). A separate environmental assessment had been prepared prior to the siting of those 405 MHz profilers. A review of that document revealed that there are no cumulative impacts with those profilers and the proposed 50 MHz or 915 MHz profiler/RASSs since they operate at different frequencies and do not lead to additive effects.

4 Summary and Conclusions

In this EA the impacts of placement and operation of meteorological and radiation measurement equipment were evaluated within separate areas of one central facility (160 acres), up to 6 boundary facilities (50-100 acres each), 6 auxiliary facilities (50-100 acres each), and 25 extended facilities (50-100 acres each). The actual disturbed area would be 1.8 acres for the central facility and 1.5 acres for each of up to 6 boundary facilities. Less than 0.1 acre would be disturbed at each of the auxiliary or extended sites.

Air quality impacts of placement and operation would be very minor because the area of disturbance would be small, and only clearing and a small amount of leveling would be needed. State of Oklahoma regulations on fugitive dust mitigation (e.g., watering to reduce emissions) would be followed during the construction.

Noise impacts to nearby residents were evaluated through actual field measurements of ambient residual environmental noise, measurements of the sound pressure levels of the 50- and 915- MHz profiler/RASSs, and modeling of noise impacts from those profiler/RASSs at each of the proposed and alternative sites. The results showed the following results in terms of noise impacts:

1. The 50-MHz and 915-MHz profiler/RASSs were found to be acceptable at the central facility for the proposed action and each of the alternatives. The baffled 50 MHz profiler/RASS and the 915-MHz profiler/RASS are acceptable at the boundary sites except for Alternative 1 for Montgomery County; Alternative 2 for McClain, Okmulgee, Kiowa, Marion, and Montgomery Counties; and Alternative 3 for Marion County. The baffled 50-MHz profiler/RASS allows the noise to be more muffled and reduced in intensity by at least 10 dB from the unbaffled 50-MHz profiler/RASS. The baffled system is a good choice at the boundary facilities because of the close proximity of residences. At least one site was found to be acceptable for the baffled 50-MHz profiler/RASS at each of the six boundary facilities.

2. The 915-MHz RASS system was found to be acceptable at all proposed sites and alternatives, including the central facility and the six boundary facilities.

Research aircraft would occasionally carry out low-level passes at 500 ft above ground level. The proposed aircraft would cause momentary speech interference for people under the flight path, a minor impact.

Water resource impacts would be very minor, with the following provision for the Okmulgee County and McClain County boundary sites: No construction or operational activities would be carried out in specified subportions of the McClain County boundary facility sites (proposed site and all three alternatives) and in the Okmulgee County proposed site and Alternative 2 because of the presence of a floodplain. However, the wetland area is a subportion of the floodplain, which is to be void of construction or operational activities in any case.

Impacts to vegetation and wildlife would be low and temporary. Most impacts would occur during the short construction period. No threatened or endangered species would be at risk.

Land use impacts would be very low because of the limited areal requirements of the project. No more than two acres per facility site would actually be disturbed, and land use in the vicinity of the project would not be affected.

The project impacts to visual resources surrounding each site would be low. The only structure in the entire project that would be visible from a vantage point of greater than two miles would be the central facility's 60-m meteorological tower. However, other man-made structures are visible on the horizon west of the proposed site.

The impacts to cultural resources would be minimal. The state historical preservation officers (SHPO) of Oklahoma and Kansas indicated that none of the proposed or alternative sites for facilities contain structures or sites listed in the National Register of Historic Places. The lower elevation of the Marion County (Kansas) site may contain archeological sites, but these areas would be strictly avoided.

Socioeconomics impacts would be minimal. Some minor economic benefits would occur in the vicinity of each proposed site, but these would consist of brief employment (30 days maximum) for only a few workers during construction and the local purchase of support materials.

The auxiliary and extended sites have not been located at this time. The positioning of such sites would be made by using the list of strict criteria (with no profiler/RASS system at these sites) described in Section 1. In addition, since siting is very flexible for these facilities, impacts would surely be very small.

Because the ARM Project activities would take place only in rural areas that have no industrial or commercial activities, which would potentially be interfered by or interfere with ARM activities, cumulative impacts would be negligible.

The no action alternative would be the loss of a U.S. site, which would be detrimental to the scientific study of global warming. The loss of the U.S. site would severely limit the ability of the project to vastly improve models and to make appropriate policy decisions on global climate change.

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7 Agencies, Organizations, and Officials Contacted

7.1 Agencies, Organizations

Federal

U.S. Army Corps of Engineers
U.S. Department of Agriculture, Soil Conservation Service
U.S. Department of Commerce, Bureau of the Census
U.S. Department of Labor, Bureau of Labor Statistics
U.S. Fish and Wildlife Service

State

Kansas Department of Health and Environment, Bureau of Air and Waste Management
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Other

Paul LaPorte, Bureau of Labor Statistics, Chicago

Appendix A

Landsat Scenes Used for Land Use Classification

Appendix A

Landsat Scenes Used for Land Use Classification

This appendix includes the individual 14 cloudless Landsat scenes that were classified for land use studies for the Southern Great Plains Cloud and Radiation Testbed (CART) study area. The classes determined were crop, majority crop, mixed crop and rangeland, rangeland and brush, grassy, water, dry creek beds and urban, and wooded. Although the dates of the scenes span approximately two years (1988-1989), they are all for late summer or early fall. Dates of the scenes are include in the figures. For the most part, the dominant crop in the area is winter wheat. Scenes have not been totally confirmed with ground truth but confidence is high (85%). All 14 scenes will be knitted for future reference.

LAND SATELLITE COORDINATES

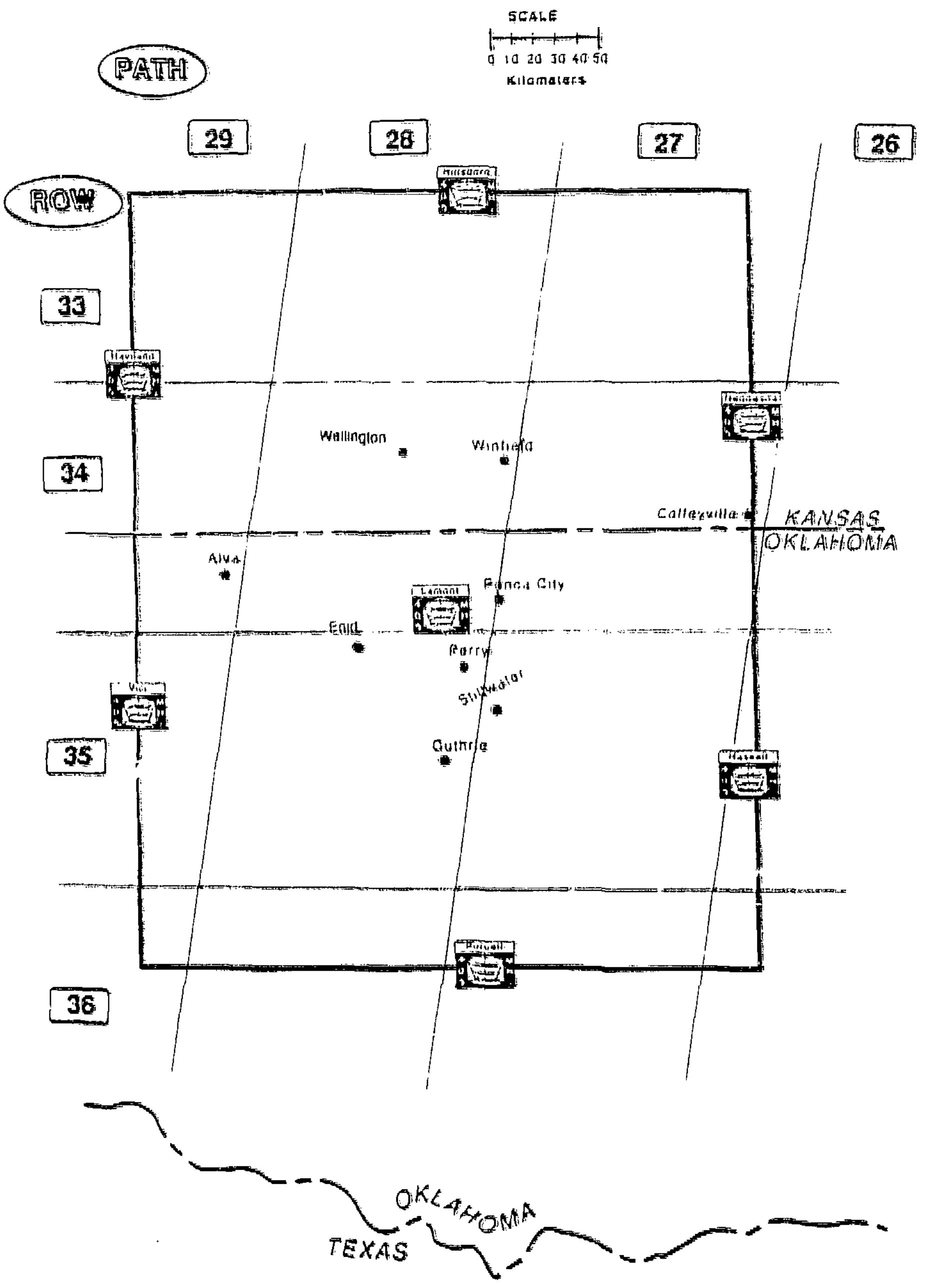

Figure A.1 The path and row of the 14 Landsat scenes. Also included are the NOAA Wind Demonstration Network Profilers that can be used to identify approximate locations of the central facility (Lamont, OK) and the six boundary facilities (Vici, Purcell, and Haskell, OK, and Neodesha, Hillsboro, and Haviland, KS). Select cities are shown for further reference.

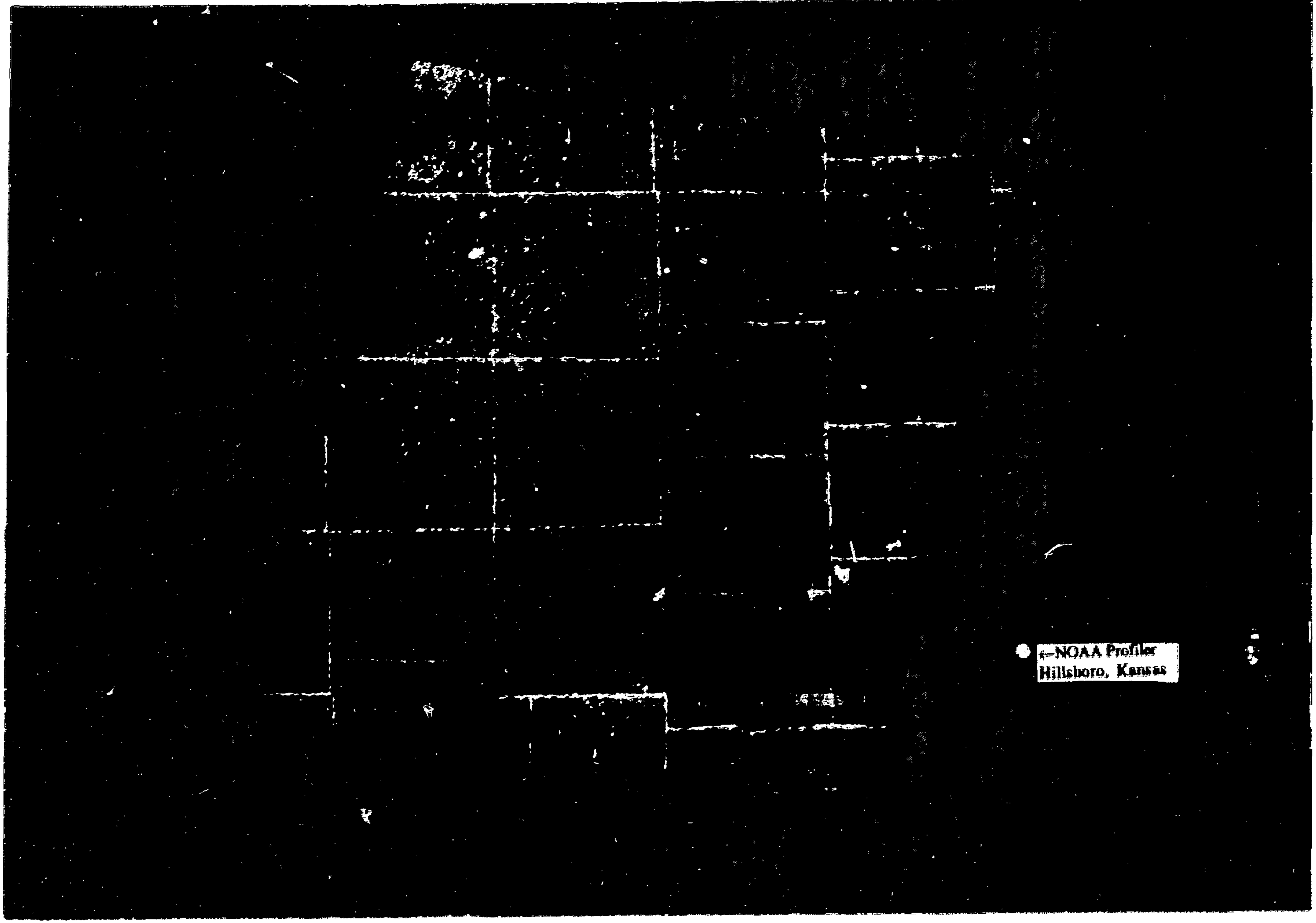

Figure A.2 Processed Land Satellite Data; Scene No. 1, Path 29, Row 33; September 25, 1988.

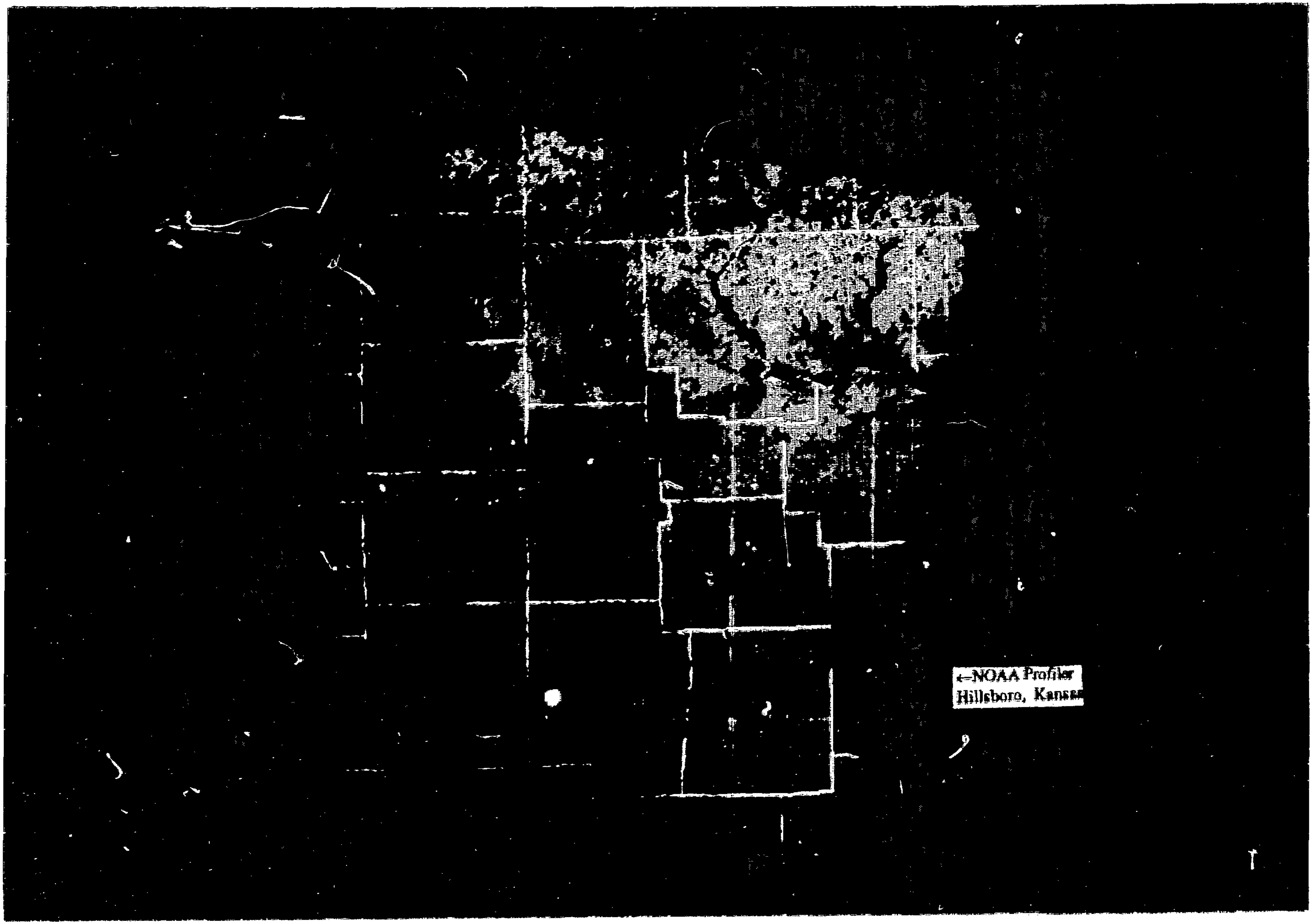

Figure A.3 Processed Land Satellite Data; Scene No. 2, Path 28, Row 33; August 4, 1989.

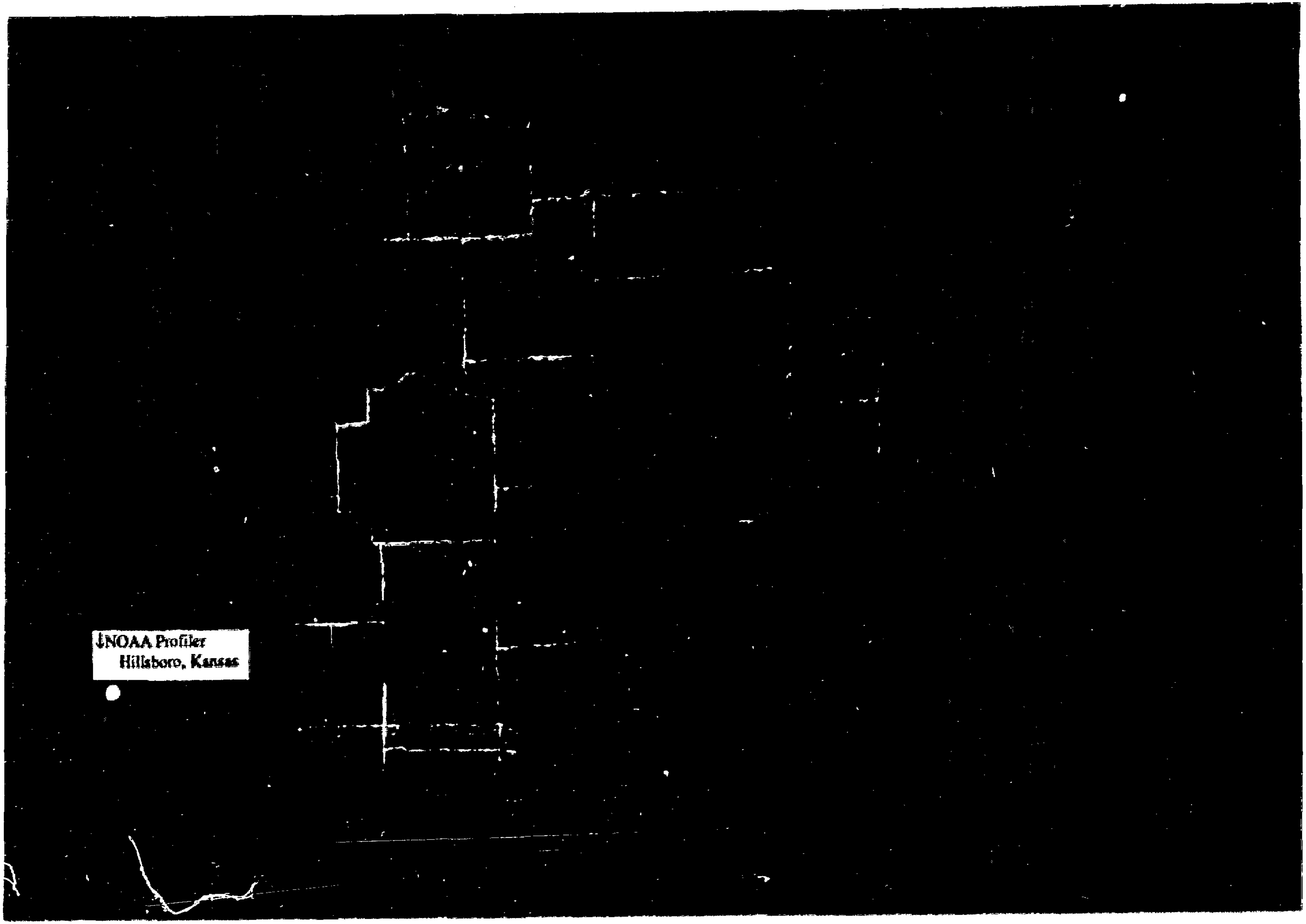

Figure A.4 Processed Land Satellite Data; Scene No. 3, Path 27, Row 33; August 28, 1988.

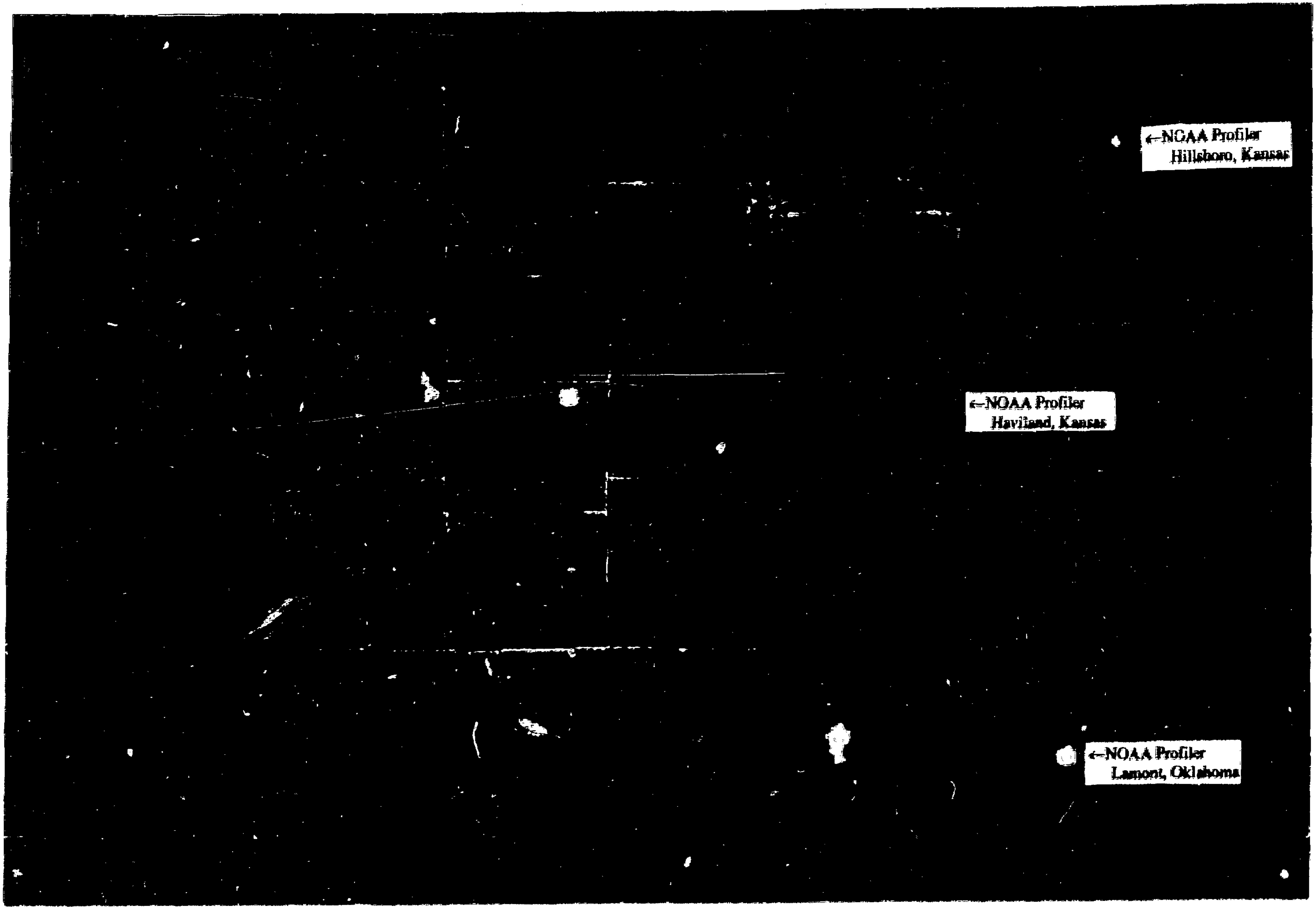

Figure A.5 Processed Land Satellite Data; Scene No. 4, Path 29, Row 34; September 9, 1988.

