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Ohio Standard Baseline Historical Documentation Package, OSU Mansfield Campus

Mansfield, Richland County, Ohio
Purchase order number 858406AA03
May 19, 2016

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SUBMITTED BY

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CULTURAL RESOURCES MANAGEMENT

PLANNING

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HDC 1553

ACKNOWLEDGMENTS

Principal Investigator and Senior Historian	**Benjamin M. Riggle**
Researcher and Context Development	**Andrew R. Sewell**
Editor	**Anne B. Lee**
Historian Assistant	**Terry Glaze**
Figure Preparation	**Michael J. Krakovsky**
Report Preparation and Authorship	This report was prepared and authored by Benjamin M. Riggle and Andrew R. Sewell. Benjamin M. Riggle took all photographs.
Additional Acknowledgments	HDC would like to thank John Snowden, former research associate for the OSB, and Kevin Payne, a deputy engineer for Richland County, for taking the time to respond to HDC's inquiries regarding the OSB. In addition, HDC would like to thank Craig Henry, Richard Van Deusen, and Brian White with OSU for all their assistance with this project, as well as Sarah Richardson, a senior associate at MKSK, for providing additional research materials.
Cover Photograph	Ca. 1966 photograph showing OSB, view looking south. Photograph courtesy of OSU Mansfield.

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ABSTRACT

This report provides documentation of the Ohio Standard Baseline (OSB), a geodetic baseline constructed on the Mansfield campus of the Ohio State University (OSU) in the mid-1960s. Geodetic baselines are used for extremely fine calibration of surveying equipment and to provide highly accurate measurements of the earth. Several such baselines were established in Europe and South America during the mid-twentieth century. Specifically, mid-twentieth century geodetic baselines were designed for use with a highly sensitive measurement device called the Väisälä Comparator, a precursor of modern laser-light measurement systems. The Väisälä Comparator required a quartz crystal of exceptionally precise dimensions to allow for the measurement of light. The OSB is the only such baseline to have been built in North America. In November 1966, a Väisälä Comparator was used to perform the final measurements necessary to commission the facility. After this point, the OSB was abandoned, and it was never used for any practical or commercial calibration purposes. The OSB, which consists of a set of concrete pillars spaced along a 500-meter distance, is scheduled for removal as part of the construction of a new entry road into the Mansfield campus from Lexington-Springmill Road, located along the western edge of the OSU Mansfield campus. While the OSB has previously been assessed for National Register of Historic Places (NRHP) eligibility and was recommended not eligible because of a lack of integrity (Lawhon 2015), OSU nevertheless recognizes that the OSB reflects an important event in the history of science in the United States, and as one of the first research initiatives undertaken at OSU Mansfield, should be recorded for posterity before its removal.

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INTRODUCTION

The intent of this report is to provide documentation of the Ohio Standard Baseline (OSB), a geodetic baseline constructed on the Mansfield campus of The Ohio State University (OSU) in the mid-1960s (Figure 1). Geodetic baselines are used for extremely fine calibration of surveying equipment, and several such baselines were established in Europe and South America during the mid-twentieth century. Specifically, mid-twentieth century geodetic baselines were designed for use with a device called the Väisälä Comparator, a precursor of modern laser-light measurement systems. The OSB is the only such baseline to have been built in North America. In addition, the OSB is likely the first academic and research initiative undertaken at the OSU Mansfield campus because the first campus building, Ovalwood Hall, also opened in 1966 (Brian White, personal communication, 2015).

The OSB consists of a set of concrete pillars spaced along a 500-meter distance (Figure 2). It is scheduled for removal as part of the construction of a new access road into the campus from Lexington-Springmill Road, located along the western edge of the campus property. While the OSB has previously been assessed for National Register of Historic Places (NRHP) eligibility and was recommended not eligible because of a lack of integrity (Lawhon 2015), OSU recognizes that the OSB reflects an important event in the history of science in the United States, and should be recorded before its removal. To that end, OSU contracted Hardlines Design Company (HDC) to produce a documentation package on the history of the OSB and complete an application for an Ohio Historical Marker to be placed at the location of the OSB after it is removed.

