NPS Form 10-900
(7-81)

United States Department of the Interior
National Park Service

National Register of Historic Places Inventory—Nomination Form

For NPS use only
received
date entered

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic Variable Density Tunnel

and/or common Variable Density Tunnel

2. Location

street & number Langley Research Center ___ not for publication

city, town Hampton ___ vicinity of **congressional district**

state Virginia **code** 51 **county** Hampton **code** 650

3. Classification

Category	Ownership	Status	Present Use	
___ district	X public	___ occupied	___ agriculture	___ museum
___ building(s)	___ private	___ unoccupied	___ commercial	___ park
X structure	___ both	___ work in progress	___ educational	___ private residence
___ site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	X yes: restricted	___ government	___ scientific
	___ being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	X other: Abandoned

4. Owner of Property

name National Aeronautics and Space Administration (NASA)

street & number

city, town Washington ___ vicinity of **state** D.C. 20546

5. Location of Legal Description

courthouse, registry of deeds, etc. National Aeronautics and Space Administration (NASA)

street & number Real Property Management Office Code NXG

city, town Washington **state** D.C. 20546

6. Representation in Existing Surveys

title None **has this property been determined eligible?** ___ yes ___ no

date ___ federal ___ state ___ county ___ local

depository for survey records

city, town **state**

7. Description

Condition		Check one	Check one
___ excellent	___ deteriorated	___ unaltered	_X_ original site
_X_ good	___ ruins	_X_ altered	___ moved date _____
___ fair	___ unexposed		

Describe the present and original (if known) physical appearance

The Variable Density Tunnel (VDT) is in Building 582 in the East Area of the Langley Research Center.[1] The VDT was constructed during the period from 1921 to 1923 at the direction of the National Advisory Committee for Aeronautics (NACA).

The tank of the VDT was built by the Newport News Shipbuilding & Dry Dock Co., of Newport News, Virginia. It is capable of withstanding a working pressure of 21 atmospheres. It is built of steel plates lapped and riveted according to the usual practice in steam boiler construction, although, because of the size of the tank and the high working pressure, the construction is unusually heavy. Entrance to the tank is gained through an elliptical door 36 inches wide and 42 inches high. The tank and its contents weigh 100 tons and are supported by a foundation of reinforced concrete.[2] The tank is 34.5 feet long and 15 feet in diameter with interior steel walls 2 1/8 inches thick. To minimize tank volume and the quantity of structural steel required (85 tons), an annular flow scheme was adopted. The test section was made 5 feet in diameter to match the National Advisory Committee for Aeronautics (NACA) Wind Tunnel No. 1. The maximum air velocity was 50 MPH at a pressure of 20 atmospheres.

The VDT was partially destroyed by fire in 1927. The interior of the tunnel was damaged but the exterior pressure tank remained intact. The tunnel was rebuilt and was operational again by 1930.

By the 1940s the tunnel was obsolete by the standards of the day and was gutted. The VDT continued to serve the needs of NACA and was used as a pressure tank to support the operation of the Vertical Wind Tunnel and the Low Turbulence Wind Tunnel. The VDT continued to serve in this capacity until it was declared potentially unsafe for further operations in 1978. Additional modifications during this time included the removal of the viewing platform and porthole from the tunnel.

The basic structure of the tunnel remains intact. At the present time there are no plans for the use of the Variable Density Tunnel.

8. Significance

Period	Areas of Significance—Check and justify below			
___ prehistoric	___ archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	___ archeology-historic	___ conservation	___ law	X science
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	___ architecture	___ education	___ military	___ social/ humanitarian
___ 1700–1799	___ art	X engineering	___ music	___ theater
___ 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation
X 1900–	___ communications	___ industry	___ politics/government	X other (specify) Aeronautical Research
		___ invention		

Specific dates 1921-1940 **Builder/Architect** Max Munk

Statement of Significance (in one paragraph)

The Variable Density Tunnel was the first facility to establish NACA as a technically competent research organization. The tunnel was a technological quantum jump that rejuvenated American aerodynamic research which in time led to the best aircraft in the world.[3]

The success of the Wright Brothers airplane was followed by a technological backward slide by the American aircraft industry. British, French, and German designers soon surpassed the Wright Brothers and other American aircraft builders. By World War 1 the United States had slipped into a position of technological inferiority compared to the European designers.

