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 for individual properties and districts. See instructions in National Register Bulletin, *How to Complete the National Register of Historic Places Registration Form.* If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions.

1. Name of Property

Historic name: Saugatuck Gap Filler Annex
Other names/site number: _____
Name of related multiple property listing:
N/A
(Enter "N/A" if property is not part of a multiple property listing

2. Location

Street & number: 753 Park Street
City or town: Saugatuck State: MI County: Allegan
Not For Publication: ☐ Vicinity: ☐

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended,

I hereby certify that this X 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 X meets ___ does not meet the National Register Criteria. I recommend that this property be considered significant at the following level(s) of significance:

___national X statewide ___local

Applicable National Register Criteria:

X A ___B X C ___D

Deputy SHPO November 17, 2022

Signature of certifying official/Title: **Date**

Michigan State Historic Preservation Office

State or Federal agency/bureau or Tribal Government

Saugatuck Gap Filler Annex | Allegan County, MI
Name of Property | County and State

In my opinion, the property ___ meets ___ does not meet the National Register criteria.

Signature of commenting official: **Date**

Title : **State or Federal agency/bureau or Tribal Government**

4. National Park Service Certification

I hereby certify that this property is:

__X__ entered in the National Register

___ determined eligible for the National Register

___ determined not eligible for the National Register

___ removed from the National Register

___ other (explain:) _____

James Gabbert 12.28.2022

Signature of the Keeper Date of Action

5. Classification

Ownership of Property

(Check as many boxes as apply.)

Private:	☐
Public – Local	X
Public – State	☐
Public – Federal	☐

Saugatuck Gap Filler Annex | Allegan County, MI
Name of Property | County and State

Category of Property

(Check only **one** box.)

Building(s)	☐
District	☐
Site	☐
Structure	☒
Object	☐

Number of Resources within Property

(Do not include previously listed resources in the count)

Contributing	Noncontributing	
1	0	buildings
0	0	sites
2	0	structures
0	0	objects
3	0	Total

Number of contributing resources previously listed in the National Register N/A

6. Function or Use

Historic Functions
(Enter categories from instructions.)
DEFENSE: Air Facility

Current Functions
(Enter categories from instructions.)
VACANT/NOT IN USE

7. Description

Architectural Classification
(Enter categories from instructions.)
OTHER: Radar Antenna Tower
OTHER: Equipment and Generator Building

Materials: (enter categories from instructions.)
Principal exterior materials of the property: METAL: Steel, CONCRETE, ASPHALT, OTHER: Fiberglass

Narrative Description

(Describe the historic and current physical appearance and condition of the property. Describe contributing and noncontributing resources if applicable. Begin with **a summary paragraph** that briefly describes the general characteristics of the property, such as its location, type, style, method of construction, setting, size, and significant features. Indicate whether the property has historic integrity.)

Summary Paragraph

The Saugatuck Gap Filler Annex property is situated at the top of a tall dune on the outskirts of the city of Saugatuck, Michigan. Rising above the annex and surrounding trees at the highest point of the dune is a steel antenna tower with a large fiberglass spherical radome at the top. One of the annex's three contributing resources, the tower dominates the site and is visible for miles in all directions. The second contributing resource is the equipment and generator building, a flat roof L-shaped single story concrete block building located at the foot of the tower on its south side. The equipment and generator building contains the third contributing resource, an AN/FPS-18 radar set and related equipment. Tower, building, radar equipment, and perimeter fence are original to the annex and in their original locations. Nearly all of the radar equipment remains in place in both the radome and building and the exterior appearance of the site is substantially as it was during the period of significance. Not original to the site, a large, illuminated star, webcam, and some small radio antennas have been attached to the tower, a security fence erected around its base, and some contemporary electronic equipment is mounted or scattered about inside the radome. These additions are minor and do not permanently compromise the historical or architectural integrity of the site. Overall, the property conveys its historic significance and retains almost all of the technological features from the period of significance which made it an essential component of our nation's national defense network.

Narrative Description

Setting and Environment

The Saugatuck Gap Filler Annex is located in Mount Baldhead Park in the city of Saugatuck on the west edge of Allegan County, Michigan, about seventy miles north of the Indiana border and four tenths of a mile inland from Lake Michigan. The installation was built at the top of Mount Baldhead, a two hundred thirty-foot dune rising from a narrow strip of land between the lake and Kalamazoo River which runs just inland of the eastern foot of the dune. Downtown Saugatuck lies immediately across and slightly south on the east bank of the river.

Mount Baldhead has played a dominate role in the area from prehistory and has been known by that name since at least the early 1800s in reference to a lack of vegetation on its upper flanks and crest. The dune is visible from many points in Saugatuck and well inland and was a gathering place for Native Americans long before the arrival of the first White settlers in the area. It became a major draw for tourists travelling primarily by ship from Chicago and other

Great Lakes ports in the decades prior to the introduction of the automobile. Nearby hotels and resorts advertised views of the dune from their establishments and visitors proudly proclaimed having made the climb to the top, a substantial undertaking before the construction of the first stairs sometime in the late 1800s. In 1884 a forty-foot observation tower was erected approximately where the radar annex is today, and in 1886 a picnic pavilion was built at the eastern foot of the dune in a tree shaded area favored by campers along the river.[1]

Almost no reaction from residents has been found in area newspapers when plans to build the radar station on this local landmark were announced. The sentiment of the public might have been indicated by the slightly defensive tone of the of the response of the village president who was quoted by the local newspaper as saying, "we are getting a lot more than we are giving," while justifying leasing the land to the Air Force.[2]

The annex is located on a small parcel of land of about two tenths of an acre at the top of the dune, enclosed by a chain link security fence, now surrounded by mature trees. The annex is perched on a high point on the spine of a line of deeply wooded dunes rising from a broad pocket in the Lake Michigan shoreline where it bows westward to both the north and south. The location was ideal for a "gap filler" radar, designed to fill gaps in the coverage of long-range radars due to the curvature of the earth or terrain blocking their view, such as the high-rising dunes along Lake Michigan.

From a vantage above the trees on the tower, the lake extends as far as the eye can see to the west and clouds follow the arc of the sky from beyond the horizon. The low roar of waves piling onto the beach carries clearly to the annex and, even on a nearly calm day, there is generally a substantial wind at the platform beneath the tower's dome. On the average day the line of dunes marking the shoreline is visible thirty or forty miles to the south, trending slightly west before vanishing into the haze. To the north the view is usually more sharply defined, the beach rapidly transitioning from waves to the steep faces of the dunes standing high above the lake. The shoreline, bending north and west fifty or sixty miles distant, is defined by the trace of the dunes' sandy slopes shimmering in the sun between the waves and the forest flowing inland from the ridges. The Kalamazoo River emerges from between the dunes one mile to the north, where it empties into Lake Michigan. The Macatawa River channel and Big Red lighthouse at Holland, Michigan, are clearly visible seven miles further up the shoreline. Closer, the Saugatuck municipal water reservoir is visible through the trees on Lone Pine Dune immediately north of the annex.

The stark white radome at the top of the antenna tower is an iconic landmark clearly visible for many miles in all directions and has been used as a navigational aid for mariners far from shore seeking Saugatuck or nearby ports since it was placed on the tower. It has frequently been depicted in the work of area artists and was prominently featured for many decades on the first page header of the local newspaper.

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[1] Kit Lane, *The Wreck of the Hippocampus and Other Tales of Saugatuck*, 1992, Pavilion Press.
[2] *Commercial Record* (Saugatuck, Mich.), June 8, 1956.

Adjoining the annex immediately to its south is the large wood overlook deck of Mount Baldhead Park at the top of 302 stairs which climb the inland side of the dune from a gravel parking lot on Park Street (Photos 0003, 0004, & 0027). Park Street runs north and south at the inland foot of the dunes, paralleling the west bank of the Kalamazoo River, and provides the primary access to Mount Baldhead and the Gap Filler Annex site today. From the deck, visitors can survey points miles inland in every direction. The city of Saugatuck is immediately across the river to the east and the city of the Village of Douglas just beyond Kalamazoo Lake to the south. A popular trail leads west from the deck on the crest of the dune and forks into two paths, each leading to Oval Beach on the Lake Michigan shore. One branch makes a gradual descent down a winding ridge while the other, which has been used over the years to move equipment to and from the radar site, runs directly down the west side of the dune through thick pine trees and deep sand.

General Characteristics

The Saugatuck Gap Filler Annex consists of a large radome supported on a seventy-foot-tall, three-legged, steel antenna tower immediately adjacent to a one-story, flat-roofed, concrete block equipment and generator building built on an L-shaped floor plan containing an AN/FPS-18 radar set inside, all enclosed within a chain link security fence (Photo 0007). The nominated property contains three Contributing resources: one building (the Equipment and Generator Building), and two structures (the Antenna Tower/Radome, and the AN/FPS-18 radar set and related equipment).

The antenna tower is positioned at the north end of the fenced enclosure with the equipment and generator building at the south side of its base. The equipment and generator building sits on a concrete slab foundation and is composed of two rooms of approximately 1,150 square feet total area. The walls of the building are ten-feet-eight-inches in interior height. The larger of the two rooms is the equipment room which forms the west half of the building with its north wall being the top of the "L." The smaller generator room is about one half the size of the equipment room and forms the lower leg of the "L," extending toward the east from the south end of the building. Layout and structural details of building and tower follow the standard plan[3] for most of the gap filler annexes built, with minor modifications to accommodate the location.

A line drawn thru the centers of the two southern most tower legs at ground level would run parallel to the north wall of the equipment and generator building, about nine feet away. A line drawn through the center of the equipment room long axis would run approximately through the center of the tower's footprint and lie about thirteen degrees to the west of north.

[3] Most AN/FPS-14 gap filler annexes followed the standard plan of an L-shaped, two-room, flat-roofed, concrete block building on a slab foundation as depicted in MIL-HDBK-162A, Department of the Army Technical Manual TM 11-487C-1, *Military Standardization Handbook, United States Radar Equipment*, Volume 1, Section 1, December 15, 1965, Radar Set AN/FPS-14. The building was standardized for the original FPS-14 radar, later replaced by an FPS-18 which is extant today.

Both tower and building are enclosed in a chain link security fence which forms the perimeter of the parcel upon which the annex is sited. The fence is of heavy construction supported by a mix of tubular and I-beam cross section steel posts in concrete footings. Three rows of barbed wire run along the top, slanted outward, now missing in many places. The fence is original to the annex and is nearly completely intact in fair condition with the exception of a missing eighteen-foot section on the south side which spanned the area between the double gate to the west and single gate to the east, both still in place. The missing section was removed within the last twenty years or so.

Antenna Tower and Radome

Looming above the building and dominating the annex, the antenna tower with its radome – the spherical fiberglass dome enclosing the radar antenna – is a landmark clearly visible for miles in every direction. The legs of the tower are fastened to three square concrete piers thirty inches to a side and twenty-four inches tall, each oriented to face the center of tower footprint and arranged with their centers forming the points of an equilateral triangle sixteen feet, six inches on a side. These piers, tilting inward to follow the angle of the legs, are each a small extension of three broad hexagonal footings sunk deep into the dune. Each tower leg begins as a massive steel beam one half inch thick, the cross section forming a flattened "U" with its sides spread to one hundred twenty degrees, approximately six inches on a side with the sides joined by radius of perhaps twelve inches. The bottom of each leg is bolted to two very substantial angle iron brackets, three-quarters of an inch thick, which are in turn welded to an inch-and-a-half-thick steel plate measuring sixteen inches by eighteen inches, fastened to the concrete pier by six one-and-one-half-inch-diameter studs and nuts. The legs are built in five sections, each of a slightly smaller cross section as it ascends, each lapping inside the next lower section and bolted at the laps (Photo 0016).

The legs slope inward as they rise to support the antenna deck, with horizontal angle iron cross braces tying them together at the laps. On all three sides of each leg section, diagonal bracing of heavy steel rods form large Xs with lugs made of thick steel plate at both ends, one end bolted to the laps of the leg sections and the other to plates at the centers of the Xs. There are no means to adjust the tension of the diagonal braces which, despite this, appear to be very taut.

Starting at the southwest leg of the tower steep metal stairs wrap their way up the periphery in five flights, each flight ending in a landing attached to a leg and doubling back to the next flight (Photo 0015). A switch mounted to the tower leg at the bottom of the stairs is connected to lights positioned to illuminate each flight. The stairs are of open grating stamped into heavy bent sheet metal treads bolted to angle iron risers and railings, all in a black finish which appears to be paint. There are seventy-one steps leading to a platform of metal bar grating at a height of sixty-two feet above the ground. Seventy feet above the ground, the antenna deck forms a ceiling over the platform. A final flight of seven treads leads from the platform to the sliding steel door that provides access to the interior of the radome, with one last step up to the antenna deck, for a total of seventy-nine.

The circular steel plate antenna deck is twenty feet in diameter and extends out well beyond the top of the tower legs. The deck is supported at its periphery by six diagonals of heavy angle iron sloping down and inward, attached to the tower legs. Made of one-eighth inch thick fiberglass panels, the radome is twenty-six feet in diameter at its equator, arcs to approximately twenty-two feet, eight inches above the deck, and is truncated at a diameter of twenty feet at the base where it attaches to a heavy C-channel ring affixed to the framework supporting the periphery of the deck.[4]

On a sunny day, amber light filters through flaws in the finish of the fiberglass dome. The AN/FPS-18 radar antenna dominates the space, frozen on its pedestal facing slightly south of west at the point it stopped rotating decades ago (Photos 0028, 0029, & 0030). In the form of a rectangular section of a parabola made of fine wire mesh supported on a welded tubular aluminum frame, the antenna's reflector is nominally eleven feet, five inches tall and spans seventeen feet, eight inches in width across the chord at the bottom, and eighteen feet at the top. Tangles of wire snake around the deck leading to a few pieces of relatively modern electronic communication equipment and antennas, most simply lying on the deck, some mounted on tripods or poles, some to the frame of the radar antenna. The dome is formed of fifty-four individual curved panels arranged in nine vertical longitudinal segments of three panels each, all held together by steel bolts through the flanges forming the edges of each panel (Photos 0031, 0032, and 0033 are of panel section part numbers). The segments meet at a final circular section at the dome's apex approximately six feet, nine inches above the top edge of the antenna where an oval hatch provides access for maintenance of the exterior and the pair of red aircraft warning lights on top. A ladder has been placed at the front of the antenna framework leaning to the top of the reflector to facilitate access to the hatch, the feet bolted to C-channel which is bolted to the antenna frame, the top tied to the reflector frame with rope.

