

United States Department of the Interior  
National Park Service

# National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations of eligibility for individual properties or districts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. If an item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, styles, materials, and areas of significance, enter only the categories and subcategories listed in the instructions. For additional space use continuation sheets (Form 10-900a). Type all entries.

### 1. Name of Property

historic name Horn Antenna  
other names/site number Horn Reflector Antenna

### 2. Location

street & number Crawford Hill Facility  not for publication  
city, town Holmdel  vicinity  
state New Jersey code NJ county Monmouth code 025 zip code 07733

### 3. Classification

Ownership of Property	Category of Property	Number of Resources within Property	
		Contributing	Noncontributing
<input checked="" type="checkbox"/> private	<input checked="" type="checkbox"/> building(s)	<u>1</u>	<u>      </u> buildings
<input type="checkbox"/> public-local	<input type="checkbox"/> district	<u>      </u>	<u>      </u> sites
<input type="checkbox"/> public-State	<input type="checkbox"/> site	<u>1</u>	<u>      </u> structures
<input type="checkbox"/> public-Federal	<input checked="" type="checkbox"/> structure	<u>      </u>	<u>      </u> objects
	<input type="checkbox"/> object	<u>2</u>	<u>      </u> Total

Name of related multiple property listing: \_\_\_\_\_  
Number of contributing resources previously listed in the National Register 0

### 4. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this  nomination  request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property  meets  does not meet the National Register criteria.  See continuation sheet.

Signature of certifying official \_\_\_\_\_ Date \_\_\_\_\_  
State or Federal agency and bureau \_\_\_\_\_

In my opinion, the property  meets  does not meet the National Register criteria.  See continuation sheet.

Signature of commenting or other official \_\_\_\_\_ Date \_\_\_\_\_  
State or Federal agency and bureau \_\_\_\_\_

### 5. National Park Service Certification

I, hereby, certify that this property is:  
 entered in the National Register.  
 See continuation sheet.  
 determined eligible for the National Register.  See continuation sheet.  
 determined not eligible for the National Register.  
 removed from the National Register.  
 other, (explain:) \_\_\_\_\_

Signature of the Keeper \_\_\_\_\_ Date of Action \_\_\_\_\_

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**6. Function or Use**

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Historic Functions (enter categories from instructions)

Research Facility

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Current Functions (enter categories from instructions)

Research Facility

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**7. Description**

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Architectural Classification

(enter categories from instructions)

no style

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Materials (enter categories from instructions)

foundation concrete

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walls N/A

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roof N/A

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other aluminum, steel

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**Describe present and historic physical appearance.**

The Horn Antenna at Bell Telephone Laboratories in Holmdel, New Jersey, was constructed in 1959 to support Project Echo--the National Aeronautics and Space Administration's passive communications satellite project.<sup>1</sup>

The antenna is 50 feet in length with a radiating aperture of 20 x 20 feet and is made of aluminum. The antenna's elevation wheel is 30 feet in diameter and supports the weight of the structure by means of rollers mounted on a base frame. All axial or thrust loads are taken by a large ball bearing at the apex end of the horn. The horn continues through this bearing into the equipment cab. The ability to locate receiver equipment at the apex of the horn, thus eliminating the noise contribution of a connecting line, is an important feature of the antenna. A radiometer for measuring the intensity of radiant energy is found in the equipment cab.

The triangular base frame of the antenna is made from structural steel. It rotates on wheels about a center pintle ball bearing on a track 30 feet in diameter. The track consists of stress-relieved, planed steel plates which are individually adjusted to produce a track flat to about 1/64 inch. The faces of the wheels are cone-shaped to minimize sliding friction. A tangential force of 100 pounds is sufficient to start the antenna in motion.

To permit the antenna beam to be directed to any part of the sky, the antenna is mounted with the axis of the horn horizontal. Rotation about this axis affords tracking in elevation while the entire assembly is rotated about a vertical axis for tracking in the azimuth.

With the exception of the steel base frame, which was made by a local steel company, the antenna was fabricated and assembled by the Holmdel Laboratory shops under the direction of Mr. H. W. Anderson, who also collaborated on the design. Assistance in the design was also given by Messrs. R. O'Regan and S. A. Darby. Construction of the antenna was completed under the direction of Mr. A. B. Crawford from Freehold, New Jersey.

See continuation sheet

## 8. Statement of Significance

Certifying official has considered the significance of this property in relation to other properties:

nationally     statewide     locally

Applicable National Register Criteria     A     B     C     D    NHL Criteria 1, 2.

