Scandia Water Tower Tank Barn: A Historical Investigation
Scandia, Washington County, Minnesota

Prepared for the Scandia Heritage Alliance
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Contents

Introduction

The City of Scandia, with a population about 4,000, does not have a municipal water supply. Properties are served by individual wells or small private distribution systems. One of the private systems, the Hilltop Water Company, has a well near the northeast corner of the intersection of Olinda Trail and Oakhill Road, the community's commercial center. For many years, the well and related pumping gear, which at one time included a windmill, was located on, in, beneath, and adjacent to a barn that was associated with a historic retail building on Oakhill Road (see photographs on the following page). When a state regulatory agency required the company to do extensive improvements to the well, it was necessary to take down the barn to complete this work.

Recognizing the historical importance of the barn to the community, Hilltop board member Susan Rodsjo worked with the board to retain a barn restoration company, Rustic Innovations, to deconstruct the barn and put the components in storage, where they remain today. In 2016, local residents formed the Scandia Heritage Alliance to preserve and promote the community's heritage. One of the group's first goals was to reconstruct the barn as part of an arts and heritage center. The Alliance was incorporated in 2018; obtained nonprofit status and evaluated potential sites for the barn in 2019; by the end of that year, selected a location and reached an agreement with the City of Scandia for making the reconstructed barn part of a larger community amenity; and, in 2020, completed a feasibility study for the arts and heritage center.

Also in 2020, with the support of a Minnesota Historical Society grant from the Minnesota Arts and Cultural Heritage Fund, the Alliance hired historian/architectural historian Charlene Roise to conduct research on the barn. The following report is the product of this initiative. Attachment B prepared by historical architect Charles Liddy assesses the barn's characteristic features and distinctive design. Both consultants meet the Secretary of the Interior's Professional Qualifications Standards for their fields. The report is an important step in the Alliance's effort to list the barn in the National Register of Historic Places under Criterion C for its architectural and engineering significance.

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Photographs before barn was disassembled.

Top: West and south sides, looking northeast.(Susan Rodsjo photograph)

Center: South and east sides, looking northwest. (Curt Richter photograph)

Bottom: North side, looking southeast. (Curt Richter photograph)

Scandia, Frank Lake, and the Barn

Swedes came to America in waves. Through the mid-nineteenth century, most were "landed farmers and their families, . . . often well-to-do persons planning to do profitable business in the expanding Middle West," according to Swedish historian Lena Andersson-Palmqvist. A famine in Sweden beginning in 1868 changed the dynamics, leading many Swedes to make the difficult decision to leave their homeland rather than starve. Swedish land reforms, which consolidated smaller and disorganized farm fields into larger and more rational tracts, were also a factor. The farms traditionally were passed on to first-born sons, pushing younger sons to move to urban areas or emigrate. Recessions in the late 1870s and early 1890s, along with more agricultural problems in the late 1880s, accelerated the trend. From the mid-nineteenth century through the first three decades of the twentieth century, America welcomed about 1.25 million Swedes, nearly a quarter of the world's Swedish population.[1]

Many found their way to Minnesota. The area around Scandia attracted the earliest Swedish settlers in the state. Ignatius Donnelly wrote his impressions of the community after visiting in 1878: "A quaint primitive . . . people with their log houses and thatched barns. They spin their own cloth from their own sheep and have lots of chickens, hogs and cattle."[2]

Without a pump, water had to be raised from a well by hand. (Olson's near Marine on Saint Croix, ca. 1900; Minnesota Historical Society)

Among them were Magnus and Brita Lake and their family, including their son, Frank, who arrived in the 1860s. Frank showed an entrepreneurial spirit, peddling wares door-to-door as a teenager. In 1879, he established the Farmer's Store at the intersection of Oakhill Road and Olinda Trail. Goods that came up the Saint Croix River were transported from the steamboat landing to his store by horse and wagon.[3]

The introduction of a rail line along the river in 1886 made it possible for Lake to receive shipments more frequently and stock a broader assortment of goods. Steam locomotives required large quantities of water on a regular basis, and railroads installed massive windmills to fill tanks at regular intervals along the tracks. This need was relatively short-lived, though, with advances in locomotive technology. In 1902, the *Stillwater Messenger* reported that "a crew of men are taking down the windmill at the [Arcola] station." Domestic windmills like the one on the barn in Scandia and at farms

[1] Lena Andersson-Palmqvist, *Building Traditions among Swedish Settlers in Rural Minnesota* (Stockholm and Växjö: The Nordiska Museet/The Emigrant Institute, 1983), 13-14.
[2] Andersson-Palmqvist, *Building Traditions*, 13-14; James Taylor Dunn, *Marine on Saint Croix: 150 Years of Village Life* (Marine on Saint Croix: Marine Restoration Society, 1989), 22.
[3] Mark and Dawn McGinley, "Frank J. Lake: From Peddler to Prominent Businessman," Part I, *Scandia Country Messenger*, August 14, 2019.

throughout the area had a longer service, some continuing in operation beyond the mid-twentieth century.[4]

In the meantime, the store Lake had founded remained a hub of the community. In 1910, the *Stillwater Messenger* reported that a new cooperative, the Scandia Mercantile Company, had taken over "from the Chisago County Cooperative company its store building, fixtures, stock of merchandise, etc." Towards the end of the century, the *Scandia Country Messenger* noted that "from 1910 and through two world wars, the Mercantile was a supply line to this community. Anything from a needle to a threshing machine could be obtained at the Mercantile," and at one point the local post office was in the building. "A tin shed between the tower barn and the main store housed some of the implements," and "the area where the Scandia Cafe and parking lot are now located was used for calf fairs and horse sales during the twenties and thirties. . . . There was also a big scale for weighing loads of grain, or whatever the farmers had to sell." During the twentieth century, the property went through a series of owners and modifications. The cafe space was added to the store in the 1930s and originally used as offices. A structure behind it, which held a plumbing and heating business, was removed at a later date, as was the tin shed. The store has not been open continuously since 1879, but it is in operation today.[5]

By the early twenty-first century, development pressures reached Scandia, raising concerns that New Scandia Township might be annexed by Forest Lake, a larger community to the west. After lengthy debate of the issue within the community, the township was officially incorporated as a city on January 1, 2007.[6]

The store and barn were situated on separate parcels of land that were in common ownership in the twentieth century until 1969. In that year the barn parcel, the north 48 feet of Lot 19, was sold to the Hilltop Water Company, which had been established that year. The entity registered as a corporation with the Minnesota Secretary of State in 1972, the same year it dug a new 280-foot well. By 2013, the company supplied "21 businesses and houses with water in the vicinity of Scandia's two-block downtown." The barn could not be connected to a sewer line, limiting reuse options, and in 2013 the Hilltop board voted three to two to demolish the deteriorating structure. Hilltop hired Rustic Innovations to take down the barn, and Susan Rodsjo, a proponent of preserving the barn, purchased the disassembled barn for future use in a new location and founded the Scandia Heritage Alliance with a group of Scandia residents.[7]

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[4] "Arcola," *Stillwater Messenger*, January 25, 1902.

[5] "New Enterprise," *Stillwater Messenger*, April 16, 1910; Wilma Schmitt, "Mercantile to Superette: Commerce at the Corner," *Scandia Country Messenger*, June 9, 1993.

[6] Mary Divine, "Townships Ponder Becoming Cities," *Saint Paul Pioneer Press*, July 10, 2005; Mary Divine, "City of Scandia Hits Maps on January 1," *Saint Paul Pioneer Press*, October 18, 2006.

[7] Two Pines Resource Group, "The Hilltop Water Company's Tower Barn, 21083 Olinda Trail, Scandia, Minnesota: Preliminary Assessment of Historical Significance," 2013, 3; Bluestem Heritage Group, "Selected Historic Sites in Scandia," 2021, 15; Kevin Giles, "Time Up for Scandia's Historic Barn?," *Minneapolis Star Tribune*, June 16, 2013; Minnesota Secretary of State, Business Filings Online, accessed February 22, 2022, https://mblsportal.sos.state.mn.us/Business/SearchDetails?filingGuid=1858e472-a8d4-e011-a886-001ec94ffe7f and https://mblsportal.sos.state.mn.us/Business/SearchDetails?filingGuid=1fdfec71-dd92-e511-adff-001ec94ffe7f.

Scandia Water Tower Tank Barn: Description and History

The barn was dismantled in 2014. Structural components were labeled to facilitate reassembly and are in storage. Access to salvaged equipment was not available until a late stage in this report's preparation. The following physical description is based on a brief examination of this equipment; historic photographs; photographs taken before and during the deconstruction; two visits to inspect the components at the storage area; interviews with local informants including Alan Bakke, Scott Kaiser, Mark McGinley, Curt Richter, Susan Rodsjo, Lester Rydeen, and Wayne Schmitt; interview with windmill expert Mark Henry, Midwest Windmill Company, Kirksville, Missouri; and drawings with measurements prepared by Richter, the owner of Rustic Innovations and a mechanical engineer.