The metal structure of the tower, finished in a black coating dulled with age, appears basically as it did when new with only the most minor surface rust evident. The dome has had occasional maintenance over the past several decades but shows some deterioration, its smooth surface giving way to strands of unprotected fiberglass with rough grayish patches where the resin and white paint have weathered away.

Equipment and Generator Building Exterior

The walls of the equipment and generator building are constructed of eight-inch-thick concrete block on the outside with a veneer of four-inch concrete block on the inside. The only exception is the wall dividing the equipment and generator rooms, which also extends north beyond the generator room to form the east wall of the equipment room. This wall is made of eight-inch block with no veneer. Also, on the left side of the equipment room door, the lower seven courses are six-inch block on the outside with a two-and-one-half-inch gap between those and the four-inch block veneer on the inside, forming a recess about sixteen inches deep the purpose of which is not evident.

[4] Phillip Davis, et al., staff, MIT Lincoln Laboratory, Rigid Radome Design Considerations, *Electronics Magazine*, April 17, 1959, Vol. 32, No. 16, McGraw-Hill, p. 66

The main entrance to most gap fillers would have been on what is the west wall of the Saugatuck annex to most effectively accommodate the standard equipment layout. In the Saugatuck installation the steep grade of the dune did not allow for the standard approach to this side of the building, so the west wall is an uninterrupted forty-one-foot expanse of cement block with no openings or appurtenances other than the weathered remains of two floodlight fixtures at the far opposite top corners (Photo 0018). Instead, at the west end of the south, or "front" wall, there is a seven-foot-wide concrete apron extending four feet from the building, sloping upward nine inches from ground level to the threshold of an eight-foot-tall double door, five-feet-four-inches wide (Photos 0008 and 0019). Somewhat crudely fabricated of thick diamond plate steel with heavy hand made hinges, the door is mounted nearly flush with the outer surface of the wall and is not original to the building although it is within the original opening.

The east half of the front wall is the south wall of the generator room and near the southeast corner are two large openings. The larger of the two is just in from the corner, measuring five-feet-ten-inches in width and running from floor level to a height of six-feet-eight-inches. Once housing a substantial quarter round steel ventilator hood which occupied the entire upper half of the opening, it is now covered by two overlapping steel plates, neither original, both welded in place. Immediately to the west of this opening is a smaller one, four-feet-wide and five-feet-four-inches tall from floor level to top, apparently having served as access to remove and install the generator and other equipment. This opening is covered with sheet metal screwed into place at numerous points around the periphery. The sheet metal cover may be original to the building.

A pipe runs up the east exterior generator room wall from beneath the ground near the corner, apparently a vent for the underground fuel oil tank, no longer present, that supplied the diesel generator and water heater. Midway along the wall, a concrete landing five-feet-four-inches wide slopes four feet away from the threshold of the generator room's exterior door (Photos 0010 and 0011). Standing seventeen inches above grade, the landing's top surface slants down at a fairly substantial incline. The door opening is now covered with a heavy sheet of diamond plate steel welded in place on a steel frame fastened to the block walls. Beneath the door, a large section of foundation has become unmoored from the rest of the structure, tilting slightly and sliding about four inches toward the east slope of the dune. The door frame, landing, and center section of the wall have traveled with the foundation while other portions and the floor remain in their proper places, resulting in a slight bulge at the center of the wall most noticeable to the right of the door opening.

The movement of the generator room's foundation is also evident on the front wall, having caused a narrow crack vertically spanning six concrete blocks to the west of the large ventilator opening. Separation has also occurred between the blocks at top right corner of the opening extending in a stair step pattern toward the upper right corner of the wall, spreading perhaps two inches at its widest. Of the entire annex, only the south and east generator room walls show evidence of significant deterioration, although not sufficiently progressed to threaten the integrity of the structure as of the date of this nomination.

On the generator room's north exterior wall, six feet, ten inches above the grade, is an opening now covered with a heavily weathered four-foot-by-six-foot sheet of three-quarter-inch plywood, long axis horizontal (Photo 0013). This opening apparently once held a ventilation grille or hood to accommodate the diesel generator, acting in companion with the large hood on the south wall. At the top right corner of this wall, near its juncture with the east equipment room wall, is the battered remnant of a photo electric switch which appears to have operated the floodlights positioned at most upper corners of the walls all around the building. The east wall of the equipment room is a featureless span of concrete block with the exception of a weathered floodlight fixture at the top of the northeast corner, its empty socket gazing blindly across toward another at the top northeast corner of the generator room north wall.

On the north end of the building is an area enclosed by a security fence with the antenna tower at the center (Photos 0012 and 0015). The north wall of the equipment room forms the center section of the enclosure's south boundary which is otherwise made of heavy tight weave wire cloth spanning metal fence poles and topped with concertina wire. Intended specifically to discourage access to the tower, this fence is separate from the perimeter fence and is not original to the annex. A contractor stated he installed this fence around 1986 but no documentation or independent accounts have been found to support this.

Inside the enclosure are two large cooling units mounted toward the outer ends of the north equipment room wall (Photo 0016). Each is about the size and shape of a medium sized refrigerator with its base nominally fifty-five inches above the grade at the wall, supported by heavy angle iron diagonals sloping down and attached to the wall. Curved intake hoods extend from both sides at the bottom of each unit, openings facing downward. Large exhaust hoods on top the units reach nearly to roof level and curve to face downward at slightly more than a forty-five-degree angle. Containing fans and a V-shaped arrangement of radiators, these units dissipated heat from the fluid cooling the klystron final output amplifier of each corresponding radar transmitter.

Between the cooling units, two conduits emerge from an opening high on the center of the wall which also accommodated the rectangular microwave waveguide, no longer present. The conduits curve upward to join a waveguide and a third conduit, cropped off with a wire or two hanging out of it, all following the center of the tower's south side cross braces to the top. The conduits protect wires which supplied electricity to the tower and carried signals to and from the radar antenna pedestal. The waveguide once fed the output of the radar transmitters to the antenna and channeled return signals back to the receivers. These are the only substantial connections between the building and the tower. There are also a number of separate wires, apparently of relatively recent age, connected to a few antennas mounted on the tower legs and to various communications equipment and antennas within the radome.

At the top of the building's walls is a fascia of two-inch-by-eight-inch boards lapping the top edge of the top row of concrete block by about an inch and extending widthwise above it. The fascia runs around the perimeter of the entire building, with all butt joints beveled and lapped and corners neatly mitered. Seriously deteriorating in some areas, the upper half of the fascia was

originally protected by large heavy copper drip edges, mostly still present but now missing or hanging loose in many places.

The roof of the annex is flat and made of multiple plies of asphalt impregnated roofing felt covered with tar and protected by a layer of crushed stone granules (Photo 0027). The surface appears surprisingly sound for the most part but shows substantial deterioration in places, primarily at the edges, with patches of grass and vegetation taking root here and there and a few holes visible. The roof over the equipment room slopes down the height of one concrete block from the center of the building to the west for drainage. The roof of the generator room also slopes down one block height from south to north. A cement block parapet one block wide and two tall, capped with copper coping, runs down the center of the roof from the south end of the building to a point adjacent to the north generator room wall. The parapet is the top of the wall separating the equipment and generator rooms.

A group of four T-shaped ventilators, standing perhaps four feet in height, are spaced evenly down the center of the equipment room roof, the group slightly offset to the south end of the roof. The two at the outer ends are air intakes, each supplying fresh air to the building interior through eight furnace filters. The two center ventilators are connected to a large duct inside the building, running down the center of the equipment room ceiling to pull out hot air generated by the equipment. Once apparently painted black, all have powered fans and three appear to be in fairly good condition with only surface rust evident. The northern-most ventilator has rusted through leaving a hole roughly twelve inches in diameter near the center of the top which is slightly dented downward.

Remnants of the partially collapsed metal chimney for the diesel fired water heater stand at the northeast corner of the generator room roof. The base of a now missing vent pipe is visible at the south edge of the generator room roof next to the parapet, its original use unknown.

The building's exterior was repainted by volunteers in 2021 with paint supplied by the city of Saugatuck, its color closely approximating the original "antique linen." Prior to this the covers of the various openings around the building were painted flat black, reminiscent of blackboard surfaces and inspiring occasional small patches of graffiti; a few inoffensive scrawls in red, white and green paint, remarkable primarily for their scarcity. From period black and white images it appears the main door and various covers were once gray and they were restored to that color during the painting. Most of the wooden trim and drip edges at the top of the exterior walls and the ventilators on the roof retain their previous flat black finish. In period images the tower appears to have been finished in a lighter color rather than the present black.

Equipment and Generator Building Interior

The equipment room, the upright of the building's L-shape, is largely filled with two parallel rows of electronics cabinets arranged down the long axis of the room and positioned toward the north end (Photo 0020). There is a single short cabinet beyond them, centered close to the north wall. A little past midway between the south wall and these rows of cabinets there are marks on the tile floor that show where a row of cabinets extended across the width of the room, offset to

the east to allow passage around the west end. Of these, only one remains in place near the east wall. Against the south wall, just east of the door, is a cabinet which contained telephone system electronics and, slightly east of that, a cabinet of fairly modern communications equipment.

A diesel generator once occupied the southeast quarter of the adjoining generator room but is no longer present. Two rotary regulators still occupy most of the southwest quarter of the room between the generator mounting pad and the wall dividing the generator room from the equipment room (Photo 0026). In the northwest corner near the dividing wall the control cabinet for the rotary regulators juts into the room from the north wall (Photo 0025). A fuel fired boiler stands in the northeast corner, and various heavy electrical devices, conduit, diesel fuel pumps, fuel tank, and plumbing are arrayed throughout the balance of the room on the floor and walls.

The front door of the building opens into the southwest corner of the equipment room. With a rectangular floor area of 780 square feet, thirty-nine-feet-eight-inches deep and nineteen-feet-eight-inches wide, this room forms the entire west half of the building. Blue-green twelve inch square vinyl tiles still cover perhaps half of the floor area, and appear to be in fairly good condition though covered with a thick layer of dirt and debris. In other areas they have completely crumbled away to reveal the concrete slab. Much of the white paint on the concrete block walls retains its gloss but is dulled and peeling in other places. The ceiling is of corrugated metal sheet supported by open web steel joists which bear on top the uninsulated block walls. While the original finish of the ceiling and its structure is now obscured in many places beneath a thickening layer of rust, vestiges of white remain on the steel joists with various expanses of gray surviving on the corrugated steel. At intervals, incandescent lights in large green enameled steel reflectors extend down from the joists on lengths of white painted conduit.

An AN/FPS-18 radar occupies most of the interior of the equipment room. The AN designation is derived from the Joint Army-Navy Nomenclature System (AN System), a standard for identification of electronic and associated equipment. In the instance of AN/FPS-18, AN/ specifies the AN System, F means “Fixed Ground”, P designates “Radar” (referring to the Pulsed output), and S stands for “Search”.[5]

The FPS-18 consists of two redundant sets of transmitters, receivers, and related accessories, facing each other across a central aisle formed by their two parallel rows of identical heavy steel electronics cabinets. The row on the west side of the room was the “A” or active channel, the other being the “B” or backup channel. Doors on the fronts and backs of the cabinets provide access for maintenance from the center aisle and from aisles running between the backs of the cabinets and the walls. Deterioration due to the passage of decades without upkeep is evident and there has been minor vandalism but, to a large extent, everything remains in surprisingly good condition. Despite a layer of light to moderate rust generally evident on exterior surfaces of the cabinets, the electronic equipment inside is in uniformly good shape with few exceptions, as are the external instrument panels with their rows of meters and indicator lights. Most of the vacuum tubes have been removed and a few other electronic components are missing, but there is little

[5] Winkler, David et al., Searching the Skies - The Legacy of the United States Cold War Defense Radar Program, 1997,
United States Air Force Air Combat Command, p. 73

evidence of smashed or broken items one would associate with vandalism and no graffiti on the walls or equipment.

Two heavy regulating transformers are mounted on the floor against the walls, one on each side of the room toward the north end. Centered beyond the north end of the FPS-18 cabinets, near the north wall, is the Control Monitor which continually checked the operation of the radar equipment and provided visual alerts when malfunctions were detected. A hand-crank sound powered telephone was mounted on the right side of the monitor cabinet, probably once connected to another in the radome. High on the north wall is an opening where the rectangular waveguide, now absent, passed through to the tower from a large mechanical waveguide switch mounted just beneath the joists, centered between the two radar sets and midway between them and the wall above the Control Monitor. Waveguides conduct microwave energy just as wires conduct electricity. Because microwaves only travel on the "skin" of a conductor, waveguides are formed of light rectangular tubing, often silver plated on the inside to improve conductivity, and are used instead of wire because they are more efficient and reduce distortion of the microwaves. The waveguide switch was used to couple the operating radar set to the antenna while isolating the spare set and diverting its output into a "dummy load" which mimicked the antenna and allowed the equipment to be operated during maintenance or repair without interfering with the function of the other set. The switch selects between the transmit/receive duplexers above each of the two radar sets from which waveguides run to each transmitter (Photo 0023) and receiver (Photo 0022). The duplexers protected the sensitive receivers from the powerful outgoing transmitter pulses.