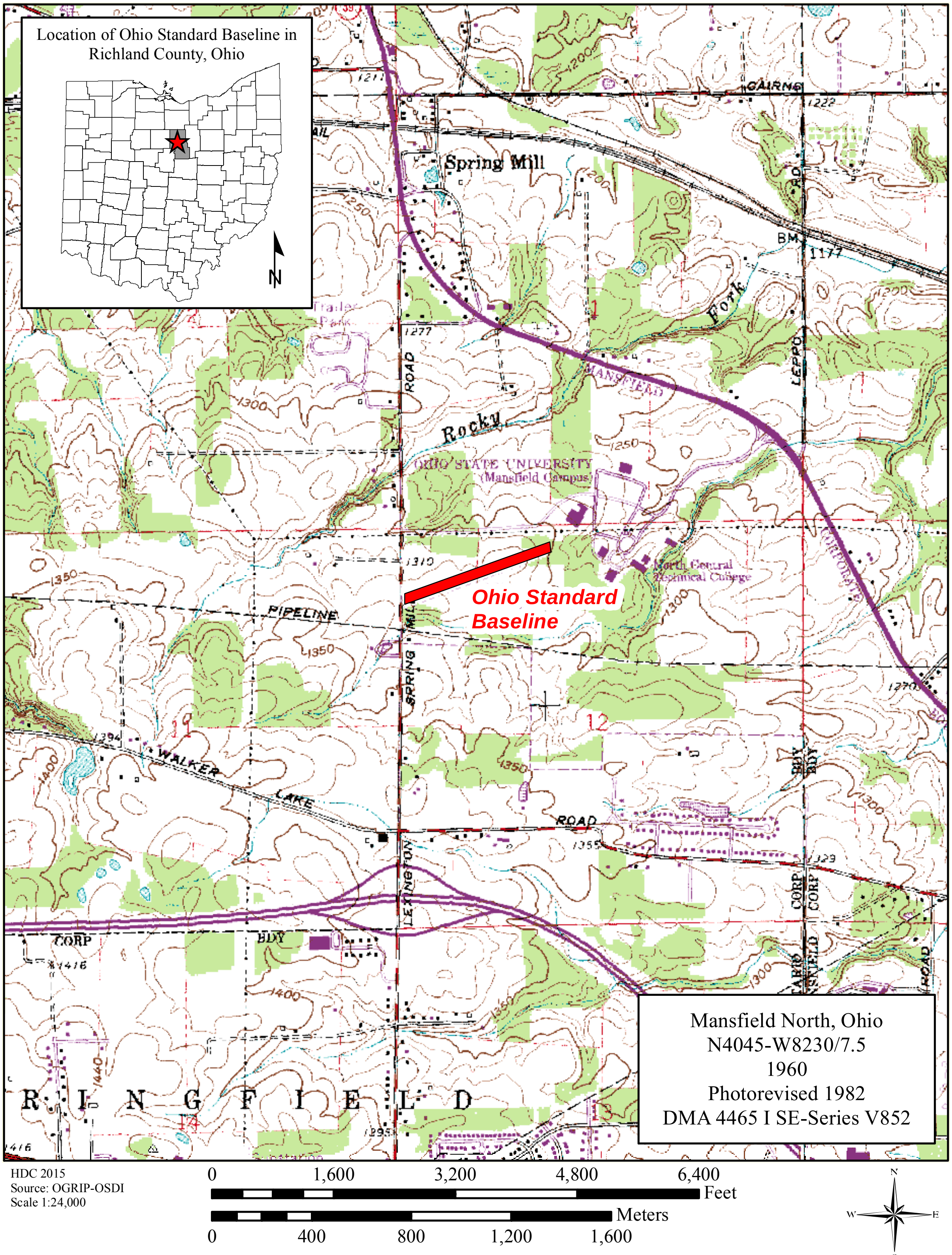

Figure 1. Ohio Standard Baseline overlaid on portion of USGS quad map last updated prior to the construction of the Health Sciences Building at OSU Mansfield.