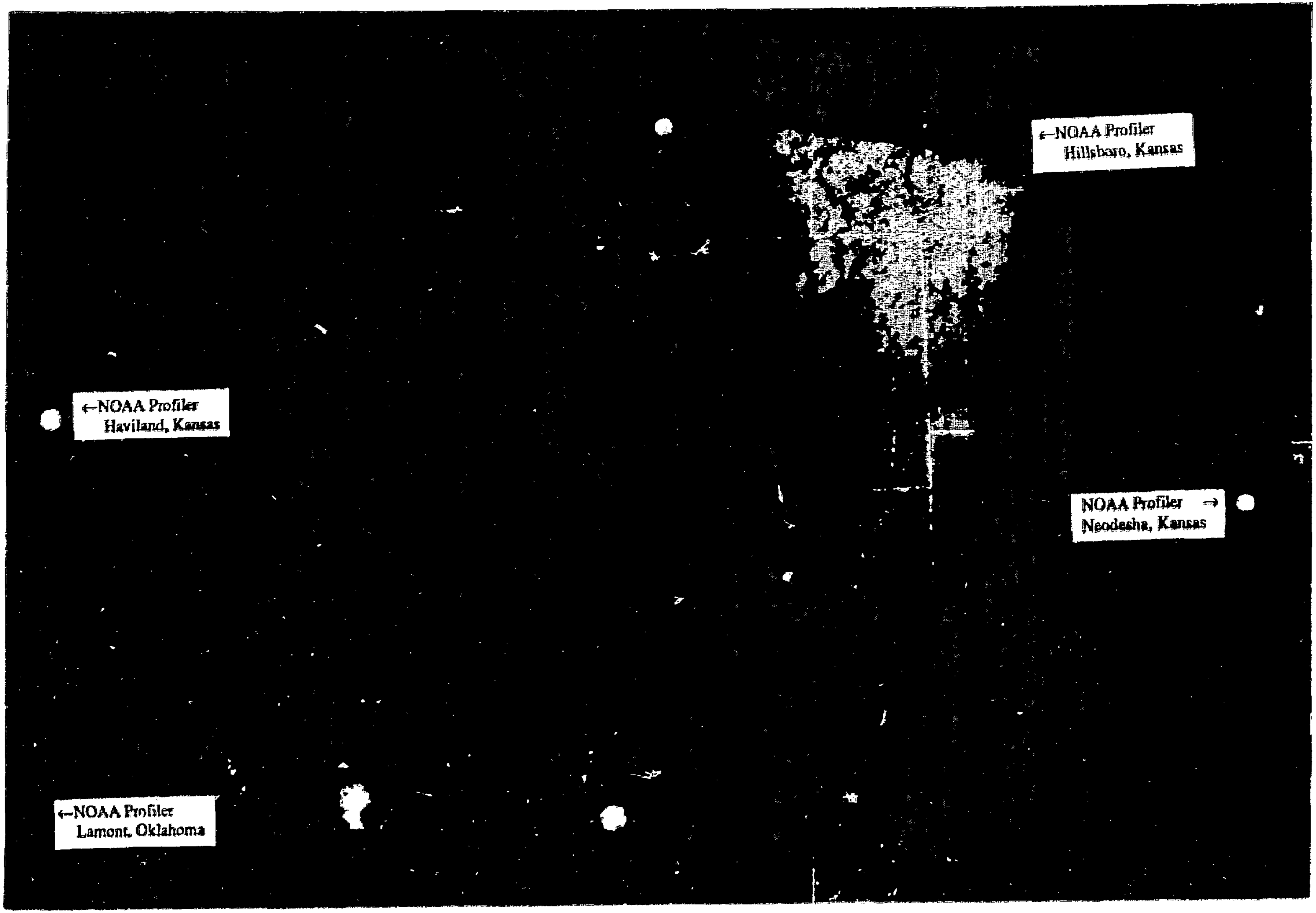

Figure A.6 Processed Land Satellite Data; Scene No. 5, Path 28, Row 34; August 18, 1988.

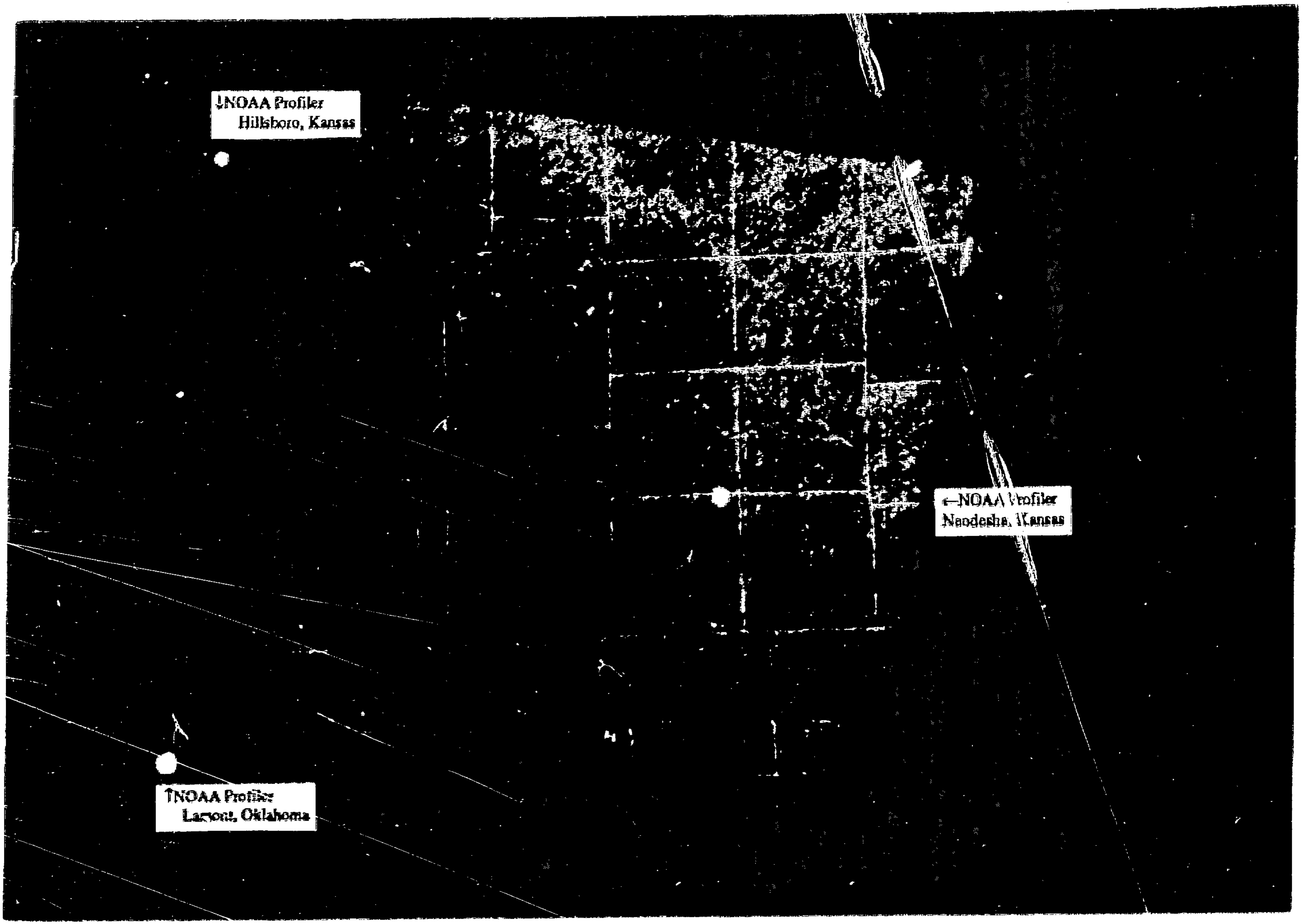

Figure A.7 Processed Land Satellite Data; Scene No. 6, Path 27, Row 34; June 27, 1988.

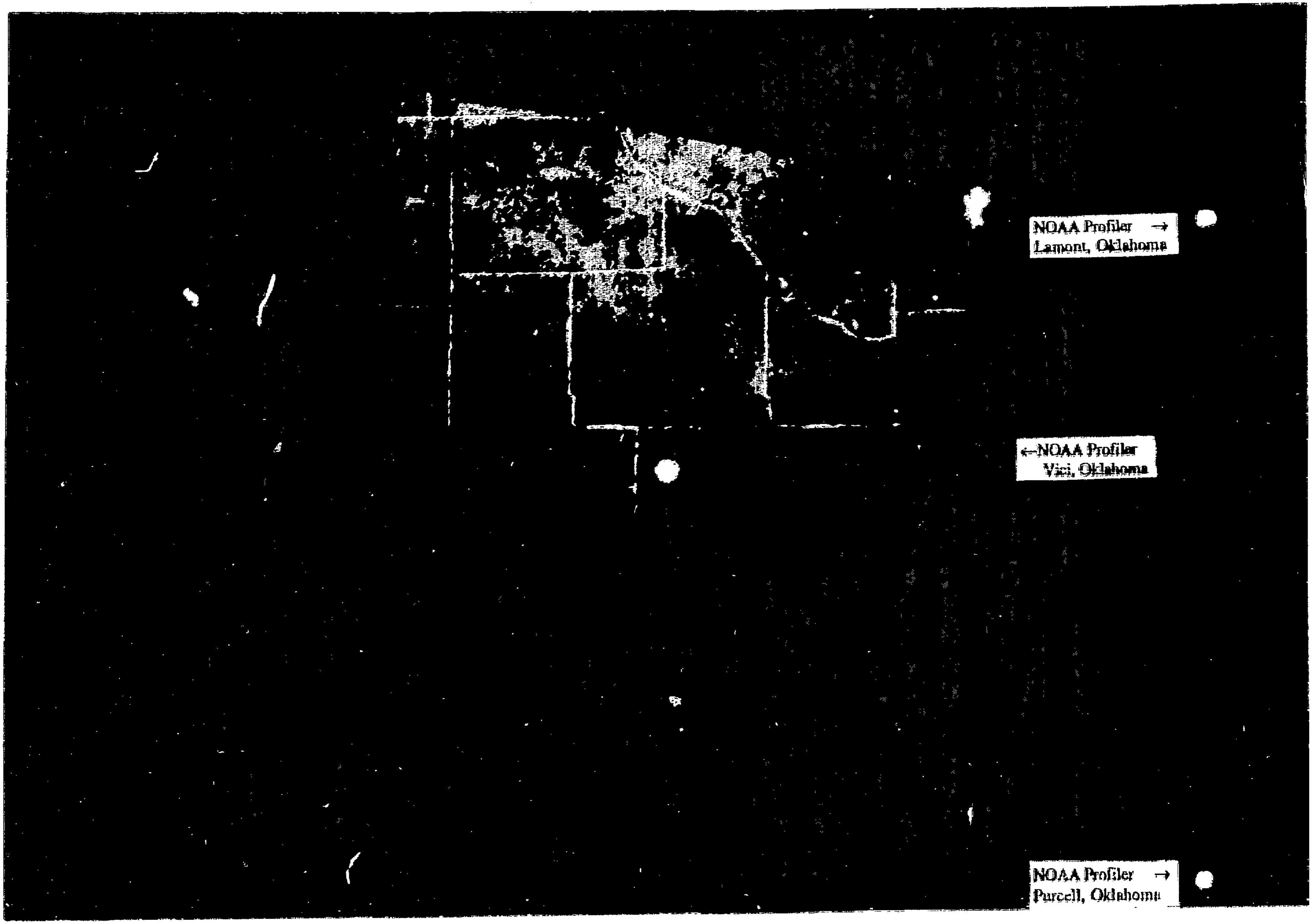

Figure A.8 Processed Land Satellite Data; Scene No. 7, Path 29, Row 35; September 8, 1988.

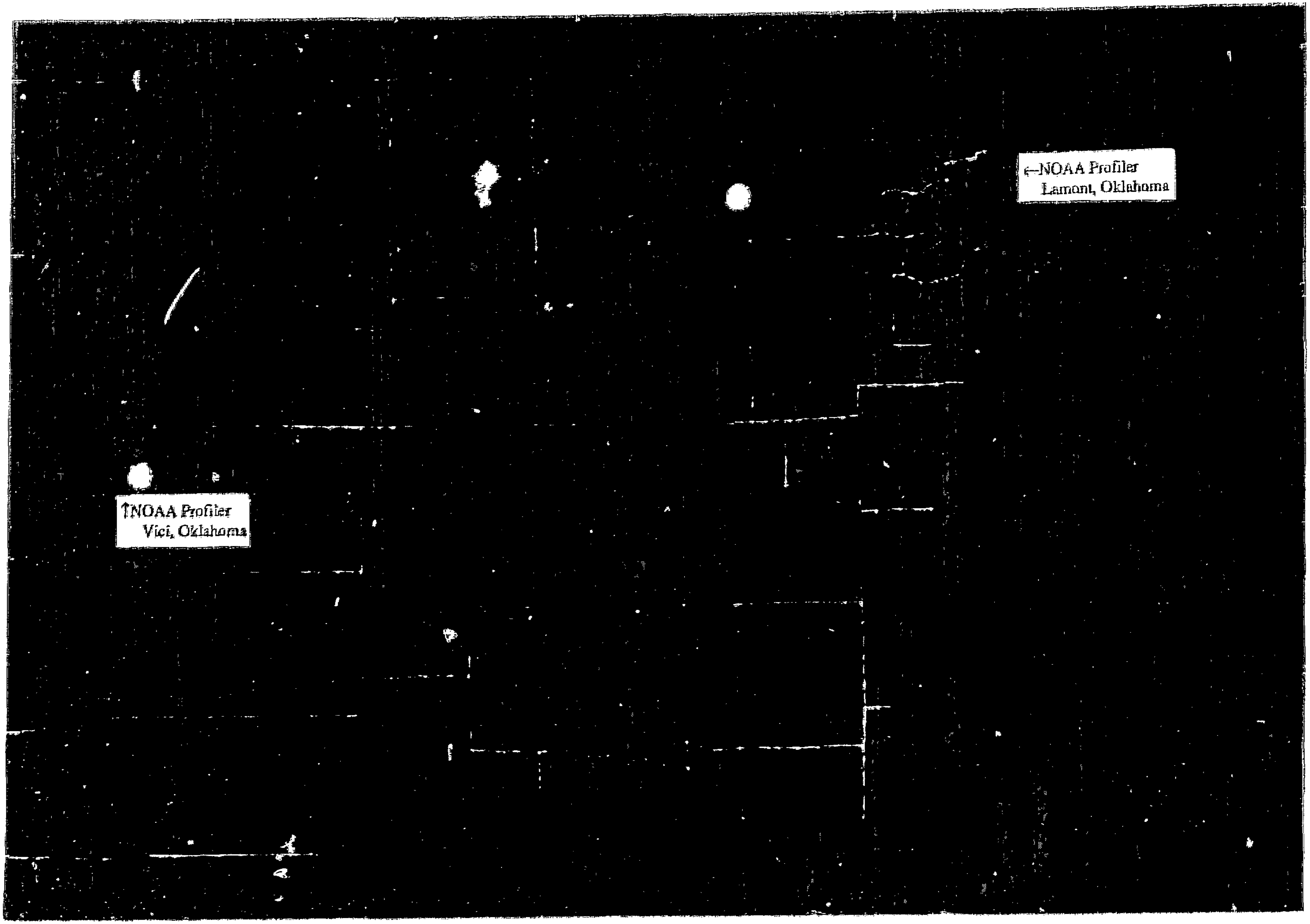

Figure A.9 Processed Land Satellite Data; Scene No. 8, Path 28, Row 35; September 29, 1989.

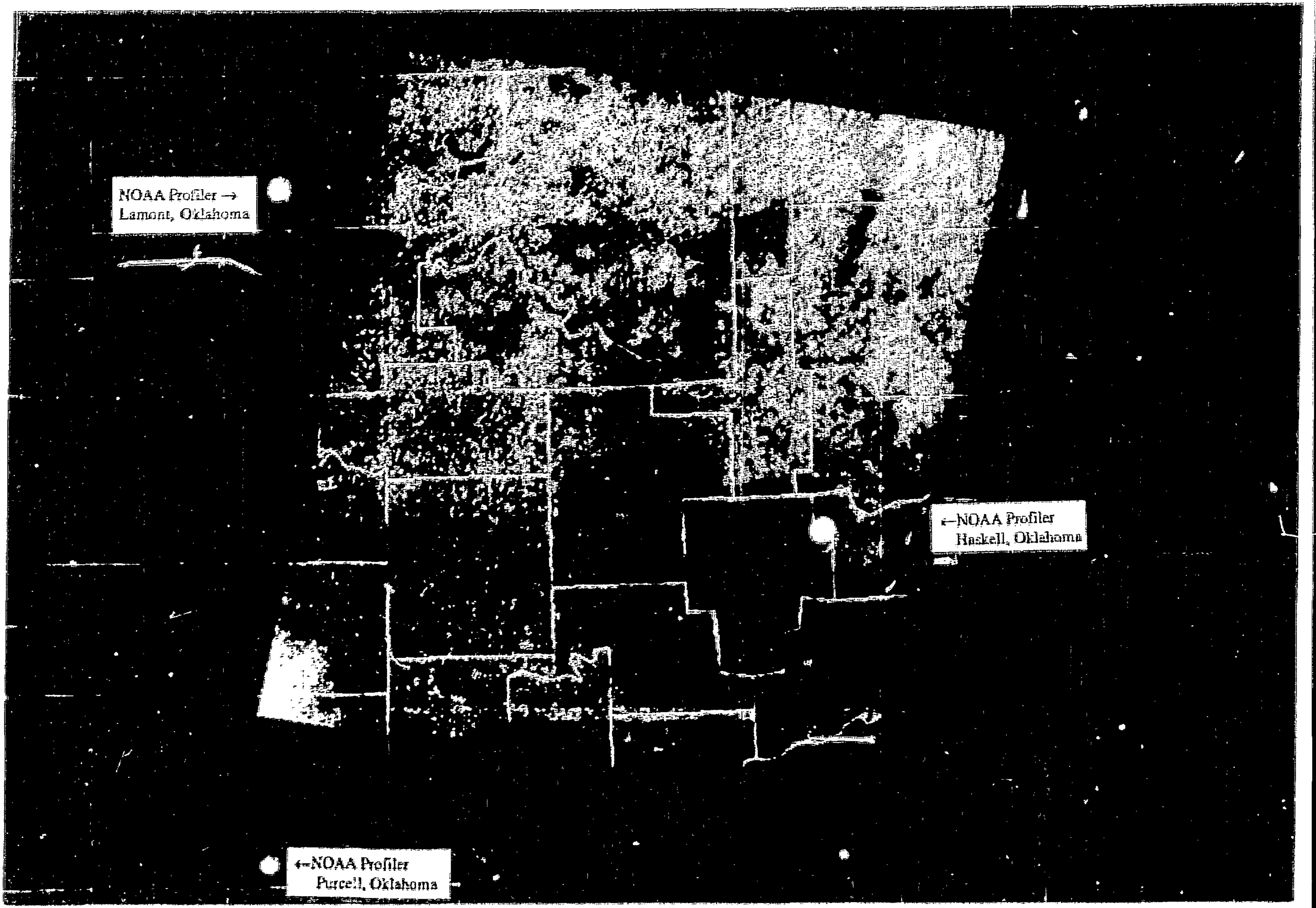

Figure A.10 Processed Land Satellite Data; Scene No. 9, Path 27, Row 35; August 26, 1988.

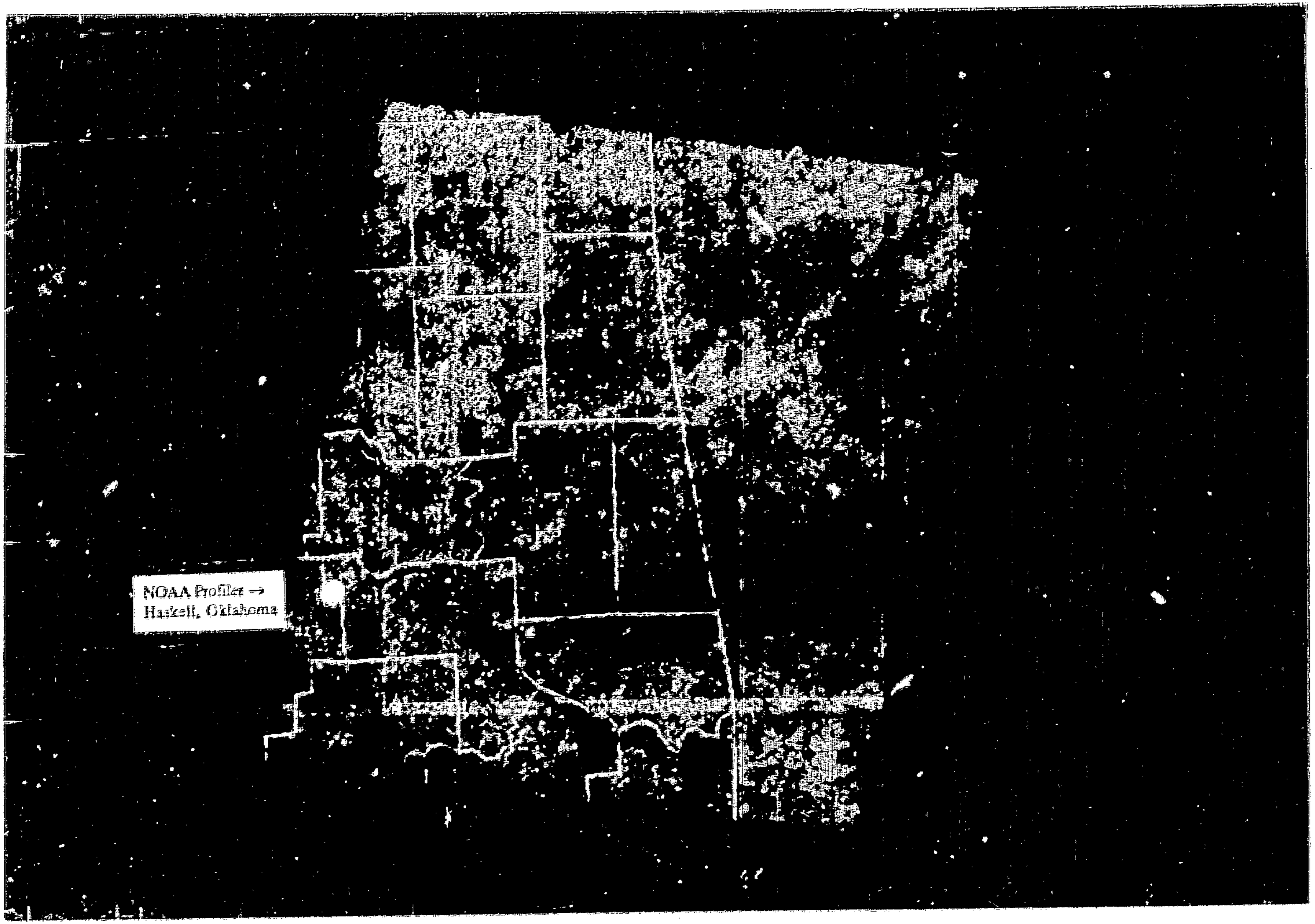

Figure A.11 Processed Land Satellite Data, Scene No. 10, Path 26, Row 35; September 20, 1988.

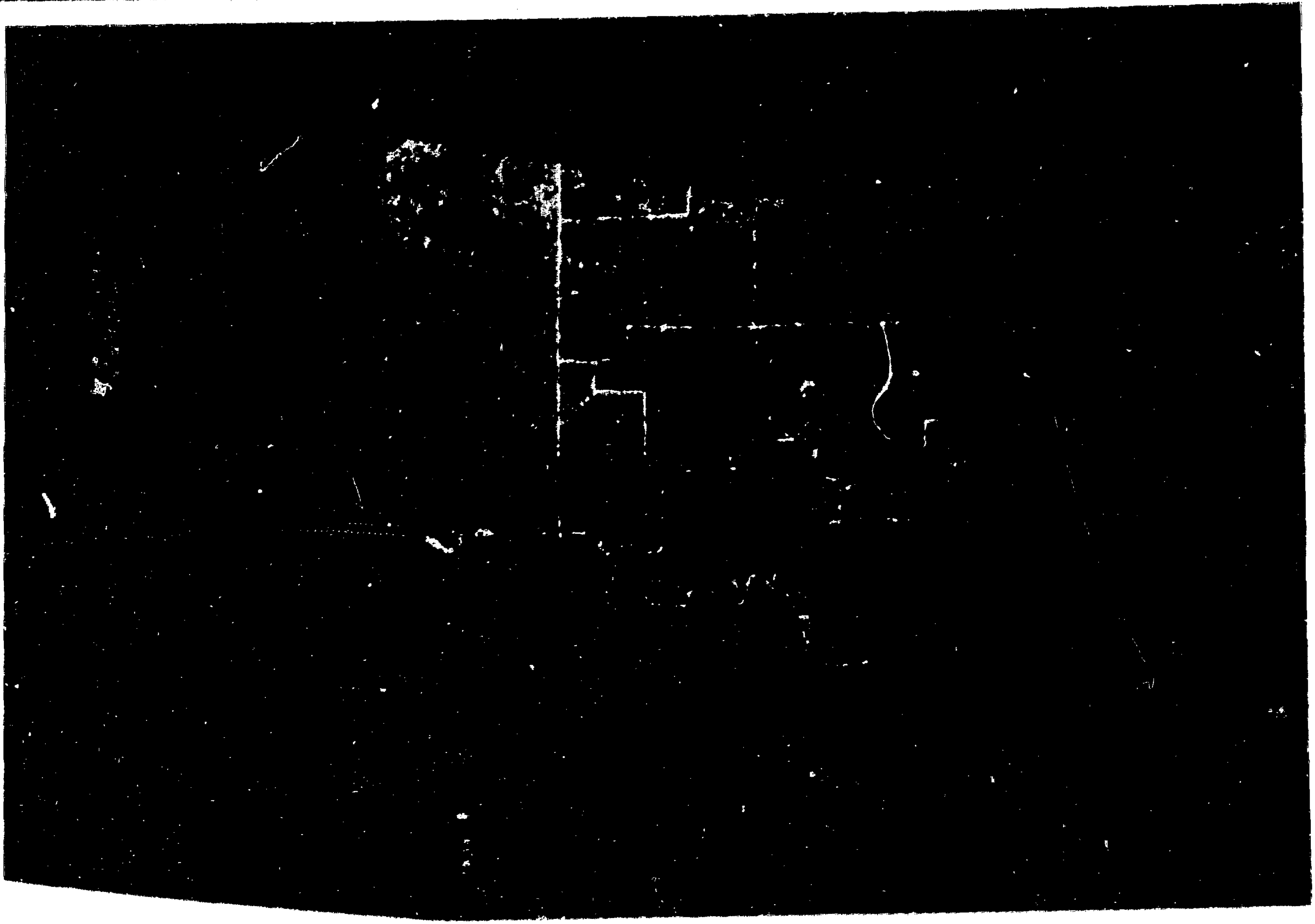

Figure A.12 Processed Land Satellite Data; Scene No. 11, Path 29, Row 36; September 9, 1988.