Criteria Considerations (Exceptions)     A     B     C     D     E     F     G

Areas of Significance (enter categories from instructions)

Period of Significance

Significant Dates

National Register Significance

1964-1965

Science

National Historic Landmark: Science,

Subtheme: Physical Science, Facet:

Astronomy

Cultural Affiliation

Significant Person

Dr. Arno A. Penzias; Dr. Robert A. Wilson

Architect/Builder

Mr. A. B. Crawford

State significance of property, and justify criteria, criteria considerations, and areas and periods of significance noted above.

### Summary

The Horn Antenna, at the Bell Telephone Laboratories in Holmdel, New Jersey, is significant because of its association with the research work of two radio astronomers, Dr. Arno A. Penzias and Dr. Robert A. Wilson. In 1965 while using the Horn Antenna, Penzias and Wilson stumbled on the microwave background radiation that permeates the universe. Cosmologists quickly realized that Penzias and Wilson had made the most important discovery in modern astronomy since Edwin Hubble demonstrated in the 1920s that the universe was expanding. This discovery provided the evidence that confirmed George Gamow's and Abbe Georges Lemaitre's "Big Bang" theory of the creation of the universe and forever changed the science of cosmology--the study of the history of the universe--from a field for unlimited theoretical speculation into a subject disciplined by direct observation. In 1978 Penzias and Wilson received the Nobel Prize for Physics for their momentous discovery.<sup>2</sup>

### History

"We live in an ocean of whispers left over from our eruptive creation, physicist George Gamow and his colleagues had said. Nobody was listening."<sup>3</sup>

By the middle of the 20th century cosmologists concerned with the creation of the universe had evolved two leading theories to explain their views. Some astronomers supported the steady-state theory of creation, which stated that the universe has always existed and will continue to survive without noticeable change. Others believed in the "Big Bang" theory of creation which taught that the universe is the glowing debris of a huge fireball that was created in a massive explosion about 16 billion years ago. No one knew for sure which theory was correct.

At Holmdel, New Jersey, in 1964 Dr. Arno Penzias and Dr. Robert Wilson were experimenting with a supersensitive, 20-foot horn-shaped antenna originally built to detect radio waves bounced off Echo balloon satellites. To measure faint radio waves from the Telstar communications satellite, they had to

See continuation sheet

**9. Major Bibliographical References**

SEE CONTINUATION SHEET

**Previous documentation on file (NPS):**

- preliminary determination of individual listing (36 CFR 67) has been requested
- previously listed in the National Register
- previously determined eligible by the National Register
- designated a National Historic Landmark
- recorded by Historic American Buildings Survey # \_\_\_\_\_
- recorded by Historic American Engineering Record # \_\_\_\_\_

See continuation sheet

**Primary location of additional data:**

- State historic preservation office
- Other State agency
- Federal agency
- Local government
- University
- Other

Specify repository: \_\_\_\_\_

**10. Geographical Data**

Acres of property \_\_\_\_\_ less than 1 acre

**UTM References**

A 

1	8
Zone	

5	6	9	1	5	0
Easting					

4	4	7	1	3	2	0
Northing						

C 

Zone	

Easting					

Northing							

B 

Zone	

Easting					

Northing							

D 

Zone	

Easting					

Northing							

See continuation sheet

**Verbal Boundary Description**

The boundary extends 50 feet in all directions from the outside walls of the Horn Antenna and the utility shed. (see attached map.)

See continuation sheet

**Boundary Justification**

The boundary encompasses the entire historic resource included in this nomination form.

See continuation sheet

**11. Form Prepared By**

name/title Harry Butowsky

organization National Park Service date May 1, 1989

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When not in use, the antenna azimuth sprocket drive is disengaged, thus permitting the structure to "weathervane" and seek a position of minimum wind resistance. The antenna was designed to withstand winds of 100 miles per hour and the entire structure weighs 18 tons.

The Horn Antenna combines several ideal characteristics: it is extremely broad-band, has calculable aperture efficiency, and the back and sidelobes are so minimal that scarcely any thermal energy is picked up from the ground. Consequently it is an ideal radio telescope for accurate measurements of low levels of weak background radiation.

A plastic clapboarded utility shed 10 x 20 feet, with two windows, a double door and a sheet metal roof, is found next to the Horn Antenna. This structure houses equipment and controls for the Horn Antenna and is included in this nomination.