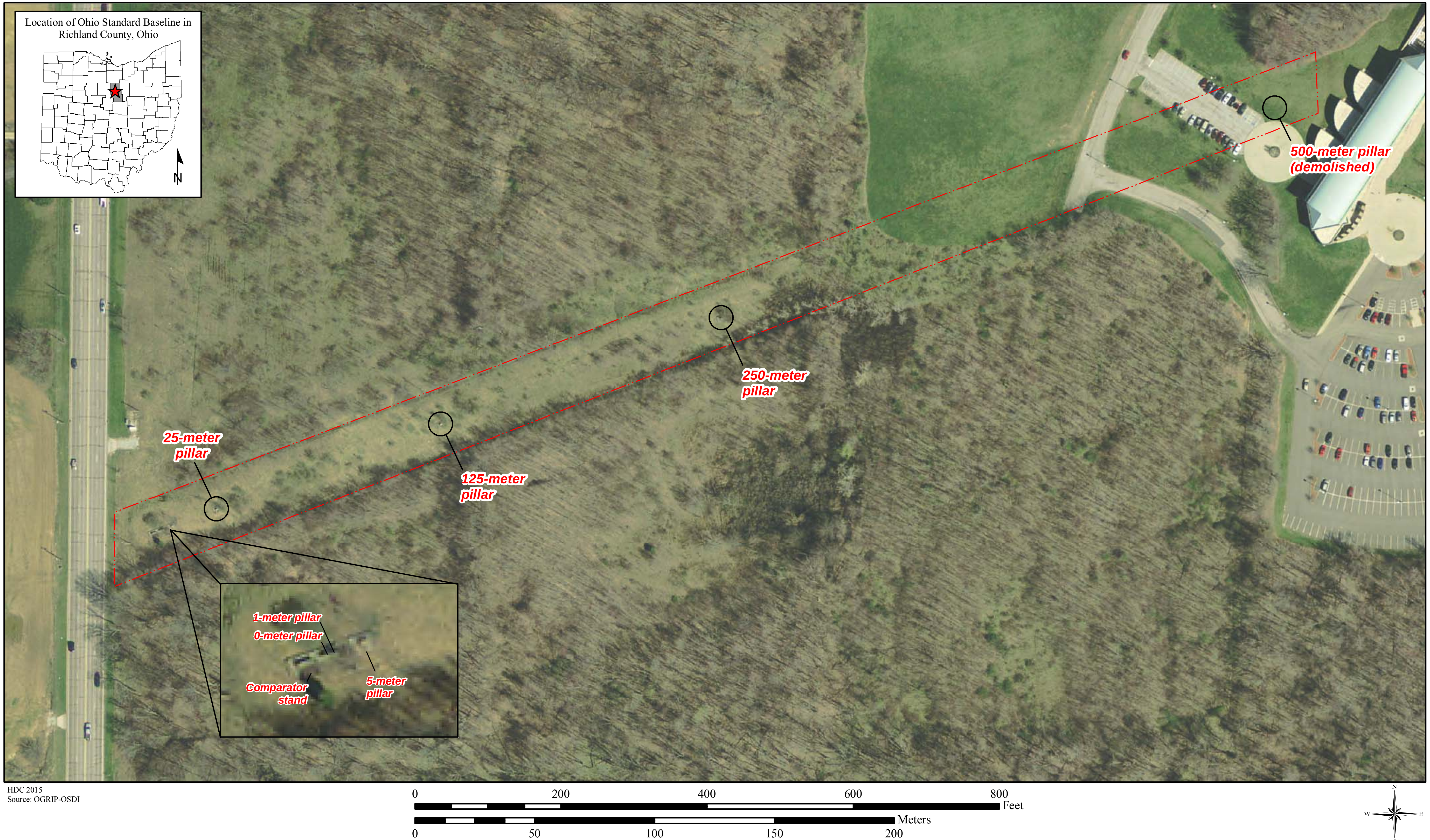

Figure 2. Locations of the pillars associated with the Ohio Standard Baseline shown on a recent aerial photograph

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HISTORICAL CONTEXT

Geodetic Measurement: An Overview

Geodetics is a scientific discipline focused on the measurement of the Earth in three dimensions. Basic geodetic surveying involves triangulation between numerous points to create a three-dimensional model of the Earth's surface in a given location. To calibrate surveying equipment, it is often tested on an established baseline that has been very precisely measured. Geodetic baselines have been in use for over 300 years as part of surveying and mapping, and typically consist of a straight line covering a set distance between two benchmarks, with other benchmarks placed in between at set intervals. Precise measurements of long distances are very important for determination of significant boundaries, ranging from private property lines to national borders (Jokela and Häkli 2006:2-3).

Early attempts at long-distance precise length measurement used rods and chains, which were prone to errors over long distances. In 1880, the Jaderin basis apparatus was introduced. This device consisted of a 24-meter-long iron wire that is stretched between two tripods with iron weights on either end (Delčev et al. 2012). While more accurate than the rod and chain method, the iron wire was problematic in that it would expand and contract in response to thermal variations, making very precise measurements difficult to obtain. The solution to this problem was the substitution of the invar nickel-iron alloy for iron, after the alloy was first created in 1896. The term "invar" is short for "invariable" that refers to the alloy's very low coefficient of thermal expansion, which makes the alloy ideal for scientific applications as the material expands at miniscule rates under thermal stress. Invar wires and tapes became preferred for land surveying for this reason, as the material would not shrink or expand as a result of changes in temperature. The use of invar wires with modified versions of the Jaderin basis apparatus allowed for precise land measurements to the millimeter (Delčev et al. 2012).

Light-wave technology was first used in creating very finely calibrated and highly accurate measurements in the early twentieth century. The use of white light interferometry was first proposed by Yrjö Väisälä in 1923 at the University of Helsinki, while Väisälä was a graduate student. This method to measure distance observes the "propagation and reflections of two light beams, which travel along different paths between mirrors" (Jokela 2014:5). Using the observations of the differences in the interference fringes created by the two light beams, Väisälä was able to determine the "mutual positions of the mirrors, with the longer distance being an exact multiple of the shorter distance" (Ibid.). Thus, the path each beam of light takes should be exactly the same length. The light beams are reflected back into a telescope, and the interference pattern generated is measured to determine the precise distance between the telescope and the mirrors, down to the micrometer. The apparatus developed by Väisälä to accomplish this feat became known as the Väisälä Comparator and became the method used for standardization of other geodetic length measurement devices, such as invar wires (Honkasalo 1960:457-458). Ultimately, the Väisälä Comparator was surpassed when a Swedish company, Geodimeter, developed the Geodetic Distance Meter, the earliest commercial Electronic Distance Measuring (EDM) instrument (Brian Conner, personal communication, 2015).