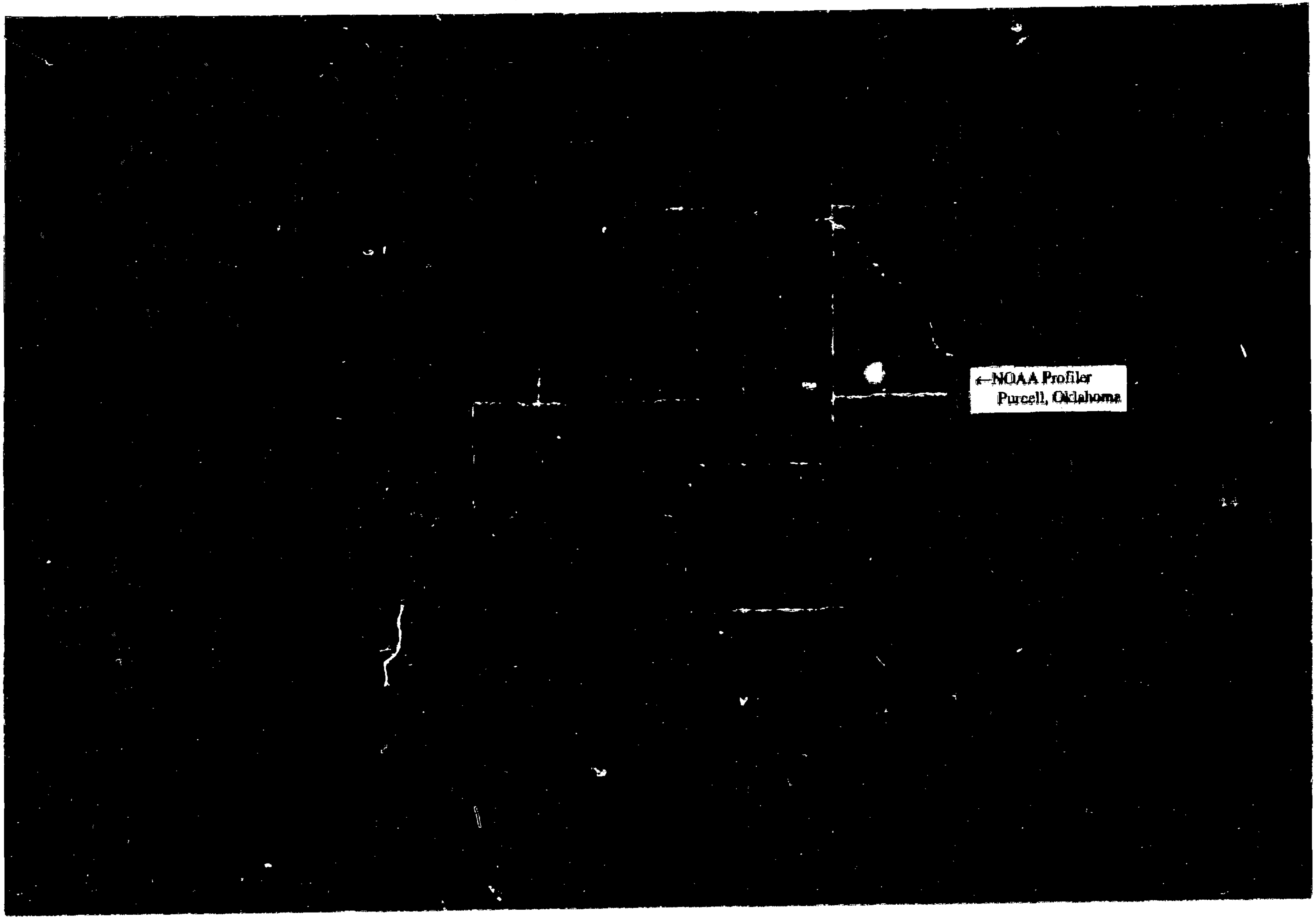

Figure A.13 Processed Land Satellite Data; Scene No. 12, Path 28, Row 36; July 19, 1989.

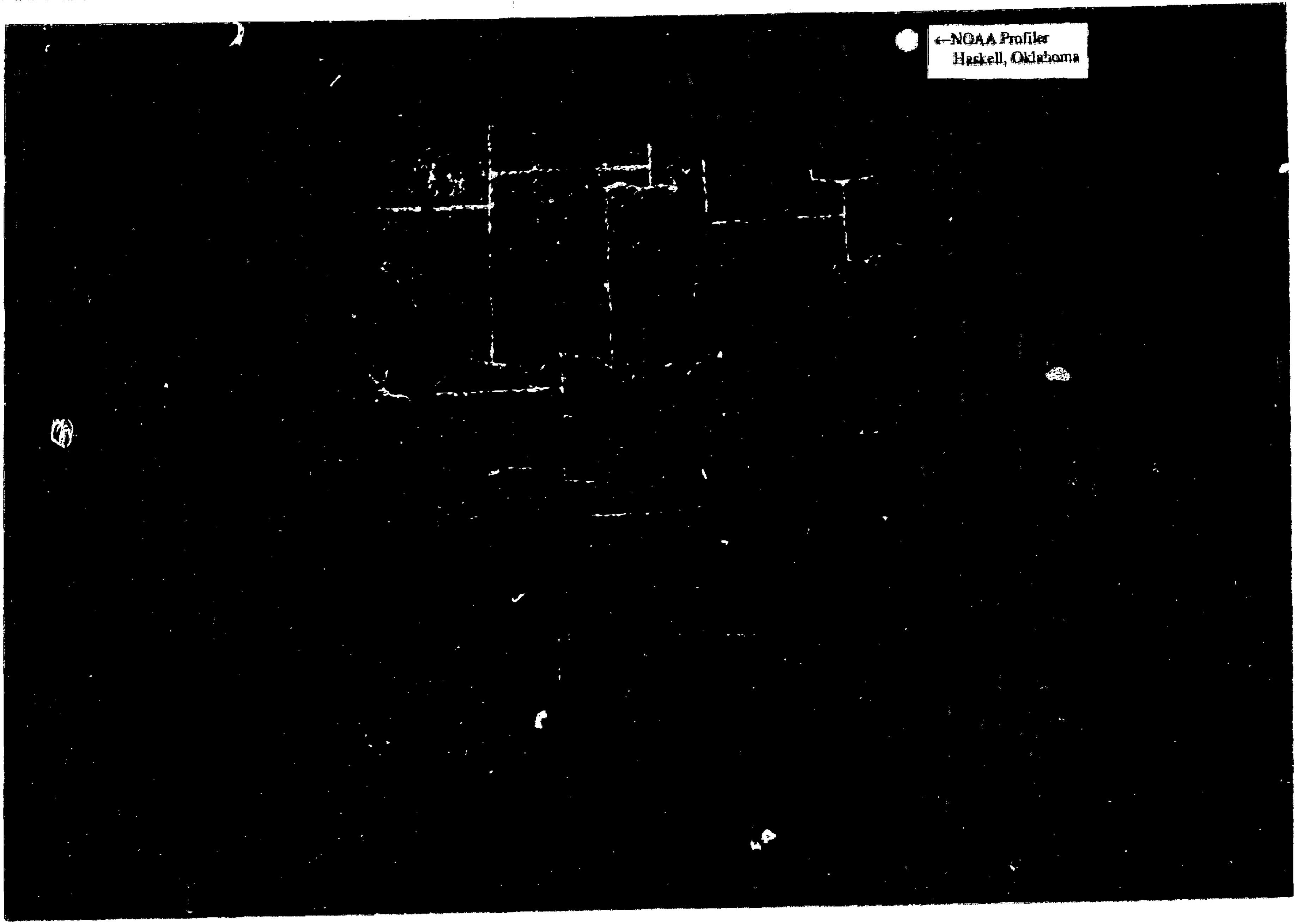

Figure A.14 Processed Land Satellite Data; Scene No. 13, Path 27, Row 36; August 5, 1989.

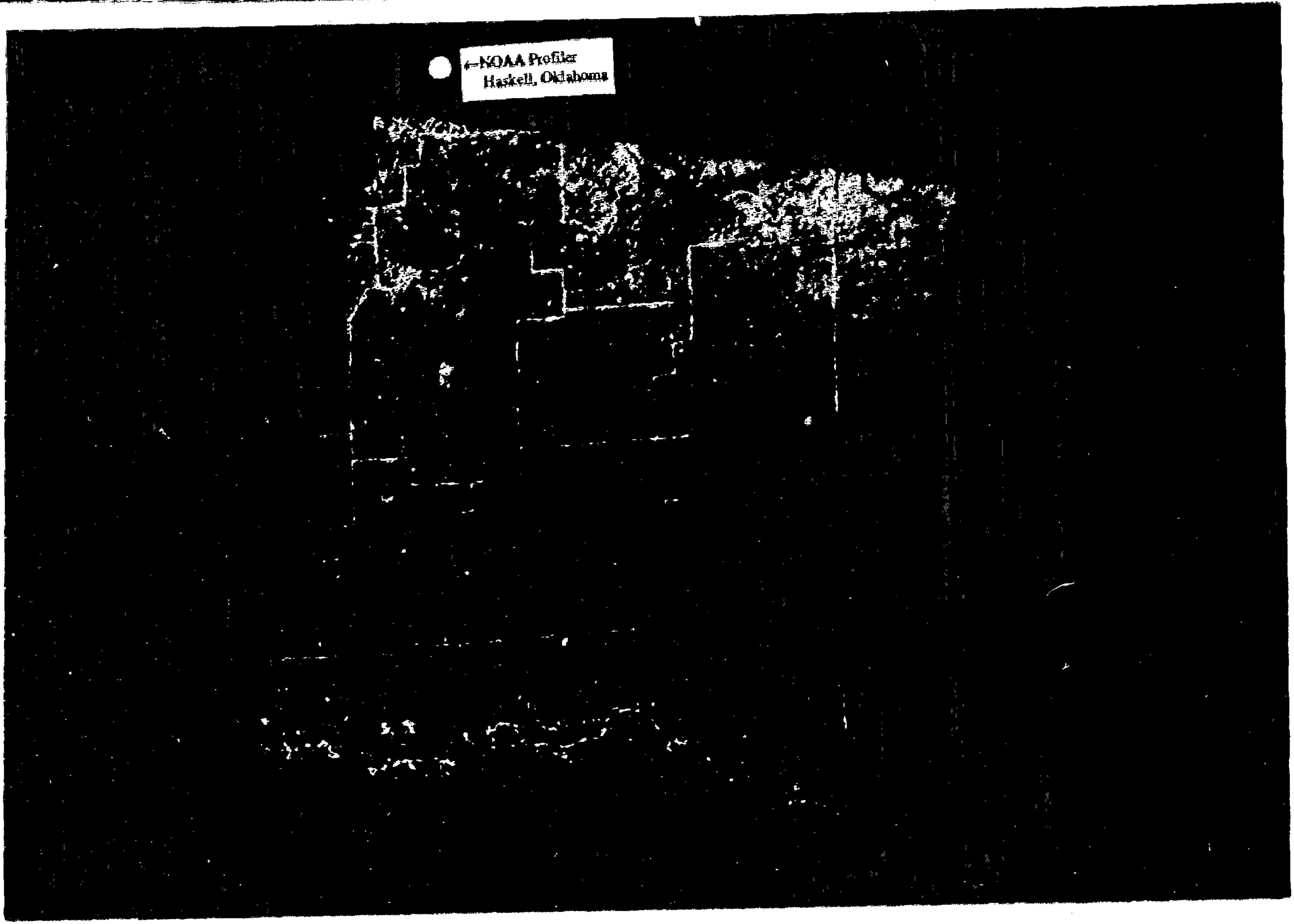

Figure A.15   Processed Land Satellite Data; Scene No. 14, Path 26, Row 36; June 19, 1989.

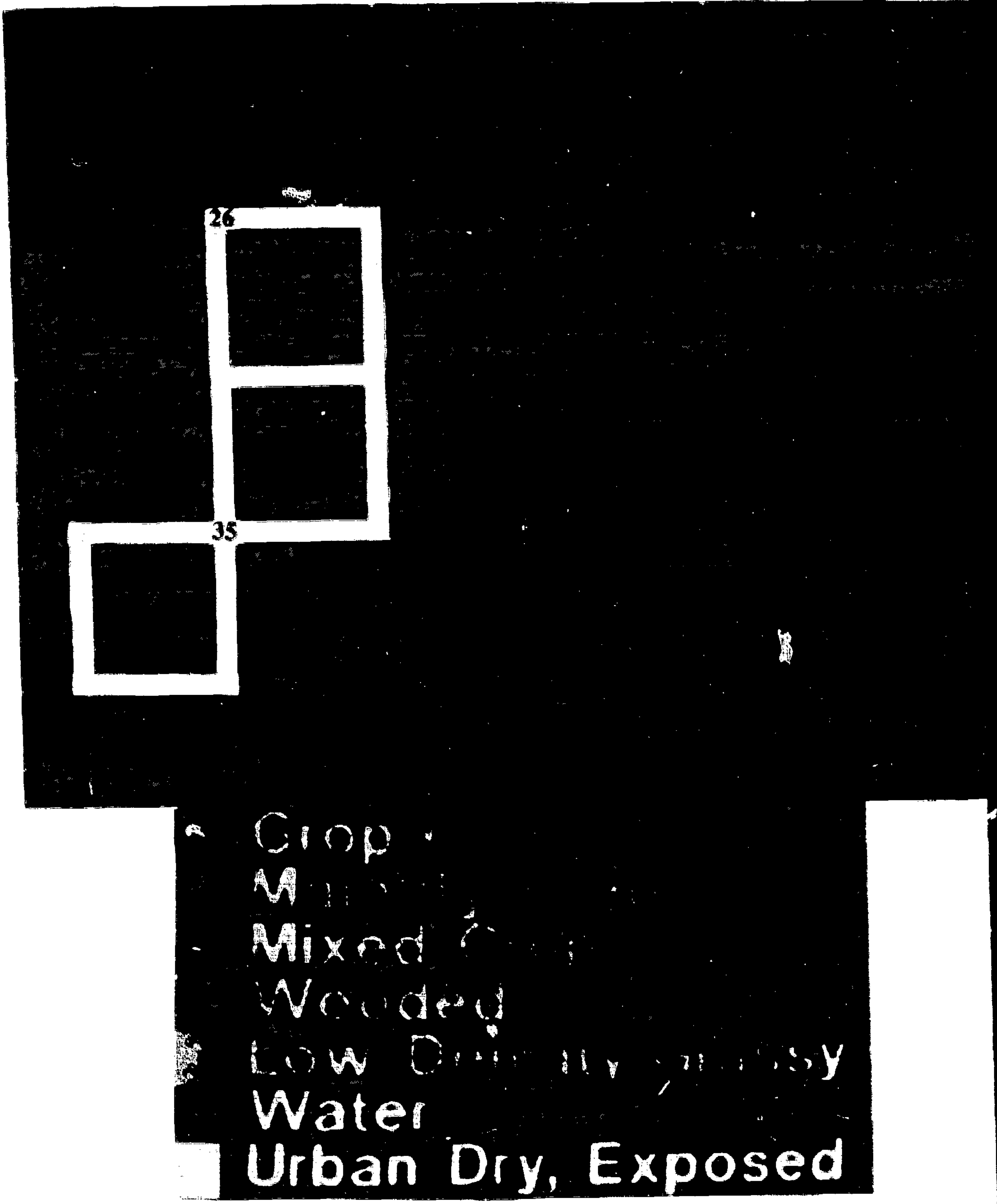

Figure A.16 Proposed location of the central facility and its two alternatives. First choice, Township 25 North, Range 3 West, Northwest 1/4 of Section 35; first alternative, Township 25 North, Range 3 West, Southeast 1/4 of Section 26; second alternative Township 25 North, Range 3 West, Southwest 1/4 of Section 35.

Appendix B

Area of Surface Disturbance and Instrument Placement for Central, Boundary, Auxiliary, and Extended Sites

Appendix B

Area of Surface Disturbance and Instrument Placement for Central, Boundary, Auxiliary, and Extended Sites

The tables in this appendix provide information about the actual surface disturbances and the space occupied by instrumentation, facilities, and fenced areas for the central, boundary, auxiliary, and extended facilities. The areas are given in square feet and acres. Totals are provided for individual facilities and also for all facilities combined within the CART conceptual study area. A detailed description of the instruments and facilities (power requirements, anticipated delivery dates, etc.) is also provided.

Table B.1 Surface Disturbances at a Typical Central Facility

	Actual Surface Disturbances (ft^2)	Space Occupied By Instrument/Facility (ft^2)	Fenced Areas (ft^2)
<u>1st Area</u>			
Microwave Radiometer	1 (4 base pads)	6	
All-Sky Camera Shelter	9	9	
Total Fence Required for 1st Area			300
<u>2nd Area</u>			
Facility[a] (7 ft x 40 ft) Housing: High-Resolution Spectrometer, and Calibration, and Ceilometer	320	280	N/A[b]
<u>3rd Area</u>			
Standard Meteorological Measurements Tower	9 (base pads)	1 [c] 1 (3 anchors)	 900 [d]
Extended Facility Broadband Radiometers Platform		1 (4 base pads)	24
Specialized Radiation Stand	1 (4 base pads)	24	
Surface Flux Station	1 (3 base pads)	32	
Total Fence Required for 3rd Area			5,625

Table B.1 (continued)

	Actual Surface Disturbances (ft^2)	Space Occupied By Instrument/Facility (ft^2)	Fenced Areas (ft^2)
<u>4th Area</u>			
Aerosol Observation Facility (8 ft x 10 ft)	90	80	N/A[b]
60-m Tower	16 (base pads)	4 [c] 96 (3 anchors)	 45,250 [d]
Total Fence Required for 4th Area			900
<u>5th Area</u>			
915-MHz RASS & Profiler	900	900	
50-MHz RASS & Profiler	62,500	62,500	
RASS & Profiler Equipment Facility (8 ft x 10 ft)	90	80	
Total Fence Required for 5th Area			90,000
<u>6th Area</u>			
RAMAN Lidar Trailer (7 ft x 40 ft)	320	280	N/A[b]
Scanning Radar Trailer (7 ft x 40 ft)	320	280	N/A[b]
Scanning Lidar Trailer (7 ft x 40 ft)	320	280	N/A[b]
<u>7th Area</u>			
Balloon Borne Sounding System Facility (8 ft x 12 ft)	132	96	
Dock/Storage Facility (consists of 15 ft x 30 ft storage area & 5 ft x 30 ft dock)	600	600	
Office/Laboratory Facility (10 ft x 60 ft)	650	650	

Table B.1 (continued)

	Actual Surface Disturbances (ft^2)	Space Occupied By Instrument/Facility (ft^2)	Fenced Areas (ft^2)
Calibration Facility (10 ft x 60 ft)	650	650	
Driveway/Parking Area (inclusive of above four items)	12,000	12,000	
Total Fence Required for 7th Area			12,000

[a] Facility used to designate either a mobile home, or portable building. The actual surface disturbance estimate exceeds the facility dimensions to compensate for tie-downs required for those cilities. These consist of concrete piers for tie-down anchors and the number varies according to the size of the trailer.

[b] N/A = not applicable.

[c] Less effective radius of guy wires.

[d] Plus effective radius of guy wires.

Table B.2 Surface Disturbances at a Typical Boundary Facility

	Actual Surface Disturbances (ft^2)	Space Occupied By Instrument/Facility (ft^2)	Fenced Areas (ft^2)
<u>1st Area</u>			
Facility[a] (7 ft x 40 ft) Housing: High Resolution Spectrometer, and Calibration and Office Area	320	280	N/A[b]
<u>2nd Area</u>			
Standard Meteorological	9 (base pads)	1[c]	
Measurements Tower		1 (3 anchors)	900[d]
Extended Facility Broadband Radiometers Platform		1 (4 base pads)	24
Surface Flux Station	1 (3 base pads)	32	
Total Fence Required for 2nd Area			5,625
<u>3rd Area</u>			
915 MHz RASS & Profiler	900	900	
50 MHz RASS & Profiler	62,500	62,500	
RASS & Profiler Equipment Facility (8 ft x 10 ft)	90	80	
Total Fence Required for 3rd Area			90,000
<u>4th Area</u>			
Balloon Borne Sounding System Facility (8 ft x 12 ft)	132	96	
Dock/Storage Facility (10 ft x 10 ft storage area & 5 ft x 10 ft dock)	150	150	
Driveway/Parking Area (inclusive of above 2 items)	2,800	2,800	
Total Fence Required for 4th Area			2,800

Table B.2 (continued)

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[a] Facility used to designate either a mobile home, or portable building. The actual surface disturbance estimate exceeds the facility dimensions to compensate for tie-downs required for those facilities. These consist of concrete piers for tie-down anchors and the number varies according to the size of the trailer.

[b] N/A = not applicable.

[c] Less effective radius of guy wires.

[d] Plus effective radius of guy wires.

Table B.3 Surface Disturbances at a Typical Auxiliary Facility

	Actual Surface Disturbances (ft^2)	Space Occupied By Instrument/Facility (ft^2)	Fenced Areas (ft^2)
All-Sky Camera Shelter	9	9	
Standard Meteorological Measurements Tower	9 (base pad)	1[a] 1 (3 anchors)	900[b]
Extended Facility Broadband Radiometers Platform		1 (4 base pads)	24
Surface Flux Station	1 (3 base pads)	32	
Total Fenced Required for Area			10,000
Scanning Lidar Trailer[c] (7 ft x 40 ft)	320	280	N/A[d]

[a] Less effective radius of guy wires.
[b] Plus effective radius of guy wires.
[c] *One of the six auxiliary facilities may have scanning lidar.*
[b] N/A = not applicable.

Table B.4 Surface Disturbances at a Typical Extended Facility

	Actual Surface Disturbances (ft^2)	Space Occupied By Instrument/Facility (ft^2)	Fenced Areas (ft^2)
Standard Meteorological Measurements Tower	9 (base pad)	1[a] 1 (3 anchors)	900[b]
Extended Facility Broadband Radiometers Platform		1 (4 base pads)	24
Surface Flux Station	1	32	
Total Fence Required for Area			5,625

[a] Less effective radius of guy wires.
[b] Plus effective radius of guy wires.

Table B.5 Total Surface Disturbances by All Facility Types and Total Surface Disturbances to the CART Study Area[a]

	Actual Surface Disturbances [ft² (acres)]	Space Occupied By Instrument/Facility [ft² (acres)]	Fenced Areas [ft² (acres)]
Central Facility	79,027 (1.83)	124,926 (2.89)	108,825 (2.52)
Boundary Facility	66,862 (1.55)	67,747 (1.57)	98,425 (2.28)
Auxiliary Facility	21[b] (0)[b] 341[c] (< 0.10)[c]	966[b] (0)[b] 1,246[c] (< 0.10)[c]	10,000 (0.23)
Extended Facility	12 (< 0.10)	957 (< 0.10)	5,625 (0.13)
CART SITE			
One Central Facility	79,027 (1.83)	124,926 (2.89)	108,825 (2.52)
Six Boundary Facilities	401,172 (9.27)	406,482 (9.39)	590,550 (13.65)
Six Auxiliary Facilities	126[b] (< 0.10)[b] 446[c] (< 0.10)[c]	5,796[b] (0.13)[b] 6,076[c] (< 0.10)[c]	60,000 (1.39)
Twenty-five Extended Facilities	300 (< 0.10)	23,925 (< 0.55)	140,625 (3.25)
Total Without Scanning Lidar	480,625[b] (11.11)[b]	561,129[b] (12.97)[b]	900,000 (20.80)
Total With Scanning Lidar	480,945[c] (11.11)[c]	561,409[c] (12.97)[c]	

[a] All totals are ± 10%.
[b] Without scanning lidar.
[c] With scanning lidar at one of six auxiliary facilities.