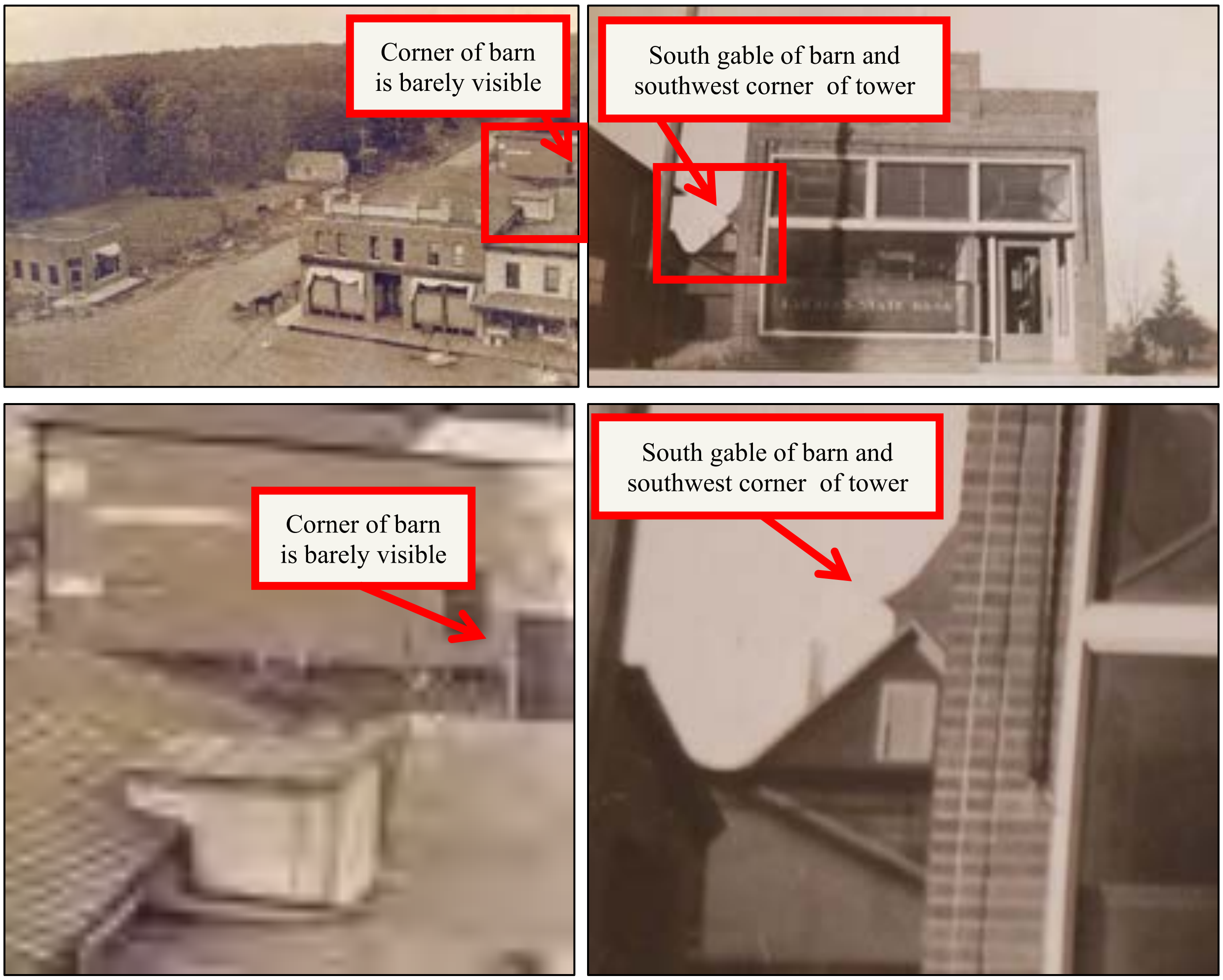
In addition, three studies of the barn and its history provided background for the present report:

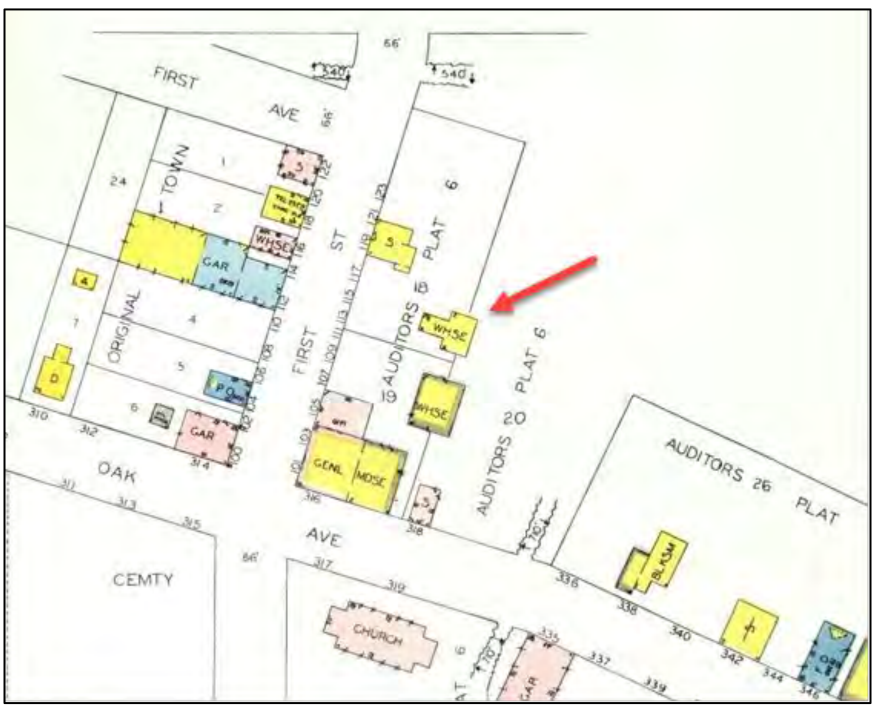
- Paul Bergson, "Inspection and Evaluation of the Hilltop Water Company Barn," February 21, 2010.
- Mark and Dawn McGinley, "Frank Lake: From Peddler to Prominent Businessman," Part I, *Scandia Country Messenger*, August 14, 2019.
- Two Pines Resource Group, "The Hilltop Water Company's Tower Barn, 21083 Olinda Trail, Scandia, Minnesota: Preliminary Assessment of Historical Significance," March 21, 2013.

Photographs on the next pages provide context for the discussion of the barn that follows. A more detailed analysis of the water system, including the windmill and tower, is in a later section.

Labeled structural members. (Curt Richter photograph)

These undated photographs appear to date from the late nineteenth/early twentieth centuries and are the earliest known images of the barn. The one to the left was taken from the bell tower of Elim Church, looking north-northwest. The Mercantile Building is on the street corner near the center. Behind the adjacent building, the southwest corner of the barn is visible. The other photograph focuses on Farmers State Bank, built just to the east of the Mercantile Building in 1919. The barn's south gable and the southwest corner of the tower can be seen behind the bank. Red outlines on the top photographs indicate areas enlarged for the lower photographs. (Collections of Greg and Mary Benson, left, and Susan Dickens, right)





Top: An aerial reproduced in Engquist's Scandia—Then and Now *(page 115) dates from "about 1940." The windmill is no longer in place.*

Bottom: 1959 Sanborn insurance map with location of barn highlighted. (Borchert Map Library, University of Minnesota, Minneapolis)

The top photograph of "Water Tower. Scandia Mn.," was taken by Melvin E. Wolff in September 1989. Although the label indicates that the view is "looking So.," the camera actually faces east-northeast. The label continues: "Wood siding painted beige. Light tan window trim." (Book 22, page 57, photo collection at Saint Croix Room, Stillwater Public Library)

The bottom image was taken shortly before the barn was deconstructed. (Curt Richter photograph)

Interior of east section, first floor. (Curt Richter photographs)
Top: View from south doorway, looking north-northwest. The metal tank to the right was part of the water system for a short period of time.
Bottom: Looking east.

Interior of east section, second floor. (Curt Richter photographs)
Top: Detail of the structure at the south end, which was exposed during the disassembly process. Looking east.
Bottom: Looking northeast at the north end, including the ladder leading up to the tank room and the space below the tank room.

Interior of west section. (Paul Bergson photographs)
Top: Second floor.
Bottom: First floor.

The barn was situated on Olinda Trail, separated from the street by a surface parking lot. The structure comprised two sections. The larger east section stood a tall two stories (about 44'–5"). The ridge of its shingled, gable roof ran north-south. The roof extended beyond the south gable end, resting on purlin brackets (also known as "lookouts") with a decorative curved tail. The lower eaves had a shallow overhang with exposed rafter tails. Brackets also supported the clipped gable at the roof's north end, delineating the bottom of a tower centered at the roof's north end. The tower's base was about 24'-10" above grade. Square in plan, the tower had walls about 12' long and 9'-10" high. Above this was a steeply sloped, pyramidal, hipped roof, flared at the base. It rose about 8'-10" and was crowned with an octagonal platform. Ornamental wood brackets ran from the roof to the bottom of the platform. Four exposed, 6" by 6" posts rose about 7'-4" above the platform. Their tapered ends joined in a point at the apex (about 50'–8" above the ground), which would have supported the base of the windmill.

Detail views of curved purlin brackets (above, right, and center), exposed rafter tails (below), and tower brackets (bottom right). (Curt Richter and Susan Rodsjo photographs)

The barn's south wall was 27' long. Centered in the first floor was a door opening flanked by two windows, and a boarded-up opening was near the peak of the gable. The door was a modern replacement. The east wall, about 32'–5" long, had no openings. On the north wall, two windows edged a door with a low lintel, about the height of the windows' meeting rails.

The building's second, one-and-one-half-story section was attached to the west wall of the east section. The gable roof of the west section had a lower pitch and the ridge was oriented east-west. The north and south walls rose about 15'–1", to just below the eaves of the east section. Like the east section, the end of the gable roof projected beyond the wall and had curved brackets. Two large barn doors on overhead tracks filled most of the first floor of the west wall, which measured about 24'–6" long. A smaller door with side hinges was centered above, with a painted sign for "Hilltop Water Co." above the lintel. Between the sign and the gable's apex, an opening was filled in with clapboard aligned with the adjacent clapboard. The 25'-long north and south walls each had two windows on the first floor and exposed rafter tails on the eaves above.

The exterior walls of both sections, including the tower, were sheathed in clapboard with flat corner boards. Both sections had wood-frame, 2/2 double-hung sash windows with simple trim.