The Ohio Standard Baseline

The OSB project was developed to create a standard baseline for measurement similar to ones developed in Europe and South America. The OSB project was sponsored by OSU in collaboration with the Finnish Geodetic Institute. In 1953, Dr. T. J. Kukkamäki, a professor in the Department of Geodetic Science at OSU, proposed establishing an Ohio Geodetic Baseline that would be part of worldwide efforts to accurately understand how the size and shape of the planet changes over time. In addition to studying changes to the earth over time, the geodetic baseline could be used to calibrate sensitive surveying equipment to allow for ultra-precise measurements for land surveys. At the time, there were six other geodetic baselines designed to use the Väisälä Comparator in the world, set up in various locations in Europe and South American under the recommendation of the International Association of Geodesy (Jokela 2014:8-10). The first such baseline was the Nummela baseline in Finland, and notably many of the professors who worked in the OSU Department of Geodetic Science were Finns.

No serious movement to actually create a baseline in Ohio occurred until 1961, when an informal proposal to set up a geodetic baseline and acquire a Väisälä Comparator to perform the measurements was written by Professor W. A. Heiskanen in the Department of Geodetic Science. The informal proposal was reviewed and expanded into a formal proposal by Professor U. A. Uotila. Then Professor R. A. Oetjen, the acting chairman of the Department of Geodetic Science, forwarded the proposal onto the Council on Research. The Council on Research approved the proposal and provided $10,000 of the requested financing to begin the project. The university agreed to entirely back the project, but the university asked the department to first search for funding from outside sources (Kukkamäki 1968:7).

The Department of Geodetic Science applied for and received a National Science Foundation grant (grant number GP-549) in 1962. The National Science Foundation provided $22,000 to be used for purchasing the necessary equipment and to consult with members of the Finnish Geodetic Institute regarding the project. When the grant was initialized, Professor Heiskanen was named supervisor, while Professor Uotila was the principal investigator (Kukkamäki 1968:8). A stipulation of the project was that the OSB needed to be constructed on property owned by the state, preferably by OSU itself. Several possible sites were evaluated in a thesis written by W. H. Carpenter, Jr., in the early 1960s. Efforts to find a location for the OSB were led by Professor S. H. Laurila during the summer of 1963. Several potential sites were visited by Professors Kukkamäki, Heiskanen, Uotila, and Laurila during that time. Finally in 1965, a small parcel of land in the corner of OSU Mansfield campus was chosen. It was around this time that Professor Heiskanen retired, and Professor Uotila was appointed supervisor while Professor Laurila became the principal investigator (Kukkamäki 1968:8).

The Mansfield location was attractive because it provided a known, stable landform for the OSB (Kevin Payne, personal communication, 2015). Core samples taken at the Mansfield satellite campus of OSU proved that the campus's soil possessed the qualities needed for such a project (Kukkamäki 1968:8; John Snowden, personal communication, 2015). Construction of the OSB was delayed because only a portion of the required land was under OSU ownership, but by August 1965, the land ownership was resolved and construction of the OSB project began. The first building constructed at the OSU Mansfield campus, Ovalwood Hall, opened in 1966, so the OSB likely represents the first academic and research initiative undertaken at the campus (Brian White, personal communication, 2015).

When the decision was made to locate the OSB at the OSU Mansfield campus, the front page of the Mansfield newspaper proclaimed in a large bold font that "City Getting Rare Measuring Device" (*News Journal* 1965:1). Professor Kukkamäki recorded that construction of the OSB was contracted to Roland R. Getz Co. for a cost of $22,000 in August 1965, and the extensive grading needed for the project began shortly afterwards (Kukkamäki 1968:8). However, a newspaper article from December 1965 noted that Roland Getz, a respected builder, contractor, and real estate developer from Mansfield, was awarded the contract to construct the OSB with a low bid of $22,400 (*Daily News* 1965:21; *News Journal* 2012). While OSU originally provided $10,000 for the project, according to a newspaper article from when the OSB was completed, the project was ultimately funded with about $25,000 from the university and the $22,000 grant from the National Science Foundation (*Daily Reporter* 1966:22).

Construction of the OSB began during late 1965. Most of the early construction work focused on grading the land to allow the OSB to operate properly. The pillars for the OSB were constructed of concrete poured in place, but severe freezing halted construction until the spring of 1966. The construction contract was completed in July 1966; however, the final detail work to the tops of the pillars, necessary to mount the sophisticated measuring equipment, was postponed until October 1966 when Professor Kukkamäki returned from Finland to assist with the completion of the OSB project. Around this time, Professor Laurila left OSU, and S. F. Cushman was appointed principal investigator. John M. Snowden, an OSU research associate, was assigned to the project to assist with the final construction and actual measurement process (Kukkamäki 1968:8–9). The design for the OSB was very similar to the other existing baselines around the world at that time, and the OSB did not have any special or unique features in comparison to the other baselines (John Snowden, personal communication, 2015).