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eliminate all recognizable interference from their receiver. They removed the effects of radar and radio broadcasting, and suppressed interference from the heart in the receiver itself by cooling it with liquid helium to  $-269^{\circ}\text{C}$ , only  $4^{\circ}$  above absolute zero--the temperature at which all motion in atoms and molecules stops.<sup>4</sup>

When Penzias and Wilson reduced their data they found a low, steady, mysterious noise that persisted in their receiver. This residual noise was 100 times more intense than they had expected, was evenly spread over the sky, and was present day and night. They were certain that the radiation they detected on a wavelength of 7.35 centimeters did not come from the Earth, the Sun, or our Galaxy. After thoroughly checking their equipment, the noise remained. Both men concluded that this noise was coming from outside our own galaxy--although they were not aware of any radio source that would account for it.

At that same time, Robert H. Dicke, Jim Peebles, and David Wilkenson, astrophysicists at Princeton University, just 40 miles away, were preparing to search for microwave radiation in this region of the spectrum. Dicke and his colleagues reasoned that the "Big Bang" must have scattered not only the matter that condensed into galaxies but also must have released a tremendous blast of radiation. With the proper instrumentation, this radiation should be detectable.

When a friend told Penzias about a preprint paper he had seen by Jim Peebles on the possibility of finding radiation left over from a fireball that filled the universe at the beginning of its existence, Penzias and Wilson began to realize the significance of their discovery. The characteristics of the radiation detected by Penzias and Wilson fit exactly the radiation predicted by Robert H. Dicke and his colleagues at Princeton University. Penzias called Dicke at Princeton, who immediately sent him a copy of the still-unpublished Peebles paper. Penzias read the paper and called Dicke again and invited him to Bell Labs to look at the Horn Antenna and listen to the background noise. Dicke, Penzias, and Wilson visited the antenna and immediately recognized the significance of their discovery--they had stumbled on to the "embers" of creation predicted by their Princeton colleagues.

To avoid potential conflict, they decided to publish their results jointly. Two notes were rushed to the Astrophysical Journal Letters. In the first, Dicke and his associates outlined the importance of cosmic background radiation as substantiation of the Big Bang Theory. In a second note, jointly signed by Penzias and Wilson titled, "A Measurement of Excess Antenna Temperature at 4080 Megacycles per Second," they noted the existence of the residual background noise and attributed a possible explanation to that given by Dicke in his companion letter.

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Harvard physicist Edward Purcell read this announcement and concluded that "It just may be the most important thing anybody has ever seen."<sup>5</sup>

Astronomer Robert Jastrow echoed this conclusion by stating that Penzias and Wilson "...made one of the greatest discoveries in 500 years of modern astronomy."<sup>6</sup>

In 1978, Dr. Arno Penzias and Dr. Robert Wilson were awarded the Nobel Prize for Physics for their joint discovery.

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Footnotes

1. The descriptive material for this section was taken from the following sources:

J.S. Hey, The Evolution of Radio Astronomy (New York: Neale Watson Academic Publications, Inc., 1973), pp. 98-99.

A.B. Crawford, D. C. Hogg, and L. E. Hunt, "Project Echo: A Horn Antenna for Space Communication," Bell System Technical Journal (July 1961), pp. 1095-1099.

2. Marcus Chown, "A cosmic relic in three degrees," New Scientist, September 29, 1988, pp. 51-52.

Richard Learner, Astronomy Through the Telescope (New York: Van Nostrand Reinhold Company, 1981), p. 154.