To support their aircraft industry European designers built major wind tunnels to test new theories and to discover better methods of building aircraft. To regain for America the technological leadership in the field of aircraft design and manufacture, President Woodrow Wilson signed into law a bill establishing the National Advisory Committee for Areonautics (NACA) March 3, 1915.

The responsibility of NACA, as the new agency was called, was to "supervise and direct the study of the problems of flight, with a view to their practical solution...." The act also provided for the construction of research facilities and a laboratory site near Hampton, Virginia. Thus the Langley Research Center came into being in 1917.

Originally called Langley Memorial Aeronautical Laboratory, later just Langley Aeronautical Laboratory, NACA Langley immediately set about the problem of building a wind tunnel to conduct aeronautical research. Because of the lack of experience in this area Langley first constructed NACA Wind Tunnel No. 1, a low speed tunnel with no return circuit for air passing through the test section. Although useful as a learning tool, this tunnel was obsolete by the standards of the day and produced no significant findings.

In June 1921 NACA's Executive Committee decided to leapfrog European wind tunnel technology and build a tunnel in which pressures could be varied. This concept was strongly advocated by Max Munk, a NACA technical assistant, who was familiar with European wind tunnel design from his days at Gottingen. The purpose of the Variable Density Tunnel, that Munk advocated, was to solve the problem of applying experimental results obtained from scale model aircraft to full size aircraft. Almost all wind tunnel tests at the time were, and still are, performed on scale model aircraft because of the expense involved in constructing full scale wind tunnels.

9. Major Bibliographical References

See continuation sheets

10. Geographical Data

Acreage of nominated property Less than 1 acre

Quadrangle name Hampton **Quadrangle scale** 1:24,000

UMT References

	Zone	Easting	Northing
A	18	380520	4104240
B			
C			
D			
E			
F			
G			
H			

Verbal boundary description and justification

The nominated property includes only the steel tank known as the Variable Density Tunnel.

List all states and counties for properties overlapping state or county boundaries

state	code	county	code
state	code	county	code

11. Form Prepared By

name/title Harry A. Butowsky

organization National Park Service **date** May 15, 1984

street & number Division of History **telephone** (202) 343-8168

city or town Washington, D.C. 20240 **state**

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature

title **date**

For NPS use only

I hereby certify that this property is included in the National Register

date

Keeper of the National Register

Attest: **date**

Chief of Registration

In a classic set of experiments, Osborne Reynolds (1842-1912) of the University of Manchester demonstrated that the airflow pattern over a scale model would be the same for the full scale vehicle if certain flow parameters were the same in both cases. This factor, now known as the Reynolds number, is a basic parameter in the description of all fluid-flow situations, including the shapes of flow patterns, the ease of heat transfer, and the onset of turbulence.[4]

In 1921 all wind tunnels were operating at normal atmospheric pressure using scale models. This meant that experimental results using these wind tunnels were open to question because the Reynolds number obtained did not match those encountered in using full scale aircraft. Thus the Reynolds number of a 1/20-scale model being tested at operational flight velocities in an atmospheric wind tunnel would be too low by a factor of 20. NACA engineers realized that since the Reynolds number is also proportional to air density that a solution was possible by testing 1/20-scale models at a pressure of 20 atmospheres. The Reynolds number would be the same in the wind tunnel as in actual flight.[5]

This was the significance of the Variable Density Tunnel. The VDT, for the first time, placed in the hands of NACA engineers a research tool superior to that found anywhere else in the world. The VDT was able to predict flow characteristics of test aircraft models more accurately than any other tunnel then in existence. The VDT quickly established itself as a primary source for aerodynamic data at high Reynolds numbers.

The result of this research led to the publication of NACA Technical Report 460 in which aerodynamic data for 78 related airfoil sections were presented. Information contained in this report eventually found its way into the design of such famous aircraft as the DC-3, B-17 and the P-38.

The VDT established NACA as a technologically competent organization and led to the production of superior American aircraft that have dominated the airways of the world since that time. All modern Variable Density Tunnels now in operation are but an extension of the original ideal first formulated and put into operation by Max Munk in 1921 with the construction of the original Variable Density Tunnel at Langley.