Table B.6 Instrument Status for Southern Great Plains

Instrument System	Instrument	Mentor	Number Needed, Location[a]	Date for Submitting Bid Specs	Number to be Ordered/ Options	Cost per Instrument	Total Costs/ Options Cost
CF and others[b]							
915-MHz Radar Wind Profiler-RASS	System	Coulter	1, CF, 1, other sites	Aug. 1991	1 / 1	150	150/ 150
50-MHz Radar Wind Profiler-RASS	System	Coulter	1, CF	Aug. 1991	1 / 0	450	450/ 0
Microwave Radiometer	System	Liljegren	1, CF; 4, EF[c]	Aug. 1991	1 / 3	125	125/ 375
Balloon-Borne Sounding System	System	Lesht	1, CF; 4, BF	Aug. 1991	1 / 5	80	80/ 400
Ceilometer for Cloud Heights	System	Griffin & Spinhirne	1, CF	Not appl.	1 / -	Not appl.	Not appl.
Raman Lidar	System	Griffin & Lapp	1, CF	1993?	1 / 0	500	500/ 0
Scanning Lidar	System	Griffin & Sassen	1, CF	1993?	1 / 0	750	750?/ 0
Scanning Radar	System	Griffin & McIntosh	1, CF	1993?	1 / 0	750	750?/ 0
60-m Tower	System	Cook	1,CF	Dec. 1991	1 / 0	80	80/ 0
Eddy Correlation Gear for Tall Tower	Multicomponent	Cook & Wesely	1, CF	Dec. 1991	1 / 0	60	60/ 0
Temp., Hum., Wind Obs. on Tall Tower	Multicomponent	Cook	1, CF	Dec. 1991	1 / 0	5	5/ 0
Aerosol Observations	Multicomponent	Laulainen &Leifer	1, CF	Dec. 1991	1 / 0	40	40/ 0
BSRN Broadband Solar and IR Sensors	Multicomponent	DeLuisi	1, CF	Dec. 1991	1 / 0	70	70/ 0
AERI	System	Griffin & Revercomb	1, CF; 4, BF	June 1992	1 / 4	90	0/ 360
Other IDP Radiometric Sensors	Systems	Griffin	Mostly CF	1993 and later	One each	?	? / -

Table B.6 (continued)

Instrument System	Instrument	Mentor	Number Needed, Location[a]	Date for Submitting Bid Specs	Number to be Ordered/ Options	Cost per Instrument	Total Costs/ Options Cost
Radiometric Sensors for Tall Tower	Multicomponent	DeLuisi	1, CF	Dec. 1991	1/0	40	40/ 0
Absolute Radiometers	each	DeLuisi	2, CF	Dec. 1991	2/0	15	30/ 0
Solar Spectroradiometer	each	DeLuisi	1, CF	Dec. 1991	1/0	20	20/ 0
UV Spectral Radiometer	System	Griffin & Harrison	1, CF	Not appl.	1/-	Not appl.	Not appl.
Calibration Facilities	Multicomponent	Hulstrom	1, CF	Dec. 1991	1/0	500	500/ 0
AF[a]							
All-Sky Imaging System	System	Thorne	1, CF; 6, AF	Dec. 1991	2/3	75	150/ 225
BF[a]							
RASS for NOAA Wind Profilers	System	Wesely	4, BF	early 1992	4	100	400/ 0
EF[a]							
Surface Meteorol. Obs. Stations	System	Hart	15, EF[a,g]	Dec. 1991	5/10	8	40/ 80
Flux Char. Sta.; EBBR	System	Whiteman	10, EF[g]	Aug. 1991	10/0	250	250/ 0
Flux Char. Sta.; Eddy Correlation	Multicomponent	Wesely & Cook	15, EF[g]	Dec. 1991	10/5	30	300/ 150
Flux Benchmarking Station	Multicomponent	Wesely & Cook	1, roving	Jan. 1991	1/0	40	40/ 0
Set of Wideband Solar and IR Sensors	Multicomponent	DeLuisi	25, EF[g]	Dec. 1991	5/5	40	200/ 200
Multifilter RSR	System	Griffin & Harrison	25, EF[g]	Not appl.	20/5	7	140/ 35

Table B.6 (continued)

Instrument System	Delivery Date/Options	Additional Procurements	Next Installation When/Where	Structures Needed	Power Needed	Comments
CF and others*						
915-MHz Radar Wind Profiler-RASS	Apr. 1992/ Dec. 1992	None for SGP	Apr. 1992/ 1, CF	50 ft^2 in shelter	0.5 kVA, AC 1f	Second unit would be a floater.
50-MHz Radar Wind Profiler-RASS	June 1992/ 0	None for SGP	June 1992/ 1,CF	50 ft^2 in shelter	2 kVA av., AC 1f,	Delivery date known only to within ± 2 months.
Microwave Radiometer	Apr. 1992/ Dec. 1992	Maybe two more for SGP	Apr. 1992/ 1, CF	None	0.1 kVA, AC 1f	Delivery date not known for certain.
Balloon-Borne Sounding System	Apr. 1992/ Dec. 1992	None for SGP	Apr. 1992/ 1, CF	Shelter provided	0.3 kVA, AC 1f, when op.	Four additional units for BFs in 1992.
Ceilometer for Cloud Heights	Sometime in 1992	None for SGP	perhaps Apr. 1992	Shelter with window	6 kVA, AC 1f	IDP project by NASA/GSFC.
Raman Lidar	Sometime in 1993?	None for SGP	1993?/ 1, CF	Must come in trailer	Unknown, much	Still early in IDP project.
Scanning Lidar	Sometime in 1994?	None for SGP	1994?/ 1, CF	Trailer	Unknown, much	Still early in IDP project.
Scanning Radar	Sometime in 1994?	None for SGP	1994?/ 1, CF	Trailer	Unknown, much	Still early in IDP project.
60-m Tower	Apr. 1992/ 0	None for SGP	Apr. 1992/ 1, CF	None	2.5 kVA, AC 1f,	Power is for elevators; otherwise about 500 W.
Eddy Correlation Gear for Tall Tower	Apr. 1992/ 0	None for SGP	Apr. 1992/ 1, CF	60-m tower	100 W, AC 1f	Consists of 2 sonics, 2 hygrometers, one computer.
Temp., Hum., Wind Obs. on Tall Tower	Apr. 1992/ 0	None for SGP	Apr. 1992/ 1, CF	60-m tower	10 W	Shares computer with previous item.
Aerosol Observations	Apr. 1992	None for SGP	Apr. 1992/ 1, CF	Trailer	1 kVA, AC 1f	Power for trailer; located near 60-m tower.
BSRN Broadband Solar and IR Sensors	Apr. 1992/ 0	None for SGP	Apr. 1992/ 1, CF	None	100 W, AC 1f	Field data acquisition System also needed.
AERI	Apr. 1992/ Feb. 1993	None for SGP	Apr. 1992/ 1, CF	Shelter with roof opening	4 kVA, AC 1f	First System is prototype provided by IDP.
Other IDP Radiometric Sensors	?	?	?/ 1, CF	Usually trailers	Unknown, much	Early in IDP projects.
Radiometric Sensors for Tall Tower	Apr. 1992 0	None for SGP	Apr. 1992/ 1, CF	60-m tower	10 W, AC 1f	Power needed for vent. and thermal control.

Table B.6 (continued)

Instrument System	Delivery Date/Options	Additional Procurements	Next Installation: When/Where	Structures Needed	Power Needed	Comments
Absolute Radiometers	Apr. 1992/ 0	None for SGP	Apr 1992/ 2, CF	Calibration facilities	10 W, AC 1f	One operated continuously and one a "shelf" reference.
Solar Spectroradiometer	Sometime in 1992/-	None for SGP	Sometime in 1992/1, CF	Calibration facilities	150 W, AC 1f	Continuous operation questionable.
UV Spectral Radiometer	Sometime in 1992	None for SGP	perhaps Apr. 1992	Frame or platform	10 W, AC 1f	USDA instrument made by SUNY Albany.
Calibration Facilities	Apr. 1992/ 0	None for SGP	Apr. 1992/ 1, CF	Two trailers and platform	2.5 kVA, AC 1f and 3f	Requires puchase of two trailers, special platform.
AF[a]						
All-Sky Imaging System	Apr. 1992/ Dec. 1992	Total of seven units needed	Apr. 1992/ 1, CF; 1, AF	None	200 W, AC 1f	Number specified in options depends on price.
BF[a]						
RASS for NOAA Wind Profilers	Sometime in 1992/-	None for SGP	Sometime in 1992/4, BF	Already exist	Not appl.	The number to be puchased by ARM is unknown.
EF[a]						
Surface Meteorol. Obs. Stations	Apr. 1992/ Sept. 1992	None for SGP	Apr. 1992/ 1, CF; 4, EF	Comes with 10-m tower	20 W, solar or AC 1f	Commercial version of PAM-like station.
Flux Char. Sta.; EBBR	Apr. & Dec. 1992/-	probably none	Apr. 1992/ 1, CF; 4 EF	None	20 W, solar or AC 1f	Five additional Systems to be installed in 1992.
Flux Char. Sta.; Eddy Correlation	Apr. & Dec. 1992/Apr. '93	None for SGP	Apr. 1992/ 4 EF	None	20 W, solar or AC 1f	Installed in tilled areas.
Flux Benchmarking Station	June 1992/ 0	None for SGP	June 1992/ 1, EF & CF	None	50 W, solar or AC 1f	Roving System for comparing to flux stations.
Set of Wideband Solar and IR Sensors	Apr. 1992/ Dec. 1992	15 more for SGP	Apr. 1992/ 1, CF; 4 EF	Frame or platform	10 W, solar or AC 1f	Power needed for vent. and thermal control.
Multifilter RSR	Apr. 1992/ Dec. 1992	None for SGP	Apr. 1992/ 1, CF; 4 EF	None	50 W, solar or AC 1f	Max. power is for thermal control in cold weather.

[a]Abbreviations: AF = Auxiliary Facility, BF = Boundary Facility, CF = Central Facility, and EF = Extended Facility.
[b]Deployment locations depend on availability of NCAR PAM-II stations and on operational readiness of Oklahoma Mesonet.
[c]Exact location of deployments depends on needs of experiments.
[d]Includes one for central facility and, as apprpriate, instruments for boundary facility locations.

Tentative List of Trailers for CART Site

(All shelters include at least 15 A, 115 V AC, for heating and cooling.)

Central Facility

One shelter, special acquisition, for 2 AERIs, other high-resolution infrared interferometers, ceilometer
Located near center of Central Facility, near array of radiometers
7 ft x 40 ft semi-trailer
Special openings in roof for all systems
At least 60 A, maybe 100 A, 115 V AC

One shelter, special acquisition, for aerosol observations, housing nephelometer, particle size sensor, filter, ozone sensor, etc.
Exact location not specified, probably near 60-m tower
8 ft x 10 ft trailer or container
Piping to outside to collect samples
50 A, 115 V AC

One shelter, special acquisition, for electronics for the profiler-RASSs
Within fence near 50-MHz and 915-MHz radar wind profiler-RASSs
8 ft x 10 ft trailer
Conduits for cables
50 A, 115 V AC

One shelter, comes with balloon-borne sounding system, for balloon-borne sounding system (in fenced area)
8 ft x 12 ft trailer
Special opening in roof for balloon release
50 A, 115 V AC

One shelter, special acquisition, dock and storage area (in fenced area)
25 ft x 30 ft storage and 5 ft x 30 ft dock
50 A, 115 V AC

One shelter, special acquisition, for calibration facility for radiometric observations (in fenced area)
10 x 60 ft mobile home
Needs optics lab, data acquisition room, work area, and a special stand, outside and perhaps above the shelter, for radiometric sensor comparisons
60 A, 115 V AC

One shelter, special acquisition, for office, laboratory area, control area (in fenced area)
10 ft x 60 ft mobile home
60 A, 115 V AC

Other future possibilities include separate shelters for Raman lidar, scanning lidar, scanning radar, each a semi of about 7 ft x 40 ft, each with 30-60 A, 115 V AC.

Boundary Facility (at each of six)

Requirements for shelters depends on instruments located at boundary facilities.

Probably one shelter (7 ft x 40 ft semi-trailer) is required with a hole in its roof to house an AERI, workshop, office area; 50 A, 115 V AC is needed.

Small shelter is required for electronics for wind profiler-RASSs if ARM needs to acquire such for the boundary facilities (as at the central facility).

Shelter is needed for balloon-borne sounding system (as at the central facility).

Storage shelter, 10 ft x 10 ft, is needed.

Appendix C

Descriptions of ARM-Related Equipment and Instruments

Appendix C

Descriptions of ARM-related Equipment and Instruments

This appendix gives a brief description of each of the instruments proposed for use by the ARM Program at the southern Great Plains CART location. Because of the interest in the ARM Program in data throughout the troposphere (depth 12-15 km), much of the instrumentation involves remote probing. Other, direct measurement sensors will be mounted on small towers. Remote sensing systems may be classified as active or passive. Active systems illuminate the object of study with their own supplied energy, whereas passive systems sense naturally occurring (emitted thermal or reflected solar) radiation. A passive system is inappropriate at wavelengths at which insignificant amounts of radiation occur naturally. An active system may not be technically feasible if too much power must be radiated in order to obtain a measurable reflected signal.

C.1 915-MHz Radar Wind Profiler and RASS Systems

The 915-MHz wind profiler system is a continuously operating radar that emits an upward microwave signal at 915-MHz. The Doppler shift tin the reflected signal frequency is measured as a function of altitude. The amount of shift can be used to determine a profile of wind speed and direction. Although this radar is designed to transmit the signal vertically, side lobes are emitted horizontally. However, these side lobes are mitigated easily by a simple fence that encompasses the radar antenna, and they do not pose safety problems for personnel. Operated in conjunction with the microwave radar, a RASS provides further meteorological information. The vertically pointing RASS (up to three transmitters/receivers that operate simultaneously) emits sound pulses in the range of 1500-2000 Hz for 5-6 min 30 or 60 min. The sound pulses can be tracked by the radar and analyzed to determine virtual temperature as a function of height. In a moist atmosphere, the virtual temperature is the temperature of dry air having the same density and pressure as the moist air. An independent profile of temperature like that from balloon-borne systems allows, in principle, the amount of moisture (a critical parameter to be measured in the ARM Program) in the atmosphere to be determined as a function of height. The RASS also produces horizontal side lobes; these are mitigated to non-annoying noise levels by sound baffles and distance criteria in siting. Because both the microwave signal and the sound pulses are significantly attenuated in the lower atmosphere, this radar and the RASS system is used to investigate wind speed, wind direction, and virtual temperature only from about 100 m above the surface to heights of about 1-2 km.

C.2 The 50-MHz Wind Profiler and RASS Systems

The 50-MHz wind profiler and RASS system is similar in concept to the 915-MHz and RASS radar system, except that the microwave signal is 50-MHz, and the sound pulses are at 50-100 Hz. However, this microwave signal and the sound pulses (up to three transmitters) are less attenuated in the lower atmosphere and are used to investigate wind speed, wind direction, and virtual temperature through the entire atmosphere depth of 12-15 km. However, because of the longer pulse wavelengths, the signals are not resolvable much below 2 km. Furthermore, the horizontal component of the sound pulses at the lower sound frequency is more difficult to mitigate. Mitigation is usually accomplished by using more rigorous siting criteria.

C.3 Balloon-borne Sounding System

A large helium-filled balloon carries a small (55 x 147 x 90 mm), lightweight (260 grams, with battery) battery-operated instrument package that transmits temperature, humidity, wind direction, and wind speed information as a function of pressure altitude. The balloon carries the instrument package up to about 30-40 km, depending upon the balloon size. Similar systems are routinely used by the National Weather Service. The instrument package is returned safely to the surface by parachute after the balloon bursts.

C.4 60-m Tower Instruments

Towers are the standard platforms for continuous meteorological investigations of the lowest 100 m of the atmosphere. Standard meteorological instruments will be used to measure wind speed and direction, temperature, humidity, pressure, downwelling radiation (the sun's radiant energy that reaches the earth's surface), and upwelling radiation (the sun's radiant energy that is reflected upward by the surface). These measurements will be made at the 25-m and 60-m levels.

C.5 10-m Standard Meteorological Measurement Tower

Standard meteorological instruments are used to measure wind speed and direction, air and soil temperature, humidity, pressure, and rain rate. The instruments require little power and could be operated by solar power.

C.6 Surface Flux Station

Standard meteorological instrumentation (Bowen ratio method) is used to determine the net rate (flux) over about 30-60 min of the gain or loss of temperature, moisture, and momentum at the earth's surface. The individual instruments are mounted on a platform about 1-3 m above the surface. These instruments require little power and can be operated by solar power. Another method for flux measurements is by eddy correlation technique. Again, standard meteorological instrumentation is used, but the platform height for the sensors is 3-10 m. Standard power is also required.

C.7 Passive Microwave Radiometer

The vertically pointing passive microwave radiometer passively measures the amount of naturally occurring, thermally generated microwave radiation in the atmosphere at certain wavelengths in the infrared radiation bands corresponding to atmospheric water.

C.8 Ceilometer

An eye-safe laser light source is used to transmit a narrow-beam, pulsed light source vertically. The ceilometer is used to measure heights of cloud bases from the time between transmission and reception of the reflected light pulse. This instrument is similar to that used by the National Weather Service to determine cloud base heights, except that the more powerful ceilometer being considered for the ARM Program is capable of determining cloud base heights of higher clouds such as cirrus (approximately 10 km).

C.9 Whole-Sky Imaging

A vertically pointing camera takes pictures of clouds with a wide angle lens. Instead of film, a high-density matrix of light-sensitive cells converts pictures into electronic images that, in conjunction with other whole-sky cameras and a computer, can produce three-dimensional images of clouds.

C.10 Lidar

A LIDAR (LIght Detection And Ranging) transmits a pulse of narrow-beam laser light (usually infrared radiation) into the atmosphere and detects the reflection some time later. By measuring the time delay and knowing the speed of propagation of the light pulse, the height of the reflecting elements can be determined. Small particles (including small water droplets and ice crystals) in the atmosphere are efficient lidar-reflecting elements. These particles follow wind motions; therefore, some lidars can determine wind speed and direction. Some lasers are eye safe, but others are not. The ARM Program will use both types. The non eye-safe laser is operated in a safe manner by using a small radar with a wider microwave beam than the laser beam. As any object comes into the path of the microwave beam, the power is automatically shut off to the laser light until the radar indicates that the object is clear. Lidars reaching to the top of the troposphere (10-12 km) have large power requirements.

C.11 Radar

A RADAR (RAdio Detection and Ranging) is an instrument used for the detection and ranging of distant "objects" that reflect radio-wave energy. The frequency or time relationships between the transmitted signal and the echo are used to determine the location of the reflecting elements, including particles carried by wind and all forms of precipitation (rain, sleet, hail, ice crystals, etc.). Radars can be used in a vertical pointing mode or in a scanning mode. The National Weather Service uses "weather" radars that show the location and movement of precipitation. The ARM Program will employ similar radars for its studies.

C.12 Specialized and Broadband Radiometers

A number of different types of solar radiation instruments (such as pyranometers, pyrgeometers, shadow-band radiometers, high-resolution spectrometers, etc.) to be used by the ARM Program operate similarly. Incoming and outgoing solar radiation is passively determined by measuring the amount of electrical power required to equalize the temperature of a known source and the temperature of a blackened (heat adsorbing) metal strip heated by the sun (incoming) or the reradiance and/or reflection of the sun's energy by the surface (outgoing). Therefore, radiometers are passive measurement instruments. Total solar radiation is a combination of direct and diffuse sunlight. Diffuse sunlight is determined by shielding the radiometer from direct sunlight to measure the general brightness of the sky. Broadband radiometers integrate solar radiation over many wavelengths. Specialized radiometers look at solar radiation through very narrow ranges of wavelengths that are important in the determination of the effect of water vapor (humidity) on total solar radiation.

C.13 Air Pollution Instrumentation

Various instruments measure particles (integrating nephelometers, optical particle analyzers, etc.) and gases (ozone, carbon dioxide, etc.) by drawing outside air into the instrument for collection and/or analysis.

Appendix D

Letters from Consulting Agencies

Oklahoma Historical Society Founded May 27, 1893

STATE HISTORIC PRESERVATION OFFICE
621 N. ROBINSON, SUITE 375 • OKLAHOMA CITY, OK 73102 • (405) 521-6249

November 12, 1991

Mr. Jack Pfingston
Environmental Assessment Division
ARGONNE NATIONAL LABORATORY
9700 S. Cass Ave.
Argonne, Illinois 60439

RE: File #0127-92; Dept. of Energy ARM Program; Garfield & Grant Counties, Oklahoma

Dear Mr. Pfingston:

We have received and reviewed the documentation submitted concerning the referenced project.

Examination of historic resource files in this office finds no properties documented within the project area that meet the criteria for listing on the National Register of Historic Places. Our research indicates that there is little likelihood such historic properties will occur.

In addition to review by this office, a review focusing on prehistoric resources by the Oklahoma Archeological Survey is required for determining the presence of National Register quality prehistoric sites. Documentation on any historic archaeological site discovered in the course of archaeological surveys should be submitted to the State Historic Preservation Office for review. This is an integral part of the Section 106 process.

Should the Oklahoma Archeological Survey conclude that there are no prehistoric archaeological sites of National Register quality, and should no historic site have been discovered in the process of survey, the State Historic Preservation Office finds no properties eligible for the National Register of Historic Places within the referenced project boundaries.

Should further correspondence pertaining to this project be necessary, the above underlined file number must be referenced. If you have any questions, please contact Mr. Marshall Gettys, Historical Archaeologist, at 405/521-6249. Thank you.

Sincerely,

Melvena Heisch

Melvena Heisch
Deputy State Historic
Preservation Officer

MH:pm

The University of Oklahoma

OKLAHOMA ARCHEOLOGICAL SURVEY
1808 Newton Drive
Norman, Oklahoma 73019-0540
(405) 325-7211

November 19, 1991

Jack Pfingston
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Re: Atmospheric Radiation Measurement (ARM) Program, proposed boundary facility locations and revised alternate location for central facility; Grant, Okmulgee, McClain, and Woodward Counties, Oklahoma

Dear Mr. Pfingston,

The above referenced project has been reviewed by the Community Assistance Program staff of this agency to identify potential areas that may contain prehistoric or historic archaeological materials. The location of your project has been cross-checked with the state site files containing approximately 13,000 archaeological sites which are currently recorded for the State of Oklahoma. No prehistoric or historic sites are recorded in or near your project area. For most of the quarter sections you asked us to review, there is little likelihood for archaeological sites to occur, and no archaeological work is recommended at this time. For Boundary Facility #2, archaeological survey before construction may be necessary, depending on the location(s) chosen for construction (see enclosed copy from Criner 7.5 quadrangle map). The enclosed table summarizes the locations reviewed and our recommendations.

I have enclosed a list of contract archaeologists who can do the field survey if necessary. Please call us if there are any questions.

This environmental review and evaluation is performed in order to locate, record, and preserve Oklahoma's prehistoric and historic cultural heritage in cooperation with the State Historic Preservation Office, Oklahoma Historical Society. Thank you for your cooperation.

Sincerely,

Francie Gettys
Staff Archaeologist

Robert L. Brooks
State Archaeologist

cc: SHPO

encl: table
map
list of contractors

The University of Oklahoma

OKLAHOMA ARCHEOLOGICAL SURVEY
1808 Newton Drive
Norman, Oklahoma 73019-0540
(405) 325-7211

December 17, 1991

Jack Pfingston
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Re: Atmospheric Radiation Measurement Program, proposed boundary facility near center, N½, Section 21, T 6 N, R 3 W; McClain County

Dear Mr. Pfingston,

We have completed the field survey for the project referenced above. No prehistoric materials were found, and no historic features will be disturbed by the proposed construction (although the existing farmstead is old enough to be considered a historic site). No further archaeological work is recommended for the ridge in the center of the north half, Section 21. If your land use plans should change and if it becomes necessary to disturb the land closer to the streams (shown in orange on the map sent with our letter dated November 19, 1991), please let us know the exact location and we will decide at that time whether additional field survey is necessary.

If there are any questions, please call us. Thank you for your cooperation and assistance.

Sincerely,

Francis Gettys
Staff Archaeologist

Robert L. Brooks
State Archaeologist

cc: SHPO

KANSAS STATE HISTORICAL SOCIETY

HISTORIC PRESERVATION DEPARTMENT
Center for Historical Research
120 West Tenth * Topeka, Kansas 66612-1291
913-296-7030 * FAX 913-296-1005

November 19, 1991

Jack Pfingston
Social and Natural Resources Section
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Re: Atmospheric Radiation Measurement Program
Boundary Site Locations in Kansas

Dear Mr. Pfingston:

Staff review of the three proposed boundary facility locations, and their alternates, located in Kiowa, Marion, and Montgomery counties has been completed. There are no properties listed on the National Register of Historic Places, nor any historical or archeological sites listed in the state inventory located within any of the proposed boundary facilities or their alternates. All potential boundary facility locations, except for proposed Boundary Facility #2 in Marion County, are in areas of low potential for discovering the surface indications of prehistoric archeological sites and no archeological survey should be needed. The lower elevations of the SW 1/4, Section 14, T20S, R1E along Rocky Creek have never been surveyed, but, based upon an analysis of recorded prehistoric sites in the region, it appears there is a potential for prehistoric archeological sites to be located there. We wish to review the specific location of the boundary facility within the one-quarter section, if this location is chosen.

If you have questions or need additional information, please contact Mr. Martin Stein at 913 296-5294.

Sincerely yours,

Ramon Powers
State Historic Preservation Officer

Richard Pankratz, Director
Historic Preservation Department

RP/ms

KANSAS STATE HISTORICAL SOCIETY

HISTORIC PRESERVATION DEPARTMENT
Center for Historical Research
120 West Tenth * Topeka, Kansas 66612-1291
913-296-7080 * FAX 913-296-1005

December 2, 1991

Jack Pfingston
Social and Natural Resources Section
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Re: Atmospheric Radiation Measurement Program
Boundary Site Locations in Kansas

Dear Mr. Pfingston:

Staff review of the three proposed boundary facility locations, and their alternates, located in Kiowa, Marion, and Montgomery counties has been completed. There are no properties listed on the National Register of Historic Places, nor any historical or archeological sites listed in the state inventory located within any of the proposed boundary facilities or their alternates. All potential boundary facility locations, except for proposed Boundary Facility #2 in Marion County, are in areas of low potential for discovering the surface indications of prehistoric archeological sites and no archeological survey should be needed. The lower elevations of the SW 1/4, Section 14, T20S, R1E along Stony Brook have never been surveyed, but, based upon an analysis of recorded prehistoric sites in the region, it appears there is a potential for prehistoric archeological sites to be located there. If the facility is located above 1450 feet MSL no archeological survey will be needed. If construction takes place below the 1450 foot contour line, we recommend an archeological survey be done. We understand construction of the facility will take place on the higher ground and we have no objection to that.

If you have questions or need additional information, please contact Mr. Martin Stein at 913 296-5294.

Sincerely yours,

Ramon Powers
State Historic Preservation Officer

Richard Pankratz, Director
Historic Preservation Department

RP/ms

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
Kansas State Office
315 Houston, Suite E
Manhattan, Kansas 66502

October 23, 1991

Jack Pfingston
Environmental Assessment and Information
Sciences Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Pfingston:

This is in response to your October 15, 1991 letter requesting threatened and endangered species information relative to your proposed Atmospheric Radiation Measurement Stations in Kansas and Oklahoma. The following information is provided for your consideration.

In accordance with Section 7(c) of the Endangered Species Act (16 U.S.C. 1531 et seq.), we have determined that the following federally listed species may occur in the project area: piping plover (Charadrius melodus), least tern (Sterna antillarum), bald eagle (Haliaeetus leucocephalus), peregrine falcon (Falco peregrinus), whooping crane (Grus americana), black-footed ferret (Mustela nigripes), Neosho madtom (Noturus placidus), pallid sturgeon (Scaphirhynchus albus), Mead's milkweed (Asclepias meadii), and western prairie fringed orchid (Platanthera praeclara). Cheyenne Bottoms Wildlife Area in Barton County, and Quivira National Wildlife Refuge in Stafford County are federally-designated critical habitat for the whooping crane. If the project may affect listed species, the Department of Energy should initiate formal Section 7 consultation with this office. If there will be no effect, or if the Fish and Wildlife Service concurs in writing there will be beneficial effects, further consultation is not necessary. I am enclosing habitat and locational information for all federally listed and proposed species in Kansas, which should prove useful in an assessment of the potential for impacts.

I am also enclosing a list of the category 1 and 2 candidate species which may occur in the project area. Category 1 species are those for which sufficient information exists to support a listing. Category 2 species are those for which the Service is seeking additional information in order to determine their biological status, to facilitate any decisions regarding their potential for listing. Candidate species have no legal protection under the Endangered Species Act; however, the Service is concerned for their conservation due to their uncertain status. The extent to which certain candidate species may be impacted by this project will depend upon final site selection.

Please be apprised of the potential application of the Migratory Bird Treaty Act of 1918 (MBTA), as amended, 16 U.S.C. 703 et seq. and the Bald Eagle Protection act of 1940 (BEPA) as amended, 16 U.S.C. 668 et seq., to your project. The MBTA does not require intent to be proven and does not allow for "take," except as permitted by regulations . . . it shall be unlawful at any time, by any means or in any manner, to . . . take, capture, kill, attempt to take, capture, or kill, possess . . . any migratory bird, any part, nest, or eggs of any such bird . . ." The BEPA prohibits knowingly taking, or taking with wanton disregard for the consequences of an activity, any bald or golden eagles or their body parts, nests, or eggs, which includes collection, molestation, disturbance, or killing activities. Please contact this office if you have any questions.