The main section's original untrimmed fieldstone foundation began failing, causing some settlement of the structure. Sections of the foundation were replaced with concrete block in the last decades of the twentieth century. A concrete floor had been poured on the interior at an earlier date. The location of the original well was delineated by cast-in-place concrete walls extending beneath the north wall, partly outside and partly inside the barn. The original well had fieldstone walls. The location and dimensions of the well were modified in the last decades of the twentieth century and the walls were lined with concrete. The well dug in 1972 was north of the barn.

On the interior of the barn's east section, the mortise-and-tenon structure was mostly exposed. Other joinery used type B cut nails, commonly available throughout the nineteenth century. In addition to hand-hewn posts around the perimeter, there were two interior rows of chamfered timber posts supporting timber beams paralleling the building's long axis. Local sources believe that the wood was tamarack, which grows straight, is strong, and would have been readily available in the late nineteenth century. The beams held floor joists of crudely trimmed logs, with floorboards above. Dimensional lumber was used for some elements, such as bracing. This could be original or might have been installed at a later date.[8]

Before the barn was disassembled, it was used for storage, making it hard to discern the physical features of the space from available photographs. The northeast corner of the first floor had a partition partly enclosing a pressurized water tank, an artifact from a later phase of the water system's evolution. Various posts, beams, and bracing were evidence of modifications over time, but details were often obscured by the items in storage. A series of square frames centered in wood panels on the east side suggested small window openings, such as those in dairy barns, but the frames were filled in and clapboard sheathing on the exterior did not exhibit any evidence of openings.

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[8] Thomas D. Visser, "Nails: Clues to a Building's History," University of Vermont Historic Preservation Program, 1-2, author's files.

The second floor was apparently used to store hay and grain. The contractor found remnants of these materials imbedded in the structure during the barn's deconstruction, and openings in the floor near each corner were likely used to move commodities to the first floor by gravity. Interior posts were also chamfered but were taller than those on the first floor. They showed signs of wear, suggesting abrasion by grain. Metal tie rods were extended diagonally from the top wall plates to the interior posts for bracing at some point.

Bark was apparently stripped from the rafters and their lower ends were trimmed at the bottom where they rested on the wall plate. The top side of the rafters was flattened to support roof decking that consisted of milled planks of varying widths, each separated by a few inches.

The framing beneath the tower at the north end was irregular and was apparently altered after the tank in the tower was removed, but a substantial post remains centered beneath the tower, where it would have supported the water tank directly above. A slender wood ladder ascended to a small door near the peak of the gable. This door was in the south wall of the tank room at the base of the tower that rose from the north end of the barn's roof. The tank was no longer in place. In contrast to the structure of the barn's first two floors, the tower framing was machined. A small door in the ceiling provided access to the attic beneath the pointed roof.

The one-and-one-half-story west section extended perpendicularly from the east section's west wall. There was no interior wall between the east and west sections on the first floor and a partial plank wall on the second floor. Milled lumber and wire nails were used in the construction of the west section. Wire nails became available after steel-making technology advanced in the late nineteenth century. Wire nails had captured 10 percent of the U.S. market by the mid-1880s, outpaced cut nails by the next decade, and claimed a 90-percent share by the 1910s. The north and south walls were not full height, making roof bracing relatively low to the floor. The bracing was irregular, suggesting that some components were salvaged.[9]

[9] Vissar, "Nails," 1-2.

Analysis

The construction history and subsequent evolution of the barn is the subject of debate. There are no known historic photographs showing the entire building. Archival research did not discover additional primary sources documenting its construction. Photographs taken in the twenty-first century, including during the deconstruction process, offer additional details but have gaps.

Curt Richter provided helpful observations and conclusions from his experience deconstructing the barn as well as access to equipment and materials salvaged from the property. Insights on windmill operation were provided by Scandia residents Lester Rydeen and Vincent Maefsky and by Mark Henry of Midwest Windmill Company, Kirksville, Missouri, who identified a storm casting salvaged from the tower's apex. Rydeen, Wayne Schmitt, and Scott Kaiser shared personal memories of the water tower barn from their many years in Scandia, but the barn's windmill had been removed from the barn before their time. Kaiser had worked on the water system associated with the well and was at one time an owner and operator of the adjacent cafe. Interviews with individuals who have lived and worked in Scandia since the 1960s provided information on more recent modifications.

The barn was located behind the store Frank Lake established at the corner of Oakhill Road (originally Boney Lake Road) and Olinda Trail (once Two Church Road). The success of Lake's venture led to construction of a larger store and other outbuildings, including the barn. According to the McGinleys, Lake founded the store in 1879. Two Pines concluded that "deed and tax records indicate that the store building was not constructed until c. 1883." Lake originally had a partner in the venture, John J. Slattegren. Lake bought out Slattegren's interest in 1888. Most sources agree that the original store burned in 1889 and the first section of the existing store building was erected soon thereafter.[10]

Various dates have been suggested for the barn's construction. The McGinleys concluded that "the barn was added by Lake around 1880 as a livery for the horses and wagons used to haul goods." Two Pines came to a different conclusion after tracing the ownership of the barn's site. Ole Olin sold the land to John Slattegren in 1882, Slattegren sold it to John Carlson in 1893, Carlson sold it to John Mattson on September 16, 1895, and Mattson sold it to Lake three days later. "Based on this historical analysis, the Tower Barn could not have been constructed prior to 1894, and was built by Lake when he acquired the land in 1895," according to Two Pines. It would not have been practical to dig a well inside the barn, so the well was created before the barn structure, either as part of the same construction project or earlier.[11]

Because of the two construction methods, some believe that the east section was built first and the west section added later, with the tower perhaps from yet another date. Two Pines asserted that the timber framing of the east section indicates it was built before the west section, and "the most likely scenario is that an existing timber-framed barn was moved to the site to form the core of the new building." To support this conclusion, the report points to "the presence of consistent dimensional framing elements throughout both sections of the building indicating that modifications to the timber-framed barn (including the addition of the tower and its reinforced

[10] McGinley, "Frank J. Lake," Part I; Two Pines, "The Hilltop Water Company's Tower Barn, " 2-3.
[11] Two Pines, "The Hilltop Water Company's Tower Barn," 3.

load-bearing floor) and the construction of the [west] portion of the building occurred at the same time. Furthermore, timber supports in the first story of the barn bear indications, such as purposeless chamfering and channeling, of having been reused or moved which is unlikely to occur in a barn that is in its original location. Also stall windows within the east wall of the original barn's first floor were filled in and clapboarded over. Once framed, the exterior of the modified barn and the east-west portion of the building were then simultaneously roofed and sheathed in clapboard resulting in the consistent exterior appearance of the building."[12]

Other research suggests that instead of relocating a complete barn, Lake might have salvaged structural elements from an older structure, perhaps a barn, outbuilding, or storehouse, and reconfigured them for the east section. The first barns in the area were typically of log construction according to a survey completed in the early 1980s by Swedish historian Lena Andersson-Palmqvist. The goal of her study was to identify the influence of Swedish practices on buildings erected by Swedish immigrants in two Minnesota counties, one of which was Chisago County, just north of Scandia. Timber framing was used for early barns in the area, and that practice carried on into the twentieth century. She quoted a Chisago County farmer who explained that "even up to that time (in 1920-25) the barn raising was done by the farmer together with neighbors that got together and helped. In that time there were many saw-mills [*sic*] in the country, where you could get the lumber and where farmers even could bring their own logs to be sawed. But the barns with heavy timber studs were hewn by craftsmen or farmers that used the broadaxe and made it all by hand."[13]

Where the east and west sections intersect, the rafter tails of the east roof were on the interior. They were trimmed differently than the rafter tails exposed on the exterior. (Curt Richter, photographer)

In considering the houses and barns in her survey, she found it difficult to trace the influence of many design features and construction methods from Sweden because immigrants adapted to conditions they found in the new land. She concluded: "The design of the pioneer building was the result of an interplay of ecological, economic, social, cultural and ethnical factors. The examples from the survey illustrate certain cultural influences on the pioneer building tradition, articulated in relation to the other factors, ecological, technical etc."[14]

The likelihood that elements of the barn were salvaged, rather than moved

[12] Two Pines, "The Hilltop Water Company's Tower Barn," 3.
[13] Quote from "Chisago County interview" in Andersson-Palmqvist, *Building Traditions*, 73. See also pages 50, 71-72.
[14] Andersson-Palmqvist, *Building Traditions*, 76, 50-51. She noted that a common Swedish measurement, the "alnar" (ell), measured 31 feet by 18 feet. The barn does not conform to this dimension, reinforcing her conclusion that conditions in the new world resulted in pragmatic changes to long-standing practices in Sweden.

Filled-in openings on the east wall before (top) and after (center) the interior sheathing was removed. The exterior clapboard (bottom) showed no evidence of the openings. (Photographs from Two Pines, top; Curt Richter, center and bottom)

whole-cloth, is also suggested by observations of a civil engineer, Paul Bergson, who inspected and analyzed the barn in 2009-2010. Bergson noted that the west section, while "constructed of dimensional lumber, . . . includes timber supports that were probably removed from the Barn hay loft support system (i.e. columns)." Also, "the majority of the hay loft beam floor support columns have been removed," and "beams supporting the hayloft show that the column supports have been removed. . . . The Barn also includes dimensional lumber, but only in a few locations."[15]

Bergson thought the west section was built after the east section based on this and other information, including the appearance of cut nails in the east section and wire nails in the west section. His observations could also support a conclusion that components of an older building (or buildings) were salvaged and reused to simultaneously construct the east and west sections. This possibility is reinforced by other evidence. While disassembling the barn, Richter observed that the trim of the east section's rafter tails beneath the exterior eaves were trimmed differently than those sheltered by the west section's roof. As a result, he though the two sections were erected at the same time. On the exterior, the cantilevered brackets beneath the roof's gable ends were the same on both sections, as were the windows and clapboard sheathing.