Footnotes

1. Much of the material in Sections 7 and 8 of this report has been adapted from Donald D. Baals and William R. Corliss, Wind Tunnels of NASA (Washington, D.C.: National Aeronautics and Space Administration, 1981), pp. 9-17.

2. Elton W. Miller, The Variable Density Wind Tunnel of the National Advisory Committee for Aeronautics Part II, Technical Report No. 227, (Washington, D.C.: National Advisory Committee for Aeronautics, 1925), pp. 411-412.

3. Baals, 17.

4. Ibid., 3.

5. Ibid., 15.

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Major Bibliographic References

Anderton, David A. Sixty Years of Aeronautical Research: 1917-1977. Washington, D.C.: National Aeronautics and Space Administration, 1978.

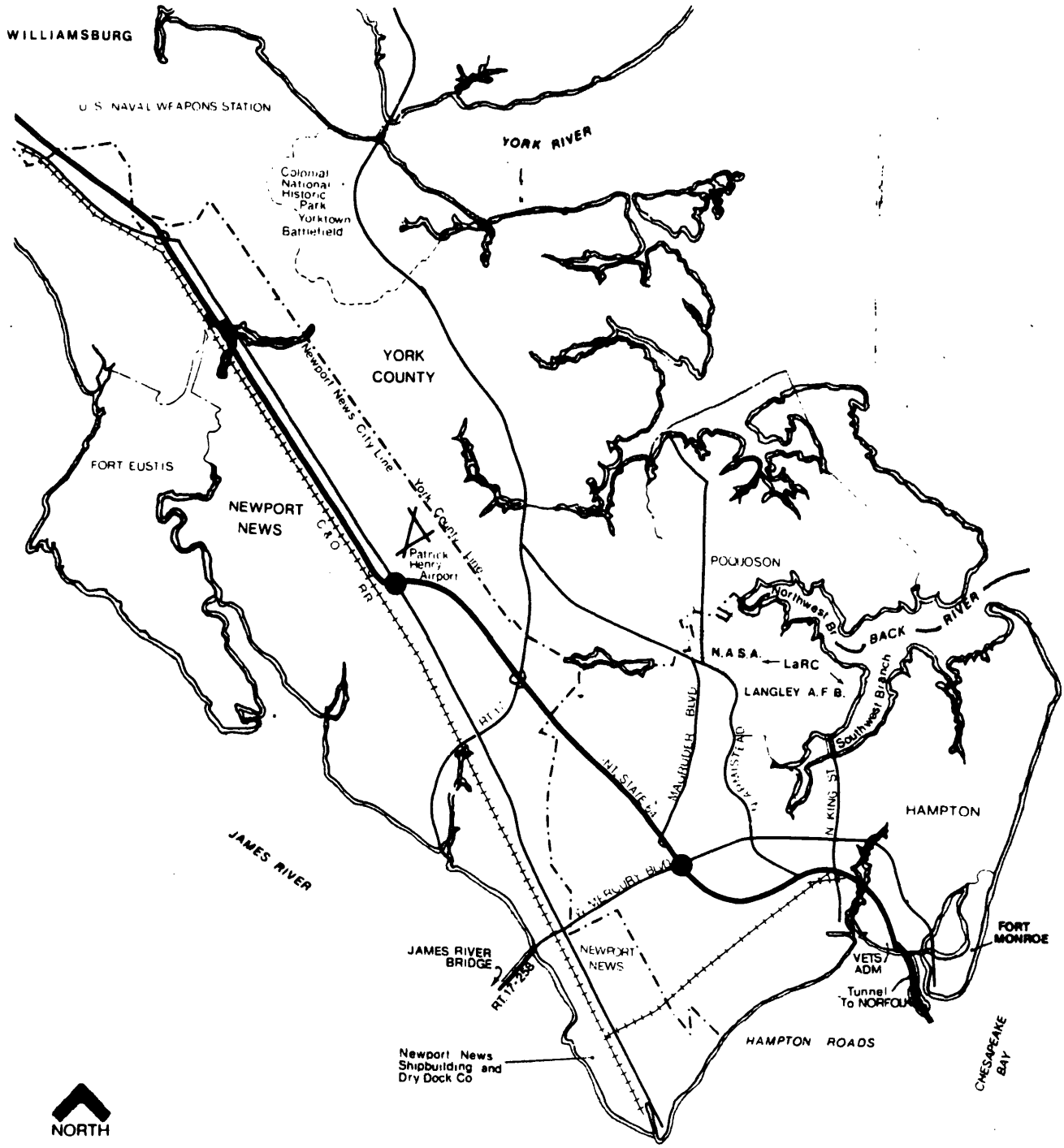
Anderson, John D. Jr. Introduction to Flight: Its Engineering and History. New York: McGraw Hill Book Company, 1978.