We further recommend that all construction areas be surveyed for the presences of marshes, river floodplains, and other wetland habitat types. If impacts to these areas are expected, a permit may be required from the U.S. Army Corps of Engineers. If a permit is required, the Service would review the application and provide recommendations.

Thank you for this opportunity to provide input on your proposal.

Sincerely,

William H. Gill

William H. Gill
State Supervisor

Enclosures
cc: FWS/FWE, Denver, Co (Section 7 Coordinator)
KDWP, Pratt, KS (Environmental Services)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Kansas State Office
315 Houston, Suite E
Manhattan, Kansas 66502

TAKE PRIDE IN AMERICA

November 25, 1991

Jack Pfingston
Environmental Assessment and
Information Sciences Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Pfingston:

This is in response to your November 7, 1991 letter and November 22, 1991 facsimile transmission to Dan Mulhern of this office, regarding the proposed Atmospheric Radiation Measurement Program in Kansas and Oklahoma. The following threatened and endangered species information is provided relative to your alternative project sites in southern Kansas.

It appears from the site descriptions you provided that all alternatives occur in upland areas, with no stream or river impacts. From this we would concur that there is probably little potential for impact to any federally-listed species from any of the sites you indicated in Marion or Montgomery County. This is also dependent upon there being no impacts to any marshes or other wetland habitats, or any areas of native tallgrass prairie. These two counties each may contain populations of the prairie mole cricket, occupying native prairie sites. This insect previously had been proposed for federal listing, but recent field surveys have led to this proposal being withdrawn. However, it is still a candidate species for which the Service is concerned due to population declines.

In Kiowa County, any wetlands may possibly provide temporary stopover habitat for the whooping crane. If rangeland containing at least 80 acres of prairie dog towns is to be impacted, this would require a black-footed ferret survey prior to any construction. If cropland is the only land use to be affected, we would not anticipate any adverse effects to any listed species.

Other category 2 candidate species which may occur in either grassland or woodland in these three counties include the eastern spotted skunk, ferruginous hawk, loggerhead shrike, Henslow's sparrow, Baird's sparrow, Texas horned lizard, regal fritillary butterfly, earleaf foxglove, and hairy false mallow. While candidate species have no legal protection under the Endangered Species Act, the Service is concerned for their conservation due to their uncertain population status.

If you have additional questions, please do not hesitate to contact our office again. Thank you for providing us this opportunity to comment on your proposed project.

Sincerely,

William H. Gill

William H. Gill
State Supervisor

DWM/WHG/dwm

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
222 S. Houston, Suite A
Tulsa, Oklahoma 74127

December 3, 1991

#2-14-92-I-48

Mr. Jack Pfingston
Environmental Assessment and
Information Sciences Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Pfingston:

This letter is in response to your letter of November 12, 1991, and fax of November 19, 1991, in which you advised us of the specific sites and alternates selected in Oklahoma for the Atmospheric Radiation Measurement (ARM) Program central facility and boundary sites.

Although several Federally listed threatened and endangered species are known to occur in the specified counties (Grant, Okmulgee, McClain, and Woodward), we do not anticipate that this project will affect these species. The prairie mole cricket (Gryllotalpa major), currently proposed to be listed as threatened, has been documented in McClain and Okmulgee counties. However, we have recommended that the proposed rule to list the species as threatened be withdrawn. The withdrawal has been sent to Washington and publication in the Federal Register is imminent. Site surveys for this species will not be required.

The quarter sections containing the proposed site and two alternative sites selected for the Central Facility do not have any wetlands of concern.

The quarter sections selected for Proposed Boundary Facility #1 (Okmulgee County) and alternative #2 have wetlands of concern (Ash Creek and Concharty Creek). Alternative sites #1 and #3 do not have any wetlands of concern. (See enclosed National Wetlands Inventory maps.)

All quarter sections selected, for proposed site location and both alternates, for Proposed Boundary Facility #2 (McClain County) have wetlands of concern (Finn Creek).

None of the quarter sections selected for Boundary Facility #3 (Woodward County) have wetlands of concern.

In accordance with Executive Orders 11990 (Protection of Wetlands) and 11988 (Protection of Floodplains), we recommend impacts to wetlands and stream areas (floodplain) be avoided by locating facilities in uplands sites. If work in wetlands is unavoidable, we recommend the following procedures be implemented to reduce impacts and protect these sites:

1. Wetland hydrology should not be altered by draining, dredging, or construction of dikes or levees.

2. Heavy equipment should be kept out of all wetland areas.

3. Vegetation clearing should be kept to a minimum, not only adjacent to wetlands, but elsewhere as well. Excessive clearing of vegetation will result in erosion of project areas, and sedimentation in area wetlands and streams.

The unavoidable loss of wetlands will require proper mitigation. This issue can be further evaluated when more specific information is available on facility locations.

We do not have general lists of plants, animals, etc. by county. A list of references for sources of information on these topics is enclosed. A copy of the Blair and Hubbell paper is enclosed as it might be difficult for you to locate. This is the classical and frequently cited reference for ecogeographic information for Oklahoma.

If you have any questions, contact Karolee Owens at 918/581-7458.

Sincerely yours,

Charles M. Scott

for Stephen W. Forsythe
Field Supervisor

Enclosures

LKO:dc

United States Department of the Interior
FISH AND WILDLIFE SERVICE
KANSAS STATE OFFICE
315 HOUSTON, SUITE E
MANHATTAN, KANSAS 66502
913-539-3474

December 23, 1991

Mr. Tony Policastro
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Policastro:

This is in response to your recent telephone conversations with Dan Mulhern of this office, and your December 9 facsimile transmission of data regarding the Radio Acoustic Sounder System (RASS) which is a part of your overall proposed weather monitoring stations in Kansas and Oklahoma. The information you provided presented an evaluation of the potential effects of the RASS on migratory birds, and requested our review and analysis.

It is the opinion of this office that there is insufficient information available to adequately assess the potential for noise-related impacts on migratory birds or other wildlife species. Page 9 of the information you sent indicated the lack of literature on the effects of sound on birds. Based on this, your information stated that anticipated effects cannot be quantified at this time. The information you provided cited potential effects of loud noises on migratory birds, based on aircraft flyover studies and inferences from migratory behavior. Such possible effects you proposed included disorientation to migrating birds, attraction to the locations of towers or guy wires, and disturbance to breeding birds to the extent they may abandon breeding areas. We agree that all of these may or may not occur, and there may be others as well. Some or all these possible effects may come under the jurisdiction of the taking provisions of the Migratory Bird Treaty Act (16 U.S.C., 703 et seq.).

Based on the uncertainty of how your proposed project may affect migratory birds, we are unable to concur with the determination that impacts are "expected to be negligible". There must first be a more thorough evaluation of possible effects. If data are not available from other similar projects, consideration should be given to designing a study to simulate anticipated conditions and monitor the resulting effects on migratory birds. The other alternative is to proceed with the project and risk a taking violation of the Migratory Bird Treaty Act.

Enclosed with this letter is a listing of the threatened, endangered, and category 2 candidate bird species which may occur in the three counties proposed to receive RASS facilities. While there are many species of migratory bird not included in this list, it will give you an idea of where to start in an evaluation of impacts. If you have additional questions, please continue to direct them to Dan Mulhern. Thank you for your cooperation.

Sincerely,

For: William H. Gill
State Supervisor

Enclosure

cc: FWS/FWE, Denver, CO (Section 7 Coordinator)
FWS/FWE, Grand Island, NE (Field Supervisor)
FWS/FWE, Tulsa, OK (Field Supervisor)
FWS/LE, Lenexa, KS (Special Agent)
KDWP, Pratt, KS (Environmental Services)

DWM/WHG/dwm

Oklahoma Biological Survey

Oklahoma
Natural Heritage Inventory

OKLAHOMA BIOLOGICAL SURVEY
2001 Priestly Avenue, Building 605
Norman, Oklahoma 73019-0543
(405) 325-1985
FAX: (405) 325-7702

DATE: Nov. 21, 1991

REF: OTH-PFF-91-339

Dear Sir/Madam:

This letter is in response to your request for information on possible endangered species or other elements of biological significance at the site(s) indicated in your request of 11-18-1991.

The Oklahoma Natural Heritage Inventory maintains a database on the status and location of rare species and significant ecological communities in Oklahoma. We have reviewed the information currently in the Heritage Inventory database and found no records of rare species or significant communities on or in the vicinity of the site. Please realize that the Natural Heritage Inventory has not conducted field surveys of that specific site. One or more field surveys of the area would be required to evaluate the specific site in detail.

The Heritage Inventory database is the most current comprehensive one available on the rare biota of Oklahoma. However, such a database is only as complete as the information that has been collected. For this reason, we cannot state for certain whether or not a given site harbors rare species or significant communities. We suggest you also contact the Environmental Division of the Oklahoma Department of Wildlife Conservation, as they may have site specific information of which we are unaware.

If we can be of any further assistance to you, please let me know.

Sincerely,

Ian H. Butler
Data Coordinator

9/12/91 dls
standard.neg

Grant County Commissioners

Room 104 Courthouse
Phone 405-395-2214
Medford, Oklahoma 73759

Ted C. Moore
District 1 Commissioner
Shop Phone 405-594-2925

Henry Berline
District 2 Commissioner
Shop Phone 405-395-2959

Jerry M. Shaffer
District 3 Commissioner
Shop Phone 405-532-6499

Carol Beggs, Bookkeeper

December 2, 1991

Jack Pfingston
Argonne National Laboratory
9700 South Cass. Ave.
Building 900
Argonne, Illinois 60439

Dear Sir:

In reference to Section 35, Township 25 North, 3 W.I.M. and Section 26, Township 25 North, 3 W.I.M. There are no land use restrictions on record in Grant County that would affect the above listed properties.

BOARD OF COUNTY COMMISSIONERS
Grant County, Oklahoma

Jerry M. Shaffer, Chairman

Ted C. Moore, Vice Chairman

Henry Berline, Member

OKLAHOMA WATER RESOURCES BOARD
1957

600 N. HARVEY AVE. P.O. BOX 150
OKLAHOMA CITY, OKLAHOMA 73101-0150

November 19, 1991

Dr. Anthony J. Policastro
Environmental Assessment
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Dear Dr. Policastro:

The floodplain information requested is enclosed. Some areas requested have never been mapped. The U.S. Army Corps of Engineers may have some data on these other areas. If necessary please call Mr. Joe Remondini in Tulsa at (918) 581-7896. If there are any questions, please contact Mr. Ken Morris of the Board's Engineering Division at (405) 231-2533.

Sincerely,

Harold L. Springer, P.E.
Chief, Engineering Division

wkm

Enclosures

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
OKMULGEE FIELD OFFICE
719 EAST 8TH STREET
OKMULGEE, OKLAHOMA 74447

Subject: Resource Analysis
SW 1/4 Section 1, T15N, R15E
SE 1/4 Section 2, T15N, R14E
SE 1/4 Section 35, T16N, R14E
NE 1/4 Section 3, T15N, R14E

Date: November 21, 1991

TO: Mr. Anthony J. Polocastro and
Jack Pfingston
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Polocastro and Mr. Pfingston:

Enclosed are two maps of the above legal descriptions. The soils maps which are delineated with solid and dashed lines, depict the major soil series in this area. There is currently no active farming in these areas. The "Vg" Verdigris soil series is a prime farmland soil type. It is found only in SE 1/4 of Section 35, T16N, R14E. Your proposed project will not have a detrimental impact on the soil resources in these described areas.

The SCS wetland maps indicate no wetland or hydric soils in any of the described areas. The USDI Fish and Wildlife Service National Wetland Inventory maps indicate a palustrine ecological system, forested wetland in the "Bu" Broken Alluvial soil type in section 35 T16N, R14E. This area does not meet the past or the current wetland definition. I can ascertain no long term detrimental impact to any soil resources on the described areas. Soil disturbance or loss due to any construction can be managed effectively with simple erosion control techniques. If you need further information on this subject, please let me know.

Sincerely,

Patrick L. Bogart, CPESC
District Conservationist

United States
Department of
Agriculture

Soil
Conservation
Service

Woodward Field Office
2411 Williams Ave.
Woodward, OK 73801

November 27, 1991

Dr. Anthony J. Policastro
Environmental Assessment & Information
Sciences Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

RE: NE¼ 33-20-20, NE¼ 32-20-20,
NW¼ 33-20-20, Woodward County

Dear Sir:

Wetlands maps and floodplain maps have been checked on all three proposed locations in Woodward County and none of them have wetlands or are in a floodplain.

James H. Shearhart
District Conservationist

United States Department of Agriculture

Soil Conservation Service

Medford Field Office
Route 1 Box 234
Medford, OK 73759

November 27, 1991

Dr. Anthony J. Policastro
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Dr. Policastro:

This information is provided to your request of a letter dated November 20, 1991 desiring some data on three tracts of land located in Grant County, Oklahoma. The following tracts are described as:

SW/4 Section 35-T25N-R3W
NE/4 Section 35-T25N-R3W
SE/4 Section 26-T25N-R3W

I have completed a study of the USDA Soil Conservation Service and the US Fish & Wildlife maps concerning identified wetlands on the above mentioned tracts. The maps indicate the only areas of impounded water on these tracts are man made ponds and are not subject to the wetland provisions. There are no true identified wetlands on these tracts.

In addition, none of these tracts are located in a flood plain area.

If you need any further information, feel free to contact our office.

Sincerely,

BOBBY J. SMITH
District Conservationist

SCS-1
10-79

United States Department of Agriculture
Soil Conservation Service

Woodward Field Office
2411 Williams Ave.
Woodward, OK 73801

December 6, 1991

Dr. Anthony J. Policastro
Environmental Assessment & Information
Sciences Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 64039

Re: NE¼ 33-20-20; NE¼ 32-20-20;
NW 33-20-20, Woodward County

Dear Sir:

Wetlands maps and floodplain maps have been checked on all three proposed locations in Woodward County and none of them have wetlands or are in a floodplain.

The NE¼ Section 33-20-20 and the NE¼ Section 32-20-20 do not contain any prime farmland. However, the NW¼ of Section 33-20-20 does contain prime farmland.

Sincerely,

James H. Shearhart
District Conservationist

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 61
TULSA, OKLAHOMA 74121-0061

REPLY TO
ATTENTION OF

January 29, 1992

Planning Division
General Planning Branch

Anthony J. Policastro, Ph.D.
Environmental Assessment and
Information Sciences Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Dear Dr. Policastro:

This is in further response to your November 20, 1991, letter and our December 13, 1991, response concerning floodplain and wetland designations for several sections in Grant, McClain, Okmulgee, and Woodward Counties in Oklahoma and Kiowa, Marion, and Montgomery Counties in Kansas. An official receipt will be forwarded to you upon receipt of your $75.00 check.

The following table indicates the type of information available for each requested county. If official Federal Emergency Management Agency Flood Insurance Rate Maps do not exist, USGS flood prone area maps were consulted. Where information is available, copies of the maps with areas indicated have been supplied.

If you have any further questions, please contact Mr. Joe Remondini at (918) 581-7896.

Sincerely,

for David Steele, P.E.
Chief, Planning Division

Enclosures

United States Department of Agriculture

Soil Conservation Service

760 South Broadway
Salina, Kansas
67401

February 20, 1992

Mr. Jack Pfingston
Environmental Assessment and Information Sciences Division
Argone National Laboratory
9700 South Cass Avenue
Argone, Illinois 60439

Dear Mr. Pfingston:

Thank you for the opportunity to review the plans for the ARM projects in Marion and Montgomery Counties.

Your proposed project should have limited effect on prime farmlands. Attached are copies of soil survey sheets with the sites identified and a list of prime farmlands in these areas. During layout of your project, it is best to avoid these prime farmlands. If you are unable to avoid the prime farmlands, a Farmland Conversion Impact Rating (Form AD-1006) is required for the specific sites.

Considerations should be made for the numerous conservation practices and the wildlife habitat existing in this area. In excavated sites, backfill should be firmly packed. We strongly encourage you to work with the Soil Conservation Service office in Marion and Montgomery Counties, for any assistance needed with modification or restoration of any conservation practices due to construction activities.

Please furnish these offices a detailed map of the installation once it is installed. This will ensure that future conservation activity will not jeopardize your installation.

Sincerely,

James N. Habiger
State Conservationist

Attachments

cc: w/o attachments
H. Lynn Gibson, Area Conservationist, SCS, Emporia, KS
Gary Schuler, District Conservationist, SCS, Marion, KS
Jodi Cushenbery, District Conservationist, SCS,
Independence, KS

Appendix E

Evaluation of Noise Impacts of the 50-MHz and 915-MHz Profiler/RASSs

Appendix E

Evaluation of Noise Impacts of the 50-MHz and 915-MHz Profiler/RASSs

E.1 Introduction

This appendix summarizes the methodology used to determine the potential impacts on people from noise created by the baffled 50-MHz, the unbaffled 50-MHz and the 915-MHz profiler/RASSs proposed for installation at the central facility and at some or all of the six boundary facilities. The potential noise impact of a 405-MHz profiler/RASS, similar to one operated by NOAA at one of its profiler facilities, was also investigated.

In order to clarify this appendix and Sections 2.4 and 3.4 of the text, a few of the terms and conventions that are used shall be discussed. A given *frequency band* refers to the corresponding 1/3-octave band of frequency (i.e. all references to the 100-Hz frequency band will be taken to be the 1/3-octave band of frequencies for which 100-Hz is the center frequency). The term *sound pressure level* (in units of energy/area) refers to the level of airborne noise heard away from a source, measured with a reference pressure of 20 micropascals. The term *sound power level* refers to the acoustic power (in units of energy) of the source, measured with a reference power of 1 picowatt. Finally, all sound pressure levels are unweighted measurements.

All four profiler/RASSs emit tonal noise. While white noise (noise from a combination of multiple frequencies such as the sounds of a waterfall or surf) usually elicits a pleasurable or neutral response from people (if the intensity of the noise is not too large), tonal noise is generally annoying to human beings. The sound made by these profiler/RASSs is an emitted tone that lasts for about 5-6 min every half hour.

The foghorn-like sound of both the baffled and unbaffled 50-MHz profiler/RASSs is a low-frequency tone, at about 108 Hz, which is made up of a continuous series of 5-second cycles (during which time the noise varies slightly in frequency, centered around the 100-Hz frequency band). The sound from the 915-MHz profiler/RASS is a high-frequency tone, centered around the 2,000-Hz frequency band. The sound from the 405-MHz profiler/RASS is a high-frequency tone, centered around 1,000-Hz frequency band. The noise from these profiler/RASSs diminishes with distance, largely because of hemispherical spreading and atmospheric attenuation. Attenuation of low-frequency sounds (100-Hz) is much less than the attenuation of high-frequency sounds (1,000 Hz and 2,000 Hz).

The question to be answered is whether these profiler/RASSs would be annoying to the residents of the nearby houses. Besides the intensity of the noise source, the distance between the source and the receptor (the closest residence) and the background ambient noise level are important for determining the noise level and the potential annoyance. Therefore, a determination must be made as to whether the proposed distances between the profiler/RASSs and the nearest residences are large enough to achieve sufficient attenuation. The analysis described below is based on the assumption that the residents are outdoors and on their property, close to their homes.

The structure of a house reduces the noise level of a sound by about 21-25 dB when windows are closed and by about 12-15 dB when the windows are open. Four profiler/RASSs are studied here: (1) the unbaffled 50-MHz profiler/RASS, (2) the 915-MHz profiler/RASS, (3) the baffled 50-MHz profiler/RASS, and (4) the 405-MHz profiler/RASS.

The predictive procedure for noise impacts follows five main steps:

1. Measurement of the sound pressure level of the (unbaffled) 50-MHz profiler/RASS and the 405-MHz profiler/RASS. Note that sound pressure with distance data were available for the 915-MHz profiler/RASS (Vik, 1991) and sound pressure level with distance data were not required for the baffled 50-MHz profiler/RASS since it could be determined from the measured unbaffled 50-MHz profiler/RASS.

2. Calculation of the sound power level of the (unbaffled) 50-MHz, the baffled 50-MHz, the 405-MHz, and the 915-MHz profiler/RASSs.

3. Calculation of the sound pressure levels, at the nearest residences, due to the (unbaffled) 50-MHz, the baffled 50-MHz, the 405-MHz, and the 915-MHz profiler/RASSs.

4. Measurement of the residual ambient environmental noise level at the nearest residence for each possible siting of a profiler/RASS. Noise levels in each frequency band of interest are required. This step includes measurements or reliable estimates at the proposed site and the two to three alternative sites for each of the central facility and the six boundary facilities.

5. Prediction of the impact of the noise emission from the profiler/RASSs at each of the locations mentioned in step 2. Two methods are used to assess the impacts of the noise emission. First, a modification of the Composite Noise Rating (CNR) method (EEI, 1984) that categorizes noise from "A" to "I." These designations, in turn, can be correlated to the expected degree of *community reaction*. Second, a method developed by Fidell (Fidell, et al., 1982; Fidell, et al., 1987; Fidell, et al., 1988) is used to categorize the impacts in terms of the probability of an individual considering the noise as ***not at all** annoyed, slightly annoyed, moderately annoyed, very annoyed,* or *extremely annoyed.*

E.2 Measurement of the Sound Pressure Level of the Unbaffled 50-MHz and the 405-MHz Profiler/RASSs

Sound pressure level measurements on the 50-MHz and the 405-MHz profiler/RASSs that are located at Coffeyville, Kansas were made by Argonne personnel on November 29-December 6, 1991, with a Bruel and Kjaer sound level meter Model 2351S. A 1/3-octave band filter set was used with a 1-in. microphone and a 5-cm windscreen. A portable Zenith PC computer was used to control the sound level meter, allowing measurements in the 100-Hz frequency band (for the 50-MHz profiler/RASS) and in the 1,000-Hz frequency band (for the 405-MHz profiler/RASS) and recording sound pressure levels taken during 1-s samples, by using the *slow* (detection time constant) setting. The computer controlled the sound level meter signal output by filtering successive 1/3-octave bands for 30-s intervals over a total measurement period of 13.5 min. The ambient noise was sufficiently steady to allow this to be done in one 10 to 15-min period.

For the unbaffled 50-MHz profiler/RASS, measurements revealed a sound pressure level of 78-dB, in the 100-Hz frequency band, (as determined from the median or "L_{50}" value of the measurements) at a location on an axis perpendicular to the two speakers, 132.6-m from the centroid of that axis.

For the 405-MHz profiler/RASS, measurements revealed a sound pressure level of 66 dB (using the L_{50} value) in the 1,000-Hz frequency band at a location 64-m from the centroid of the four-speaker system.

Similar measurements were made by Radian Corp. personnel (Vik, 1991) on a 915-MHz profiler/RASS in Texas. Data were supplied in the form of a table of unweighted, 2,000-Hz, frequency band sound pressure levels vs. distance for the 915-MHz profiler/RASSs that Radian Corp. manufactures. Since the four speaker system is only a few feet across, it can be considered a point source, and therefore the closest data measurement point was used (10 m from the centroid of speaker system). At the 10 m location, the measured sound pressure level is 75.8 dB, at the 2,000-Hz frequency band.

E.3 Calculation of the Sound Power Level of the Baffled 50-MHz, the Unbaffled 50-MHz, and the 915-MHz and 405-MHz Profiler/RASSs

From all of the profiler/RASSs the sound power level of the respective source was calculated by adding the estimated loss (in dB due to hemispherical and atmospheric attenuation) from a profiler/RASS to the point at which the sound pressure level was known (as measured from the centroid of the speakers out to the location of the field measurement), using the empirical formulas from the Edison Electric Institute *Environmental Noise Guide* (EEI, 1984).

For the unbaffled 50-MHz profiler/RASS, the sound power level of the measured source was calculated to be 129 dB at the 100 Hz frequency band. The sound power level was then corrected by +2 dB to account for the fact that the 50-MHz profiler/RASS would be a three speaker system rather than the two speaker system that was measured. Therefore, the estimated sound power level of the source (during the 5-min periods when it was on) was 131 dB at 100 Hz frequency band. For the baffled 50-MHz profiler/RASS, the sound power level would therefore be 121 dB at 100 Hz frequency band.

For the 405-MHz profiler/RASS, the sound power level of the measured source was calculated to be 111 dB at 1,000-Hz frequency band. For the 915-MHz profiler/RASS, the sound power level of the sourc was calculated to be 104 dB at 2,000-Hz freque cy band. Table E.1 summarizes the sound pow r levels of the various profiler/RASSs.

E.4 Calculation of the Sound Pressure Level at the Residences Nearest Potential Locations for the Baffled 50-MHz, Unbaffled 50-MHz, 915-MHz, and 405-MHz Profiler/RASSs

Given the ambient sound power level of the profiler/RASSs, the sound pressure level at the nearest residences from these profiler/RASSs was calculated. The sound pressure level was determined by subtracting the estimated loss (in dB due to hemispherical and atmospheric attenuation) from the profiler/RASSs (with known sound power level) to the various residences (at known distances from the potential profiler/RASSs), using the empirical formulas from the Edison Electric Institute *Environmental Noise Guide* (EEI, 1984). Figure E.1 gives the sound pressure levels as a function of radial distance from the profiler/RASSs, for each potential profiler/RASS. Note how the low-frequency sounds attenuate less with distance than do high-frequency sounds.

E.5 Measurement of Background Ambient Noise Levels at the Residences Nearest Potential Locations for the 50-MHz, 915-MHz, and 405-MHz Profiler/RASSs

Sound pressure level measurements were made at the nearest residence of several of the possible site locations for the 50-MHz, 915-MHz, and 405-MHz profiler/RASSs The protocol for the measurements included the following requirements:

1. Wind speeds were to be low, i.e., under 5 mph (or 5-10 mph if that were not possible) so that the wind-induced noise on the microphone screen would be much lower than the background noise level being measured.