The designed length of the OSB was 500 meters. The physical structure used to measure the baseline involved a series of concrete pillars that supported a series of mirrors and instruments (Figure 3 and Figure 4). Eight pillars were constructed, one to support the quartz meter, and seven others supporting mirrors at distances along the OSB of 0, 1, 5, 25, 125, 250, and 500 meters (Figure 5). Each pillar extended 1.5 meters above the ground surface, with one meter of the total pillar length below the surface, and measured 50 centimeters square at the top of the pillar. Each pillar was placed over an underground marker, located at the base of a small well that was subsequently filled with water for the observations. A wooden observer platform was built around each pillar. A small canvas-sided shed was constructed to shelter the equipment at the quartz meter support pillar and 0-meter mark of the OSB (Figure 6 and Figure 7). Because the location of the OSB was on a slight slope, the top surface of each pillar was slanted to mimic the slope degree along the line of the OSB. A thermometer was placed at each pillar to record ambient temperature. When not in use, the equipment was sheltered in a wooden box set atop each pillar (Kukkamäki 1968:7-10).

The main piece of measuring equipment was the Väisälä Comparator, which measures the reflection of light over a set distance using a quartz meter rod, and a series of mirrors and lenses, all observed through a telescope (Figure 8). Differences in the distance traveled by the reflected light are measured in micrometers by examining the diffraction interference observed in the telescope. The comparator used at the OSB consisted of eight mirrors and two quartz meters (Kukkamäki 1968:11-12). As designed, the accuracy of the OSB was said to be such that it could detect “the pressure of a finger” touching one of the pillars (*News Journal* 1966:31).

Dr. Kukkamäki, by now the Director of the Finnish Geodetic Institute, directed the operation of the OSB in November of 1966. The operation faced difficulties with weather and some very slight, yet significant, physical shifting of some of the pillars, but all measurements were completed in four weeks. Taking into account the effects of atmospheric pressure and temperature on the quartz meter, the comparator was used to take several measurements and the final length of the OSB was determined to be 500,028.22±0.076 mm (Kukkamäki 1968:7).

Despite the successful implementation of the Väisälä Comparator at the OSB, the equipment was removed after the measurements were completed and likely returned to Finland (John Snowden, personal communication, 2015). Plans to establish the OSB as part of a larger geodetic measurement effort were abandoned. Foundation issues caused by drainage problems impacted the stability of the pillars, and because the facility required extreme precision, stability issues would make long term use suspect (Brian White, personal communication, 2015). Plans to rent the OSB to private businesses to allow those businesses to precisely calibrate land surveying equipment never came to fruition, which resulted in a lack of the funding necessary to maintain and to preserve the highly precise accuracy of the OSB (John Snowden, personal communication, 2015).

By 1973, the status of the OSB had declined, demonstrated by a conflict that arose with proposed improvements to Lexington-Springmill Road, along the western edge of the OSB. Initially, paving and widening the road was blocked by the State of Ohio because of concerns that the construction would impact the OSB in a way that would affect its accuracy (*News Journal* 1973:11). However, the road project eventually moved forward when the State determined that further work at the OSB was very unlikely to occur (Kevin Payne, personal communication, 2015), and the road project was ultimately completed in the late 1970s. Also during the late 1970s, the National Geodetic Survey (NGS) launched the Electronic Distances Measuring Instruments (EDMI) Calibration Base Line Program, which allowed local surveyors to verify their precise measurement equipment. The NGS EDMI required the equipment to be accurately set up directly above the mark, and the OSB’s concrete pillars would have prevented that requirement (Brian Conner, personal communication, 2015). The OSB was never put in use again, and the pillars and support bases were left in place to decay. The 500-m pillar was likely removed when the Health Sciences Building was built in 1995.