The building might have been reclad at some point, though. Several boarded-up openings are visible on the east wall, including at least two that cut through columns, and there is also a filled-in opening in the tank room's north wall (see "Tank Room" section below).

The clapboard on the barn's tower also matches, suggesting that it was constructed at the same time as the rest of the structure. The tower's structure is dimensional lumber, again

[15] Paul Bergson, "Inspection and Evaluation of the Hilltop Water Company Barn," letter report, February 21, 2010.

reinforcing the conclusion that hand-hewn elements on lower levels were salvaged from another building. This also supports a construction date in the1890s. The tower was clearly built to support a windmill. The original windmill was apparently manufactured by Ideal Steel, which began producing pumping windmills in 1982, and replaced by an Aermotor Company windmill not long thereafter (see "Windmills" section below). The first Aermotors were manufactured in 1888 but they were not widely distributed until the following decade. Frank Lake married Ida Peterson in 1886 and their first child was born in 1889, with four more joining the family within the next six years. The running water provided by the windmill and tank would have been welcomed by the growing family, which moved from a residence by the store to a new house across Olinda Trail in the 1890s. Pipes carried water from the tank to both the house and store, as well as to other nearby buildings. During this period, the importance of access to clean water was increasingly recognized as not only an amenity but a health issue.[16]

There is no documentation of when the windmill was removed from the apex of the barn's tower, but it does not appear in a circa 1940 aerial photograph. Windmills became obsolete after electrical and water systems were upgraded and they were often removed to eliminate a potential hazard. If brakes and other components of an abandoned windmill failed, the deteriorating, wind-tossed equipment could become a liability, potentially harmful to the structure supporting it and to people, vehicles, or other objects on the ground below.

When the Scandia barn was disassembled in 2014, Richter found fragments of equipment and other material inside. These fragments, along with photographs of the barn before and during deconstruction, provide information on the tower and windmill, with two caveats: 1) there are many gaps in the data, so it is difficult to gain a complete understanding of historic conditions; and 2) items in the barn were not necessarily associated with the structure historically. The barn was used for storage by the store and, later, by others who rented space there. Because it was difficult to reach the tank room in the tower, though, it seems reasonable to assume that anything found there had a historic relationship to the barn.

The next sections provide context and analysis on the barn's windmill and related components, beginning with a historical overview of windmill development and continuing with a detailed assessment of system components.

[16] T. Lindsay Baker, *A Field Guide to American Windmills* (Norman: University of Oklahoma Press, 1984), 300-301; "Cupid's Conquests," *Stillwater Messenger*, January 1, 1887; McGinley, "Frank J. Lake," Part I.

Windmills: European Precedents and American Innovations

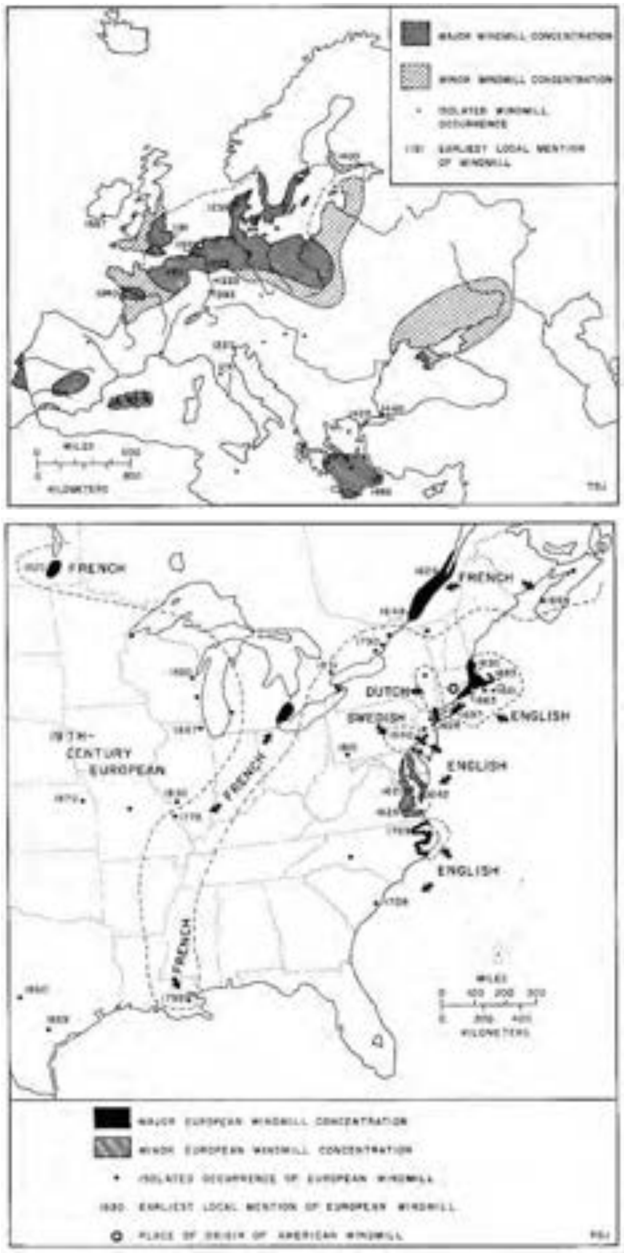
General historical information and details on specific features of windmills, pumps, wells, and tankhouses were obtained from primary and secondary sources. For the following assessment, the most valuable primary sources were historic trade catalogs, including those at the University of Minnesota's Northwest Architectural Archives and others available on the internet, as well as information from businesses currently producing and maintaining windmills, particularly the Aermotor Company. There is a great deal of secondary literature on windmills, but many authors focus on European-style mills or provide rather superficial historical or operational information. The publications that proved most helpful are by historians T. Lindsay Baker and his protégé, Christopher C. Gillis. Local informants, mentioned above, were also invaluable.

Efforts to harness wind as a source of power began long before the Industrial Revolution. A small, primitive form of wind-driven mill was reported in Central Asia in the fifth century. Persians used an early form of windmill to irrigate gardens in the tenth century. Europeans had developed windmills to grind grain by the thirteenth century, and industrious Dutch set windmills to work pumping water from lowlands in by the fifteenth century. Europeans who arrived in North America brought the technology with them.[17]

Early European mills were typically post mills, which had a vertical post or tube supporting a horizontally rotating fan. The entire mechanism pivoted. By the sixteenth century, a new design had been introduced with a fixed base that held grindstones, pumps, or other equipment. Known as a tower windmill, the structure was topped by a rotating section outfitted with sails and transmission machinery. The design of sails was also improved by changing their flat profile to a more aerodynamic curved shape. Further innovations came in the eighteenth century with the adoption of a fantail (predecessor of the windmill vane), which maintained a sail's orientation into the wind, and technology to adjust sail shape as wind strength changed.[18]

The 1864 Seppman Mill, a stone structure at Minneopa State Park near Mankato, is a good example of a European-style tower gristmill, although its arms are not extant.

[17] Volta Torrey, *Wind-Catchers: American Windmills of Yesterday and Tomorrow* (Brattleboro, Vt.: Stephen Greene Press, 1976), x; Roger Stanley Manning, "Windmills and Tankhouses in California: A Geographical Analysis" (Master's thesis, University of California, Geography, 1969), 31-32, 40-41.
[18] Manning, "Windmills and Tankhouses in California," 41-43.



From Jordan, "Evolution of the American Windmill," 3-4.

Scholar Roger Stanley Manning noted that windmills "could be found all over Europe by the eighteenth century. In effect, the windmill created a Medieval Industrial Revolution based upon the power of the wind." The European design was imported to America by Dutch settlers, who erected a wind-powered sawmill in Manhattan in 1633. Other mills soon appeared along the East Coast, built by groups arriving from England, France, and the southern coast of Sweden. The cumbersome European-style windmills, though, faced competition from facilities harnessing readily available waterpower, a resource less common in much of Europe. Steam engines became another attractive option as that technology improved in the 1700s.[19]

Windmills experienced a major revival in the following century when American inventors came up with a new and improved design that was built up from smaller parts, was inexpensive to manufacture, and was easy and efficient to operate. Daniel Halladay, a New England mechanic, is generally credited with designing the American windmill in 1854. The "Halladay Standard" was self-governing thanks to a vane that, like a weathervane, kept the wheel oriented to the wind. "In light winds the blades faced the wind at an angle to derive the greatest power from it," historian T. Lindsay Baker explained, "but as the wind velocities increased and the wheel spun faster, a centrifugal governor changed the pitch of the blades so they presented less of their surface to the wind, thus controlling their speed. When winds were high, or when the mill was turned off by an operator, the blades pivoted into a position parallel with the wind and the wheel ceased turning." The Halladay Wind Mill Company set up a factory in Connecticut and was soon busy keeping up with the demand.[20]

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[19] Torrey, *Wind-Catchers*, xi; Manning, "Windmills and Tankhouses in California," 44-45; Terry G. Jordan, "Evolution of the American Windmill: A Study in Diffusion and Modification," in *Pioneer America* 5, no.2 (July 1973): 3-4, accessed November 14, 2021, https://www.jstor.org/stable/20831813.

[20] Baker, *Field Guide*, 7.