A rectangular galvanized metal air duct runs down the center of the ceiling between the radar sets. Two smaller rectangular ducts run parallel to the main duct, one to either side, joined to it by a central cross duct. Each smaller duct is positioned directly above one row of the equipment cabinets with individual flared rectangular intakes extending down above each cabinet to carry away the heat generated by the vacuum tube electronics. The ductwork is attached to the joists and connects to the bases of large ventilators on the roof which protrude down through the ceiling. Some white paint remains on the ducts but has largely given way to the oxidized galvanized surface beneath.

At the south end of the main duct is a "T" with air intakes suspended above an empty space once occupied by a row of four electronics cabinets containing the dual redundant AN/FST-1 Coordinate Data Transmitter Set. This is the only major piece of original equipment that is no longer in place in the room, having been removed by a private party at some point, probably in the mid-1990s. One cabinet of this unit has been recovered with some of the electronic modules but the location of the rest is unknown. At the east end of this row was a fifth cabinet containing the AN/FSW-1 Control Monitor Set which is still in place near the east wall.[6] This unit allowed the essential functions of the annex to be monitored and controlled over telephone lines. It is distinct from the FPS-18 Control Monitor, but communicated directly with it.

[6] MIL-HDBK-162A, Department of the Army Technical Manual TM 11-487C-1, Military Standardization Handbook, United States Radar Equipment, Volume 1, Section 1, December 15, 1965, Control Monitor Set AN/FSW-1

On the ceiling, midway between the mostly absent row of FST-1 equipment and the south wall, the base of the southernmost ventilator on the roof protrudes down and connects to a plenum holding eight furnace-type filters to supply cooling air to the room. There is another identical to it near the north end of the room.

On the south wall, just to the east of the door, is a Bell System rack cabinet which once contained various digital electronics modules associated with the phone system. The modules are of vacuum tube design and are still in the building, but most have been removed from the cabinet which now contains some fairly modern computer equipment connected to a TV camera mounted on the antenna tower.

The wall separating the equipment room from the generator room was not originally provided with a communicating door, apparently meant to act as a firewall. Access to this room was through a door centered on the east wall which has since been closed off with a steel plate. At some point in more recent times several blocks were removed from the firewall to provide passage between the two rooms through a cramped rough hole (Photo 0020, far right).

The generator room has a floor area of 370 square feet measuring nineteen-feet-eight-inches south to north by eighteen-feet-eight-inches in width, extending slightly north of east from the building's south end forming the foot of its L-shape. A diesel driven generator was once mounted in the southeast quarter of the room but is no longer present, although a large, galvanized plenum still extends from the south wall to where the diesel engine's radiator once was. The two original rotary regulators remain in place on their heavy steel skids in the west half of the room. Standing on the floor near the dividing wall and extending perpendicularly into the room from its place against the north wall is a large electrical enclosure containing controls associated with the regulators and switch gear for the generator. A squat vertical fuel oil fired water heater stands in the northeast corner of the room connected to an expansion tank suspended from the ceiling and, via pipes running across the ceiling and through the dividing wall, to a heating unit mounted near the ceiling toward the south end of the equipment room. Various other electrical boxes, pipes, valves are mounted here and there about the room. On the floor at the southeast corner of the room two fuel pumps driven by electric motors are connected to a large tank hanging from the ceiling. The tank and all associated plumbing are painted orange. The pumps, augmented by a manual pump mounted above them on the east wall, appear to have been transfer pumps from the fuel tank which was below grade outside the building, since removed. Some of the original brick red paint remains visible on the floor which, in places, is scattered deeply with assorted debris. The walls, not quite ten feet in height, are still covered with white paint, peeling in places and dulled by time. Gypsum board or some similar material covers the ceiling, its original finish uncertain and now faded to a sooty color, detaching in many places and fallen or hanging in strips. Visible through patches of missing ceiling, the roof structure is identical to that in the equipment room. A number of light fixtures hang down from the ceiling on conduit, with incandescent lamps in green enamel shades. This room exhibits more deterioration than the equipment room, with heavier rust evident on all of the remaining equipment and paint in worse condition on all surfaces of structure and machinery.

Integrity

The Saugatuck Gap Filler Annex retains integrity through its location, design, setting, and materials. Workmanship, feeling, and association also contribute to the ability of the property to convey significance. The property appears today almost exactly as it did during the period of significance, with the exception of the mature trees surrounding the site which were not present at that time. The antenna tower, equipment and generator building, and security fence remain in their original locations, nearly completely intact with no major alterations, as does the radar equipment inside the equipment and generator building and radome.

Location

The location of the property high atop Mount Baldhead and overlooking Lake Michigan was a determining factor in its function and construction. The building and structures retain integrity of location including the antenna tower, equipment and generator building, and security fence.

Design

The property retains its original design elements in structural form, plan, roof design, window and door placement, and tower construction. There have been few additions or changes to the design of the property, and none threaten the integrity of the property from its period of significance.

Changes to design include a chain link fence surrounding the tower structure and the addition of several small communication antennas and a webcam located high on the tower structure. Neither compromises the structure's architectural integrity.

An illuminated star twenty-four feet in height, fabricated with an aluminum frame is also attached to the tower structure, facing east. A star was first placed on the Mount Baldhead site in 1953.[7] Although not original to the annex, the new star was built to closely replicate its wooden predecessor. The original star was mounted on a utility pole where the radar annex now stands and was moved to a new utility pole in November 1956 to accommodate construction of the annex.[8] This star was illuminated during the holiday season for fifty-nine years. It was connected to electricity from the annex by the radar technicians in December 1958, just months after the radar became operational, and powered by the annex thereafter.[9, 10] When Saugatuck bought the annex in 1969 the original star was moved to the present location on the antenna tower. The current star replaced the original on the tower December 14, 2012.[11]

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[7] "Mt. Baldy Star To Shine Again," *Commercial Record*, (Saugatuck, Mich.), December 13, 1957.
[8] "New Pole For Xmas Star," *Commercial Record*, (Saugatuck, Mich.), November 9, 1956.
[9] "Star Shining on Mount Baldhead Thanks to Scouts," *Commercial Record*, (Saugatuck, Mich.), December 12, 1958.
[10] "Observations," *Commercial Record*, (Saugatuck, Mich.), December 19, 1968.
[11] "City council thanks Brent Birkholz, volunteers for work on holiday star," *Holland Sentinel* (Holland, Mich.), January 15, 2013.

Setting

As with location, the physical environment of the property was an intrinsic part of its function and use during the period of significance and remains important to the present day. The height and topography of Mount Baldhead makes the property distinctive as a Cold War military site (see Background – The Cold War, below). The experience of ascending a wooden staircase to the radar site maintains continuity with the past; visitors today must climb the steps to reach the annex just as military operators and contractors did in the mid-twentieth century. Four or five sets of stairs have been built to the top of Mount Baldhead from as early as the late 1800s. A new set was built as part of the radar installation in 1956; the current stairs were built on the same site in 2009. There is additional vegetation and tree cover around the radar site than during the period of significance, but it does not undermine the integrity of setting.

Materials

The property retains key materials from its original construction. Concrete block, steel trusses, ventilator hoods, doors, windows, steel tower elements bolted together, and fiberglass radome all remain in place. The site is free from the distracting use of new materials or replacement doors and windows.

Workmanship

As a Cold War era utilitarian structure, the radar station relies on standardized and modular construction methods. This in itself is evidence of the technological practices and aesthetic principles of modernism in the mid-twentieth century.

Feeling

The feeling evoked by the Saugatuck Gap Filler Annex is distinctive and powerful. The remoteness of the site and necessity of climbing to the top of Mount Baldhead to view it creates an experience similar to that of the builders and radar operators who used the station in its period of significance. The lack of significant alterations or intrusive elements allows the site to convey its historic feeling.

Association

The direct link between the Saugatuck Gap Filler Annex and the history of the communities of Saugatuck and Douglas is most powerful as a visible landmark in Saugatuck's cultural landscape from the Cold War era through to the present day. As a soaring natural feature situated between Lake Michigan and the Kalamazoo River, Mount Baldhead has long served as a landmark for the community. Since the 1950s, the radar tower and its iconic white dome has become a recognizable feature that distinguishes the Saugatuck area from other communities along the Lake Michigan shore region. This association is well documented in the visual arts and promotional images of the community as well as playing an important role in shaping Saugatuck's cultural identity for residents and visitors.

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing.)

[X] A. Property is associated with events that have made a significant contribution to the broad patterns of our history.

[ ] B. Property is associated with the lives of persons significant in our past.

[X] C. Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

[ ] D. Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations
(Mark “x” in all the boxes that apply.)

[ ] A. Owned by a religious institution or used for religious purposes

[ ] B. Removed from its original location

[ ] C. A birthplace or grave

[ ] D. A cemetery

[ ] E. A reconstructed building, object, or structure

[ ] F. A commemorative property

[ ] G. Less than 50 years old or achieving significance within the past 50 years

Areas of Significance
(Enter categories from instructions.)
MILITARY
ENGINEERING

Period of Significance
1956-1969

Significant Dates
1956
1963
1968
1969

Significant Person
(Complete only if Criterion B is marked above.)
N/A

Cultural Affiliation
N/A

Architect/Builder
N/A

Statement of Significance Summary Paragraph (Provide a summary paragraph that includes level of significance, applicable criteria, justification for the period of significance, and any applicable criteria considerations.)

The Saugatuck Gap Filler Annex is one of the few remaining radar installations from the vast Cold War-era Semi-Automatic Ground Environment (SAGE) air defense system, primarily designed to automatically detect and respond to Soviet bombers attacking from the north. An enormous continent-wide network of computers and radars, SAGE was the eyes and ears of the North American Air Defense Command.[12] The SAGE project was of such importance in the Cold War era that it was more expensive and involved more people than even the Manhattan Project which developed the first atomic bomb. Magnetic-core memory was invented for SAGE and real-time computing, interactive graphics, modems, and wide area networking were first implemented in the SAGE system. The Saugatuck Gap Filler Annex is one of only four SAGE radar sites to have survived in its original location with the antenna tower and building intact and is, at most, one of two to have retained nearly all of the pioneering and once classified electronic technology inside the original building. It is the only nearly complete SAGE facility in public ownership. The Saugatuck Gap Filler Annex is nominated for inclusion in the National Register under Criterion A with military significance at the state level spanning the period of 1956, when construction began, to 1969, when the Air Force sold the structures and equipment on the site to the City of Saugatuck. The property is also nominated under Criterion C as are the radar transmitters, receivers, antenna, and associated electronic equipment, and facilities that house them, are of significance in engineering at the state level.

Narrative Statement of Significance

Background – The Cold War

Early in World War II, the United States, United Kingdom, and Union of Soviet Socialist Republics (Soviet Union) joined forces in the Grand Alliance against the Axis Powers, primarily Germany, Italy, and Japan. That the Grand Alliance was often referred to as the "Strange Alliance" is indicative of the strain between the allies, particularly the United States and the Soviet Union. Aggravated by the United States and the United Kingdom excluding the Soviet Union from their secret development of the atomic bomb – the Manhattan Project – the long-held wariness between the former two allies and the latter grew into nearly open hostility as they and their post war partners vied to reinforce and extend their influence in Europe after the conclusion of the war, mid 1945.

The atomic bombs that were used against Japan in August 1945 are widely credited with having ended World War II in the Pacific, but it is also largely viewed that Japan's surrender was imminent, the bombings unnecessary, and carried out primarily to intimidate the Soviet Union. A

[12] Kenneth Schaffel, *The Emerging Shield: The Air Force and the Evolution of Continental Air Defense 1945-1960*, Office of Air Force History, 1991, p. 268

significant number of the Manhattan Project physicists, including the director, had strongly expressed their fears that failure to involve the Soviet Union in the project would engender deep distrust and trigger an arms race between the ex-allies after the war's conclusion.

Tensions crested when, in June 1948, the Soviets imposed a total blockade on the sectors of Berlin occupied by the United States and its post-war western allies. At the brink of open conflict with the Soviet Union, the United States and the United Kingdom launched the massive Berlin Airlift which delivered critical supplies for nearly a year until the Soviets lifted the failed blockade.

Despite increasing Soviet aggressions, the United States felt its nuclear monopoly was an effective deterrent until mid-1949 when the Soviet Union successfully tested its first atomic bomb, about four years sooner than had been anticipated. Earlier, they had unveiled the totally unexpected TU-4 bomber, a literal copy of the United States B-29 with one-way range sufficient to carry an atomic bomb from the Soviet Union to most large cities in the continental United States.

The Berlin Blockade is generally considered to have been the opening skirmish of the "Cold War" in which the key adversaries were to be the Soviet Union and the United States. The subdued but ever-present aura of fear that defined the period found its roots in the Soviet atom bomb and the TU-4 but, in 1957, the Soviets' successful launch and orbit of Sputnik, the world's first artificial satellite, introduced an entirely new menace: the intercontinental ballistic missile (ICBM). The space race was on, and missile technology evolved so rapidly that by the early 1960s it was displacing the long-range bomber as the primary air defense threat.

Throughout the 1950s and 1960s the world was immersed in an unrelenting sense of impending nuclear Armageddon as the Soviet Union and the United States engaged each other through proxy wars and traded military and political feints, peaking with the Cuban Missile Crisis, late 1962. In the United States, air raid siren tests, duck-and-cover drills, and "we interrupt this program" announcements punctuated the endless waiting-in-dread anticipation of the rumble of Soviet nuclear bombers approaching over the northern horizon or the silent fall of a nuclear missile.