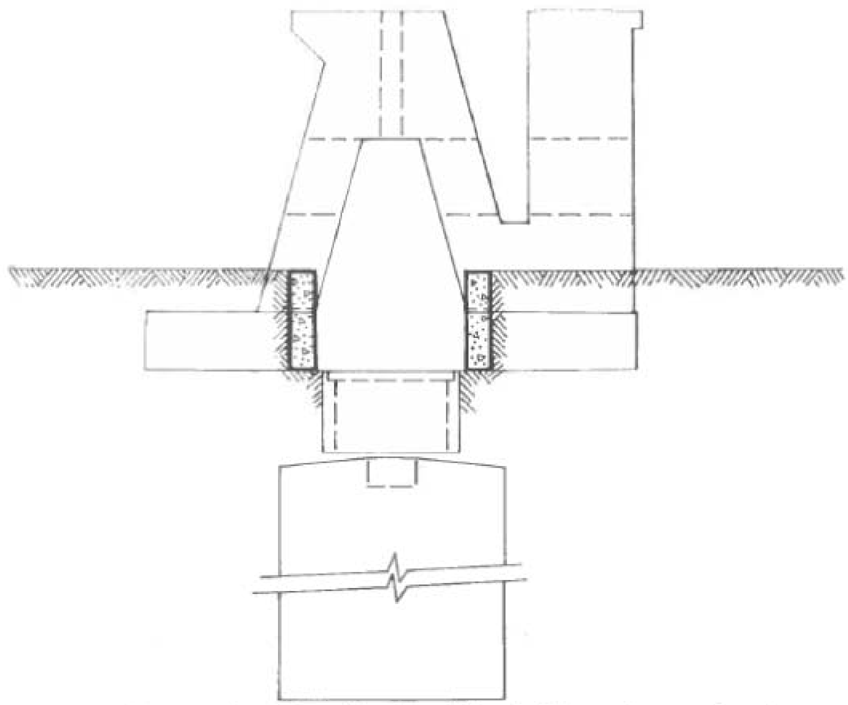

Fig. 4. Construction of the pillar (0) — (1) and of the underground marker.

Figure 3. Construction detail drawing of 0-m and 1-m pillar (Kukkamäki 1968:19)

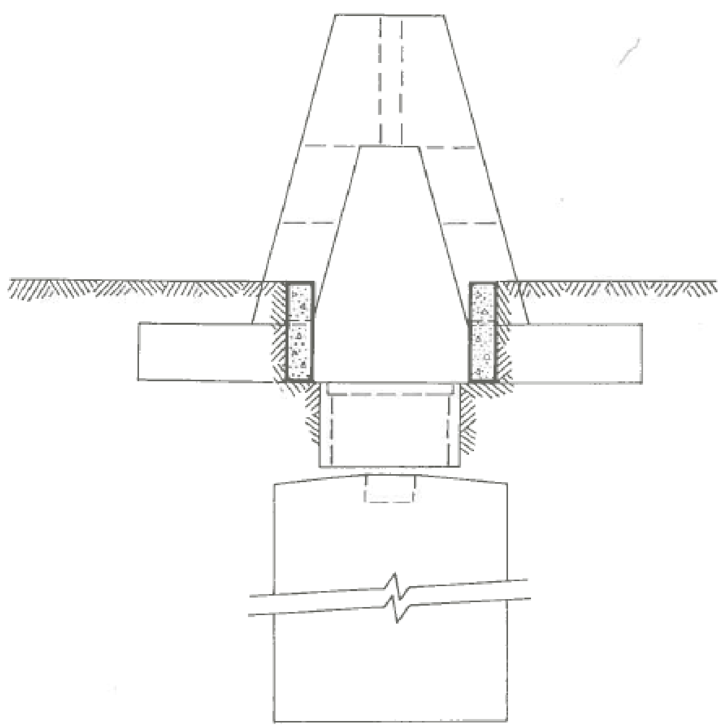

Fig. 5. Construction of the pillars (5) to (500).

Figure 4. Construction detail drawing of 5-m and 500-m pillars (Kukkamäki 1968:20)

Figure 5. Ca. 1966 overview photograph of the OSB (photo courtesy of OSU Mansfield)

Figure 6. Ca. 1966 photograph showing OSB (photo courtesy of OSU Mansfield)

Figure 7. Ca. 1966 photograph showing detail of 0-m and 1-m pillars (photo courtesy of OSU Mansfield)