2. Measurements were to be taken in the late evening or at nighttime (between 10 p.m. to 6 a.m.) to cover the period when residents are most sensitive to the noise (i.e., when they are sleeping or are attempting to fall asleep). At those

Table E.1 Sound Power Level of the Various Profiler/RASSs

Profiler/RASSs	Sound Power Level (dB)
Baffled 50-MHz	121
(Unbaffled) 50-MHz	131
405-MHz	111
915-MHz	104

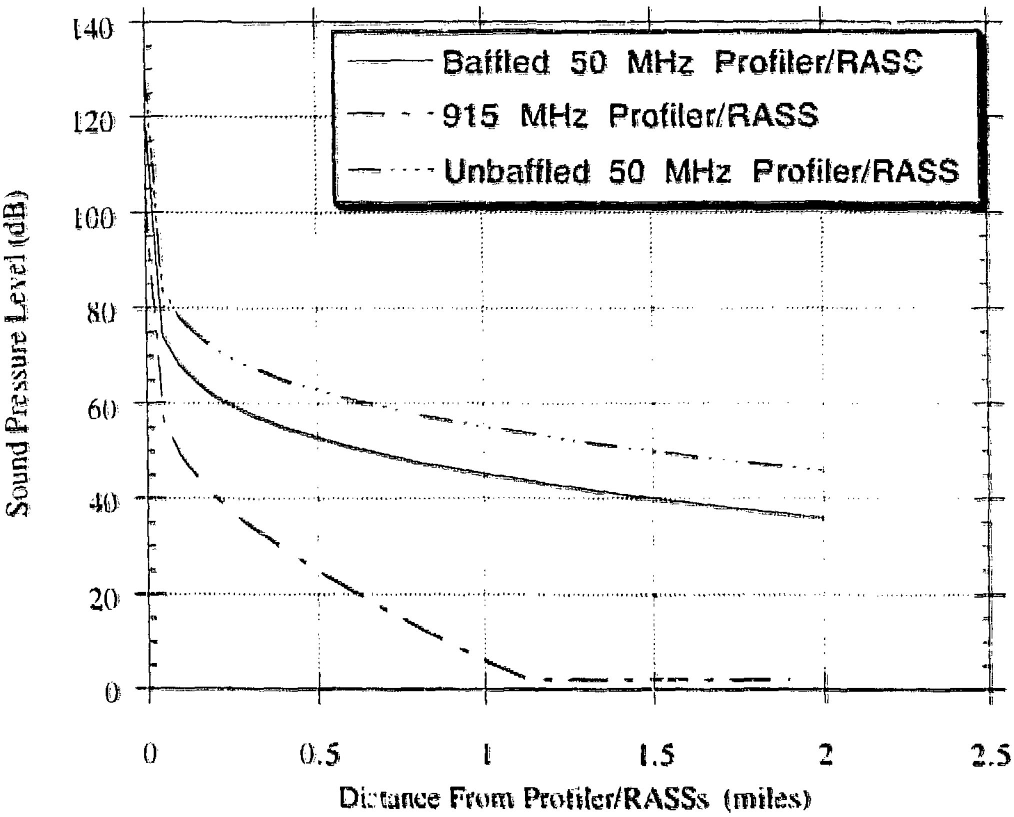


Figure E.1 Decay of Sound Pressure Level with Distance for the Profiler/RASSs

times, the background noise level (and ambient surface winds) are likely to be at their lowest level for the day.

3. Measurements were to be taken at the closest public property (generally a rural road right-of-way) adjacent to the tract of land that contains the residence. The precise location would be chosen to avoid sound reflections from the nearby home.

4. Measurements were to be taken during a 2-hour period and would include sound pressure level data on the full 1/3-octave band spectrum and a 30-min. time series of data in the 100-Hz, 1,000-Hz, and 2,000-Hz frequency bands. The sound levels in each frequency band were expected to be rather steady, allowing measurements over this period to be representative of longer measurement times.

Background data were collected at five residences. Because of the difficulty of collecting reliable data (mostly because of high wind speeds), the L_{90} values were determined from the best data set, because the noise environments appeared to be similar at all of the residences (L_{90}

represents the sound pressure level that is exceeded by 90% of the measured data). Table E.2 lists the residual ambient noise levels for each frequency band of interest. These data were used in the subsequent calculations of the sound pressure levels in the 100-Hz, 1,000-Hz, and 2,000-Hz frequency bands at each residence. Figure E.2 is a sample histogram of the 100-Hz frequency band ambient noise level measured at the Montgomery County, Kansas, boundary site, indicating that the L_{90} value is 30 dB.

E.6 Prediction of the Human Reaction at the Residence Nearest the Operation of the 50-MHz and 915-MHz Profiler/RASSs

In this EA, two methods are used to assess the effects of the noise on the people at the residences near the profiler/RASSs: (1) the modified Community Noise Response (CNR) model (EEI 1984) and (2) a method by Fidell (Fidell et al., 1982; Fidell et al., 1987; Fidell et al., 1988), which is composed of the Probabilistic Noise Audibility (PNA) model and the Individual Annoyance Prediction (IAP) model. A brief discussion of these methods is given here.

E.6.1 The Modified CNR Method

The modified CNR method (EEI, 1984) is the method most accepted for predicting community reaction by the power industry for fixed, continuous noise sources. The profiler/RASSs qualify as continuous sound sources, and the methodology is applicable. The method is based on empirical data taken from social surveys of annoyance due to fixed noise sources. Data used in the method include the following:

1. The sound pressure levels of the intrusive noise at the residence location and the environmental background noise levels.

2. The character of the noise source (such as whether it is of very low frequency or of tonal character) and also its intermittence (ratio of the source's on time to a reference time period of, say, 1 h). Included also are seasonal (winter, summer) operation and other temporal factors (daytime or nighttime only).

Table E.2 Measured Ambient Noise Levels Used in Modeling of Profiler/RASS Noise Impacts

Frequency Band (Hz)	L_{90}(dB)
100	30
1,000	12
2,000	8

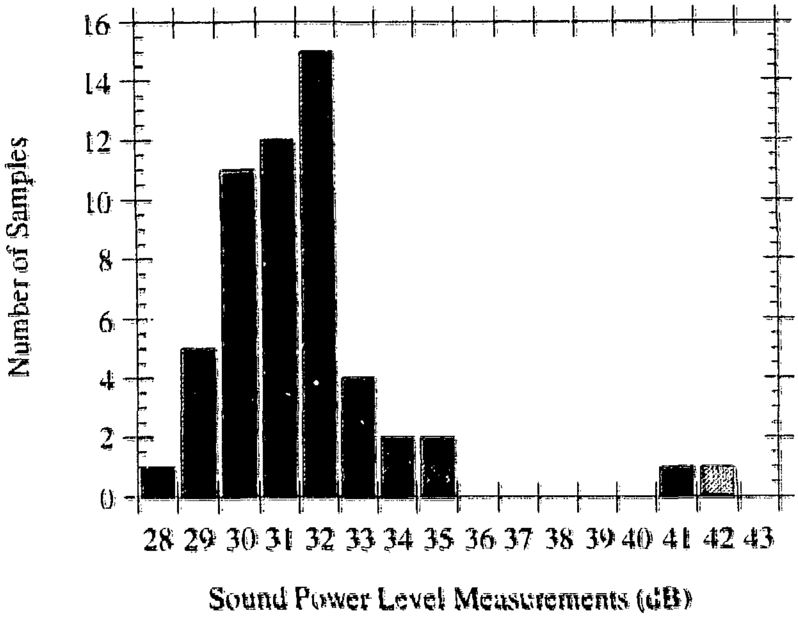


Figure E.2 Histogram of Sound Pressure Level Measurements

3. Subjective factors such as the previous exposure history of the community to that noise source and the community attitude.

The modified CNR method categorizes noise from A to I. These designations, in turn, can be correlated to the expected *community reaction*. Figure E.3 gives the range of *community reaction* for the various composite noise ratings.

E.6.2 Fidell's Method (PNA/IAP Models)

The second model of human annoyance that was used is the psychoacoustic model of Fidell (1987, 1988). This model was used as a supplement to the modified CNR findings, in order to verify that sites determined by the CNR model would also be acceptable by this model. The Fidell model, a new and different type of computer model, was also applied to the issue of siting the profiler/RASSs. Fidell and Teffeteller (1971) demonstrated that test subjects engaged in an attention-demanding foreground task did not report noticing intruding sounds until the sounds had a considerably higher signal-to-noise ratio than would be required for detection in a deliberate listening task. The intensity of subsequent annoyance judgments made by test subjects after the presence of an intruding noise was noted (but while the subjects were still engaged in an absorbing foreground task) was directly proportional to the detectability of the intruding sounds (dB above masking level). Figure E.4, adapted from Fidell and Teffeteller, displays this relationship.

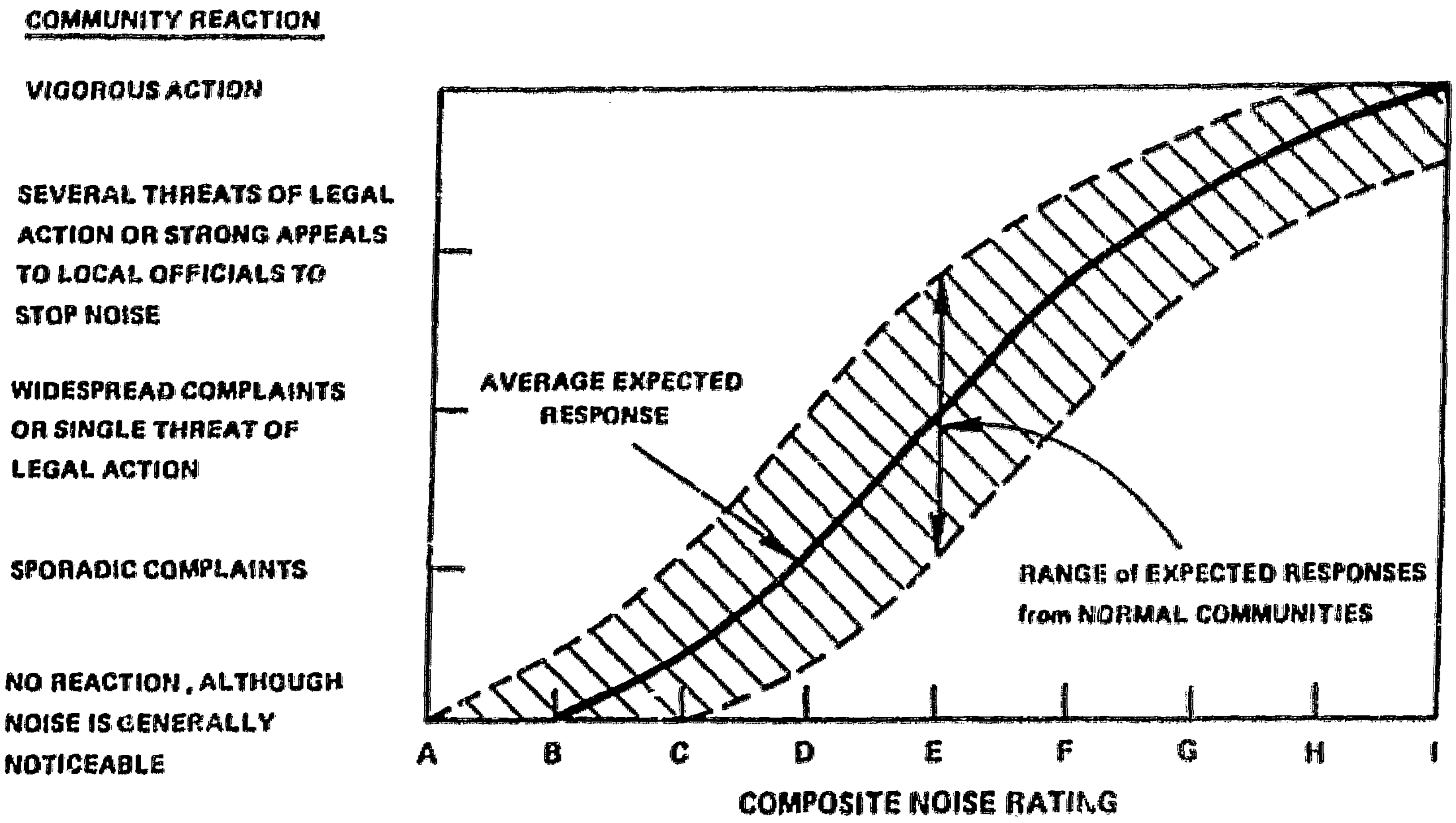


Figure E.3 Estimated Community Response vs. Composite Noise Rating - Modified CNR Model (Reproduced by permission of Edison Electric Institute, Washington, D.C.)

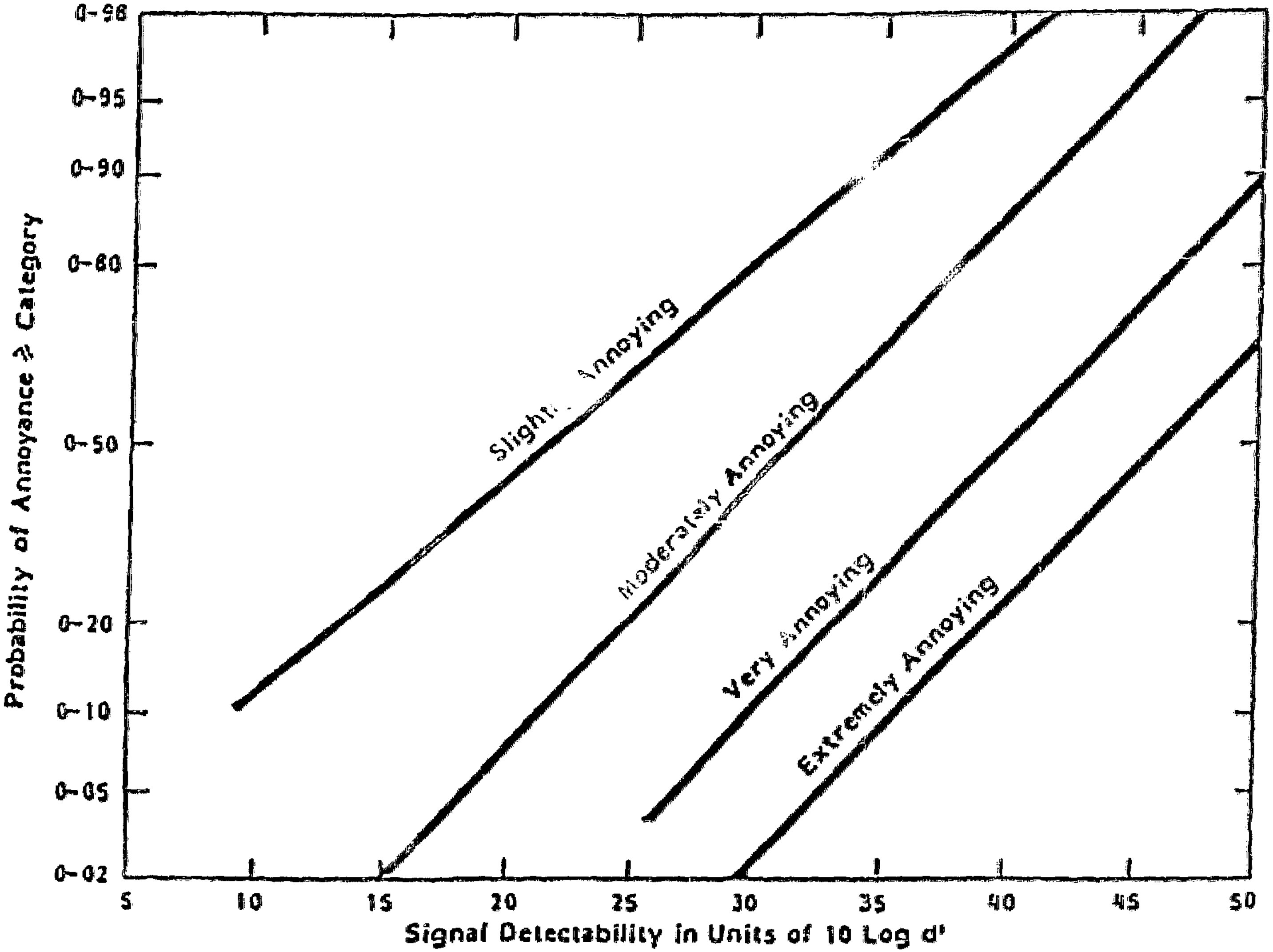


Figure E.4 Relationship Between Annoyance and Detectability of Intruding Noises -- Fidell Model

Half of the subjects engaged in an absorbing foreground task first noticed an intruding sound when it attained a signal-to-noise ratio characterized by a value of 10 log d' = 14 dB. People not preoccupied in a task can reliably distinguish a signal from noise when its detectability attains a value of d' = 1 or 10 log d' = 0. Pearsons, et al. (1979) found that subjects first noticed an intruding sound for which they were not specifically listening at a value of d' = 2.3 or 10 log d' = 4 dB. The difference in results reported by Fidell and Teffeteller and by Pearsons et al. (1979) suggests that an absorbing task can have an effect of about 10 dB on the way people judge intruding sounds.

These data led to the inference that the level of detectability of an intruding sound (d') must be three orders of magnitude (30 dB) greater than the barely audible level before 50% of the subjects, engaged in activities other than listening for the sound, are moderately annoyed. The data suggest that intruding sounds four orders of magnitude (40 dB) greater than the barely audible level are required before half the subjects become extremely annoyed.

Since 1971, Fidell and others have been investigating probabilistic models for predicting the audibility level of an intrusive noise in the presence of a background masking noise, on the basis of fundamental psychoacoustic detectability theory (Fidell and Teffeteller, 1971). In addition, corollary research has progressed on the relationship between the audibility level and its annoyance to an individual. This research has been supported by the U.S. Environmental Protection Agency, the U.S. Air Force, the U.S. Army, and the Electric Power Research Institute. This extensive program (including the data described above) has led to the development of probabilistic models for predicting the following:

1. The detectability and audibility of an intrusive noise in the presence of a masking background sound (PNA model)

2. The level of individual annoyance caused by that intrusive noise, taking into account certain nonacoustic variables involved (IAP model)

Because no field verification studies are yet available for the IAP model, that methodology must still be considered to be in the research phase, and the sponsoring agencies listed above withhold unqualified endorsement until field testing can be accomplished. Nevertheless, because verification is likely to be achieved in the foreseeable future and because it is more advanced scientifically than the modified CNR methodology, the PNA-IAP paired models have been included in this study.

The first step in the procedure is to use as input to the PNA model both the baseline environmental ambient L_{90} spectrum and the predicted profiler/RASS intrusive noise spectrum (resulting from sound propagation and atmospheric attenuation) at the residence. These values determine the audibility of the intrusive noise, expressed as an intrusion level in dB, for a specified detection efficiency and a nominal 50% probability of detection by the listener (and a 1% probability of false detection). The second step is to assign the following psychological factors for the individual who is assumed to typify the resident: affected state, concentration, and Bayesian criterion, which collectively determine a tolerance index and a decision criterion index, all in dB units. The relationship between these subjective indices is as follows:

Affected State (AFS)	+	Concentration Index (COA)	=	Tolerance Index (TOL)

Tolerance Index (TOL)	+	Bayesian Criterion Index (BAC)	=	Decision Criterion Index (DCI)

The IAP model uses the above data for the profiler/RASS noise to predict the most probable degree of individual annoyance in a five-step descriptive scale: *not at all annoyed, slightly annoyed, moderately annoyed, very annoyed,* and *extremely annoyed.* These terms are correlated with specific dB ranges of intrusion level along with the nonacoustic variable indices selected as appropriate for rural residents.

To cover the range of possibilities, two decision criterion indices were used in the analysis to reflect two separate scenarios. Scenario 1 has the assumption that an individual has a neutral attitude toward the ARM Program and is not concentrating on any specific task, leading to a tolerance index of 0. Scenario 2 has the assumption that an individual has a positive attitude toward the ARM Program and is concentrating on a specific task, leading to a tolerance index of +10. Fidell has recommended, until better data are available, that the Bayesian criterion be set to zero.

The steps required for calculating of the level of noise impacts at the residence nearest a profiler/RASS (unbaffled 50-MHz, 915-MHz, 50-MHz baffled, or 405-MHz) is as follows:

1. Predict the propagation of the noise from the profiler/RASSs to the nearest residences, assuming standard day conditions (50° F, 70% relative humidity) with no wind. The propagation formulas and tables presented in the Edison Electric Institute *Environmental Noise Guide* (EEI, 1984) were used for this purpose. Predictions had to be made only for the 1/3-octave band in which the noise occurs; background noise from the other 1/3-octave bands cannot mask the noise from the profiler/RASSs in the 100-Hz (for either of the 50-MHz profiler/RASSs), 2,000-Hz (for the 915-MHz profiler/RASS), or 1,000-Hz (for the 405-MHz profiler/RASS) frequency bands.

2. From the background ambient measurements, determine the masking level for the 1/3-octave band of interest by adding 2.2 dB to the 100-Hz-band ambient level, adding -4.6 dB to the 1,000-Hz-band ambient level, or adding -5.5 dB to the 2,000-Hz-band ambient levels. If the resulting masking level is below the threshold of hearing, the threshold of hearing is used instead. That threshold is 30 dB at the 100-Hz 1/3-octave band, 6 dB at the 1,000-Hz 1/3-octave band, and 3 dB at the 2,000-Hz 1/3-octave band.

3. From the residual ambient noise level and the propagated noise from the profiler/RASSs in the 100-Hz, 1,000-Hz, or 2,000-Hz 1/3-octave bands and the tolerance indices of both 0 and +10, use the IAP code to determine the predicted response of the residents. The predictions are in terms of levels of annoyance.

E.6.3 Results

Tables E.3-E.10 summarize the predictions of the modified CNR method and the Fidell method (for tolerance indices and decision criterion indices of 0 and 10) for the proposed action and the 1-3 alternatives for the central facility and the six boundary facilities, for each profiler/RASS of interest. Differences among the reactions result from the different distances of the residences from the profiler/RASSs.

A point of explanation is needed concerning the Fidell model results presented in Tables E.3-E.10. The raw output of the Fidell model is in terms of cumulative probabilities of annoyance (not presented here), while in Tables E.3-E.14 the Fidell results are in levels of annoyance. The levels of annoyance presented are the lowest levels of annoyance associated with at least a 50% cumulative probability (which are the most likely levels of annoyance of the individual). For example, the level of annoyance for the Kiowa County boundary facility alternative 2 (*moderately annoyed*) listed in Table E.6 was determined from the cumulative probabilities presented Figure E.5. Note that level of annoyance is the lowest level of annoyance associated with at least a 50% cumulative probability. In this case, the *moderately annoyed* is associated with a cumulative probability of 63.4%.

The commonly-used criterion for acceptability of noise impacts is *community reaction* A, B, or C as defined by the modified CNR method. Under the modified CNR criterion, the profiler/RASSs are acceptable at the locations indicated in Table E.15. Only the central facility (proposed site and alternatives) is acceptable for the unbaffled 50-MHz profiler/RASS, because of the relatively large distance between the site of the profiler/RASS and the residences nearest the central facility. For the baffled 50-MHz profiler/RASS, the proposed sites are acceptable at all of the locations and some of the alternative sites are acceptable. The 915-MHz profiler/RASS is acceptable at all sites and alternatives. The 405-MHz profiler/RASS is also acceptable at all sites and alternatives.

The modified CNR predictions summarized in Table E.11 indicate that the ARM proposed plan for locating profiler/RASSs is acceptable: (1) for the central facility, an unbaffled 50-MHz profiler/RASS along with a 915-MHz profiler/RASS, and (2) for each of the boundary facilities, a baffled 50-MHz profiler/RASS and a 915-MHz profiler/RASS.

The Fidell method was used to give supplementary information on individual annoyance (given information about the state and attitudes of the individual under consideration using the decision index). By using the usual level of *slightly annoyed* as a measure of acceptability (a conservative measure), the Fidell method supports the predictions of the modified CNR model in that all of the proposed sites were found to be acceptable.