The impact of the new design is hard to overstate. As a representative of a windmill manufacturer observed in the 1920s, “The United States did for the windmill what it has done for the automobile. Both have been put on a manufacturing basis where many can use them.” He added, “There would be very little use made of windmills in the United States today if the design had not been changed to adapt the mill in size and operation to the needs of the small farmer and stock-raiser for the pumping of water.” What American windmills lacked in aesthetic appeal—they were sometimes called “pinwheels on stilts”—they made up for on other fronts. He listed items unique to the American design:

1. Ability to be shipped knocked down and yet hastily erected with simple tools by ordinary mechanics.
2. Interchangeability of parts.
3. Durability.
4. Minimum amount of material used, keeping cost of material and transportation as well as erection down.
5. Simple lubrication.
6. Self-governing, both as to staying in the wind and as to maintaining a uniform speed regardless of velocity of wind.[21]

Railroads quickly embraced the new windmills as an efficient means to pump the large volume of water needed to operate steam locomotives. By the 1870s, the Chicago area, a major railroad hub, had emerged as the center of the windmill industry. Halladay reinforced this concentration in 1863 by moving its factory to Batavia, Illinois, a short distance from Chicago, to be closer to the growing market as the frontier pushed west. Halladay adopted the name of the Chicago distributor of his brand, U.S. Wind Engine and Pump Company. Immigrants to the United States provided a source of labor for windmill factories. “In the Fox River Valley west of Chicago,” a historian reported, “many workers were of Scandinavian origin; a company in this area named one of its windmills the Terrible Swede.”[22]

Immigrants also became major customers for windmill manufacturers as they established farms across the prairie. In an influential study of the Great Plains published in 1931, historian Walter Webb asserted that three things enabled settlers to conquer the frontier: revolvers, barbed wire, and windmills. Wind was plentiful—the plains were notoriously one of the windiest areas in North America—and surface water was scarce. Windmills provided an efficient means to tap groundwater, making it possible for people, animals, and crops to thrive. According to Webb, “Within a short time after its introduction the windmill became the unmistakable and universal sign of human habitation throughout the Great Plains area.”[23]

Early windmills were made primarily of wood. Iron and steel were used for some connections, gears, and other components by the 1870s, but wood remained the primary material until the 1890s, when improvements in technology made production of high-quality steel more

[21] Torrey, *Wind-Catchers*, 7; representative of Fairbanks, Morse and Company, quoted in Walter Prescott Webb, *The Great Plains* (1931; reprint 1981, Lincoln, Neb., and London: Bison Book, University of Nebraska Press), 340.
[22] Torrey, *Wind-Catchers*, xi; Manning, “Windmills and Tankhouses in California,” 44; T. Lindsay Baker, *American Windmills: An Album of Historic Photographs* (Norman: University of Oklahoma Press, 2007), 24-31, 33, 35.
[23] Webb, *The Great Plains*, 270, 336, 339.

economical. Some manufacturers and customers remained dedicated to wood, but a survey by the U.S. Department of Agriculture found the market share of wood mills dropped from 37 to 23 percent between 1889 and 1914.[24]

Steel vanes could be curved, giving them an aerodynamic advantage over wood vanes, which were generally flat. In 1882-1883, engineer Thomas Perry set up a primitive testing facility at the U.S. Wind Engine and Pump Company and conducted thousands of experiments to find the most efficient wind-wheel design. His scientific process produced a steel wheel nearly 90 percent more effective than most wood wheels. Perry was far from the only inventor exploring efficient steel windmill designs in the 1880s and other companies came out with similar products, but the wheel, "made from concave sheet steel blades mounted on steel rims and arms, [is] today known among windmill makers as the Perry wheel," according to historian Baker.[25]

After supporting Perry's experiments, though, the U.S. Wind Engine and Pump Company did not use his findings to overhaul its Halladay line. Frustrated, Perry left the firm and joined forces with inventor and entrepreneur La Verne Noyes, who had a track record of producing and marketing innovative agricultural equipment. They formed a new business, the Aermotor Company, in Chicago. Their windmills used back-gearing to solve an issue raised by the efficient steel design: the wheels turned too fast to allow a pump stroke with every revolution as "direct stroke" wood wheels had done. The solution was to put a small pinion gear at the end of the shaft holding the wheel, with the pinion's teeth driving a larger crank gear on a different shaft that drove a pump. Using two gears and two shafts stepped down the power, enabling pumping in higher wind, and also allowed the mill to operate in wind as light as four miles an hour. Perry established that the back-gearing should be proportioned so "about three revolutions of the wheel [produced] one stroke of the pump." The gears and other elements were open, exposed to the elements.[26]

Aermotor and other companies aggressively marketed their windmills. In the industry's competitive early days, Aermotor pulled a publicity coup at the 1893 World's Columbian Exposition (Chicago World's Fair) where a number of windmill manufacturers had exhibits. All were grouped in one area, and the cluster of mills rising high over other exhibits drew much attention. A widely read publication, *Scientific American*, ran an article the following spring calling

Above: Baker, Field Guide*, 114.*

Right: Aermotor's exhibit at the Chicago World's Fair. ("A High Windmill," Scientific American*, 1894)*

[24] Baker, *Field Guide*, 33.
[25] Baker, *Field Guide*, 36-37; Webb, *The Great Plains*, 338-339.
[26] Baker, *Field Guide*, 37; Gillis, *Still Turning*, 42-43.

out one display: "Among the windmills shown, . . . that of the Aermotor Co. . . was perhaps the most unique and striking. It was 55 feet from the ground to the turret of the old Dutch windmill, from which sprang a galvanized steel tower 87 feet high, surmounted by a 16-foot wheel, making a total height of 150 feet. The windmill towered above all competitors at the fair."[27]

Minneapolis, a key waystation on rail lines connecting Chicago to the west by the late nineteenth century, became a powerhouse for wholesaling agricultural implements, including windmills, as frontier prairies were transformed into farm fields. The 1896 Minneapolis city directory listed five companies under the category of "wind mills," all clustered together in the warehouse district just north of downtown: Aermotor Company at 334 North First Street; Bradley, Clark and Company at 227-229 North Fifth Street; Dean and Company at 300 Third Avenue North; the Minneapolis Tubular Well Company at 311 Third Avenue North; and the Northwestern Wind Engine Company at 239-241 Third Avenue North.[28]

Some of these businesses offered a broad range of goods. Bradley Clark took out a full-page advertisement in the directory, touting itself as "manufacturers and jobbers of 'Garden City Clipper' plows, agricultural implements, pumps." Dean also advertised as a dealer of various agricultural implements, carriages, bicycles, and other equipment. The 1896 directory listed Bradley Clark, Dean, and Northwestern, along with the Elgin Wind Power and Pump Company at 313 Third Avenue North, under the category of "pumps."[29]

Often manufacturers established a network of branches to distribute their wares and related products exclusively. The Northwestern Wind Engine Company, for example, was a branch of the Baker Manufacturing Company, which produced the Monitor line of windmills. While the company's factory was in Evansville, Wisconsin, the Northwestern branch was separately incorporated in Minnesota. Northwestern's president, W. A. S. Baker, apparently part of the Baker dynasty that founded and ran Baker Manufacturing, was based in Evansville. Northwestern's secretary, W. C. C. Elfelt, oversaw operations in Minnesota and the Dakotas and had four traveling salesmen covering the territory. An 1894 book described the Minneapolis warehouse as having "a large stock of the different articles of their manufacture" including "monitor geared and pumping wind mills, pumps, tanks, pipe and fittings, scales, feed mills, wood saws and wind mill supplies." [30]

Aermotor and Elgin also had a sales force promoting their goods to retail outlets. By choosing which products to stock, local merchants influenced the brands of windmills that appeared in their trade area. Consumers did, though, have other options, including ordering directly from suppliers like Sears Roebuck and Montgomery Ward. One windmill historian observed, "The choice of a windmill brand was often based on the advice of a relative or friend or on the fact

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[27] "A High Windmill," *Scientific American* 70, no. 19 (May 12, 1894): 292-293, accessed November 14, 2021, https://www.jstor.org/stable/26113511.
[28] *Davison's Minneapolis City Directory, 1896*, vol. 24 (Minneapolis: Minneapolis Directory Company, 1896), 84, 1329.
[29] *Davison's Minneapolis City Directory, 1896*, 84, opposite 219, 1299, 1329, opposite back cover, 1329.
[30] *Pen and Sunlight Sketches—Minneapolis* (Minneapolis and Chicago: Phoenix Publishing Company, [1894], 168; Baker, *Field Guide*, 69-70, 87.

that the local farm equipment supply store stocked a particular brand. . . . The advertisements of manufacturers in the rural newspapers played an important role in influencing choice of mill."[31]

In the area around Scandia, the most common windmill was Aermotor, which was sold by the Scandia Mercantile according to Mark McGinley. An Aermotor advertisement in the *Stillwater Messenger* in 1900 asked "Have you a good windmill?" It continued: "No farm is complete without a wind-power mill. It pumps water, saws wood, grinds feed, chops fodder and works gladly and freely every day in the year." Despite these enthusiastic claims, mills were designed for one primary function, either to pump water or provide power, each requiring specific gear ratios and other mechanisms. When the company brought out its first windmills in 1888, it gave the name "Pumping Aermotors" to the open back-geared mills developed for that purpose.[32]

The design of the 1888 mill was modified in 1890 and again in 1898, when roller bearings replaced some babbitted bearings. Owners could trade out just the motor (also called the head) of an existing mill, keeping their original wheel, vane, and other parts. Aermotor promoted this option in an advertisement in the *Stillwater Messenger* in April 1898, offering to exchange "the working parts of any Aermotor . . . for a roller bearing, zephyr-running, ever-going, everlasting, power-doubling, up-to-date '98 motor." Prices were $6 for an 8-foot wheel, $12 for a 12-foot wheel, and $30 for a 16-foot wheel. "They run like a bicycle, and are made like a watch," the ad asserted. "The new beats the old as the old beat the wooden wheel." Aermotor made additional modifications in 1899 and 1905 (the R. A. Model). Historian Baker noted that "despite these design changes . . . the basic operation of the mill remain[ed] the same."[33]

Aermotor's efficient manufacturing process made the company's mills economical and very popular. The company went from selling 45 mills in 1888 to some 60,000 only four years later, and were producing half of the mills sold in the country by the end of the century.[34]