3. Timothy Ferris, The Red Limit: The Search for the Edge of the Universe, (New York: Quill Press, 1983), p. 141.

4. Herbert Friedman, The Amazing Universe (Washington, DC: National Geographic Society, 1975), p 166-167.

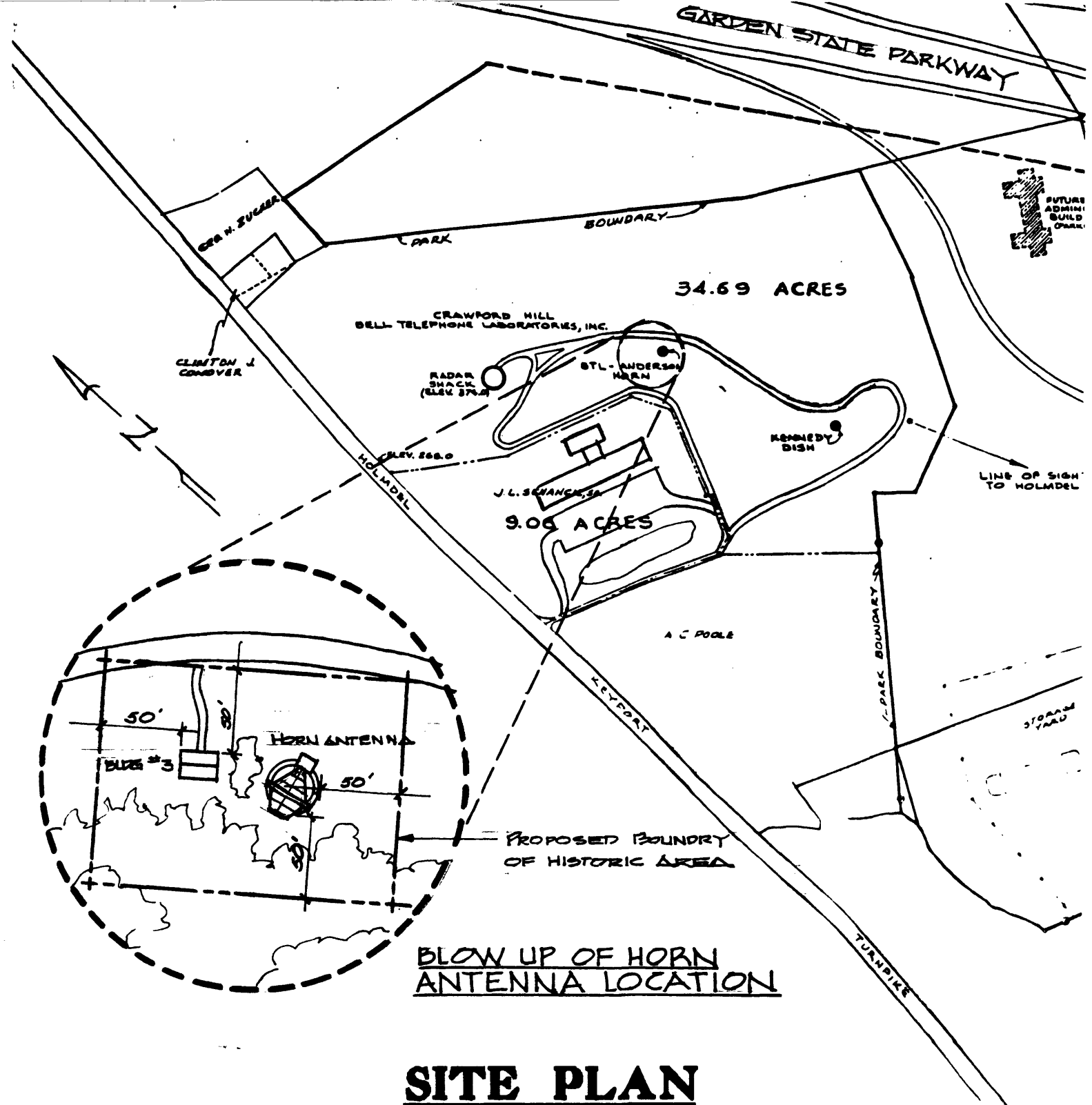
5. Ferris, op. cit., 151.