Deterrence vs. Defense

From the end of World War II, many in the United States Air Force advocated construction of an air defense system to protect the northern approaches to the North American continent, these being the shortest route of possible attack from the Soviet Union. The official strategy of the Air Force, however, was deterrence in the form of the atom bomb and the Strategic Air Command's massive, long range bombing capability. Lacking a tangible threat and with post war military funding limited, support for the defensive systems promoted by the Air Defense Command had very low priority. This view was reassessed when the threat of potential nuclear attack emerged with the arrival of the Soviet atomic bomb and the TU-4, but it wasn't until the Korean War, mid 1950, that any real sense of urgency developed in the Air Force, reinforced by growing public demands for effective air defense. The Soviet Union demonstrating their first thermonuclear

bomb, mid 1953, provided a decisive impetus. The United States was again confronted with an adversary on equal strategic footing.

In 1949 the only vestige of a North American continental defense system was a motley collection of surplus WWII-era radars scattered sparsely across Canada and the northern United States, euphemistically named the Lashup system. By mid-1952 these had been reinforced with the emerging Permanent System[13] network of radars, then the Mid-Canada radar fence, capable only of detecting the passage of aircraft, not direction or speed. The Ground Observer Corps (GOC), disbanded at the end of World War II, had been brought back into service and greatly expanded to address the inability of existing radars to detect aircraft below an altitude of five thousand feet. Visual sightings of aircraft by GOC observers and those detected by radar were reported by telephone to Manual Control Centers where tracks of suspect flights and those of interceptors were plotted by hand on large plexiglass maps as controllers attempted to verbally guide fighter pilots to investigate potential attackers.

The manual control approach exhibited significant difficulties with filtering duplicate sightings, sorting legitimate air traffic from potential attackers, and slow communication and reaction times. These issues were aggravated by numerous gaps in long range "heavy" radar coverage of the northern approaches to the continent and low-level blind spots where terrain blocked the view of the heavy radars. Simulated exercises repeatedly demonstrated this system was easily overwhelmed by even small numbers of attacking bombers. As a result, the United States Air Force commissioned a series of studies early in the 1950s to determine the best approach to providing effective air defense capabilities.

These studies concluded that the manual component of continental defense had to be minimized. Among other things it was recommended that ground observers be replaced with radars and that all radars should be capable of transmitting data directly to high-speed digital computers which would track flights, compare them with airline and military flight plans to identify suspect aircraft, and determine the most effective of the available responses. The computer would present a rapidly updated composite of all this information on graphical displays from which Air Force personal would select the most appropriate intercept options with the press of a button.

The lack of radar coverage, both low altitude and long range, was simple to address by building more radars, but no digital computers existed that were capable of processing the huge volumes of data generated by those radars in "real time," rapidly enough to support effective interception of potential threats. At that point there was not even an adequate method of transmitting the data from radars to computers.

SAGE

The Saugatuck Gap Filler Annex was a single unit of an immense, continent-wide network of automated and manned installations which sought to identify, track, and respond to airborne

[13] *History of Strategic Air and Ballistic Missile Defense: Volume I, 1945-1955*, Center of Military History, United States Army, 1975, p. 61

attackers. Known as the Semi-Automatic Ground Environment (SAGE), this system was controlled by the most capable real-time digital computers of its era and led the cutting edge of digital processing, networking, and communications.

The SAGE system was originally planned to consist of more than thirty air defense sectors covering the entire United States, its coastal waters, and portions of Mexico and Canada. Each SAGE sector was controlled by a Direction Center located within the sector. Direction Centers were huge concrete blockhouses, each containing an enormous AN/FSQ-7 vacuum tube digital computer, physically the largest computers ever built. SAGE was the first non-research implementation of stored program real-time computers, modems, graphical interfaces, light pens – a precursor to the mouse, wide area networking,[14] and numerous other digital-computer-related "firsts," including magnetic-core memory which was invented for SAGE and revolutionized processing speeds and reliability.

The Massachusetts Institute of Technology (MIT) had played a critical role in radar development during World War II. In the late 1940s, researchers there began constructing a powerful digital computer named Whirlwind, transferring some of the very short electronic pulse technology developed for radar to achieve the fastest digital computer processing speeds of the era. Whirlwind, originally designed for aircraft flight simulation, was one of few digital computers in existence at that time. It was the only computer that offered the potential of sufficient speed and capability for the air defense application despite being built almost completely with vacuum tube technology due to the recently invented transistor having not yet achieved adequate reliability or availability.

In early 1950 the Air Force contracted with MIT to investigate the feasibility of a computer automated air defense system. Before the year was out Whirlwind had successfully communicated with a single radar a few miles away, graphically displaying the track of an aircraft in real-time from digital data sent over telephone lines. In 1951 Whirlwind's capability was expanded to presenting flight tracks from a network of several distant radars on a single display. From this, the project grew exponentially, ultimately employing nearly two thousand engineers and technicians. By 1955 Whirlwind was controlling a fully functional prototype SAGE "subsector," processing the data from thirteen radars and demonstrating the ability to simultaneously display the tracks of forty-eight aircraft and the locations and range of available antiaircraft resources while guiding manned interceptors to investigate potential attackers. With the basic concept proven, IBM was contracted to design and produce a more capable computer based on the architecture of Whirlwind which was then further optimized for the air defense application. Initially dubbed Whirlwind II this computer was officially named the AN/FSQ-7 as it moved from the prototype stage into production.

The SAGE system became operational on June 26, 1958, with the commissioning of two Direction Centers, both in New York state but covering separate multi-state sectors. The AN/FSQ-7 computer at each Direction Center processed the immense amounts of data from all

[14] Alan Grometstein, MIT Lincoln Laboratory - Technology in Support of National Security, 2011, Lincoln Laboratory, p. 33

the radars in its sector of responsibility. As additional Direction Centers came online each FSQ-7 communicated with those in adjacent Direction Centers and with similar computers in three widely dispersed supervisory Combat Centers, cumulatively maintaining an overview of every aircraft operating over northern North America which was continuously updated and graphically displayed on multiple computer consoles and huge projected maps at each center. The FSQ-7 computers compared radar flight tracks with flight plans filed by airlines and the military from which each aircraft was determined to be either a legitimate flight or an unknown. The positions and headings of suspect aircraft were presented on the display consoles with the nearest available interceptor aircraft and missiles also shown and automatically selected. Flight officers need only authorize the most appropriate response after which the FSQ-7 directed interception. Fighter pilots performed the takeoff, then the FSQ-7 took over. If required, missiles were launched and guided to their targets and anti-aircraft artillery batteries were controlled directly by SAGE.

SAGE became more functional as additional Direction Centers were built and came online. When fully deployed in the early 1960s SAGE received data from hundreds of swiftly erected radars sent via telephone lines and radio to Direction Centers, most placed at intervals along the northern border of the United States with one in Canada. Sources vary on how many Direction Centers were placed into service but, of the more than thirty originally planned, twenty-three is most often cited as the total constructed.

The number of heavy and gap filler radars in the network that reported to SAGE was continually in flux but reached a peak in 1962 with nearly 250 from the Permanent and Mobile Systems,[15] distributed primarily across the northern United States with some in Canada, their squadron assignments and command hierarchy constantly changing. To augment the Permanent System heavy radars and address low altitude blind spots around 240 gap filler radar sites were planned between 1956 to 1962. Not all of those were constructed and, even if actually built, not all had the radar equipment and tower installed. As funding was reduced due to emphasis shifting toward missile defense in the early 1960s, production of radar sets decreased, and equipment was often transferred from existing installations to newer gap filler locations that offered some advantage. Ultimately, a maximum of 131 gap fillers were in service at any one time.[16]

Also reporting to SAGE were the Distant Early Warning (DEW) Line radars just north of the arctic circle, Canada's Mid-Canada Line radar fence, and the Pinetree Line radars, located roughly parallel to the fiftieth line of latitude. To these were added a small number of radars carried by early warning aircraft and radar picket ships which operated off both coasts, a few dirigibles, and three ill-fated oil-rig-like "Texas Tower" radar installations built on the continental shelf off the New England coast. One of the Texas Towers was lost with all hands in a storm in 1961. Within two years of that catastrophe, the others were decommissioned due to structural, functional, and safety issues.

[15] David Winkler, et al., *Searching the Skies - The Legacy of the United States Cold War Defense Radar Program*, United States Air Force Air Combat Command, 1997, p. 37
[16] Winkler, p. 36

The SAGE project was initially the responsibility of the United States Continental Air Defense Command (CONAD). After its creation on May 12, 1958, the North American Air Defense Command (NORAD) assumed control of all air defenses in the United States and Canada, including SAGE. The defense assets available to SAGE during an attack on the North American continent varied constantly across the period it was operational. At its peak, SAGE was authorized to take command of more than forty squadrons totaling hundreds of interceptor aircraft from the Strategic Air Command fighter escort wings, Tactical Air Command, Air Defense Command, and, under NORAD, the Royal Canadian Air Force.[17] In addition, during an attack the SAGE system would direct the Army's anti-aircraft artillery batteries, positioned around scores of high importance targets, and provide targeting data to their Nike missiles at over one hundred sites in North America. SAGE also had exclusive control of sixteen Bomarc missile batteries.[18]

Two SAGE Direction Centers were located in Michigan: DC-14 at K.I. Sawyer Air Force Base south of Marquette in the Upper Peninsula,[19] initially responsible for the Sault Ste. Marie Air Defense Sector, and DC-06 at Custer Air Force Station near Battle Creek in the Lower Peninsula to which the Saugatuck Gap Filler Annex would eventually report. When it first became operational DC-06 was responsible for coverage of the Detroit Air-Defense Sector which included Michigan's southern Lower Peninsula and portions of Indiana and Ohio.[20] As with all Direction Centers, DC-06's sector of responsibility was adjusted repeatedly throughout its existence, sometimes extending as far as Minnesota, New York state, and Kentucky, although never concurrently. Accordingly, the number of radar squadrons and gap fillers reporting to the DC was also continually changing.[21]

At SAGE's peak presence in Michigan there were six prime site heavy radar facilities in service. Seventeen gap fillers were planned for Michigan but only eleven were actually built.[22] All of these SAGE facilities were built and in service in the same approximate time frame as the Saugatuck Gap Filler Annex. There were several Air Force bases with interceptor aircraft in both the upper and lower peninsulas of Michigan and at least one Bomarc missile squadron just to the west of and under the responsibility of Kincheloe Air Force Base in the eastern Upper Peninsula. In addition, there were approximately ten United States Army Nike missile sites scattered about in the state, and a handful of army anti-aircraft artillery battalions positioned as the last defense around potential targets of high importance such as Detroit and the Soo Locks.

Despite the array of resources available to SAGE the system was helpless against ICBMs. The radars were not designed to detect objects in space and, even had they been able to, lacked the

[17] Winkler, p. 37
[18] Historical Reference Paper No. 11, Nineteen Years of Air Defense, Directorate of Command History, Headquarters NORAD, May 1, 1965, p. 28
[19] Winkler, p. 123-125
[20] Aircraft Flash, The, Official G.O.C. Magazine, Vol. 7, No. 2, October 1958, Sage System Radar Sites & Sector Boundaries map 06-16-58, p. 4
[21] Cornett, Johnson, A Handbook of Aerospace Defense Organization 1946-1980, December 31, 1980, Office of History, Aerospace Defense Center, Peterson AFB
[22] https://www.radomes.org/museum/acwgapfiller.php, USAF CONUS Gap-Filler Radar Sites, document undated, accessed September 2021

range to provide sufficiently advanced warning of missiles approaching at speeds exceeding ten thousand miles per hour. Nevertheless, SAGE was viewed as an essential component of NORAD, being its only resource able to detect and respond to a wave of attack by Soviet nuclear bombers which was felt to be likely following an initial nuclear missile strike. As air defense evolved into aerospace defense SAGE was slowly phased out and replaced by the Joint Surveillance System but maintained a role in defending the North American skies until 1983 when the last Direction Center was decommissioned.[23]

The Saugatuck Gap Filler Annex - History

On June 1, 1956, the United States Air Force entered into an agreement with the City of Saugatuck, lease number DA-20-064-ENG-2130, for use of a total of 0.34 acres of land on which to build the Saugatuck Gap Filler Annex. In addition to the radar site of approximately 0.2 acres at the top of Mount Baldhead, the lease apparently also covered an area at the dune's base located about forty feet south of the stairs that contained an underground fuel tank, pumps, and other ancillary equipment. Additionally, the lease appears to have included an easement running parallel to the south side of the stairs, connecting the lower and upper sites.[24]

Construction of the equipment and generator building, and the radar antenna tower foundations began in August 1956 with completion anticipated by January 1957. To prepare the site for the building and tower, the top of the dune was leveled about one foot and, as part of the lease agreement with the village, the existing stairs, climbing the east side of the dune from the parking area at its base, were replaced.[25] The general contractor was C & C Construction company of Fort Wayne, Indiana, under supervision of the District Engineer of the United States Army Corps of Engineers, Detroit District. One anecdotal account attributes construction of the perimeter fence to Safe-T-Fence of Allegan, Michigan. The sparsely vegetated dune peak was stabilized with creosoted wood retaining walls while the flanks were planted with trees, bushes, and vines to control sand migration.[26] The completion date probably applies only to the building, tower foundations, fuel tanks and related plumbing at the top and foot of the dune, and electrical service equipment. The site likely stood vacant through the balance of 1957 waiting for availability of radar equipment.

Building materials were carried up the side of the dune using a tram running on a wooden framed track with steel rails, built parallel to the new stairs on their north side. At the city's request the track remained in place for many years but there is no indication it was ever used after construction was complete. Anecdotal accounts from residents and radar technicians describe the sandy trail ascending the dune from the west side being used to carry equipment to the annex during construction and in later years. There is also a very clear and steep bulldozer trail curving

[23] Winkler, p. 89
[24] Memorandum, E05MI0140_01.08_0003, Army Corps of Engineers, June 18, 1991, Enclosure 1, para. 1; Enclosure 3, p. 3 & 4
[25] "We get more than we give," *Commercial Record*, (Saugatuck, Mich.) June 8, 1960.
[26] "Progress Report," *Commercial Record*, (Saugatuck, Mich.) September 28, 1956.

up the north flank of the dune from just north of the parking area at its east foot to near the northwest side of the equipment and generator building, although no accounts relating its use have been discovered.