One of the chief drawbacks of mills produced during this period was the need to oil the bearings and gears frequently, requiring a hazardous climb to the top of the tower. A mill "used for two or three hours per day should be oiled once per week," an Aermotor publication from 1905 advised. While "in summer the oil used should not evaporate, . . . in cold weather some kerosene should be added to the oil to keep it from congealing. Aermotor oil is nonvolatile and is fluid at zero."[35]

Bearings were initially an alloy made of lead, copper, and tin, with other metals sometimes added. Babbitt bearings, used in the earliest Aermotors, were formed by pouring molten metal into a bearing box around the wheel shaft, where it hardened as it cooled. Later, mass-produced babbitt bearings and roller bearings were easier to install and replace. A grease cup above the bearing provided lubrication by gravity and heat as the mill operated, but this reservoir needed frequent refilling. In the early twentieth century, graphite, bronze, and other materials were

[31] Baker, *Field Guide*, 75; Manning, "Windmills and Tankhouses in California,"159.
[32] McGinty interview; "Have You a Good Windmill?" *Stillwater Messenger*, October 20, 1900; Baker, *Field Guide*, 114-115.
[33] Baker, *Field Guide*, 114-115; Aermotor advertisement, *Stillwater Messenger*, April 2, 1898.
[34] Baker, *Field Guide*, 38.
[35] Aermotor Company, *Aermotor Applications of Wind Power*, 9.

adopted for so-called “oilless” bearings. Even so, they worked better and lasted longer if they received occasional lubrication.[36]

The Elgin Wind Power and Pump Company began offering a mill in 1906 that enclosed the main shaft and crankshaft bearings in large casings that held substantial reservoirs of oil. This system successfully lubricated these parts and the reservoirs needed less frequent replenishment. It was an immediate success. The company expanded on this concept, encasing all the working parts of the mill and bringing out the first truly self-oiling mill in 1912. Competitors took note and were soon working on their own versions. Aermotor was among the first to follow Elgin, introducing a self-oiling mill, the 502 Model, in 1915.[37]

As Aermotor had done in 1898, the company encouraged owners of the open back-geared motors to trade them in. Many owners were eager to be liberated from the frequent maintenance these machines required and, as a result, open back-geared Aermotor mills became “comparatively rare,” according to Baker. “The influence of oil-bath windmills was so great that today it is unusual to see any functioning mills that do not have the self-oiling feature.”[38]

Electric pumps often replaced windmills when rural areas were connected to the power grid. Lester Rydeen examines an electric pump installed below the windmill on his farm at 13140 205th Street North.

Windmills began facing competition from steam, gasoline, and electric pumps by the late nineteenth century, but they continued to be an important source of energy for Midwestern farms until a federal program in the 1930s brought electric power to rural areas.[39]

Aermotor remained in Chicago until 1964, when its manufacturing plant moved to Oklahoma. It relocated to Argentina in 1969, then back to the United States in 1980. The company has produced windmills in San Angelo, Texas, since 1986.[40]

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36 Baker, *Field Guide*, 22-23.
37 Baker, *Field Guide*, 43-44, 116.
38 Baker, *Field Guide*, 114-115.
39 Torrey, *Wind-Catchers*, xi; Manning, “Windmills and Tankhouses in California,” 44; T Baker, *American Windmills*, 29-30.
40 Baker, *Field Guide*, 339; Aermotor Windmill Company, “A History We’re Proud Of,” accessed March 14, 2022, https://aermotorwindmill.com/pages/a-history-were-proud-of.

An interesting side note: The success of Aermotor made a fortune for La Verne Noyes, who put some of his gains into philanthropy. A 1918 publication reported a gift to the University of Chicago of “real estate valued at $2,500,000, the income of which is to be used for the education of soldiers of this war and their children and descendants.” Noyes had “already given to the university the great clubhouse and gymnasium [continued next page]

Anatomy of a Windmill System

Tremendous interest in the history and ongoing operation of windmills has generated numerous publications and organizations dedicated to the subject. Windmills, towers, and pumps have a distinct vocabulary, with some variation in the use of terms between manufacturers, operators, and enthusiasts. The following discussion is based on Aermotor's mill and adopts its terms.[41] A glossary from Christopher Gillis's *Still Turning: A History of Aermotor* is included as Attachment A for reference.

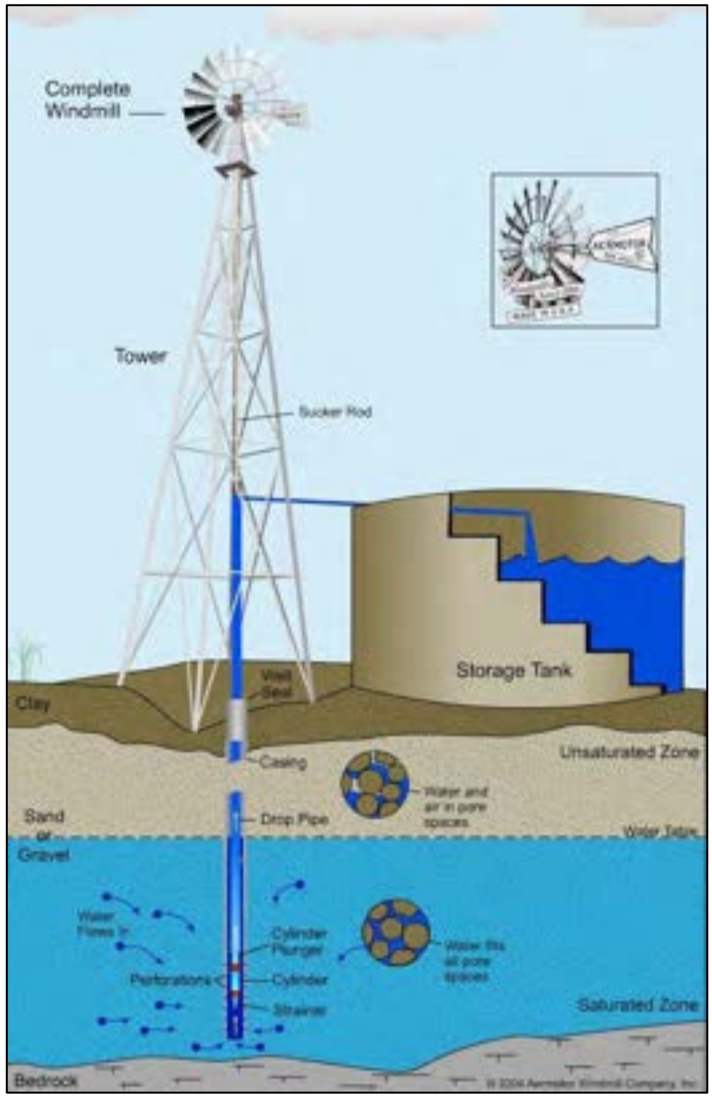


Illustration of "How a Windmill Pumps Water."
(Aermotor Windmill Co. website)

Wind Wheel

The circular wheel is perpendicular to the ground and has blades (also known as sails) contoured to efficiently catch the wind. Braced laterally by two circular, steel rims, the blades are attached to steel arms tied into a central cast-iron hub. The number of blades and their design varied from manufacturer to manufacturer; Aermotor always used eighteen, regardless of the size of the wheel.

Wheels for pumping Aermotors came in diameters ranging from 6 to 20 feet. With a well 50 feet or less in depth, the 8-foot model could supply sufficient water for "200 head of stock" or "twelve to fifteen families," according to a 1905 company publication. A 10-foot wheel provided the same capacity with a 75-foot-deep well.[42]

for women, Ida Noyes Hall (named in honor of his wife), at a cost of more than half a million dollars." ("Illinois," *Journal of Education* 88, no. 8 (September 5, 1918): 220-221, accessed November 14, 2021, https://www.jstor.org/stable/42798687)

[41] Local informants believed the Scandia barn windmill was made by the Aermotor Company, and surviving windmills in the area are from that manufacturer. As a result, this report relies heavily on information related to Aermotor windmills. The information can generally be applied to other windmills of the same era as well. It was only near the very end of the project that salvaged components from the Scandia barn windmill, including the storm casing at the apex of the tower, became available for examination, and still later, after the draft report had been prepared, that the storm casing was identified as part of an Ideal Steel windmill.

[42] Aermotor Company, *Aermotor Applications of Wind Power*, 10.



Baker explained that the Aermotor "wheel consists of curved galvanized sheet steel blades which are riveted to sheet steel wheel clips which in turn are bolted to steel arms which vary in design. The initial Aermotor arms were hairpin-shaped steel bars with trussed support members, but by 1898 these were replaced with V-shaped steel rods with threads on their ends. Once the wheel is assembled on these later wheels, it holds itself in tension somewhat like a bicycle wheel with wire spokes." The wheel's central steel hub had an internal oil chamber and was mounted on one end of the horizontal wheel shaft. The other end was attached to the mainframe.[43]

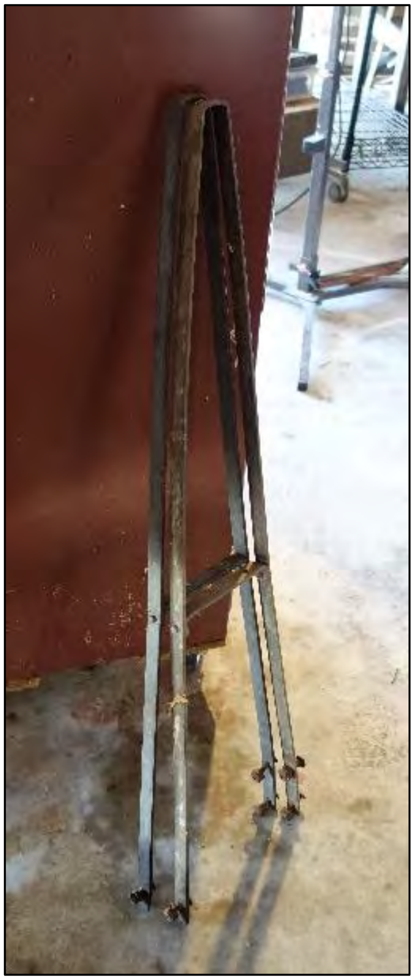
Richter salvaged three windmill sails from the Scandia barn. The sails measure 29 inches long, tapering from about 5-3/4" to 12-1/4" in width. The inner end of each sail is attached to a curved steel bar, with about 6" separating the attachments. Another curved bar bisects each sail about 12" from its outer end.