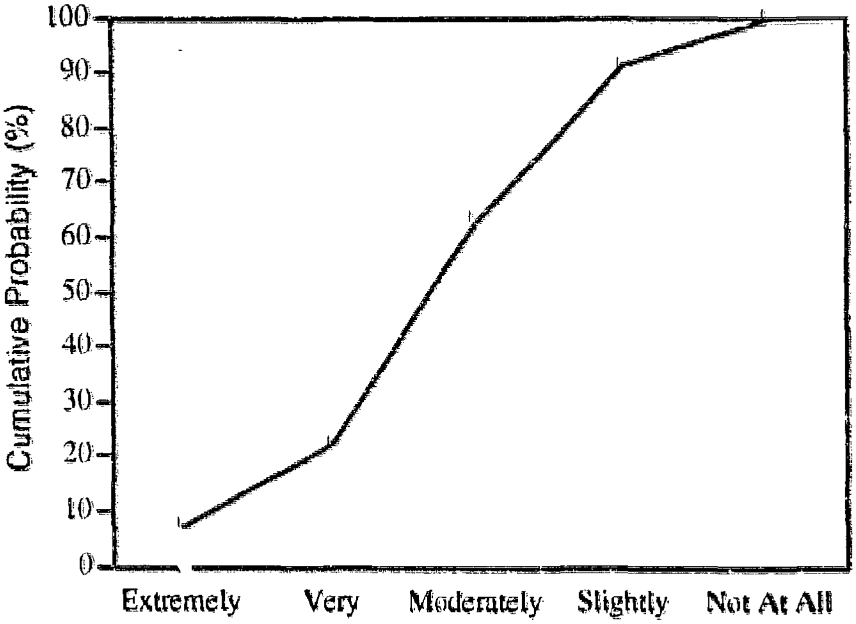


Figure E.5 Cumulative Probability vs. Fidell's Category of Annoyance

Table E.3 Public Reaction to Unbaffled 50-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = 0)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	13	B	Not At All
Alt. 1	1.9	14	B	Not At All
Alt. 2	2.0	14	B	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	27	E	Moderately
Alt. 2	0.5	31	F	Moderately
Alt. 3	0.6	29	E	Moderately
McClain County, Oklahoma				
Proposed	0.6	29	E	Moderately
Alt. 2	0.5	31	F	Moderately
Alt. 3	0.6	29	E	Moderately
Woodward County, Oklahoma				
Proposed	0.6	29	E	Moderately
Alt. 1	0.7	27	E	Moderately
Alt. 2	0.7	27	E	Moderately
Montgomery County, Kansas				
Proposed	0.6	29	E	Moderately
Alt. 1	0.5	31	F	Moderately
Alt. 2	0.5	31	F	Moderately
Marion County, Kansas				
Proposed	0.6	29	E	Moderately
Alt. 2	0.6	29	E	Moderately
Alt. 3	0.5	31	F	Moderately
Kiowa County, Kansas				
Proposed	0.7	27	E	Moderately
Alt. 1	0.8	26	E	Slightly
Alt. 2	0.5	31	F	Moderately
Alt. 3	0.7	27	E	Moderately

Table E.4 Public Reaction to 915-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = 0)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	0	A	Not At All
Alt. 1	1.9	0	A	Not At All
Alt. 2	2.0	0	A	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	14	A	Not At All
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.6	18	A	Slightly
McClain County, Oklahoma				
Proposed	0.6	18	A	Slightly
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.6	18	A	Slightly
Woodward County, Oklahoma				
Proposed	0.6	18	A	Slightly
Alt. 1	0.7	14	A	Not At All
Alt. 2	0.7	14	A	Not At All
Montgomery County, Kansas				
Proposed	0.5	23	A	Slightly
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.5	23	A	Slightly
Marion County, Kansas				
Proposed	0.5	23	A	Slightly
Alt. 1	0.6	19	A	Slightly
Alt. 2	0.5	23	A	Slightly
Kiowa County, Kansas				
Proposed	0.7	14	A	Not At All
Alt. 1	0.8	11	A	Not At All
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.7	14	A	Not At All

Table E.5 Public Reaction to Baffled 50-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = 0)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	3	B	Not At All
Alt. 1	1.9	4	B	Not At All
Alt. 2	2.0	4	B	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	17	C	Slightly
Alt. 2	0.5	21	D	Slightly
Alt. 3	0.6	19	C	Slightly
McClain County, Oklahoma				
Proposed	0.6	19	C	Slightly
Alt. 2	0.5	21	D	Slightly
Alt. 3	0.6	19	C	Slightly
Woodward County, Oklahoma				
Proposed	0.6	19	C	Slightly
Alt. 1	0.7	17	C	Slightly
Alt. 2	0.7	17	C	Slightly
Montgomery County, Kansas				
Proposed	0.6	19	C	Slightly
Alt. 1	0.5	21	D	Slightly
Alt. 2	0.5	21	D	Slightly
Marion County, Kansas				
Proposed	0.6	19	C	Slightly
Alt. 2	0.6	19	C	Slightly
Alt. 3	0.5	21	D	Slightly
Kiowa County, Kansas				
Proposed	0.7	17	C	Slightly
Alt. 1	0.8	16	B	Not At All
Alt. 2	0.5	21	D	Slightly
Alt. 3	0.7	17	C	Slightly

Table E.6 Public Reaction to 405-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = 0)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	0	A	Not At All
Alt. 1	1.9	0	A	Not At All
Alt. 2	2.0	0	A	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	24	B	Slightly
Alt. 2	0.5	30	C	Moderately
Alt. 3	0.6	27	C	Slightly
McClain County, Oklahoma				
Proposed	0.6	27	C	Slightly
Alt. 2	0.5	30	C	Moderately
Alt. 3	0.6	27	C	Slightly
Woodward County, Oklahoma				
Proposed	0.6	27	C	Slightly
Alt. 1	0.7	24	B	Slightly
Alt. 2	0.7	24	B	Slightly
Montgomery County, Kansas				
Proposed	0.6	27	C	Slightly
Alt. 1	0.5	30	C	Moderately
Alt. 2	0.5	30	C	Moderately
Marion County, Kansas				
Proposed	0.6	27	C	Slightly
Alt. 2	0.6	27	C	Slightly
Alt. 3	0.5	30	C	Moderately
Kiowa County, Kansas				
Proposed	0.7	24	B	Slightly
Alt. 1	0.8	21	A	Slightly
Alt. 2	0.5	30	C	Moderately
Alt. 3	0.7	24	B	Slightly

Table E.7 Public Reaction to Unbaffled 50-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +2)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	13	B	Not At All
Alt. 1	1.9	14	B	Not At All
Alt. 2	2.0	14	B	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	27	E	Slightly
Alt. 2	0.5	31	F	Moderately
Alt. 3	0.6	29	E	Slightly
McClain County, Oklahoma				
Proposed	0.6	29	E	Slightly
Alt. 2	0.5	31	F	Moderately
Alt. 3	0.6	29	E	Slightly
Woodward County, Oklahoma				
Proposed	0.6	29	E	Slightly
Alt. 1	0.7	27	E	Slightly
Alt. 2	0.7	27	E	Slightly
Montgomery County, Kansas				
Proposed	0.6	29	E	Slightly
Alt. 1	0.5	31	F	Moderately
Alt. 2	0.5	31	F	Moderately
Marion County, Kansas				
Proposed	0.6	29	E	Slightly
Alt. 2	0.6	29	E	Slightly
Alt. 3	0.5	31	F	Moderately
Kiowa County, Kansas				
Proposed	0.7	27	E	Slightly
Alt. 1	0.8	26	E	Slightly
Alt. 2	0.5	31	F	Moderately
Alt. 3	0.7	27	E	Slightly

Table E.8 Public Reaction to 915-MHz Profiler/RASS (for Fidell method, tolerance index = decision index =+2)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	0	A	Not At All
Alt. 1	1.9	0	A	Not At All
Alt. 2	2.0	0	A	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	14	A	Not At All
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.6	18	A	Not At All
McClain County, Oklahoma				
Proposed	0.6	18	A	Not At All
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.6	18	A	Not At All
Woodward County, Oklahoma				
Proposed	0.6	18	A	Not At All
Alt. 1	0.7	14	A	Not At All
Alt. 2	0.7	14	A	Not At All
Montgomery County, Kansas				
Proposed	0.6	18	A	Not At All
Alt. 1	0.5	23	A	Slightly
Alt. 2	0.5	23	A	Slightly
Marion County, Kansas				
Proposed	0.6	18	A	Not At All
Alt. 2	0.6	18	A	Not At All
Alt. 3	0.5	23	A	Slightly
Kiowa County, Kansas				
Proposed	0.7	14	A	Not At All
Alt. 1	0.8	11	A	Not At All
Alt. 2	0.5	23	A	Slightly
Alt. 3	0.7	14	A	Not At All

Table E.9 Public Reaction to Baffled 50-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +2)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	3	B	Not At All
Alt. 1	1.9	4	B	Not At All
Alt. 2	2.0	4	B	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	17	C	Not At All
Alt. 2	0.5	21	D	Slightly
Alt. 3	0.6	19	C	Not At All
McClain County, Oklahoma				
Proposed	0.6	19	C	Not At All
Alt. 2	0.5	21	D	Slightly
Alt. 3	0.6	19	C	Not At All
Woodward County, Oklahoma				
Proposed	0.6	19	C	Not At All
Alt. 1	0.7	17	C	Not At All
Alt. 2	0.7	17	C	Not At All
Montgomery County, Kansas				
Proposed	0.6	19	C	Not At All
Alt. 1	0.5	21	D	Slightly
Alt. 2	0.5	21	D	Slightly
Marion County, Kansas				
Proposed	0.6	19	C	Not At All
Alt. 2	0.6	19	C	Not At All
Alt. 3	0.5	21	D	Slightly
Kiowa County, Kansas				
Proposed	0.7	17	C	Not At All
Alt. 1	0.8	16	B	Not At All
Alt. 2	0.5	21	D	Slightly
Alt. 3	0.7	17	C	Not At All

Table E.10 Public Reaction to 405-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +2)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	0	A	Not At All
Alt. 1	1.9	0	A	Not At All
Alt. 2	2.0	0	A	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	24	B	Slightly
Alt. 2	0.5	30	C	Moderately
Alt. 3	0.6	27	C	Slightly
McClain County, Oklahoma				
Proposed	0.6	27	C	Slightly
Alt. 2	0.5	30	C	Moderately
Alt. 3	0.6	27	C	Slightly
Woodward County, Oklahoma				
Proposed	0.6	27	C	Slightly
Alt. 1	0.7	24	B	Slightly
Alt. 2	0.7	24	B	Slightly
Montgomery County, Kansas				
Proposed	0.6	27	C	Slightly
Alt. 1	0.5	30	C	Moderately
Alt. 2	0.5	30	C	Moderately
Marion County, Kansas				
Proposed	0.6	27	C	Slightly
Alt. 2	0.6	27	C	Slightly
Alt. 3	0.5	30	C	Moderately
Kiowa County, Kansas				
Proposed	0.7	24	B	Slightly
Alt. 1	0.8	21	A	Slightly
Alt. 2	0.5	30	C	Moderately
Alt. 3	0.7	24	B	Slightly

Table E.11 Public Reaction to Unbaffled 50-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +10)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	13	B	Not At All
Alt. 1	1.9	14	B	Not At All
Alt. 2	2.0	14	B	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	27	E	Slightly
Alt. 2	0.5	31	F	Slightly
Alt. 3	0.6	29	E	Slightly
McClain County, Oklahoma				
Proposed	0.6	29	E	Slightly
Alt. 2	0.5	31	F	Slightly
Alt. 3	0.6	29	E	Slightly
Woodward County, Oklahoma				
Proposed	0.6	29	E	Slightly
Alt. 1	0.7	27	E	Slightly
Alt. 2	0.7	27	E	Slightly
Montgomery County, Kansas				
Proposed	0.6	29	E	Slightly
Alt. 1	0.5	31	F	Slightly
Alt. 2	0.5	31	F	Slightly
Marion County, Kansas				
Proposed	0.6	29	E	Slightly
Alt. 2	0.6	29	E	Slightly
Alt. 3	0.5	31	F	Slightly
Kiowa County, Kansas				
Proposed	0.7	27	E	Slightly
Alt. 1	0.8	26	E	Not At All
Alt. 2	0.5	31	F	Slightly
Alt. 3	0.7	27	E	Slightly

Table E.12 Public Reaction to 915-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +10)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	0	A	Not At All
Alt. 1	1.9	0	A	Not At All
Alt. 2	2.0	0	A	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	14	A	Not At All
Alt. 2	0.5	23	A	Not At All
Alt. 3	0.6	18	A	Not At All
McClain County, Oklahoma				
Proposed	0.6	18	A	Not At All
Alt. 2	0.5	23	A	Not At All
Alt. 3	0.6	18	A	Not At All
Woodward County, Oklahoma				
Proposed	0.6	18	A	Not At All
Alt. 1	0.7	14	A	Not At All
Alt. 2	0.7	14	A	Not At All
Montgomery County, Kansas				
Proposed	0.6	18	A	Not At All
Alt. 1	0.5	23	A	Not At All
Alt. 2	0.5	23	A	Not At All
Marion County, Kansas				
Proposed	0.6	18	A	Not At All
Alt. 2	0.6	18	A	Not At All
Alt. 3	0.5	23	A	Not At All
Kiowa County, Kansas				
Proposed	0.7	14	A	Not At All
Alt. 1	0.8	11	A	Not At All
Alt. 2	0.5	23	A	Not At All
Alt. 3	0.7	14	A	Not At All

Table E.13 Public Reaction to Baffled 50-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +10)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	3	B	Not At All
Alt. 1	1.9	4	B	Not At All
Alt. 2	2.0	4	B	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	17	C	Not At All
Alt. 2	0.5	21	D	Not At All
Alt. 3	0.6	19	C	Not At All
McClain County, Oklahoma				
Proposed	0.6	19	C	Not At All
Alt. 2	0.5	21	D	Not At All
Alt. 3	0.6	19	C	Not At All
Woodward County, Oklahoma				
Proposed	0.6	19	C	Not At All
Alt. 1	0.7	17	C	Not At All
Alt. 2	0.7	17	C	Not At All
Montgomery County, Kansas				
Proposed	0.6	19	C	Not At All
Alt. 1	0.5	21	D	Not At All
Alt. 2	0.5	21	D	Not At All
Marion County, Kansas				
Proposed	0.6	19	C	Not At All
Alt. 2	0.6	19	C	Not At All
Alt. 3	0.5	21	D	Not At All
Kiowa County, Kansas				
Proposed	0.7	17	C	Not At All
Alt. 1	0.8	16	B	Not At All
Alt. 2	0.5	21	D	Not At All
Alt. 3	0.7	17	C	Not At All

Table E.14 Public Reaction to 405-MHz Profiler/RASS (for Fidell method, tolerance index = decision index = +10)

Site	Nearest Residence (miles)	Level above Masking (dB)	Modified CNR Rating	Fidell Annoyance Level
Grant County, Oklahoma, Central Facility				
Proposed	2.1	0	A	Not At All
Alt. 1	1.9	0	A	Not At All
Alt. 2	2.0	0	A	Not At All
Okmulgee County, Oklahoma				
Proposed	0.7	24	B	Not At All
Alt. 2	0.5	30	C	Slightly
Alt. 3	0.6	27	C	Not At All
McClain County, Oklahoma				
Proposed	0.6	27	C	Not At All
Alt. 2	0.5	30	C	Slightly
Alt. 3	0.6	27	C	Not At All
Woodward County, Oklahoma				
Proposed	0.6	27	C	Not At All
Alt. 1	0.7	24	B	Not At All
Alt. 2	0.7	24	B	Not At All
Montgomery County, Kansas				
Proposed	0.6	27	C	Not At All
Alt. 1	0.5	30	C	Slightly
Alt. 2	0.5	30	C	Slightly
Marion County, Kansas				
Proposed	0.6	27	C	Not At All
Alt. 2	0.6	27	C	Not At All
Alt. 3	0.5	30	C	Slightly
Kiowa County, Kansas				
Proposed	0.7	24	B	Not At All
Alt. 1	0.8	21	A	Not At All
Alt. 2	0.5	30	C	Slightly
Alt. 3	0.7	24	B	Not At All

Table E.15 Acceptable (A) and Unacceptable (U) Sites for the Profiler/RASSs using the Criteria of the Modified CNR Method for Acceptability of Noise Impacts

Facility (County, State)	Proposed Site	Alternative 1	Alternative 2	Alternative 3
Unbaffled 50-MHz Profiler/RASS				
Central (Grant Co., Okla.)	A	A	A	-
Boundary (McClain Co., Okla.)	U	-	U	U
Boundary (Okmulgee Co., Okla.)	U	-	U	U
Boundary (Woodward Co., Okla.)	U	U	U	-
Boundary (Kiowa Co., Kans.)	U	U	U	U
Boundary (Marion Co., Kans.)	U	-	U	U
Boundary (Montgomery Co., Kans.)	U	U	U	-
Baffled 50-MHz Profiler/RASS				
Central (Grant Co., Okla.)	A	A	A	-
Boundary (McClain Co., Okla.)	A	-	U	A
Boundary (Okmulgee Co., Okla.)	A	-	U	A
Boundary (Woodward Co., Okla.)	A	A	A	-
Boundary (Kiowa Co., Kans.)	A	A	U	A
Boundary (Marion Co., Kans.)	A	-	U	U
Boundary (Montgomery Co., Kans.)	A	U	U	-
915-MHz Profiler/RASS				
Central (Grant Co., Okla.)	A	A	A	-
Boundary (McClain Co., Okla.)	A	-	A	A
Boundary (Okmulgee Co., Okla.)	A	-	A	A
Boundary (Woodward Co., Okla.)	A	A	A	-
Boundary (Kiowa Co., Kans.)	A	A	A	A
Boundary (Marion Co., Kans.)	A	-	A	A
Boundary (Montgomery Co., Kans.)	A	A	A	-
405-MHz RASS Profiler/RASS				
Central (Grant Co., Okla.)	A	A	A	-
Boundary (McClain Co., Okla.)	A	-	A	A
Boundary (Okmulgee Co., Okla.)	A	-	A	A
Boundary (Woodward Co., Okla.)	A	A	A	-
Boundary (Kiowa Co., Kans.)	A	A	A	A
Boundary (Marion Co., Kans.)	A	-	A	A
Boundary (Montgomery Co., Kans.)	A	A	A	-

Appendix F

Federal Candidate Species Potentially Occurring in Counties Containing ARM Project Central and Boundary Facilities

Federal Candidate Species

State	Species	Candidate Category[a]
KANSAS	Arkansas River shiner	1
	Eastern spotted skunk	[illegible]
	Ferruginious hawk	2
	Snowy plover	2
	Loggerhead shrike	2
	Long-billed curlew	2
	White-faced ibis	2
	Black tern	2
	Black rail	2
	Henslow's sparrow	2
	Baird's sparrow	2
	Alligator snapping turtle	2
	Texas horned lizard	2
	Blue sucker	2
	Arkansas darter	2
	Sturgeon chub	2
	Sicklefin chub	2
	Speckled chub	2
	Topeka shiner	2
	Paddlefish	2
	Western fanshell	2
	Neosho mucket	2
	Ouachita kidney-shell	2
	Ozark emerald dragonfly	2
	Regal fritillary butterfly	2
	Clanton's Cave amphipod	2
	Earleaf foxglove	2
	Fameflower	2
	Weak nettle	2

Federal Candidate Species

State	Species	Candidate Category[a]
KANSAS (cont)		
	Ozark dropseed	2
	Dwarf burhead	2
	Hall's bulrush	2
	Hairy false mallow	2
	Skinner's purple false foxglove	2
	Cleftsedge	2
OKLAHOMA		
	Arkansas River shiner	1
	Alligator snapping turtle	2
	Arkansas River speckled chub	2
	Carex fissa	2
	Ferruginious hawk	2
	Long-billed curlew	2
	Migrant loggerhead shrike	2
	Mountain plover	2
	Swiftfox	2
	Texas horned lizard	2
	Western snowy plover	2
	White-faced ibis	2

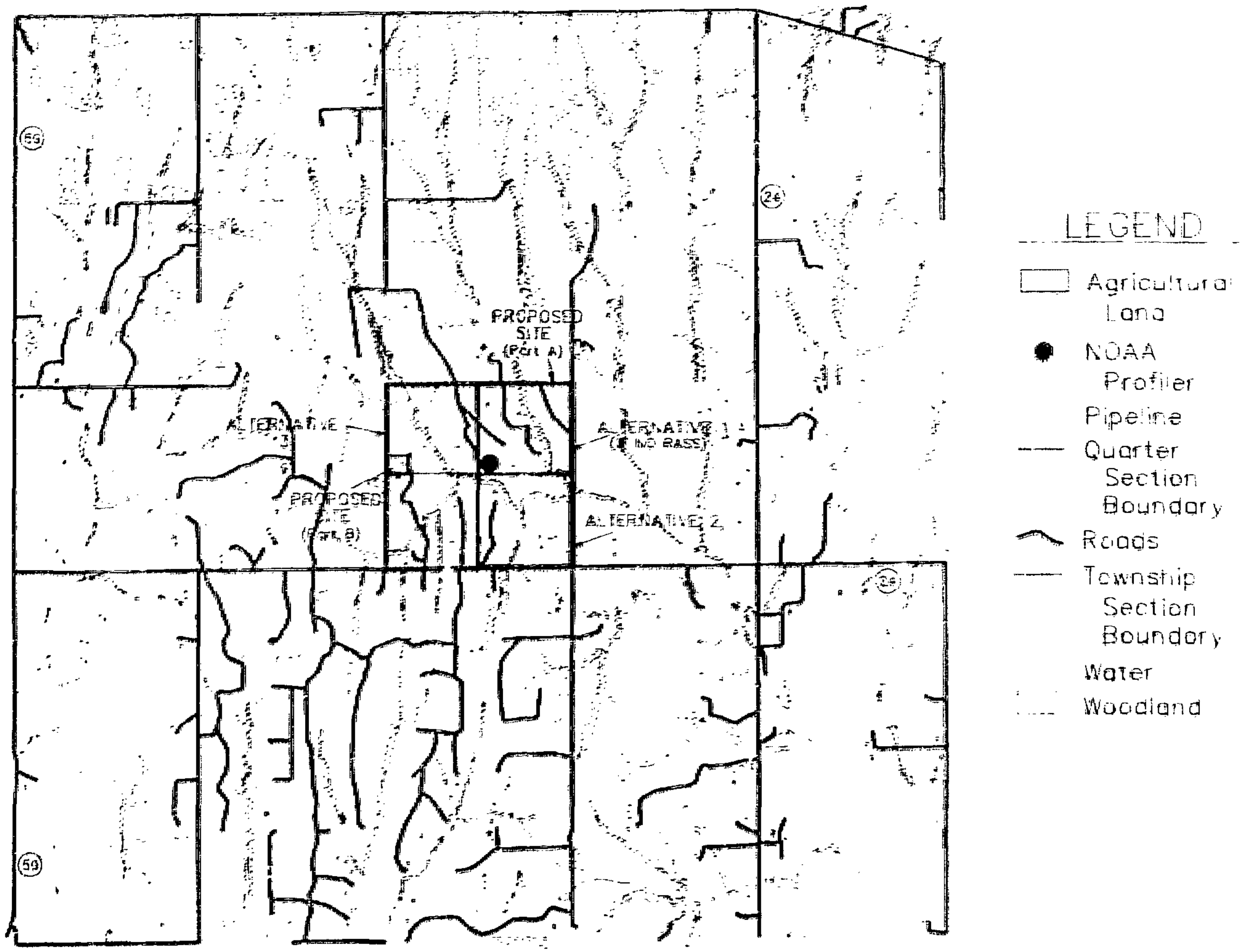
[a] *Candidate 1 species have the potential for an official federal listing by* the U.S. Fish and Wildlife Service. Candidate 2 species are those for which the Fish and Wildlife Service is collecting data on in order to make a decision concerning their status.

Source: U.S. Fish and Wildlife Service.

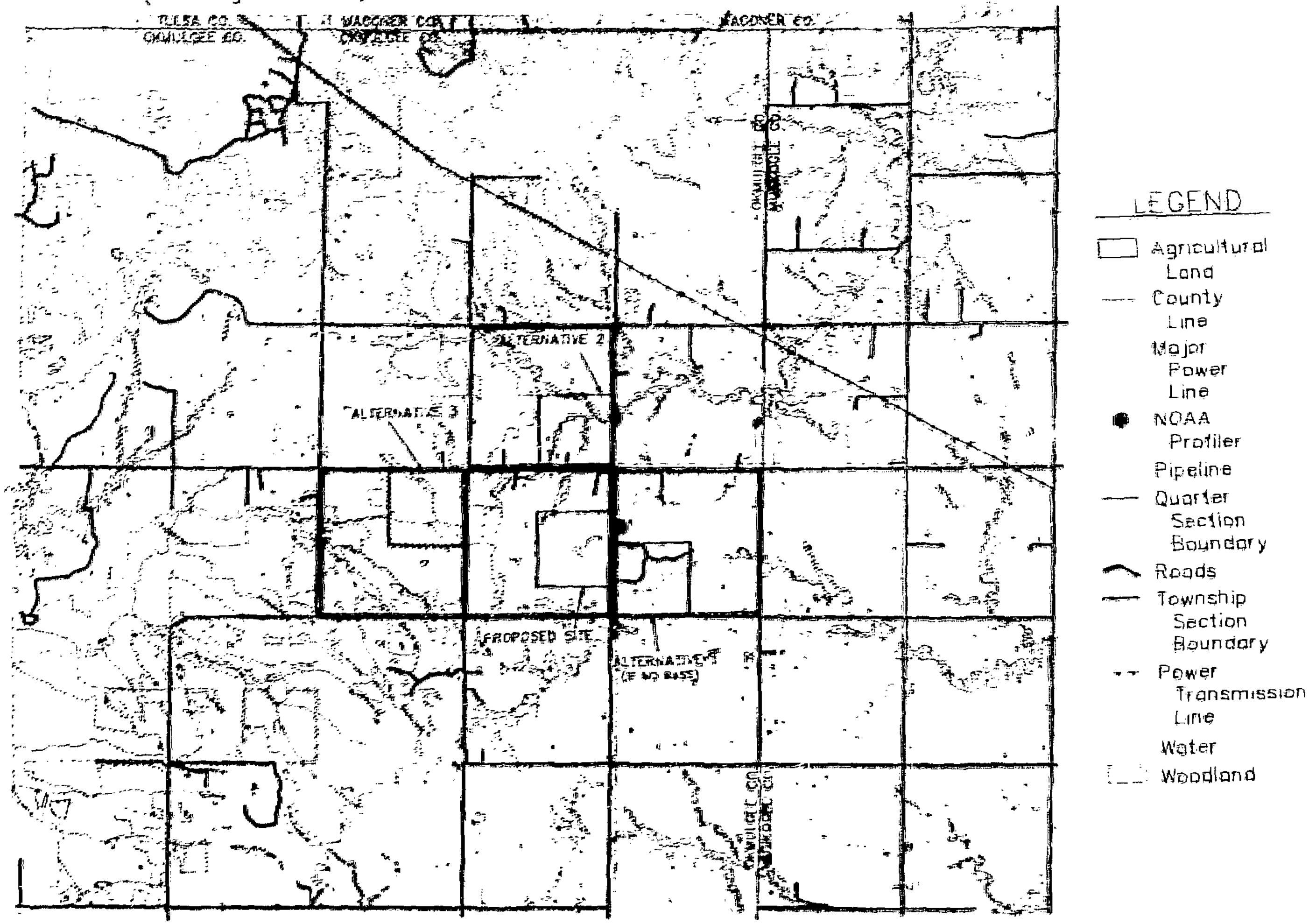
Appendix G

Existing Land Use Maps of Vicinity around Boundary Facilities

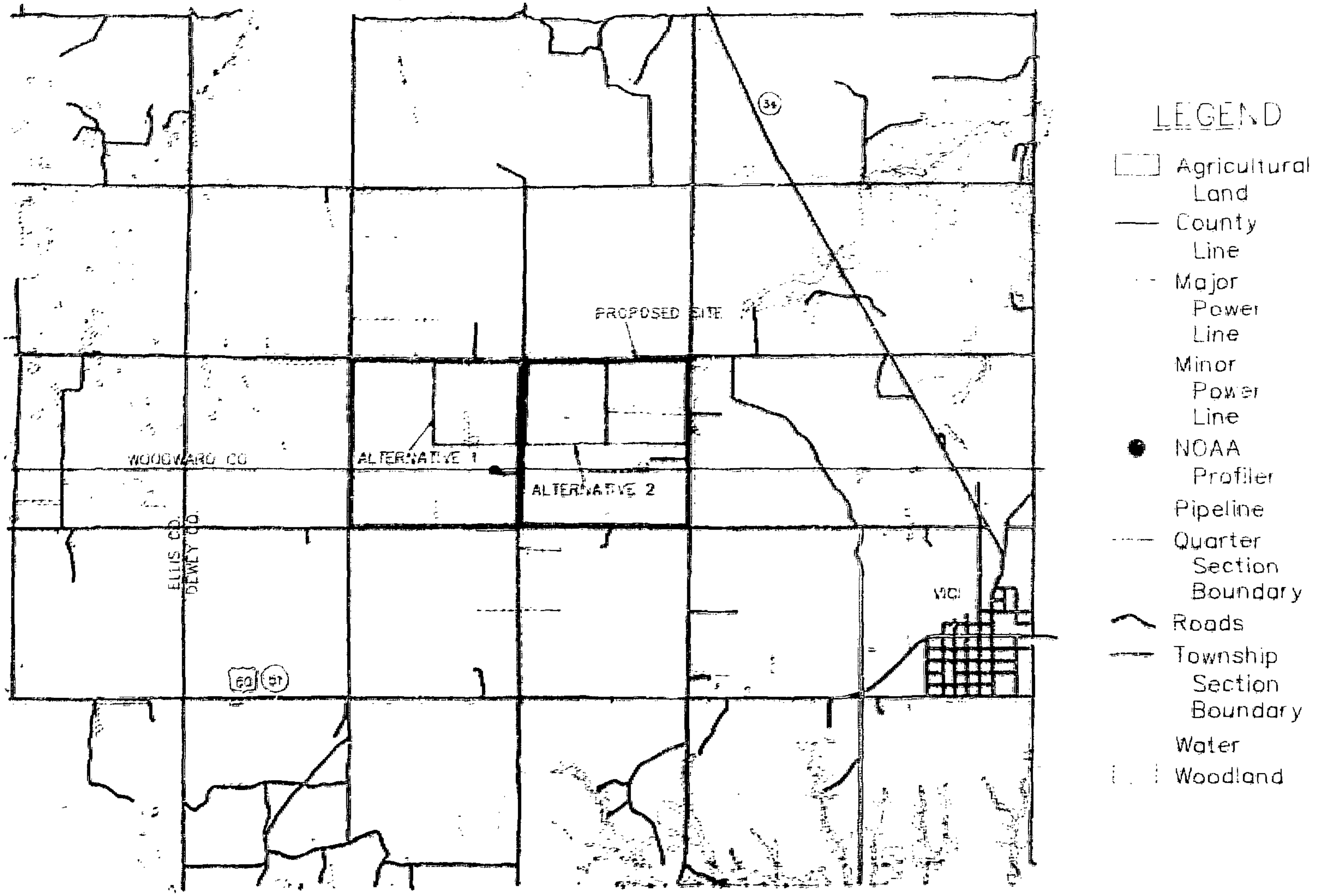
Existing Land Use in the Immediate Vicinity of the Proposed Action and Its Alternatives (McClain County, Oklahoma)