The equipment and generator building was built on a standard L-shaped floor plan used at nearly all of the gap filler installations.[27] Most gap fillers would have had the door to the equipment room on what is the west side of the Saugatuck annex building but, due to the dune sloping sharply away on that side, the door was located at the southwest corner of the building instead. Some gap fillers would have had larger generator rooms to accommodate as many as three diesel generators, but the Saugatuck annex had only one.

Eventually the AN/FPS-14 radar equipment arrived, and, after installation and testing, the annex became operational in the period between April 1 and June 30, 1958.[28] The Saugatuck Gap Filler Annex was now the southernmost air defense radar that could detect a bomber, skimming Lake Michigan along the shore on an approach from the north, before it reached the steel mills of Indiana and the city of Chicago. The annex's range extended to about the middle of the lake and slightly overlapped a gap filler near Shelby, Michigan, about seventy miles north. It augmented three heavy radar sites, one about fifty miles inland to the southeast, another 120 miles directly west, and another about the same distance to the southwest,[29] none of which could see an aircraft at low altitude or distinguish it against the background of the dunes.

The Saugatuck Gap Filler Annex was controlled and serviced by the 781st Aircraft Control and Warning (AC&W) Squadron, the "prime site," near Battle Creek, Michigan. During this time equipment had been installed at the prime site to allow it to receive and view radar data transmitted digitally via telephone lines from the gap fillers under its control. Also in this period, the squadron's "long association" with the 172nd Air National Guard Fighter Interceptor Squadron ended due to the interceptors being reassigned to reconnaissance duties. The 172nd was stationed at Kellogg Air National Guard Base, also near Battle Creek, just a few miles from the 781st. In their place, the 319th Fighter Interceptor Squadron, stationed at Bunker Hill Air Force Base, Peru, Indiana, became the prime associated interceptor squadron.[30]

The 781st AC&W Squadron was based at the Custer Air Force Station (AFS) where the "heavy" long range radars were located, just west of Battle Creek and about fifty miles southeast of Saugatuck. Ultimately, the squadron had responsibility for four gap filler sites: Saugatuck, Shelby, and Midland in Michigan, and a site near Richland Center, Indiana, all built in quick succession, with Saugatuck the second to achieve operational status. Custer AFS was known by its Permanent System identification number, P-67. As a subordinate of Custer AFS, the

[27] MIL-HDBK-162A, Department of the Army Technical Manual TM 11-487C-1, Military Standardization Handbook, United States Radar Equipment, Volume 1, Section 1, December 15, 1965, Radar Set AN/FPS-14.
[28] AFHRA (Air Force Historical Research Agency), 600 Chennault Circle, Maxwell AFB, AL 36112-6424, microfilm reel K0388, 781st AC&W Squadron History, frame 357.
[29] Aircraft Flash, The, Official G.O.C. Magazine, Vol. 7, No. 2, October 1958, Sage System Radar Sites & Sector Boundaries map 06-16-58, p. 4
[30] AFHRA, K0388, frame 353

Saugatuck Gap Filler Annex was designated P-67C. In the last quarter of 1958, the 781st successfully conducted operational testing of the new equipment to be used for communication with the SAGE system.[31]

SAGE Direction Center DC-06 became operational September 1, 1959, co-located with Custer AFS. The 781st AC&W Squadron's heavy and gap filler radars now began to send data digitally via telephone lines directly to the AN/FSQ-7 computer at DC-06. The squadron's title changed to 781st Radar Squadron (SAGE) October 1, 1959,[32] when it officially joined SAGE and discontinued its manual control center function.

Saugatuck's AN/FPS-14 radar was removed in June 1963,[33] to be upgraded by an AN/FPS-18 radar. The FPS-18 was an improved design with a more refined ability to discriminate between fixed and moving targets and with output power of one megawatt, a little over twice that of the FPS-14.[34] A few months delay followed the removal of the old radar, waiting for the new equipment to arrive. Meanwhile, effective July 31, 1963,[35] all SAGE system radar squadron designations were changed from the Permanent System "P" prefix to "Z" to indicate inclusion in the SAGE system. Custer AFS was now designated Z-67. The 781st squadron history refers to the Saugatuck annex as Z-67C for the first time in the entry reporting the installation of the AN/FPS-18 radar which became operational December 14, 1963,[36] and remains in place in the equipment room to the present. Also noted is installation of a rigid fiberglass radome by the 2863rd Ground Electronics Engineering Installation Agency (GEEIA) Squadron. This is the iconic white ball still visible for miles in all directions. Until that time, the radar antenna had been exposed and could be seen slowly rotating at the top of the tower.

The 781st Radar Squadron (SAGE) ceased operation effective March 1, 1965, and deactivated on June 25 of that year,[37] a result of the incremental decommissioning of the SAGE system due to its inability to detect ICBMs. Control of the gap filler radar at Saugatuck was transferred to the 752nd Radar Squadron (SAGE) on January 27, 1965,[38] which was located at Empire Air Force Station, Z-34, near Empire, Michigan. The Saugatuck gap filler was redesignated Z-34G and commissioned on February 2, 1965.[39] As the missile threat continued to gain priority, the 752nd received notice on March 31, 1968,[40] that operation of all gap fillers would be terminated. The

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31 Ibid, frame 349
32 AFHRA (Air Force Historical Research Agency), 600 Chennault Circle, Maxwell AFB, AL 36112-6424, microfilm reel K0606, 781st Radar Squadron (SAGE) History, frame 884
33 Ibid, frame 940
34 MIL-HDBK-162A, Department of the Army Technical Manual TM 11-487C-1, Military Standardization Handbook, United States Radar Equipment, Volume 1, Section 1, December 15, 1965, Radar Sets AN/FPS-14 and AN/FPS-18
35 Winkler, p. 93.
36 AFHRA, K0606, 781st, frame 949
37 Ibid, frame 970
38 Ibid, frame 975
39 AFHRA, microfilm reel K0603, 752nd Radar Squadron (SAGE) History, frame 1537
40 Ibid, frame 1648

squadron was directed to drain and flush the transmitter coolant systems, tape the doors of the equipment cabinets, and prepare the diesel generators for storage.

April 1, 1968, the Saugatuck Gap Filler Annex was deactivated permanently.[41] After removing the diesel generator and all spare parts,[42] the Air Force terminated its lease of the annex site effective December 31, 1968. Possession of the land reverted to the Village of Saugatuck which purchased the building, tower, and all the radar equipment for two hundred fifty dollars in July 1969.[43]

There was some brief confusion as to what was to stay and what was to remain immediately prior to the sale being officially closed. Sometime in the week of July 18, 1969, a crew from the Air Force was observed dismantling the radome.[44] After a flurry of telephone calls, some reportedly to the Pentagon, the misunderstanding was cleared up before the Air Force crew had proceeded very far and they cheerfully reassembled the portions of the dome they had removed and caulked the joints.

At some point the equipment related to the underground fuel tank at the bottom of the dune was removed, although no record of this was found. The fuel tank and another underground tank near the annex building were removed in 1993 by the United States Army Corps of Engineers.[45]

Chain of command for the Saugatuck Gap Filler Annex during the period it was in operation was nebulous and ever changing but, at the time the Saugatuck annex became operational, the 781st AC&W Squadron reported to the 30th Air Division (SAGE) as its immediate superior, which in turn reported to the Air Defense Command, in turn reporting to North American Aerospace Defense Command (NORAD).[46] NORAD was founded in 1958 and combined the air defense capabilities of the United States and Canada under one unified command. At the end of 1960, after the 781st AC&W Squadron had been rechristened the 781st Radar Squadron (SAGE), its immediate superior was the Detroit Air Defense Sector (SAGE), which then reported to the previous command structure.[47]

At the time the Saugatuck annex was deactivated, the 752nd Radar Squadron (SAGE) Empire listed its immediate superior to be the 34th Air Division, which was assigned to the First Air

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[41] Ibid, frame 1667
[42] "Saugatuck Now Has Own Radar Station," *News Palladium*, (Benton Harbor, Mich.), September 13, 1969, p. 7
[43] Memorandum, E05MI0140_01.08_0003, Army Corps of Engineers, June 18, 1991, Enclosure 1, para. 3; "Saugatuck to Buy Dome on Mt. Baldhead," *Commercial Record*, (Saugatuck, Mich.), July 03, 1969; "Saugatuck Now Has Own Radar Station," *News Palladium* (Benton Harbor, Mich.), September 13, 1969.
[44] "Hey! Leave Our Radar Installation Alone," *News Palladium* (Benton Harbor, Mich.), July 25, 1969.
[45] Environmental News, Calhoun County, Michigan, June 2006, U.S. Army Corps of Engineers, Former Saugatuck Gap Filler, p. 1
[46] AFHRA, microfilm reel K0388, 781st AC&W Squadron History, frame 356
[47] AFHRA, microfilm reel K0606, 781st Radar Squadron (SAGE) History, frame 888

Force, in turn reporting to the newly minted Aerospace Defense Command,[48] having previously been the Air Defense Command, both sharing the acronym ADC. For some reason the 752nd never lists NORAD in its chain of command, although the ADC reported to NORAD.

Engineering Significance

Like nearly all gap fillers, the Saugatuck annex was designed to be controlled remotely by the prime site via telephone lines and had no provisions for a permanent crew. The FPS-14 radar was a Bendix ASR-3 airport surveillance radar modified for unattended operation with the antenna redesigned to meet gap filler coverage requirements.[49] With the exception of equipment malfunctions, radar technicians only visited for a day or two of routine maintenance every week or so. To provide redundancy in the event of failures the site's primary electronic equipment, the initial AN/FPS-14 and later FPS-18 radar and the AN/FST-1 Coordinate Data Transmitter, each consisted of two identical sets that could be monitored, selected, and controlled remotely.

The FPS-18 radar had fairly conservative capabilities, even for the era, apparently designed to closely match the limitations of the FST-1. The FPS-18's "range," the distance between the radar and a target, is generally reported to have been about sixty-five miles at its maximum, although anecdotal accounts and notes found on test equipment from the Saugatuck annex suggest it may have exceeded one hundred miles (Photos 0034 & 0035). The radar had a beam that fanned thirty degrees vertically with the lower edge elevated a half degree above the horizon to enable it to detect any object from just above the lake's surface to a fairly high altitude while avoiding reflections from waves. Its specifications state it could detect a jet fighter sized aircraft at seventeen thousand feet altitude thirty-five miles away.[50] Range resolution, while unstated, was probably like that of the FPS-14's one-ninth of a mile. Horizontally the beam spread 1.4 degrees, which provided horizontal angular "azimuth" resolution of around one mile at sixty-five miles.

Radars transmit an extremely short pulse of radio frequency energy in a tight beam then measure the time required for it to reflect off any distant object and return. The speed of radio waves is known, so range is easily calculated from the time required for the round trip. Like all "search" radars of the era, the FPS-18 could discern only azimuth and range. Altitude was interrogated by a height finder radar at the prime site if an aircraft was determined to be of interest.

As the FPS-18 antenna rotated at 5.33 revolutions per minute the transmitter swept a continuous train of pulses across the horizon, each revolution taking just over eleven seconds and each pulse lasting one millionth of a second. The receiver streamed an analog signal containing any "returns" to the AN/FST-1 Coordinate Data Transmitter, along with a "north pulse" each time the antenna passed north. The antenna pedestal – the motorized mount on which the antenna

[48] AFHRA, microfilm reel K0603, 752nd Radar Squadron (SAGE) History, frame 1656
[49] Bendix Radio Foundation Oral History, Cramer Bacque interview, July 19, 2006, p. 24
[50] MIL-HDBK-162A, Department of the Army Technical Manual TM 11-487C-1, Military Standardization Handbook, United States Radar Equipment, Volume 1, Section 1, December 15, 1965, Radar Set AN/FPS-18

rotated – was also equipped to send continuous position data via a device called a synchro, presumably to the FST-1. The FST-1 utilized electronics at the leading edge of the era's technology. It processed the raw analog data from the radar receiver, rejected stationary and spurious echoes to determine which were actual aircraft, then digitized and transmitted the data to the prime site via leased telephone lines. It was a combination analog and digital device, built primarily with vacuum tube technology. At its heart was the first modem ever used in an actual application and an RCA 6499 Radechon barrier grid storage vacuum tube, a device designed as computer memory and made available just prior to being incorporated into the FST-1. [51]

The FST-1 stored all of the radar returns from one rotation of the antenna into a circular grid of 256 azimuth sectors in the barrier grid storage tube, each representing 1.43°, basically the FPS-18's beam width. 256 is a common number in digital electronics, represented in one eight-bit byte of binary data. The choice of 256 rather than 365 sectors is indicative of the digital nature of the FST-1. Each sector was divided into 64 "range blocks," the number 64 also common in binary math. One complete sweep of the antenna produced a total of 16384 digital bits of data, one bit for each of 64 range blocks in each of 256 sectors, all which had to be transmitted down the telephone lines in the 11.26 seconds it took the antenna to complete a revolution. The FST-1's modem could transmit at about 1600 bits per second which allowed just enough time to send all of the data before it was cleared from memory by the north pulse, ready for the next sweep.

While the FPS-18 had nominal range of 65 miles with resolution of around one-ninth of a mile, the FST-1 had a "presentation range" of only 48 miles, setting the actual limit for the range of the radar annex.[52] Because there were only 64 range blocks, the FST-1 could record distance to a resolution of only about three-quarters of a mile. Thus, the gap filler reported the position of any target with an overall resolution averaging roughly just under one mile, range, and azimuth, throughout most of its range.

The resolution of the gap filler as a system does not seem very high by modern standards and the range of the FPS-18 radar was conservative even for its era, but the capability of the FST-1's digital electronics was pushing the technology of the day to the very edge despite being implemented primarily with vacuum tube technology. Most important, it was able to consistently and reliably alert SAGE to the presence and flight track of any aircraft in its range.