Baals, Donald D., and Corliss, William R. Wind Tunnels of NASA. Washington, D.C.: National Aeronautics and Space Administration, 1981.

Gray, George W. Frontiers of Flight: The Story of NACA Research. New York: Alfred E. Knopf, 1948.

Miller, Elton W. The Variable Density Wind Tunnel of the National Advisory Committee for Aeronautics Part II, Technical Report No. 227, Washington, D.C.: National Advisory Committee for Aeronautics, 1925.

Pope, Alan, and Harper, John J. Low-Speed Wind Tunnel Testing. New York: John Wiley & Sons, 1966.



NASA
National Aeronautics and Space Administration

Langley Research Center
Hampton, Virginia
23665

FIGURE 1-1
Regional Map

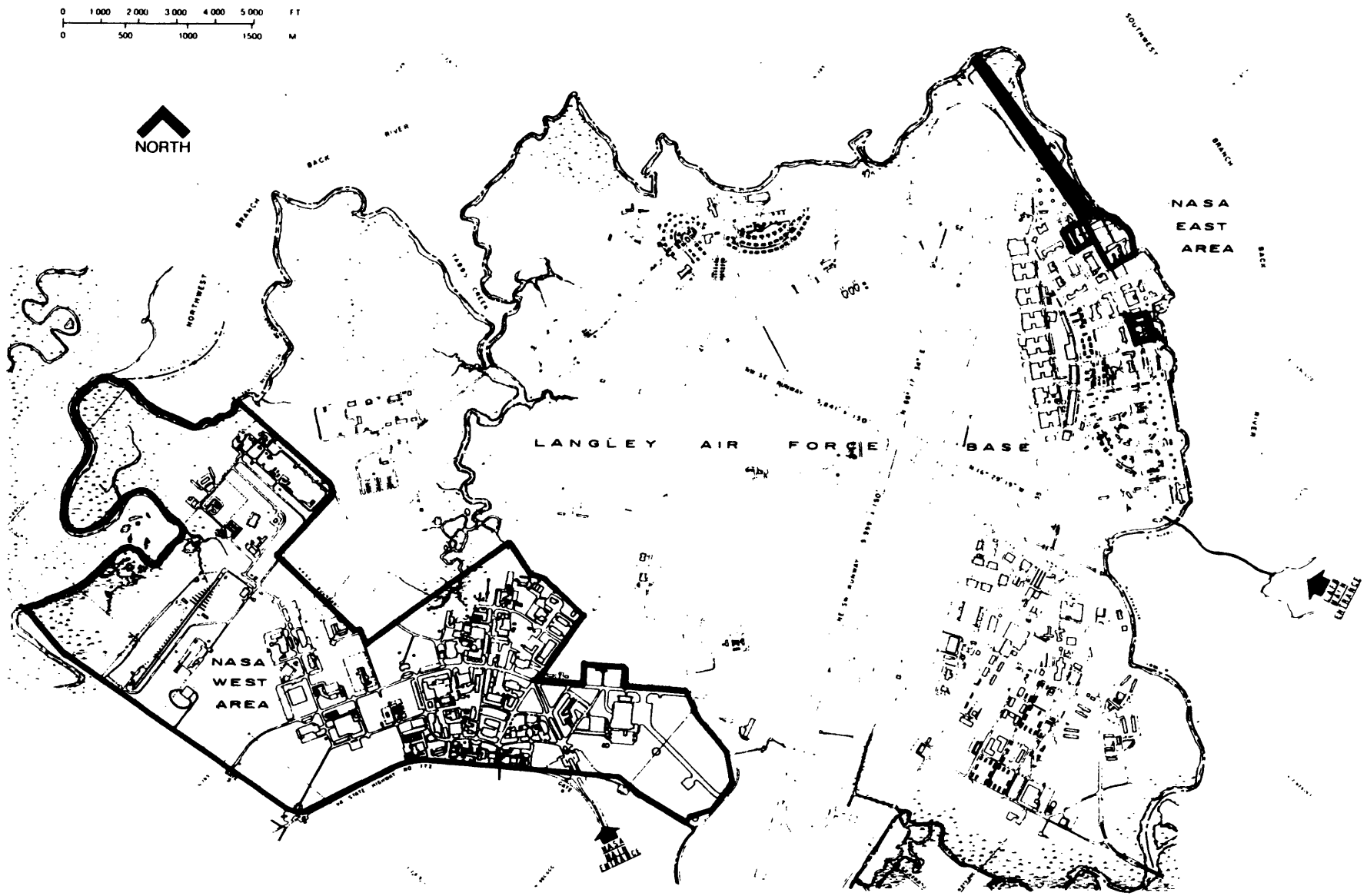


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FIGURE 1-2
Combined East & West Area