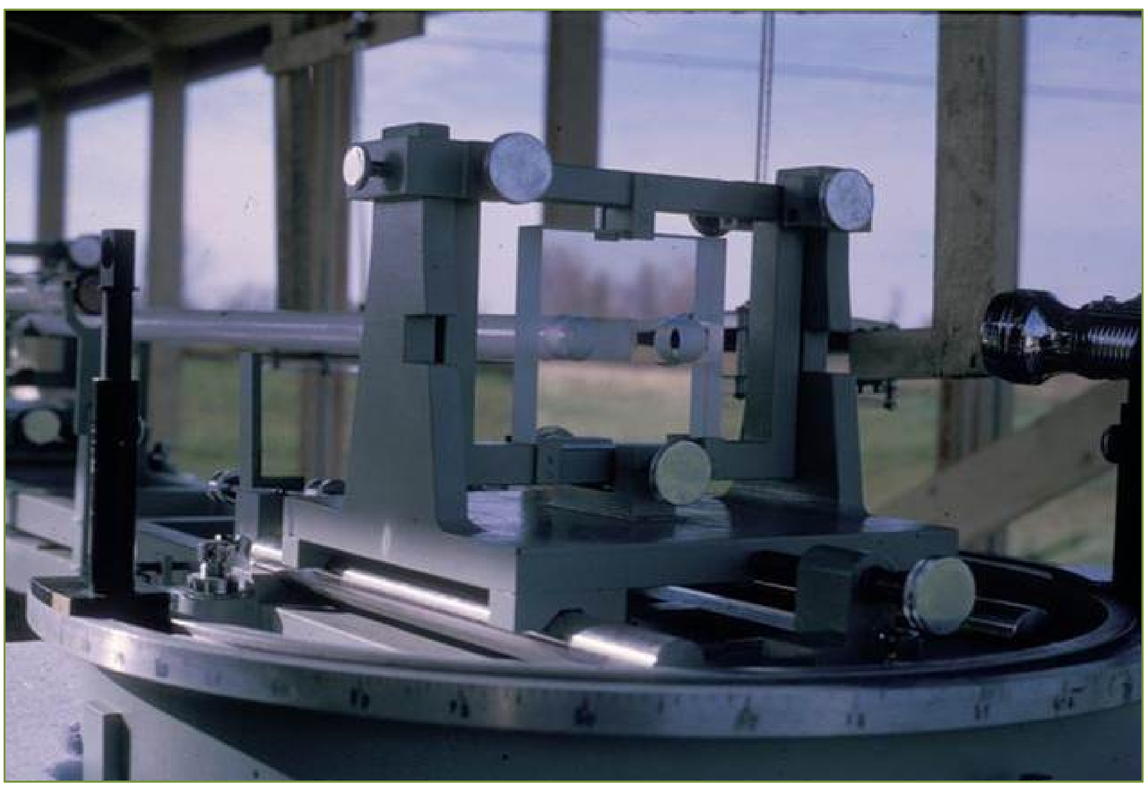

Figure 8. Ca. 1966 photograph showing detail of the Väisälä Comparator (photo courtesy of OSU Mansfield)

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CURRENT CONDITIONS OF THE OHIO STANDARD BASELINE

Physical Description

The condition of the OSB has deteriorated significantly since it was abandoned; however, with the exception of the 500-m pillar, the concrete pillars used for the project remain. The concrete pillars have begun to deteriorate due to environmental factors including freeze/thaw and vegetation growth. The metal mounting hardware remains on the tops of the OSB pillars, and has suffered only modest corrosion despite being exposed to the elements. A stainless steel rod still mounted on the 5-m pillar has suffered no corrosion. The underground marker pits also remain, but they have been infilled with dirt and vegetative debris because of the lack of maintenance. The wood platforms surrounding each pillar, constructed primarily of treated two-by-eight boards, remain but are deteriorated because of rot and damage caused by demolition debris not associated with the OSB. Remains of the low-pitch gable-roof pavilion originally protecting the comparator stand and first two pillars were not located. The landscape surrounding the west portion of the OSB is overgrown because the corridor has not been maintained. The east portion of the OSB has been changed by the addition of a gravel hiking trail connecting the parking lot of the Health Sciences Building at OSU Mansfield with housing south of the campus. The trail was constructed between 2014 and 2015 along the north side of the 250-m pillar before the path turns south between the 125-m and 250-m pillars. See Appendix A for photographs taken September 29, 2015, showing the condition of the OSB.

Previous NRHP Assessment

In 2014, Lawhon and Associates prepared a short NRHP eligibility assessment of the OSB (Lawhon 2015). Lawhon considered the OSB to be a site resource (the location of a significant event). Lawhon noted that while the OSB is nationally significant under Criterion A for its association with "the development of laser technology through its use of light waves for distance measurement," the site's integrity was judged to be severely compromised through deterioration of the concrete pillars and wooden platforms, the change in setting through the growth of vegetation, and the lack of "basic features that conveyed its historic appearance and function" (Lawhon 2015:3, 4). Lawhon and Associates recommended the OSB as not eligible for the NRHP. A subsequent internal OSU assessment opined that the OSB could be considered eligible under Criterion C for its representation of the use of the Väisälä Comparator in standardizing geodetic length measurement devices, and that it retained sufficient integrity to be eligible (Myers 2015).

CONCLUSION

Despite being recommended not eligible for the National Register (Lawhon 2015), OSU recognized that the OSB reflects an important event in the history of science in the United States. Because of this, the OSB is worthy of being recorded prior to its removal to make way for a new access road from Lexington-Springmill Road. The OSB represented the only geodetic baseline constructed in North America, and likely the first academic and research initiative undertaken at the OSU Mansfield campus. Geodetic baselines are used for extremely fine calibration of surveying equipment and to provide extremely detailed measurements of the earth. While several such baselines were established in Europe and South America during the mid-twentieth century, the United States did not have one.

Efforts led by Dr. T. J. Kukkamäki, a professor in the Department of Geodetic Science at OSU, eventually led to the construction of a baseline similar to the other baselines located around the world. Mid-twentieth century geodetic baselines were specifically designed for use with a highly sensitive measurement device called the Väisälä Comparator, a precursor to modern laser-light measurement systems. The Väisälä Comparator required a quartz crystal of extremely precise dimensions to allow for the measurement of the speed of light.