Other Surviving SAGE Radar Installations

There is no official, available documentation regarding how many of the original gap filler annexes still exist in some form or another or, for that matter, how many were built. The most accurate tally of planned and remaining gap fillers is maintained by The Air Defense Radar Veterans' Association, an organization of United States and Royal Canadian Air Force veterans. The cofounder of this association states they have done the most complete research and are

[51] Grometstein, Alan, MIT Lincoln Laboratory - Technology in Support of National Security, 2011, Lincoln Laboratory, p. 21.
[52] MIL-HDBK-162A, Department of the Army Technical Manual TM 11-487C-1, Military Standardization Handbook, United States Radar Equipment, Volume 1, Section 1, December 15, 1965, Coordinate Data Transmitting Set AN/FST-1

therefore the most authoritative source on cold war era radar sites and that there are only three gap filler annexes surviving externally intact,[53] located at Saugatuck and Emery, Michigan, and Bridgewater, Maine.

Utilizing the Air Defense Radar Veterans' Association's database of gap filler installations and satellite and street level imagery available on the internet,[54] an exhaustive survey was conducted prior to preparation of this nomination to determine which of the approximately 240 gap filler sites originally planned still exist in any form in the United States and if the antenna tower and dome are present. Where internet imagery was inconclusive the locations were physically visited or owners or parties responsible for those sites were contacted to ascertain if the radar equipment was still present. Numerous other sources were also reviewed – published, online, and anecdotal – to add support to the conclusions presented here.

This investigation reveals the vast majority of gap filler sites have been demolished and most of those still existing have been repurposed for agricultural use or storage, a few as residences or offices. Surviving buildings are frequently altered to the degree they bear little or no resemblance to the original gap filler, and in most instances, the antenna tower has been removed. The tower is still present at a small number of these sites, but the radome remains in place on the tower at only three. The conclusion of this thorough research with available information is that, at most, only two gap filler annexes retain their radar equipment in place in the equipment and generator building, including Saugatuck which is the only one of those two in public ownership.

The most likely candidate for another gap filler site that is nearly intact is that near Emery, Michigan, northeast of Ann Arbor. Physical visits to the site reveal that, externally, it is very complete. The radome is on the tower, although in very poor condition. This indicates the antenna is nearly certainly still in place because the radome would have to be at least partially dismantled to remove the antenna. All original wall mounted ventilation hoods and louvers that could be observed are still in place as are the original doors, but the ventilators that are prominent on the roof of most gap filler buildings are absent. With that exception, every indication suggests the radar equipment is potentially still in place in the building, but numerous attempts to contact the private owner to determine this have been unsuccessful.

Another potentially complete site is the gap filler annex located on Number 9 Mountain near Bridgewater, Maine, where building, tower, and dome are present and in fair condition. The tower is not typical of gap fillers, having four legs and a fire look-out cabin at the top, just beneath the radome. The equipment and generator building is now used to house Maine's state radio operations equipment. An email from the emergency services director of the county in which the gap filler is located states it is his understanding the original equipment has long since been removed.[55] Although attempts to verify this with state personnel were not successful, the

[53] Tom Page, cofounder radomes.org, email dated May 31, 2020; Page email dated August 24, 2021
[54] https://www.radomes.org/museum/acwgapfiller.php, USAF CONUS Gap-Filler Radar Sites, document undated, accessed September 2021
[55] Darren Woods, Director, Aroostook County Emergency Management, Caribou, Maine, email dated January 9, 2019

number of modern radio antennas mounted on the building and tower suggest the need for substantial floor space to accommodate the associated radio equipment. A fairly contemporary peaked roof installed over the rear half of the equipment room closest to the tower and non-standard heating and ventilation equipment also evident on that portion of the building, all strongly suggest the radar equipment has been removed to make room for radio equipment.

The gap filler near Andes, New York, was considered by some sources to be fairly complete. It is not included among the potentially intact three sites, above, but discussed here to eliminate any ambiguities. Satellite imagery and inspection of the site reveal the radome and antenna, while still on site, are not in place on the tower. A serviceman with the 2861st GEEIA stated he participated in the removal of the radar equipment from this location.[56] Information provided by the present owner, including a hand sketch of alterations to the equipment room to accommodate county radio equipment, firmly establish the radar equipment is no longer in place. [57]

Subsequent History

A period of heightened public interest followed Saugatuck's purchase of the annex in 1969 but quickly faded. Marine communications equipment on the tower took the place of grand plans such as a viewing platform. Reduced to storage of maintenance materials for the park's stairs and deck, the annex was left to weather the years in benign neglect. By the 1990s a fair amount of equipment and small items had been removed from the building both by souvenir collectors and by those protecting it from being lost and from the leaking roof. In 2009 the stairs built on the east side of the dune during construction of the annex were replaced with the current set.[58] By the late 2010s the electronics cabinets were badly rusted and the City of Saugatuck considered demolishing the building.

In 2016 the annex was the subject of a well-attended presentation at the Saugatuck-Douglas History Center. It then took a central place in the 2017 and 2018 History Center museum exhibits with a display of restored equipment and a visit by an United States Air Force technician who serviced the radar during the early 1960s (Photo 0035). Saugatuck again considered demolition of the building mid-2020, actually setting aside funds for the purpose, but concerned residents alerted the city to the historic importance of the site and a workgroup was commissioned by the city to stabilize the site and examine alternatives for its future. Heavy vegetation that was overtaking the property was removed, security was improved, and temporary repairs were made to the roof and walls. The public was solicited for return of objects removed from the annex resulting in a number of important artifacts being recovered. As of the writing of this nomination (June 2022) a 501(c)3 nonprofit is being organized to accept funds with which to address the shifting foundation and perform long term repairs on the roof.

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[56] Vince Sibel, 2861st GEEIA Message Board, entry April 29, 2007, Andes FPS-18 removal.
[57] David Bartlem, owner of gap filler, Andes, New York, email dated March 24, 2017.
[58] "Plaggemars builds Mount Baldhead stairs," *Hamilton Herald*, September 4, 2009.

Described as "a real museum" by a respected cold war radar expert,[59] the annex and the AN/FPS-18 radar and associated equipment offer the only public opportunity to study details, in situ or otherwise, of the technology and construction of Cold War era radar transmitters, receivers, and associated electronics and the structures that housed them. Of specific importance are the remaining portions of the AN/FST-1 Coordinate Data Transmitter, an artifact representing the bridge between vacuum tube analog electronics, digital electronics, and the computer era.

[59] Tom Page, cofounder radomes.org, email dated August 25, 2021

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https://www.radomes.org/museum/acwgapfiller.php
Document undated; accessed September 2021

fortwiki.com
John Stanton, 2018 “Custer Air Force Station”
http://fortwiki.com/Custer_Air_Force_Station
Document revised July 2021, accessed September 2021

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 # _____
____ recorded by Historic American Landscape Survey # _____

Primary location of additional data:

____ State Historic Preservation Office
____ Other State agency
____ Federal agency
____ Local government
____ University
_X_ Other
Name of repository: Saugatuck-Douglas History Center
130 West Center Street, Douglas, Michigan 49406

Historic Resources Survey Number (if assigned): _____

10. Geographical Data

Acreage of Property _Less than one (0.2 acres)_____

Use either the UTM system or latitude/longitude coordinates

Latitude/Longitude Coordinates (decimal degrees)
Datum if other than WGS84:_____
(enter coordinates to 6 decimal places)
1. Latitude: 42.661250 Longitude: -86.209083

2. Latitude: Longitude:

3. Latitude: Longitude:

4. Latitude: Longitude:

Verbal Boundary Description (Describe the boundaries of the property.)

Boundaries are those of the security fence depicted in the sketch below.

Boundary Justification (Explain why the boundaries were selected.)

The security fence is original to the radar annex and precisely defines the boundaries of the area of historical interest. Per Allegan County Geographic Information System, the Saugatuck Gap Filler Annex straddles two large parcels owned by the City of Saugatuck which have not been subdivided, thus there is no legal description of the area occupied by the annex and no survey or other description has been found.

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11. Form Prepared By

name/title: Chuck Gustafson and Paula Bedford, Members
Eric F. Gollannek, PhD, Executive Director

organization: Saugatuck-Douglas History Center
street & number: 130 West Center Street
city or town: Douglas state: MI zip code:49406

e-mail: mechanique@wmol.com (Chuck Gustafson)
pgbedford1368@gmail.com (Paula Bedford)
director@sdhistoricalsociety.org (Eric Gollannek)

telephone: 269-857-1218 (Chuck Gustafson)
734-646-2706 (Paula Bedford)
269-857-5751 (Eric F. Gollannek)

date: June 30, 2022

Additional Documentation

Submit the following items with the completed form:

- **Maps:** A **USGS map** or equivalent (7.5 or 15 minute series) indicating the property's location.
- **Sketch map** for historic districts and properties having large acreage or numerous resources. Key all photographs to this map.
- **Additional items:** (Check with the SHPO, TPO, or FPO for any additional items.)

Photographs

Submit clear and descriptive photographs. The size of each image must be 1600x1200 pixels (minimum), 3000x2000 preferred, at 300 ppi (pixels per inch) or larger. Key all photographs to the sketch map. Each photograph must be numbered and that number must correspond to the photograph number on the photo log. For simplicity, the name of the photographer, photo date, etc. may be listed once on the photograph log and doesn't need to be labeled on every photograph.

Photo Log

Name of Property: Saugatuck Gap Filler Annex
City or Vicinity: Saugatuck
County: Allegan State: Michigan
Photographers: Chuck Gustafson unless otherwise noted; John Kerr, Allegan County Sheriff's Office (ACSO)
Date Photographed: As noted below

1 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0001
Radar antenna tower and equipment and generator building, from intersection of Mason and Water streets, Saugatuck. April 12, 2022

2 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0002
Pump House Museum, Mt. Baldhead Park, picnic pavilion, stairs, and radar annex, from directly east across Kalamazoo River. April 12, 2022

3 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0003
Mt. Baldhead Park parking area, stairs, and radar annex, from slightly south of east on Park Street. April 23, 2022

4 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0004
Mt. Baldhead Park observation deck and stairs foreground, Mt. Baldhead Park Trail left with Lake Michigan in background, radar annex ahead, from south. April 12, 2022

5 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0005 ACSO
Aerial view, Saugatuck Gap Filler Annex, from northwest. January 28, 2022

6 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0006 ACSO
Aerial view, Saugatuck Gap Filler Annex, from slightly west of south. January 28, 2022

7 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0007 ACSO
Aerial view, Saugatuck Gap Filler Annex, from directly overhead. January 28, 2022

8 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0008
Front of equipment and generator building, from south. June 23, 2022

9 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0009
Closer view of antenna tower, from southeast. April 12, 2022

10 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0010
Generator room exterior, ventilator openings, door, from southeast. June 14, 2022

11 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0011
Generator room east exterior wall and door, from east. April 12, 2022

12 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0012
Equipment room east exterior wall, antenna tower security fence, from southeast. June 14, 2022

13 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0013
Generator room north and equipment room east exterior walls, from northeast. June 14, 2022

14 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0014
View of wooden retaining wall, annex perimeter fence, antenna tower fence, tower base, equipment, and generator building, from north. April 12, 2022

15 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0015
Tower security fence from northwest corner of perimeter fence. June 27, 2022

16 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0016
Equipment room north wall, cooling units, from north beneath tower. June 14, 2022

17 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0017
View of antenna tower, from slightly south of west. June 23, 2022

18 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0018
Equipment room west wall, from slightly north of west. June 14, 2022

19 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0019
Equipment and generator building, west fence line, antenna tower security fence, antenna tower, from southwest. June 27, 2022

20 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0020
Equipment room from door, foreground to background; telephone cabinet, opening to generator room, FSW-1 Control Monitor Set, FPS-18 cabinet rows, FPS-18 Control Monitor, voltage regulating transformer (west/left wall), one of two. June 14, 2022

21 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0021
Equipment room, two rows of redundant FPS-18 radar equipment Cabinets, A-Channel on right, B-Channel on left, with receivers closest, FPS-18 control monitor near far north wall, from south. June 27, 2022

22 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0022
A-Channel FPS-18 radar receiver, from west. June 14, 2022

23 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0023
A-Channel FPS-18 radar transmitter, from west. June 14, 2022

24 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0024
Equipment room from north, foreground; transmitter power supplies, transmitters, receivers and other cabinets not clearly visible. Background right to left; door, telephone equipment cabinet with doors open and relatively modern computer monitor in front, modern computer equipment cabinet. June 27, 2022

25 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0025
Generator room, rotary regulator motor generators and control panel, access hole in wall to equipment room, from east. April 12, 2022

26 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0026
Generator room, foreground to background from west; rotary regulators, diesel generator cooling air intake, fuel pumps beyond on floor, steel plate filling door opening, diesel fired water heater left corner. April 12, 2022

27 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0027
View from antenna tower, third landing, looking slightly east of south; star, equipment and generator building roof, southwest wooden retaining wall with Mt Baldhead Park Trail to Oval Beach just beyond descending to right, Mt Baldhead Park observation deck, and stairs descending left. April 12, 2022

28 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0028 Kerr
Interior of radome from door on south quadrant of antenna deck: relatively modern cellular phone and microwave antennas foreground; FPS-18 radar antenna reflector, frame, rotating pedestal, and drive motor beyond with non-original ladder to hatch; fiberglass radome panels background, sunlight filtering through areas of missing exterior paint. May 7, 2022

29 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0029 Kerr
Interior of radome from northwest, relatively modern communications equipment strewn and mounted here and there, sliding door – nearly closed – barely visible as horizontal white line on floor in background. May 7, 2022

30 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0030
Radar antenna reflector from west inside radome. April 12, 2022

31 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0031
Radome fiberglass panel identifying numbers, bottom section. June 16, 2022