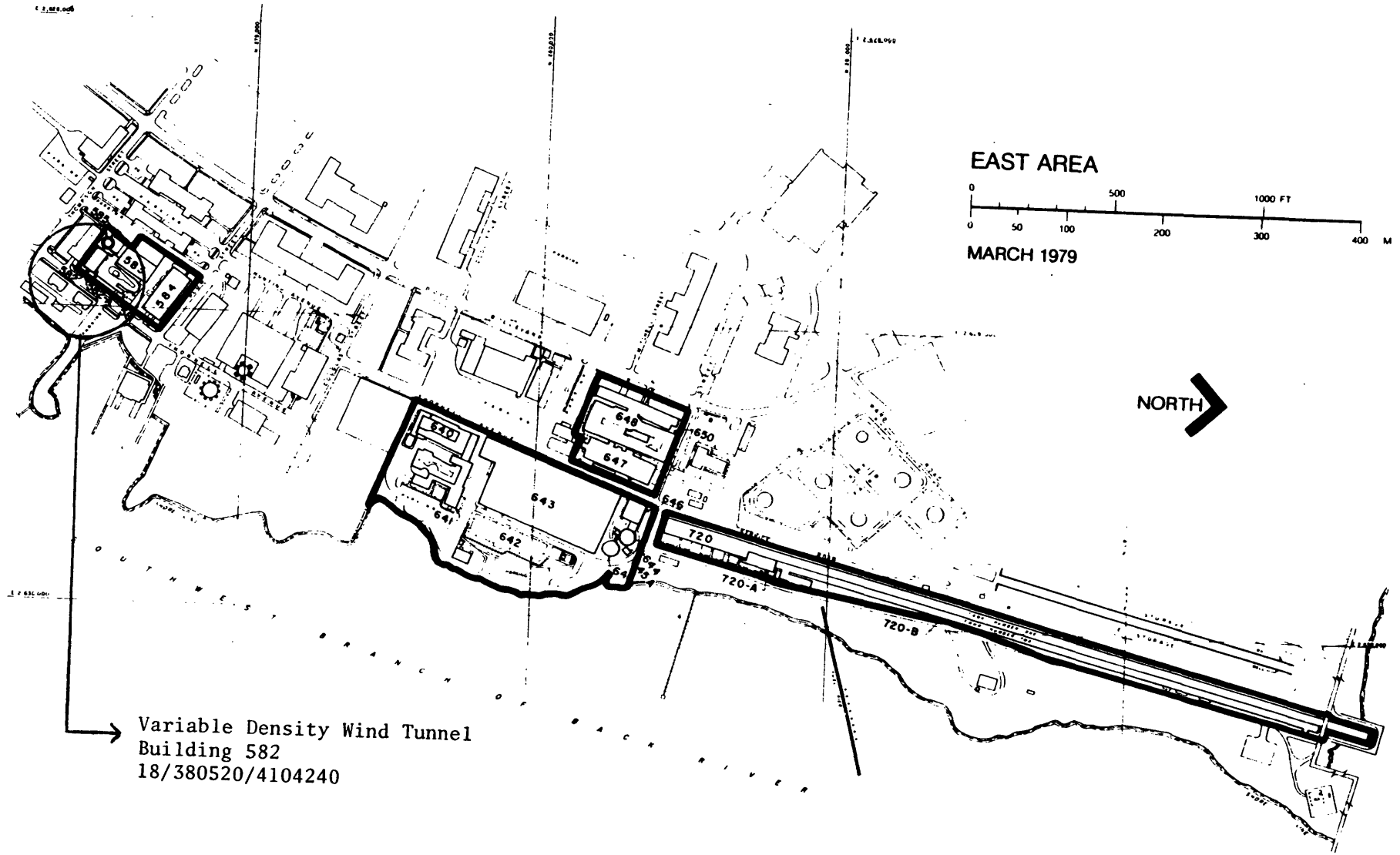

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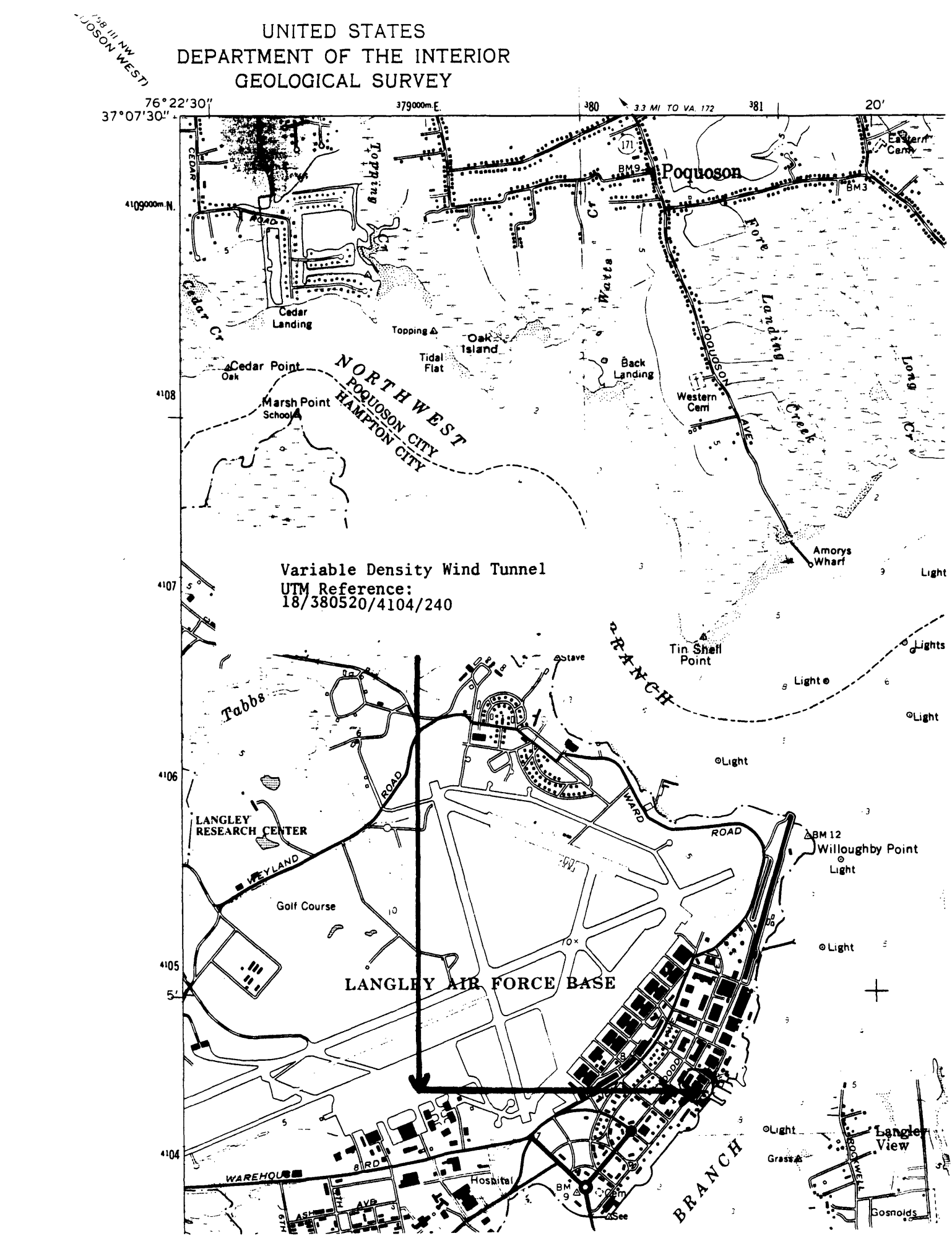
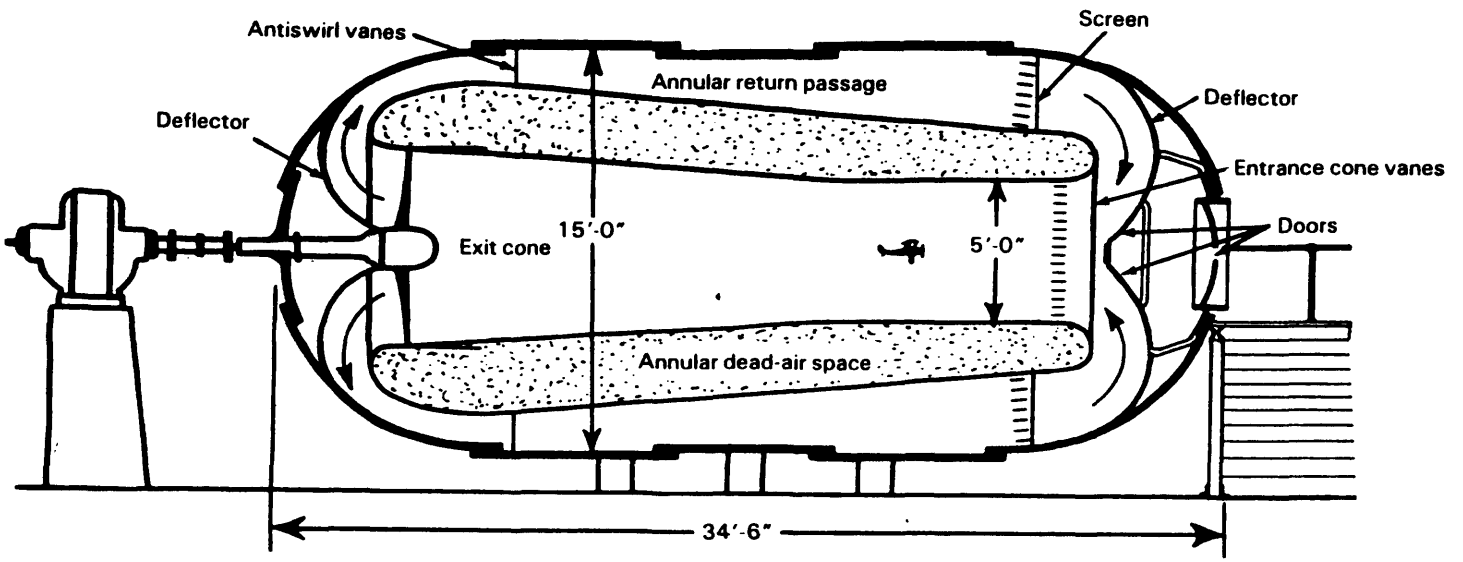
FIGURE 1-3
East Area


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
76°22'30"
37°07'30"
379000m.E.
380
3.3 MI TO VA. 172
381
20'
4109000m.N.
4108
4107
4106
4105
5'
4104
Poquoson
Eastern Cem
BM9
BM3
Topping Cr
Cedar Cr
Cedar Landing
Topping
Oak Island
Tidal Flat
Back Landing
Cedar Point
Oak
Marsh Point
School
NORTHWEST
POQUOSON CITY
HAMPTON CITY
Western Cem
POQUOSON AVE.
Fore Landing Creek
Long Cr
Amorys Wharf
Light
Variable Density Wind Tunnel
UTM Reference:
18/380520/4104/240
Tin Shell Point
Lights
Stave
Tabbs
ROAD
LANGLEY RESEARCH CENTER
WEYLAND
Golf Course
LANGLEY AIR FORCE BASE
WARD
ROAD
BM 12
Willoughby Point
Light
DODD
WAREHOUSE
8TH
Hospital
BM 9
Cem
See
BRANCH
Grass
Langley View
ROCKWELL
Gosnolds

Variable Density Tunnel



Source: Baals, p. 16.