The bars were secured to V-shaped, 7/8" wide, flat-bar arms. Two arms were salvaged from the barn (see photograph on following page). A complete wheel had six arms to support its eighteen sails. The salvaged arms are about 39" long with bolts (two on one side and one on the other) where they were attached to the hub. The two sides of the V are separated by about 9" at the base, reflecting the width of the hub. A cross brace to support the inner curved bar is about 17" from the hub. The salvaged arms are apparently the "trussed" pre-1898 arrangement described by Baker, which supports a mid-1890s construction date for the barn and windmill.

Left: A section of a wheel comprising three sails attached to inner and outer bands was salvaged from the barn.

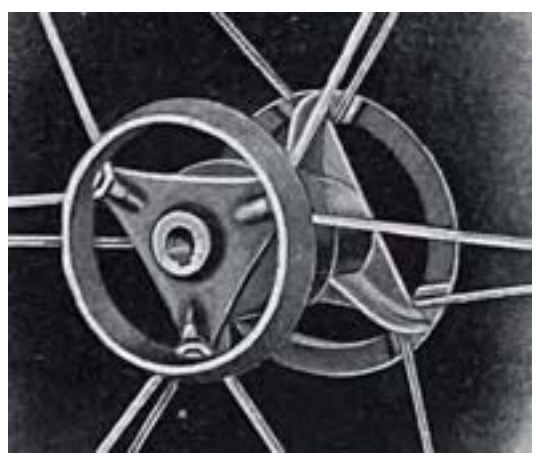
[43] Baker, *Field Guide*, 114; Aermotor Company, *Aermotor Applications of Wind Power*, 10-12.

Aermotor sold replacement parts including units with three sails, raising the possibility that the salvaged section was not installed on the barn mill. Weathering on the salvaged materials, though, suggests that they were used. The dimensions of the blades and arms indicate that the windmill's wheel was 8 feet in diameter.



Above: Two arms of the wheel were salvaged from the Scandia barn. The arms match the wheel arm (Part 32—at the top of the diagram) in a pre-1898 Aermotor catalog. ("Early Bell Hub Parts," http://www.vintagewindmillpartslist.com/id1.html)

Right: The wheel hub was modified in 1898 to the design depicted in this 1905 Aermotor publication. (Aermotor Company, Aermotor Applications of Wind Power*, 11)*



Vane and Tailbone

An early twentieth-century Aermotor motor, tailbone, and vane.(Aermotor Company, Aermotor Applications of Wind Power*, 11)*

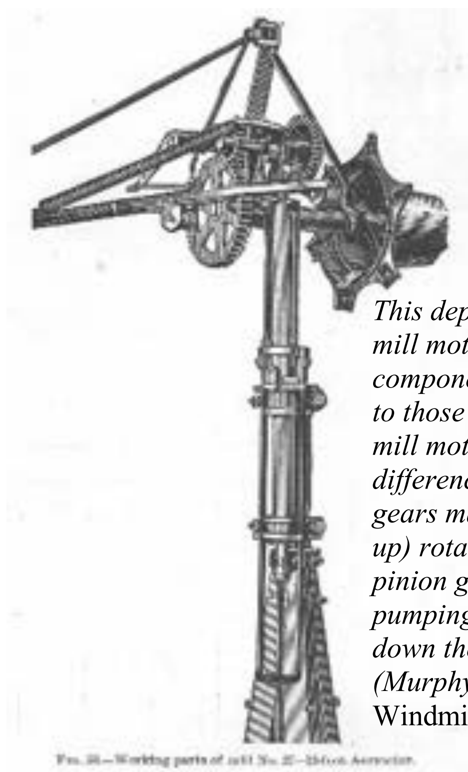
A pennant-shaped sheet of galvanized metal is fixed on a steel tailbone attached behind the wheel. Often bearing the name of the manufacturer, the vane remains parallel to the wind, pivoting as the breeze shifts.

The galvanized steel-sheet vane was supported by a "tailbone" metal stem on a hinge mounting on the back of the mainframe. An Aermotor vane, Baker noted, had "wire beading around its outer edge and . . . a V-shaped brace on one side" and displayed the company's name, stenciled in red."[44]

The vane and tailbone extended behind the shaft and were always parallel to the wind. Their purpose was to keep the wheel turned to the wind.[45]

Motor

Also called the head or engine, the motor contains "all the working parts of a windmill, including the hub and gears, which translate the circular motion of the wind wheel to reciprocating movement of a pump rod." It could be protected by a galvanized sheet-metal cover called a hood or helmet.[46]



This depicts a power mill motor, but the components are similar to those of a pumping mill motor. The primary difference is that power gears maximize (step up) rotations while the pinion gear of the pumping mill steps down the speed. (Murphy, The Windmill*, 87)*

Mainframe (Main casting)

This large, iron casting at the opposite end of the wheel shaft from the hub supports other parts including:

- **Gears: A small pinion gear is mounted on the wheel shaft, driving a large gear that steps down the shaft's rotation to a speed that can be accommodated by a pump.**
- **Rockers or pitmans: Steel arms that are attached at one end to the large gear and at the other end to a bracket connected to the pumping rod. They convert the mill's rotating movement to the up-and-down motion required for pumping.**

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[44] Baker, *Field Guide*, 114.
[45] Aermotor Company, *Aermotor Applications of Wind Power*, 10-12, 14.
[46] Gillis, *Still Turning*, 231.

- **Bearings: Also called boxings or journals, bearings minimize friction between two moving parts but require lubrication.**
- **Mast pipe: runs from the base of the mainframe to the top of the tower. The windmill rotates on a bearing at one end of the mast pipe.**
- **On self-oiling models, the mainframe encapsulates the lubricant.**

The back-geared design, with a smaller pinion gear turning a larger gear, "gives the pump a long, easy stroke instead of the short, quick, and jerky stroke of a direct-stroke mill in high winds," Baker explained. In addition, it "divides the work of the mill between two shafts and generally four bearings instead of a single shaft and only two bearings. On the direct-stroke mills the load of the wheel is borne on the front end of the shaft and its bearing, while the load of the pump is on the other end. On the new mills the weight of the comparatively light steel wheel and pinion gear is carried on one shaft, with the load of the pump being thrown to the slowly revolving shaft caring the larger crank gear."[47]

An innovation adopted by Aermotor and other manufacturers by the late 1890s was "double-gearing"—having two pinions on the wheel shaft, each linked to a larger gear and both powering the pumping rod. This arrangement was more durable and ran more smoothly. With either the single- or double-geared design, mills needed a mechanism to convert the wheel's rotary motion to vertical to operate a rod that connected to a pumping cylinder in a well. Manufacturers offered a number of alternatives. A popular design featured a pitman running from the large gear to a crosshead, which moved vertically on steel guides and held the pump rod. On Aermotor mills, the pitmans were attached to rocker arms instead of a crosshead.[48]

A component salvaged from the Scandia barn is stamped "327." An Aermotor catalog published in about 1906 listed Part A 327 as "Chain Roller, plain, for A 202." ("A" indicated an 8-foot wheel.) Part A 202, which weighed 36 pounds, 8 ounces, was listed as "Main Casting (used on '98 model only)." Assuming Part 327 was from the barn's windmill, it indicates that the windmill motor dates from 1898. Since the wheel is of an earlier design, it appears that Frank Lake responded to Aermotor's announcement of an improved motor design in 1898 and replaced his earlier motor, retaining the windmill's other original components.[49]

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[47] Baker, *Field Guide*, 37-38.
[48] Baker, *Field Guide*, 38-39.
[49]Aermotor Company, "Parts List for All Pumping Aermotors," n.d, http://www.vintagewindmillpartslist.com/id1.html. The list for replacement parts for a 10-foot wheel has a main frame number B 202, for the 1898 model only, but not a corresponding part B 327, reinforcing the likelihood that the Scandia mill had an 8-foot wheel.

Pump rod/sucker rod

The pump rod transmits the up-and-down motion from the motor to sucker rods, which extend to the pumping cylinder in the well.

A swivel casting connected the upper end of the pump rod to the motor, and the base of the rod was attached to a series of sucker rods. Pump rods and sucker rods were made of wood or steel. If the motor or pumping cylinder became jammed, the less expensive poles were designed to be sacrificial, the weakest element that would break first and prevent greater damage to the other components. Sucker rods came in segments that were screwed together to reach an appropriate depth in the well for the pumping cylinder. The pumping cylinder's plunger valve was connected to the bottom of a sucker rod.[50]

A wood pole salvaged from the Scandia barn (photographs below and to the right) appears to be a pump or sucker rod with splice straps.

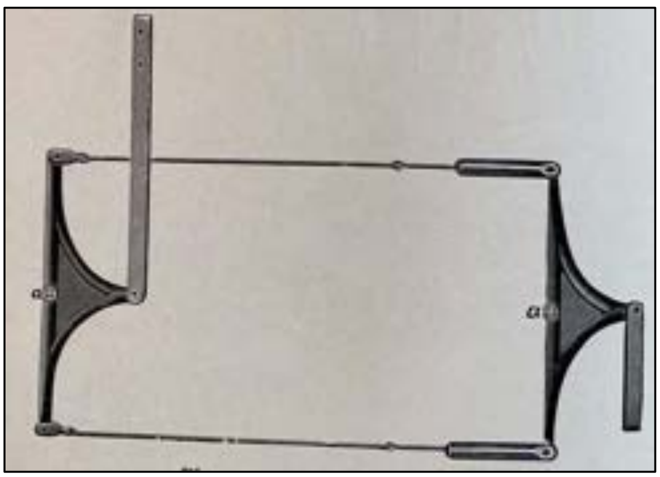
[50] Baker, *Field Guide*, 18.