32 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0032
Radome fiberglass panel identifying numbers, middle section. June 16, 2022

33 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0033
Radome fiberglass panel identifying numbers, top section. June 16, 2022

34 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0034
Permanent Echo chart on Range & Azimuth Indicator, a diagnostic tool used with the FPS-18 radar at the Saugatuck annex. Chart notes degrees azimuth to fixed objects returning "permanent echos," azimuth counter pulses (ACP) to same, and range in miles. Observe that longest range is 165 miles, well beyond radar's rated maximum range. This data was used to verify the radar was correctly displaying the range and azimuth to know fixed objects. April 18, 2017

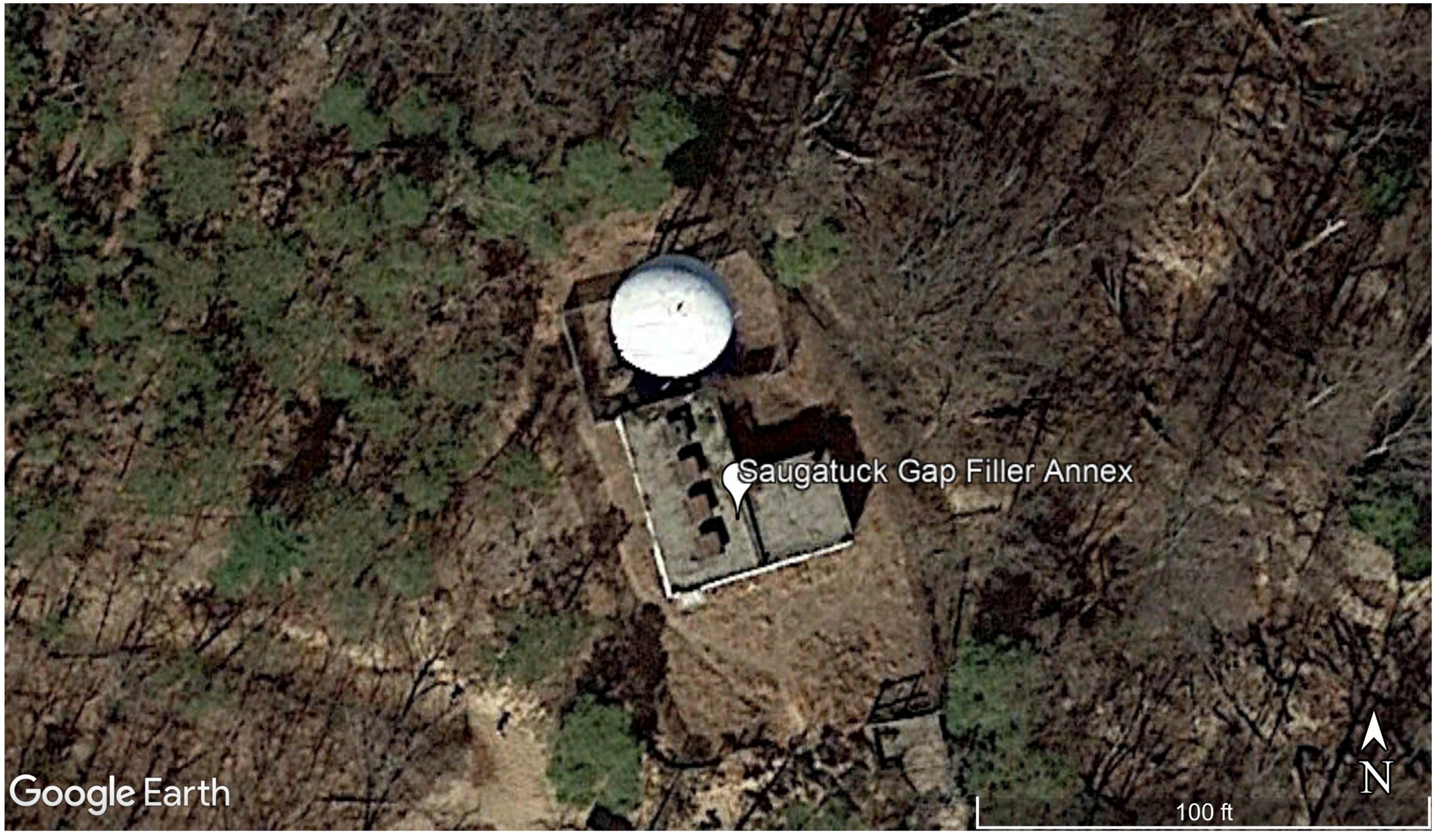
35 of 35. MI_Allegan County_Saugatuck Gap Filler Annex_0035
Range & Azimuth Indicator from annex in 2017-18 Saugatuck-Douglas History Center Museum exhibit with Permanent Echo chart taped to front table by 1960s radar technicians. May 24, 2017

Saugatuck Gap Filler Annex

753 Park Street, Saugatuck, Allegan County, Michigan

Latitude: 42.661250 Longitude: -86.209083

MICHIGAN SHPO STATE HISTORIC PRESERVATION OFFICE

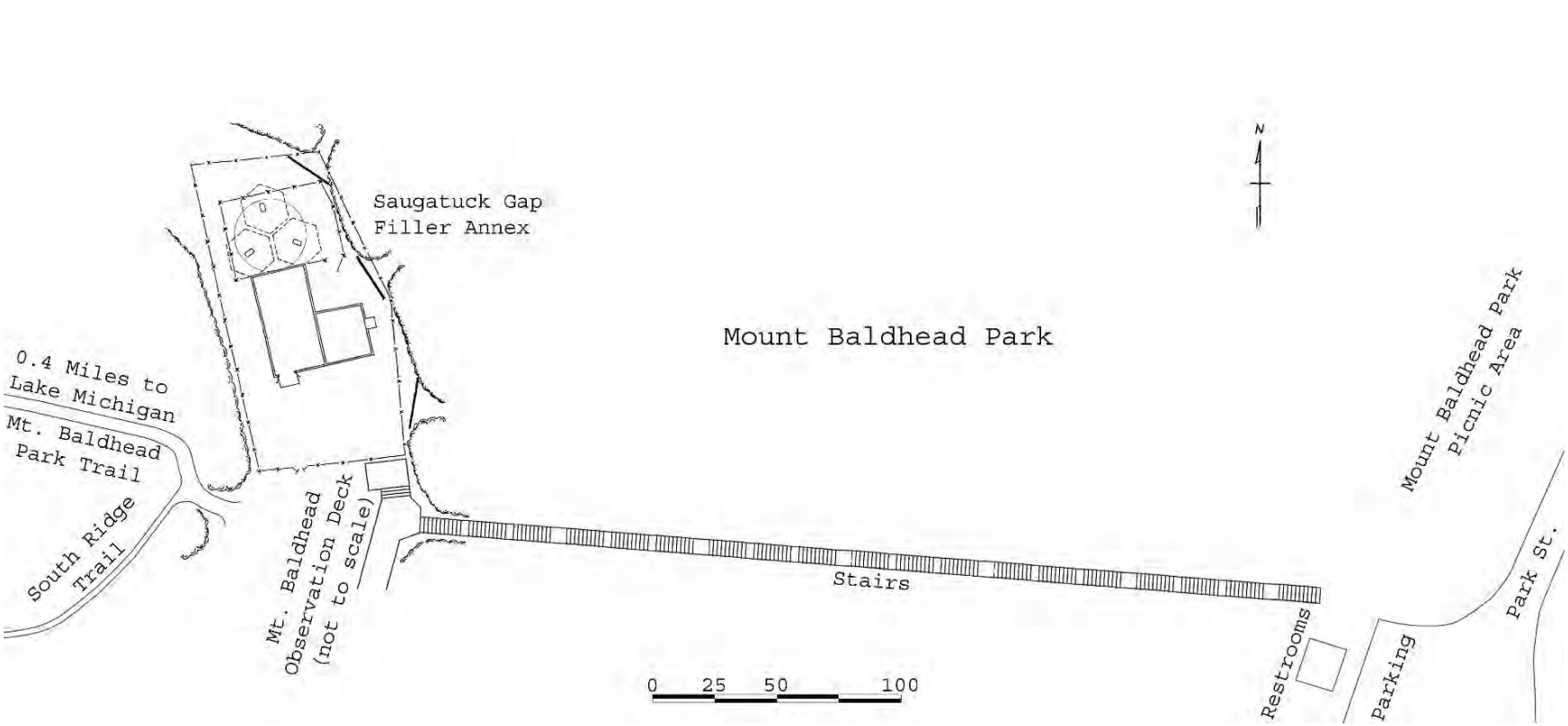


Saugatuck Gap Filler Annex

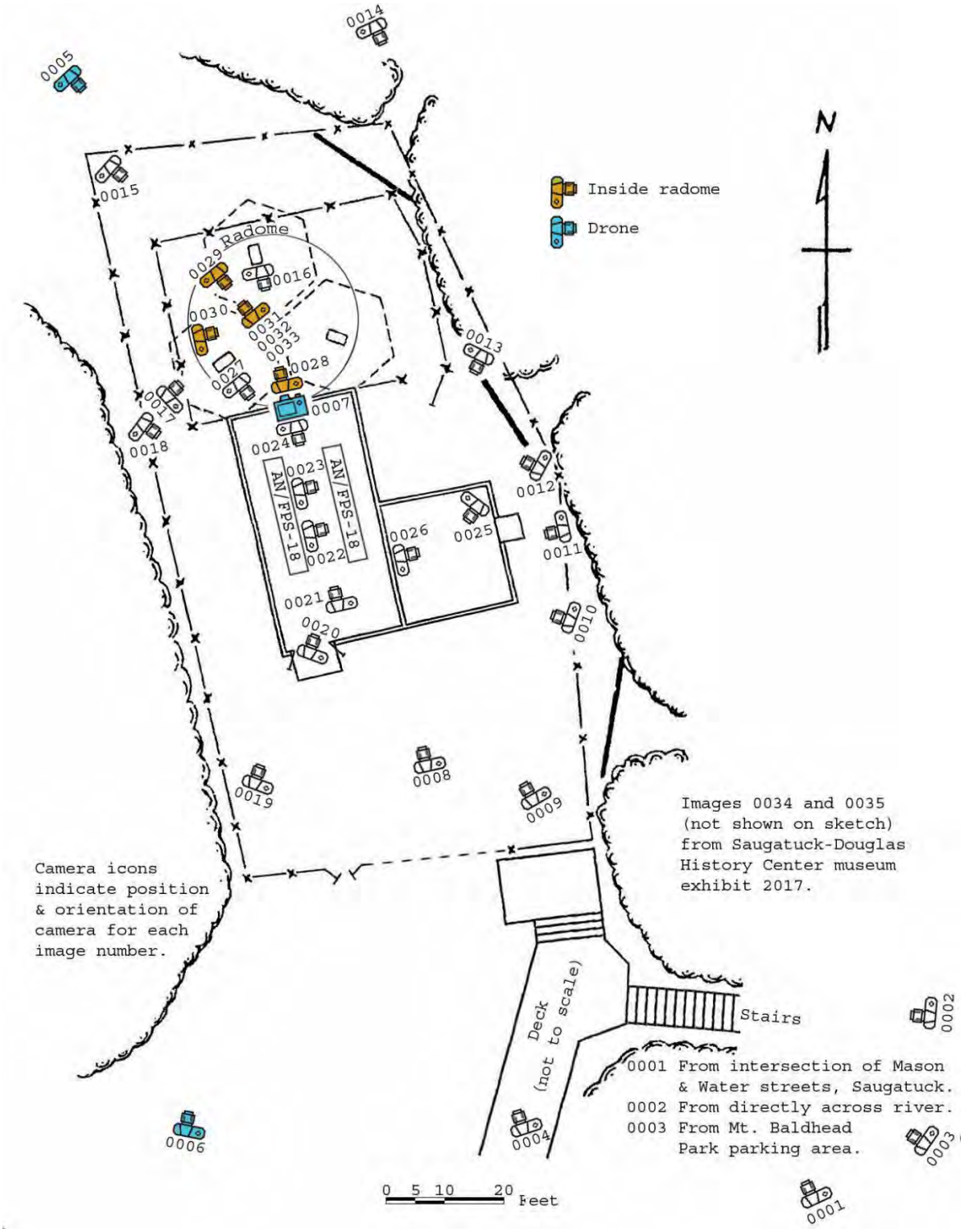
753 Park Street, Saugatuck, Allegan County, Michigan