The OSB originally consisted of a set of eight concrete pillars spaced along a 500-meter distance. Although the 500-m pillar at the end of the OSB was demolished in the 1990s, all other original pillars are extant. The OSB was calibrated and commissioned in November 1966, but it was never used for any practical or commercial measurement calibration project. By the early 1970s, continued usage of the OSB became so unlikely that a road widening project along Lexington-Springmill Road that could have impacted the precision of the baseline was allowed to proceed. The remains of the OSB represent scientific structures constructed to allow for standardizing geodetic length measurement, and despite being abandoned for over 40 years, these ruins continue to convey their association with mid-twentieth century geodetic baselines and represent the only example of such in North America.

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2015 Personal communication. Program Analyst & Project Manager, OSU Mansfield. 2 November.

APPENDIX A. SURVEY PHOTOGRAPHS

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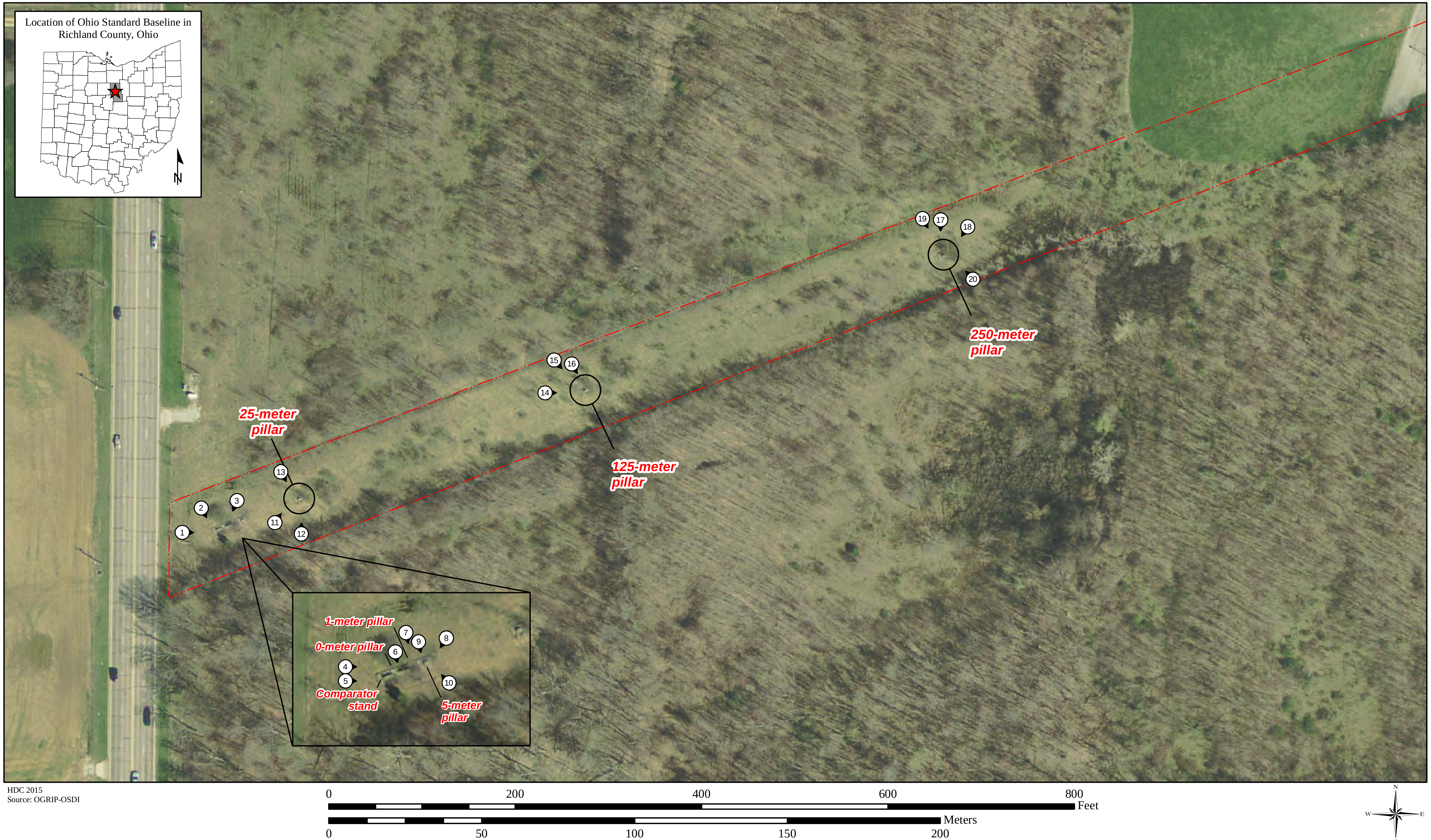

Figure 1. Photo locator map superimposed on an aerial photograph

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Photo 1. Comparator Stand and 0-m pillar, looking east

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Photo 3. Detail of top of Comparator Stand, looking southwest

Photo 4. Detail of 0-m and 1-m pillars, looking east

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