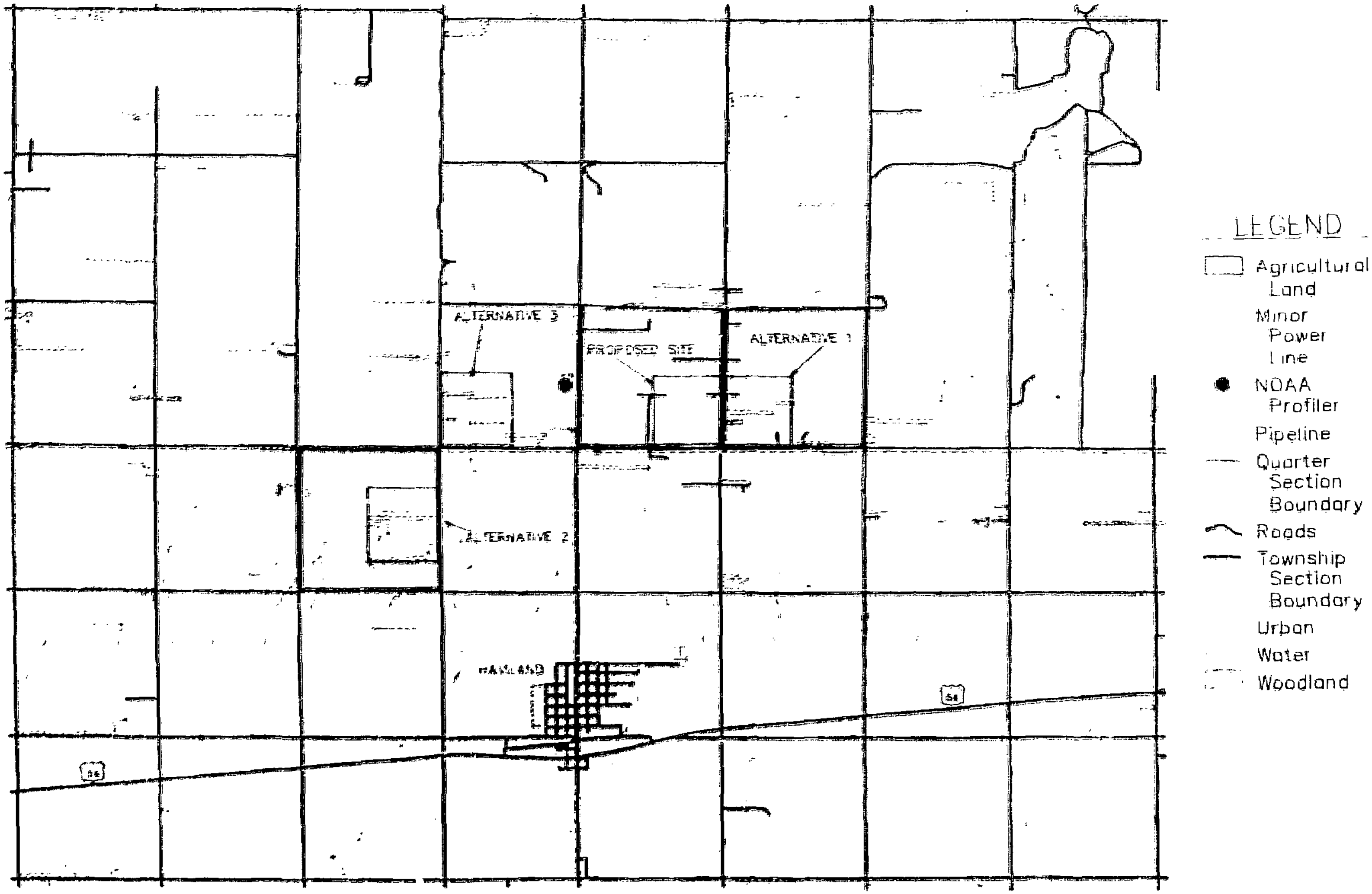
Existing Land Use in the Immediate Vicinity of the Proposed Action and its Alternatives
(Okmulgee County, Oklahoma)



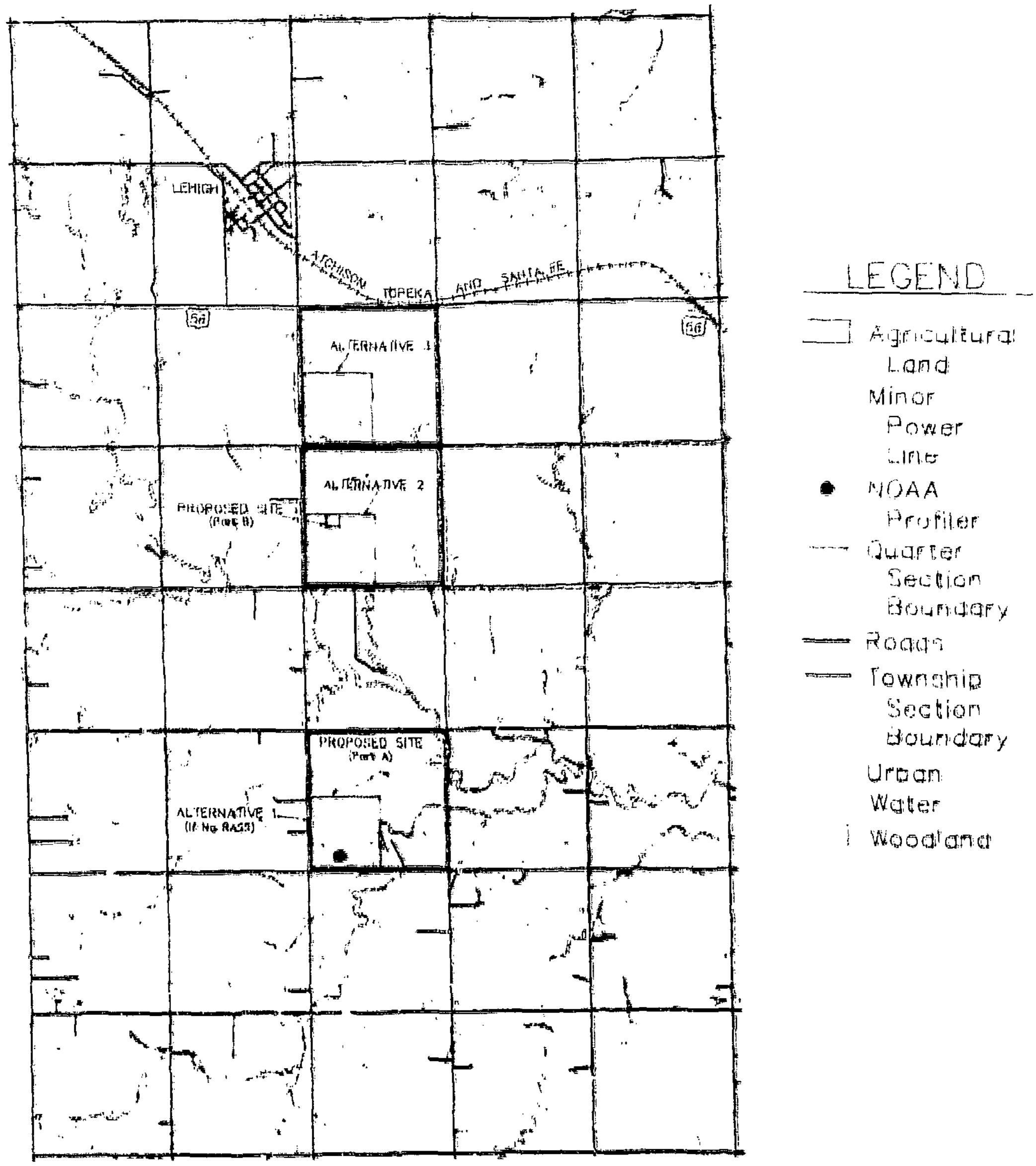
Existing Land Use in the Immediate Vicinity of the Proposed Action and its Alternatives
(Woodward County, Oklahoma)



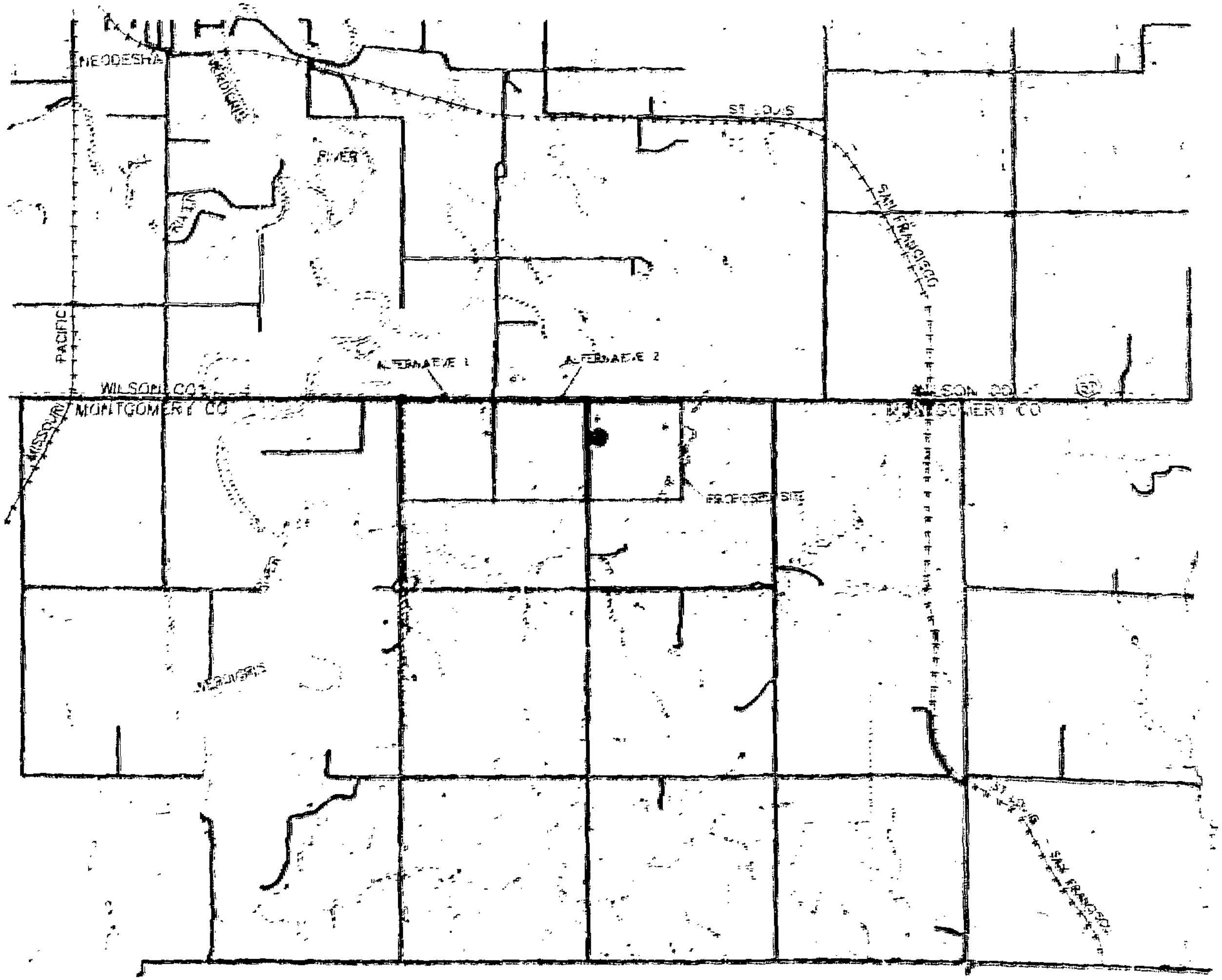
Existing Land Use in the Immediate Vicinity of the Proposed Action and its Alternatives
(Kiowa County, Kansas)



Existing Land Use in the Immediate Vicinity of the Proposed Action and its Alternatives (Marion County, Kansas)



Existing Land Use in the Immediate Vicinity of the Proposed Action and its Alternatives
(Montgomery County, Kansas)

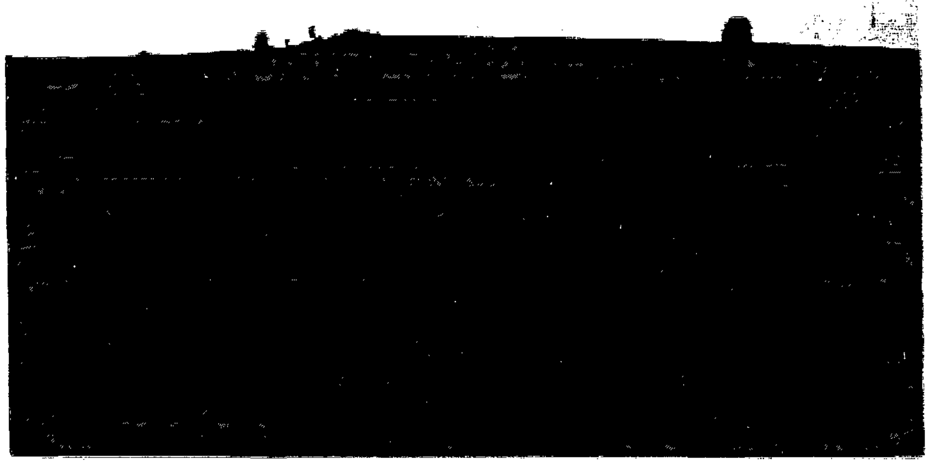


LEGEND

- Agricultural Land
- County Line
- Minor Power Line
- NOAA Profiler
- Quarter Section Boundary
- Roads
- Township Section Boundary
- Urban
- Water
- Woodland

Appendix H

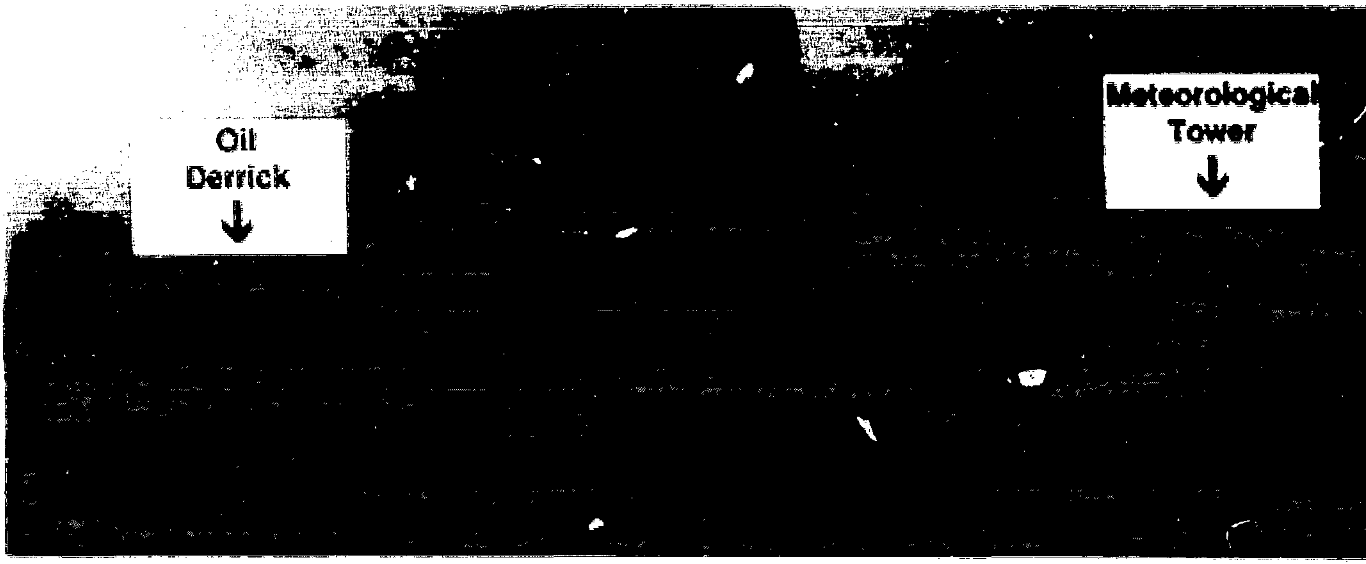
Photographs of Areas in Proximity to Grant and McClain County Facilities



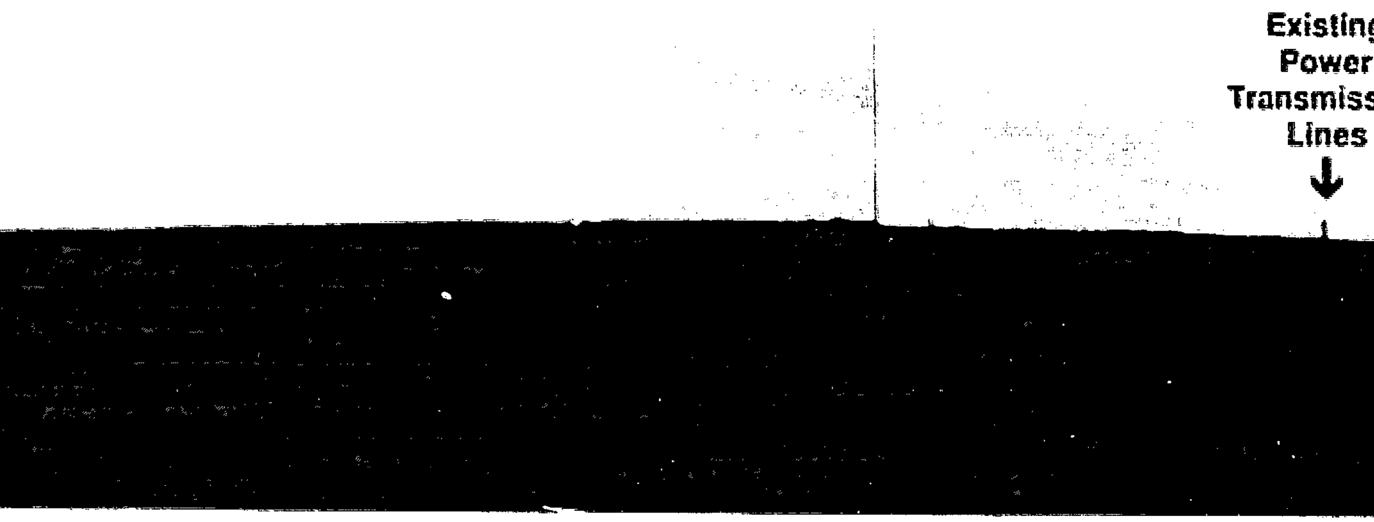
Foreground (0 – 1/4 mi) View of Proposed Site for Central Facility, Grant County, Oklahoma
View Looking Southwest

Middleground (1/4 – 2 mi) View of Proposed Site for Central Facility, Grant County, Oklahoma
View Looking Northwest

Background (2 – 5 mi) View of 1/4 Section Containing the Proposed Central Facility, Grant County, Oklahoma
Taken from Section Road, 2.2 mi Southeast of Proposed Site – View Looking Northwest



Middleground (1/4 – 2 mi) View of Section Containing Proposed McClain County (Oklahoma) Boundary Facility
View Looking West/Southwest



Background (2 – 5 mi) View of Section Containing Proposed McClain County (Oklahoma) Boundary Facility
Taken from State Highway 24 – View Looking Southwest

Appendix I

National Register of Historic Places Listings for Oklahama and Kansas Counties Containing Central and Boundary Facilities

Appendix I

National Register of Historic Places Listings for Oklahama and Kansas Counties Containing Central and Boundary Facilities

The following sites are recorded in the National Register of Historic Places as of September 1991 and are located in the counties containing the ARM program's central and boundary facilities. The date of entry into the National Register is given for each listing. The sources of the information are the Kansas State Historical Society and the Oklahoma Historical Society.

Grant County, Oklahoma

Deer Creek General Merchandise Store, South Main Street, Deer Creek (3-8-84)
Dayton School, SE of Lamont (9-8-88)
Grant County Courthouse, West Guthrie Street, Medford (8-23-84)
Medford Bathhouse and Swimming Pool, Guthrie and Fifth Street, Medford (9-8-88)

McClain County, Oklahoma

McClain County Courthouse, Courthouse Square, Purcell (8-23-84)

Okmulgee County, Oklahoma

Isparhecher House and Grave, 4 miles west of Beggs (7-12-76)
Henry Home, North Third Street, Henryetta (8-18-83)
Wilson School, NW of Henryetta (1-28-81)
Creek National Capitol, Sixth Street and Grand Ave., Okmulgee (10-15-66)
Eastside Baptist Church, 219 N. Osage Ave., Okmulgee (11-23-84)
First Baptist Central Church, 521 N. Central Ave., Okmulgee (11-23-84)
Okmulgee Black Hospital, 320 N. Wood Dr., Okmulgee (6-22-84)
Okmulgee County Courthouse, 300 West Seventh Street, Okmulgee (8-23-84)
Okmulgee Public Library, 218 South Okmulgee Ave., Okmulgee (7-28-83)
Severs Block, 101 East Sixth Street, Okmulgee (3-22-91)
St. Anthony's Catholic Church, 515 South Morton Street, Okmulgee (7-14-83)
Nuyaka Mission, 9 miles west of Okmulgee (4-13-72)

Woodward County, Oklahoma

Fort Supply Historic District, Western State Hospital grounds, Fort Supply (6-21-71)
L.L. Stein House, 1001 Tenth Street, Woodward (10-7-83)
Woodward Crystal Beach Park, Jim Ben and Temple Houston Streets, Woodward (9-8-88)

Kiowa County, Kansas

Greensburg Well, Sycamore Street, Greensburg (2-23-72)
Belvidere Medicine River Bridge, .25 miles north of Belvidere (7-2-85)
Roth Petroglyph Site, Belvidere vicinity (7-9-82)
Star Petroglyph Site, Belvidere vicinity (7-9-82)
Fromme-Birney Round Barn, 6 miles southwest of Mullinville (7-16-87)

Marion County, Kansas

Bethel School, 5 miles east of Lincolnville (12-17-87)
Burns Union School, southwest corner, Main and Ohio, Burns (3-26-75)
Harvey House, 204 West Third, Florence (8-14-73)
Pioneer Adobe House, US-56 and Ash Street, Hillsboro (3-30-73)
Elgin Hotel, Third and Santa Fe Streets, Marion (9-13-78)
Hill Grade School, 601 East Main, Marion (5-28-76)
Marion County Courthouse, Third and Williams, Marion (7-2-73)
Old Peabody Library, Walnut and Division, Peabody (7-2-73)
Peabody Township Carnegie Library, 214 Walnut, Peabody (6-25-87)
Lost Springs, Lost Springs vicinity (9-30-76)
Marion Archeological District, Marion vicinity (4-21-76)

Montgomery County, Kansas

Cherryvale Carnegie Free Library, 329 East Main, Cherryvale (8-18-87)
Brown Mansion, Walnut and Eldridge Streets, Coffeyville (12-12-76)
Condon National Bank, 811 Walnut Street, Coffeyville (1-12-73)
Terminal Building, 717 Walnut Street, Coffeyville (6-14-82)
Blakeslee Motor Company Building, 211 West Myrtle, Independence (8-25-89)
Booth Hotel, 201-209 West Main, Independence (4-28-83)
Booth Theatre, 119 West Myrtle, Independence (10-13-88)
Federal Building-U.S. Post Office, 123 North 8th, Independence (10-19-88)
Independence Bowstring Bridge, Burns Street, Independence (1-4-90)
Independence Public Carnegie Library, 220 East Maple, Independence (1-11-88)
Pennsylvania Avenue Rock Creek Bridge, Pennsylvania Avenue over Rock Creek, Independence (7-2-85)

Montgomery County, Kansas (cont'd)

Union Implement and Hardware Building-Masonic Temple, 121-123 West Main, Independence (10-13-88)
Dewlen-Spohnhauer Bridge, 1 mile east of Independence on old US 160 (3-10-83)
Elk River Archeological District, Elk City vicinity (9-13-78)
Infinity Archeological Site, Elk City Reservoir (3-24-71)
Treaty Rocks Petroglyph Site, Liberty vicinity (7-9-82)
Lookout Station Petroglyph Site, Liberty vicinity (7-9-82)
Onion Creek Bridge, .5 miles south of Coffeyville (1-4-90)
Petroglyph Site, 14MY365, Liberty vicinity (7-9-82)
Petroglyph Site, 14MY1320 Liberty vicinity (7-9-82)