Latitude: 42.661250 Longitude: -86.209083

MICHIGAN SHPO STATE HISTORIC PRESERVATION OFFICE

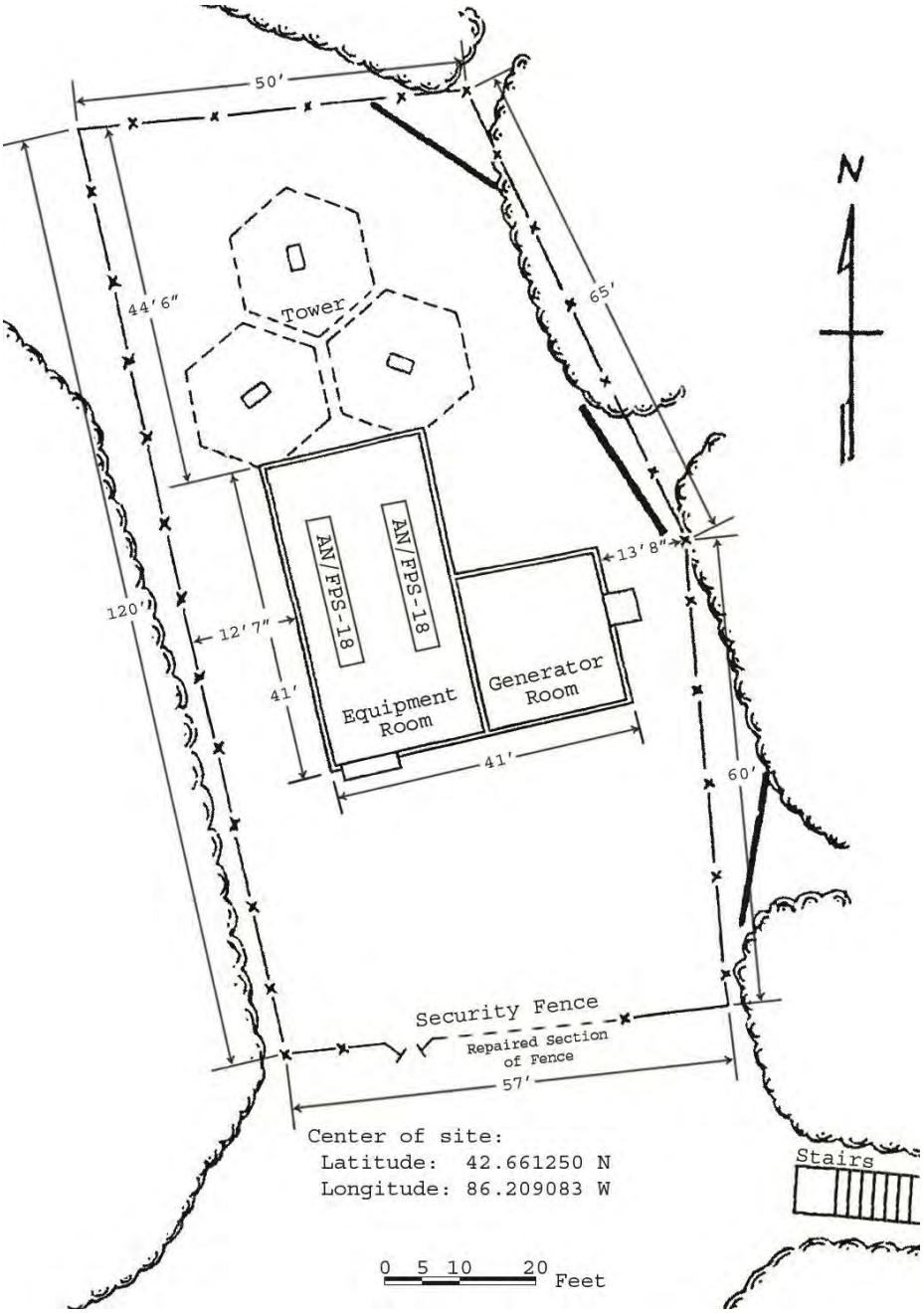


Saugatuck Gap Filler Annex, Saugatuck, Allegan County
Property Detail Sketch Map



Saugatuck Gap Filler Annex, Saugatuck, Allegan County

Photo Log Location Map



Saugatuck Gap Filler Annex, Saugatuck, Allegan County

Site Plan


CORAL GABLES


MUSEUM
Saugatuck


MT.
BALDHEAD
PARK
VILLAGE OF
SAUGATUCK


RESTRICTED AREA
U.S. GOVT. PROPERTY
NO
TRESPASSING


NO


KEEP
OUT
KEEP
OUT


NO


South CAB Lights
BAR 24

CAUTION
TO AVOID DAMAGE TO MIXER XTALS, SET LO ATTENUATOR
FULL COUNTER CLOCKWISE BEFORE RETUNING STALO

DANGER
HIGH
VOLTAGE

DANGER
HIGH
VOLTAGE


MODULATOR TRIGGER TIME DELAY ADJUST
DANGER HIGH VOLTAGE
DANGER RADIATION HAZARD
DANGER HIGH VOLTAGE
DANGER RADIATION HAZARD
DANGER HIGH VOLTAGE
DANGER HIGH VOLTAGE


CAUTION

RADOME CW 413
F.S.N. 5840-779-1754
PART NO. D-9159-6
CONTRACT NO. AF 30 635 -24826
LONG SAULT WOODCRAFT LIMITED
A PANEL BOTTOM

RADOME CW 413
F.S.N. 5840-779-1754
PART NO. D-9159-7
CONTRACT NO. AF 30 635 -24820
LONG SAULT WOODCRAFT LIMITED
B PANEL BOTTOM

RADOME CR 413
F.S.N. 5840-779-1754
PART NO. D-9158-8

CONTRACT NO. AF 30 635 -24820
LONG SAULT WOODCRAFT LIMITED
C PANEL BOTTOM

Saugatuck P.E

54°	38 acr	18 mi
117°	83 Acr	34 mi
[illegible]	137 Acr	165 mi

SAGE WAS SO AMBITIOUS IT RIVALS THE MANHATTAN PROJECT AND THE APOLLO PROGRAM IN SCOPE AND BUDGET, YET FEW PEOPLE KNOW ABOUT IT TODAY.

To counter the threat of Russian bombers, the US Air Force, in conjunction with MIT and IBM, built a computerized air defense system unlike any the world had ever seen.

The **Semi-Automatic Ground Environment (SAGE)** combined radar input with commercial airline flight information to paint a live picture of what should, or shouldn't, be flying in American airspace. If anything looked out of place, SAGE commanders scrambled fighter jets to intercept.

SAGE replaced the grease-pencil manual plotting of radar blips, adequate against propeller-driven bombers, but a method too slow to be effective against jets flying at 600 miles per hour.

By 1961, the Air Force built 23 SAGE centers around the continental U.S. At the heart of each center lay an enormous, 4-story windowless blockhouse that contained two 250-ton AN/FSQ-7 computers. Each computer was powered by 49,000 vacuum tubes, occupied half an acre of floor space and cost the equivalent of $1.89 billion in today's dollars.

SAGE technology was eventually overmatched by the speed of the new intercontinental ballistic missiles and microprocessors. SAGE remained the backbone of NORAD's air defence system into the 1980s and the technology led to SABRE, the airline reservation system still in use today.

Prototype SAGE building layout at MIT's Lincoln Labs

Before the Computer Mouse | When SAGE operators wanted to identify a flight on the display screen, they pointed a light gun at the spot and pulled the trigger. Flight identification would then appear on the screen. The console also included an onboard ashtray and lighter, visible to the left of the operator's hand.

Rendering of a typical display on the custom 19-inch cathode ray tube (CRT).

Console operations at the Experimental SAGE Subsector Direction Center at Lincoln Laboratory (MIT) in 1957

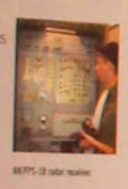
Gap filler radar sites, like Mt. Baldhead, fed information into a complex system.

SAGE system planning map c. 1958 | A number of centers and gap filler radar sites shown were never deployed, mostly due to budgetary limitations.

WHAT'S UP THERE?

The Annex is a two room, concrete block building with three-legged radar antenna tower and dome. The installation was designed to be controlled remotely and to run unattended. Before the fiberglass radome was added in 1963, the antenna could be seen rotating at a stately 5.33 revolutions per minute (RPM).

The building has two separate rooms with no communicating doorway. One room housed two diesel power generators that were removed in 1969. Still in place are two motor/generator type rotary regulators. The larger room on the west side contains two AN/FPS-18 receiver/transmitter pairs, substantially intact but deteriorating by exposure to a leaking roof and vandalism. Also in this room are the FSW-1 Site Monitor and half of the FST-1 Coordinate Data Transmitter.



AN/FPS-18 radar receiver.

The white radar dome is an iconic landmark visible for miles in all directions and used as a navigational aid for mariners seeking Saugatuck or nearby ports.

The Mt. Baldhead Gap Filler Radar Annex, some time after July 1958.

TIMELINE

1884 | The Village of Saugatuck purchased Mt. Baldhead for a public park. The 40-foot-high wooden observation tower built on top of the dune was soon a tourist destination.

June 1, 1956 | The United States Air Force leased 0.34 acres of land atop Mt. Baldhead from the Village of Saugatuck.

August 5, 1956 | Construction of the building and tower began.

July 1958 | The Bendix AN/FPS-14 radar was operational, sending data to the 781st Aircraft Control and Warning (AC&W) Squadron in Battle Creek, Michigan.

June 1963 | The AN/FPS-14 radar and antenna was deactivated and removed. At this time the site was under command of the rechristened 781st Radar Squadron (SAGE) at Ft. Custer, Michigan.

December 14, 1963 | The new AN/FPS-18 radar and antenna, enclosed in a protective dome, began operation.

1964-8 | SAGE system phased out. Command of the Mt. Baldhead Annex transferred to the 752nd Radar Squadron (SAGE) at Empire, Michigan.

April 1, 1968 | Mt. Baldhead radar permanently deactivated.

December 31, 1968 | The Air Force terminated its lease and the land reverted to the Village of Saugatuck.

July 1969 | Village of Saugatuck purchased the building, tower and radar equipment for $250. Soon after, the Village defended the dome from erroneous dismantling.

News-Palladium, Sept. 12, 1969

Today | Visitors willing to climb the Mt. Baldhead stairs can view an essentially intact Cold War defensive installation. The building is closed to the public but efforts are underway to add the site to Michigan's Register of Historic Places.

THE CASE OF THE RIFLED RADAR

Commercial Record, July 24, 1969

Next: Civil defence in the atomic age

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
EVALUATION/RETURN SHEET

Requested Action:	Nomination
Property Name:	Saugatuck Gap Filler Annex
Multiple Name:	
State & County:	MICHIGAN, Allegan

Date Received:	Date of Pending List:	Date of 16th Day:	Date of 45th Day:	Date of Weekly List:
11/17/2022	12/8/2022	12/23/2022	1/3/2023	

Reference number:	SG100008508
Nominator:	SHPO

Reason For Review:

__ Appeal	__ PDIL	__ Text/Data Issue
__ SHPO Request	__ Landscape	__ Photo
__ Waiver	__ National	__ Map/Boundary
__ Resubmission	__ Mobile Resource	__ Period
X Other	__ TCP	__ Less than 50 years
	__ CLG	

X Accept _____ Return _____ Reject **12/28/2022** Date

Abstract/Summary Comments:	Rare surviving unit in a complex system of advance warning radar installations developed to warn of impending incursions during the Cold War. Part of the SAGE (Semi-Automatic Ground Environment) system of early warning centers, the Saugatuck Gap Filler is one of a small number of such sites that retains all or most of its components. The gap filler stations were intended to literally fill in gaps of larger systems, primarily low altitude. POS is 1956-1969, the period when the system was active and integral to the defense of the US. Significant in Engineering and Military.
Recommendation/ Criteria	Accept / A & C

Reviewer Jim Gabbert Discipline Historian

Telephone (202)354-2275 Date

DOCUMENTATION: see attached comments : No see attached SLR : No

If a nomination is returned to the nomination authority, the nomination is no longer under consideration by the National Park Service.

GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
MICHIGAN STRATEGIC FUND
STATE HISTORIC PRESERVATION OFFICE

QUENTIN L. MESSER, JR.
PRESIDENT

Thursday, November 17, 2022

Ms. Joy Beasley, Keeper
National Park Service
National Register of Historic Places
1849 C Street, NW, Mail Stop 7228
Washington, DC 20240

Dear Ms. Beasley:

The enclosed file contains the true and correct copy of the nomination for the **Saugatuck Gap Filler Radar Annex, 753 Park Street, Saugatuck, Allegan County, Michigan**. This property is being submitted for listing in the National Register of Historic Places. This nomination is a __X__ New Submission ____Resubmission ____Additional Documentation ____Removal.

__1__ Signed National Register of Historic Places Registration Form
__2__ Locational maps (incl. with form file)
__3__ Sketch map(s) / figures(s) / exhibits(s) (incl. with form file)
__3__ Pieces of correspondence (incl. with correspondence file)
__35__ Digital photographs (individual TIFF format files)
____ Other: _____

COMMENTS:

____ Please ensure that this nomination is reviewed.
____ This property has been approved under 36 CFR 67.
____ The enclosed owner objections constitute a majority of property owners.
____ This nomination has been funded by the following NPS grant:
Underrepresented Communities Grant (2019)
____ Other:

Questions concerning this nomination should be addressed to Todd A. Walsh, National Register Coordinator, at (517) 331-8917 or walsht@michigan.gov.

Sincerely yours,

Martha MacFarlane-Faes
Deputy State Historic Preservation Officer

MICHIGAN SHPO STATE HISTORIC PRESERVATION OFFICE

300 NORTH WASHINGTON SQUARE • LANSING, MICHIGAN 48913
michigan.gov/**shpo** • (517) 335-9840

Michigan State Historic Preservation Office
300 N. Washington Sq.
Lansing, MI 48913

To Whom It May Concern:

As owner of the Saugatuck Gap Filler Radar Annex located at 753 Park St., Saugatuck MI, the City of Saugatuck requests the designation as a historic property and supports the nomination as written by Chuck Gustafson, member, Mt. Baldhead Radar Station Workgroup, Paula Bradford, volunteer, Saugatuck-Douglas History Center, and Eric Gollannek, PhD, Executive Director, Saugatuck-Douglas History Center.

Thank you for your consideration.

Sincerely,

Ryan Heise
City Manager, City of Saugatuck

Walsh, Todd (LEO)

From: Victor Bella <deltuck@aol.com>
Sent: Tuesday, September 13, 2022 12:05 PM
To: Walsh, Todd (LEO)
Subject: Saugatuck Gap Filler Annex

Categories: NRHP

Dear Mr. Walsh,

As a long-time resident of Saugatuck, I am writing in support of the nomination of the Saugatuck Gap Filler Annex to the National Register. I have been a member of the Saugatuck Douglas History Center for twenty two years and a past chairman of the Saugatuck Historic District Commission for eight. Preserving our local and state histories has always been a priority for me. The Saugatuck Gap Filler Annex is an important part of that. I have volunteered with the group that has been responsible for its recent clean-up and signage.

It is my upmost hope that the Review Board act favorably on our application. If you would like any further information, please contact me at any time.

Sincerely,

Victor Bella