6. Robert Jastrow, God and the Astronomers (New York: W. W. Norton & Company, Inc., 1978), p. 20.



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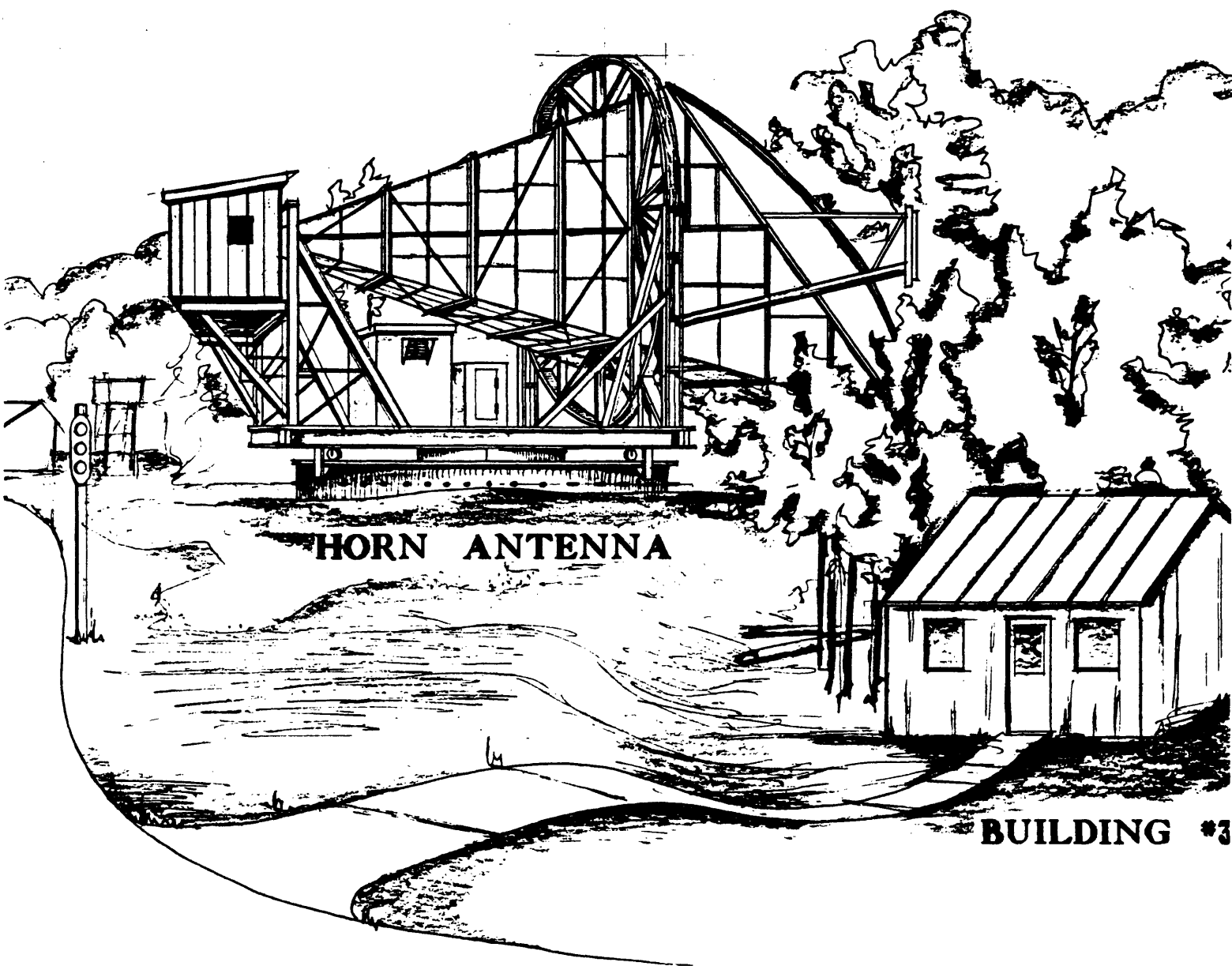
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- Abell, George O. Exploration of the Universe. 4th ed., Philadelphia: Saunders College Publishing, 1982.
- Asimov, Isaac. Asimov's Biographical Encyclopedia of Science and Technology. 2nd ed., New York: Doubleday & Company, Inc., 1982.
- Bernstein, Jeremy. Three Degree Above Zero: Bell Labs in the Information Age. New York: Charles Scribner's Sons, 1984.
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- Disney, Michael. The Hidden Universe. New York: Macmillan Publishing Company, 1984.
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- Friedman, Herbert. The Amazing Universe. Washington, DC: National Geographic Society, 1975.
- Hey, J.S. The Evolution of Radio Astronomy. New York: Neale Watson Academic Publications, Inc., 1973.
- Jastrow, Robert. God and the Astronomers. New York: W. W. Norton & Company, Inc., 1978.
- Kirby-Smith, H.T. U.S. Observatories: A Directory and Travel Guide. New York: Van Nostrand Reinhold Company, 1976.
- Learner, Richard. Astronomy Through the Telescope. New York: Van Nostrand Reinhold Company, 1981.
- Penzias, A.A., and R. W. Wilson. "A Measurement of the Flux Density of CAS A At 4080 Mc/s," Astrophysical Journal Letters, May 1965, pp. 1149-1154.



BLOW UP OF HORN ANTENNA LOCATION

**SITE PLAN**  
**HORN ANTENNA**

**AT&T BELL LABORATORIES**  
**CRAWFORD HILL FACILITY**  
**HOLMDEL, NEW JERSEY**



**HORN ANTENNA**

**BUILDING #3**

**HORN ANTENNA**

**AT&T BELL LABORATORIES  
CRAWFORD HILL FACILITY**

**HOLMDEL, NEW JERSEY**