Triangles

Pump poles usually run vertically from the motor to the sucker rods. If obstructions—like a water tank—block this direct connection, pairs of triangular metal plates, connected by two strong wires, transfer this energy horizontally between vertical shafts.

A pumping triangle was salvaged from the Scandia barn. A catalog for Monitor windmills gives a good description of the function of this mechanism: "These triangles are used for operating a pump at a distance from a windmill and should always be set as show in the cut [see illustration below]. The points marked 'A' should be firmly stayed so that the draw of the wires will not move them. If the distance is short, they may be bolted between two pieces of two by six and these firmly stayed in the windmill tower and over the pump."[51]

The tank was directly below the windmill in the Scandia barn, so the sucker rods had to either go through the tank or, with the aid of pumping triangles around it. The salvaged triangle is attached to a sturdy timber that was located in the tower attic. Available photographs do not clearly show where the rod passed through the ceiling and floor of the tank room.

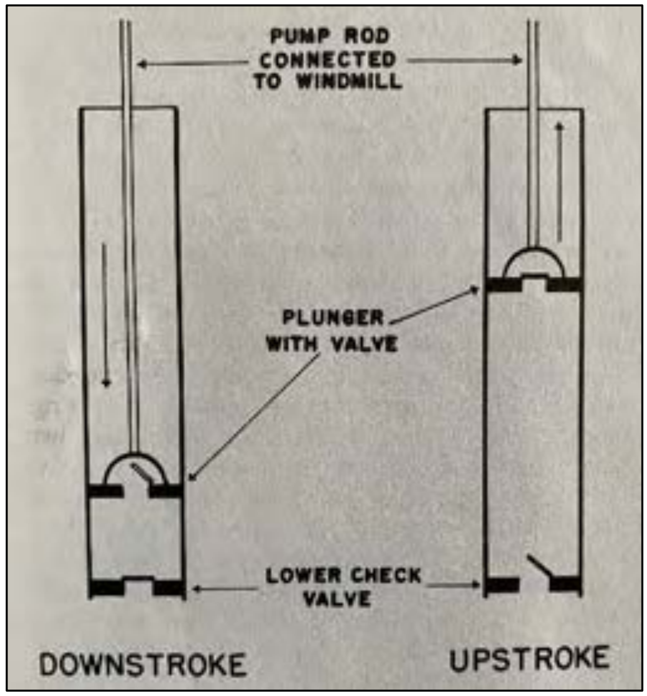


The illustration to the left is from a catalog for Monitor windmills. (Baker Manufacturing Company, Monitor Windmill Catalogue No. 50*, 44)*

[51] Baker Manufacturing Company, *Monitor Windmill Catalogue No. 50* (Evansville, Wisc: by the company, n.d.), 44.

Pumping cylinder and pipes

The pumping cylinder, which encloses the piston, is usually made of brass with leather valves at each end. The drop pipe supports the pumping cylinder, protects the sucker rods, and delivers water from the well for immediate use or storage.



NAME	ALL BRASS	BRASS BODY	BRASS LINED	CAST IRON
Caps	Brass	Iron	Iron	Iron
Body	Brass	Brass	Br. Lined	Iron
Plunger Cage	Brass	Brass	Brass	Brass
Plunger Follower	Brass	Brass	Iron	Iron
Plunger Poppet	Brass	Brass	Brass	Iron
Plunger Rings	Brass	Brass	Iron	Iron
Check Cage	Brass	Brass	Brass	None
Check Poppet	Brass	Brass	Brass	Iron
Check Valve	Rubber	Rubber	Rubber	Leather
Valve Seat	Brass	Brass	Brass	Brass

Top: Diagram of pumping cylinder (Baker, Field Guide*, 19)*
Bottom: Pumping cylinders (Aermotor Company, Aermotor Applications of Wind Power*, 37)*

"Although great variety exists in the types of valves used in [pumping cylinders], their principles remain the same," Baker observed. "The cylinder, which extends vertically into the water table at the base of the drop pipe, is fitted with a check valve in its lower end. Inside the cylinder, usually made from brass, a plunger, actuated by the sucker rod, moves up and down like a piston. The plunger is also fitted with a valve. When the plunger moves down, the valve in it opens and the check valve in the bottom of the cylinder closes. Then when the plunger reverses direction and rises, its valve closes and the check valve at the base of the cylinder opens. As this cycle continues in sequence, the cylinder forces a column of water to the surface for immediate use or storage. In installations in which a mechanism known as a 'packer head' or 'stuffing box' is used, the water can be forced under pressure through pipes to a more distant and perhaps higher point."[52]

Selecting the right-sized cylinder and related piping was important for an efficient operation. Because "the piston travel of a pump operated by an Aermotor on its longest stroke is about ten inches per second, . . . if a 3-inch cylinder delivers water through a 1-1/4-inch pipe, the water must travel at the rate of five feet per second through the pipe. If a 1-inch pipe were used,

[52] Baker, *Field Guide*, 18-19.

the velocity of the water in the pipe would be eight feet per second in the pipe."[53]

"Pumping Aermotors are designed to take advantage of light winds and to regulate off at the highest speed at which it is safe to operate the pumps," the company explained. "Hence, we advocate pump cylinders of small or moderate size, piping at least half the size of the cylinder, between the cylinder and the pump stand when steel pump rod is used, or equal to the diameter of the cylinder if wood rod is used. Pump stands or pump heads should have large free passages, and if water is to be forced some distance into a tank or reservoir the pipe should be at least two-fifths of the diameter of the pump cylinder. If water is to be forced more than 200 feet through line pipe, use pipe one-half of the cylinder diameter; if 500 feet, use the next larger size."[54]

Aermotor stated that "water may be delivered into a tank and withdrawn by the same piping, even when the flow into a tank is . . . regulated by a float valve [see Regulator section below]. A reversed check valve prevents the water from entering the tank except through the float valve, while it permits the water from the tank to flow into the pipe, even when the float valve is closed." The company encouraged installation of brass expansion joints on pipes running to elevated tanks "to prevent leaks in strained joints."[55]

Hand pump

Hand pumps allow water to be taken directly from the well if more convenient than the tank. They are also invaluable if the tank runs low when the wind is calm for an extended period.

A 1905 Aermotor publication explained that its "pump standards are built on the interchangeable plan. A dealer having an assortment of four styles of standards, four styles of tops and five styles of spouts can in a moment make up any one of the innumerable styles of pumps that he may be called upon to furnish."

The Scandia barn likely had a hand pump, but no documentation of its design or location could be found. Other examples of hand pumps are extant in Scandia.

Vincent Maefsky with a hand pump beneath the Aermotor windmill at his Scandia farm, Poplar Hill Goat Farm, 12521 Mayberry Trail North.

[53] Aermotor Company, *Aermotor Applications of Wind Power*, 8.
[54] Aermotor Company, *Aermotor Applications of Wind Power*, 8.
[55] Aermotor Company, *Aermotor Applications of Wind Power*, 40.

Well

An opening dug or drilled to the water table and lined with a casing to prevent the walls from collapsing.

A well was an integral part of a pumping windmill system and usually installed first. Early wells were dug by hand, sometimes with the aid of an auger, limiting their depth to around 30 feet. For another hand-drilling method, a pipe with a drive point and strainer was pounded into the ground, with sections added until the pipe reached the water table. To maintain stability, well walls were lined with stone, brick, or, later, concrete.

By the late nineteenth century, technology to drill deeper wells was powered by horses, which "walked in a circle around a mechanism that connected by way of gears and a shaft to the drilling rig. The rig repeatedly raised a heavy metal drill bit and then let it drop to peck a hole in the ground one blow at a time."[56]

Above: Drilling well on Hogswen Farm at Sioux Agency, ca. 1915 (Minnesota Historical Society)

Left: Drilling well to set up Dempster windmill, ca. 1915 (William L. Bostock, photographer; Nebraska Historical Society)

[56] Webb, *The Great Plains*, 334-335; Gillis, *Still Turning*, 13-14.

Towers and tankhouses

Most windmills are mounted on three- or four-legged towers that sometimes incorporate water tanks. Tanks are also found in freestanding structures or inside houses and barns. The well is usually located a few feet outside of these tankhouses with the windmill directly over the well. It is more unusual for a windmill to be installed on top of a tankhouse.[57]

Towers were initially made of wood but by the twentieth century were usually galvanized steel, prefabricated by windmill manufacturers. Steel towers are made of a number of simple, individual bars, angles, rods, and other components, either built up from the ground or assembled on the ground horizontally, then raised up. Gin poles helped lift the wheel to the top of a tower. Ladder rungs attached to a tower leg enabled workers to reach the apex.[58]

Wood or steel towers could hold tanks for water storage. In warmer climates, tanks could be exposed to the elements. Even in temperate areas, though, where tanks did not necessarily need an enclosure to keep water from freezing, aesthetic and functional considerations led people to build tankhouses. A noteworthy concentration of tankhouses in California has resulted in two major studies, a master's thesis completed by Roger Stanley Manning in 1969 and a well-illustrated book published by Thomas Cooper in 2011.[59]

In *Field Guide to Windmills*, Baker noted that "especially in the Midwest during the late nineteenth and early twentieth centuries, owners of windmills often enclosed their wooden towers for a variety of reasons. Most frequently the enclosed derrick served an additional role as a well house or as a shelter for cooling troughs to refrigerate food during the summer. Other users built additions to their barns in order to mount mills above their roofs, thus avoiding the need to erect separate towers. Most of the barn-top mills pumped water into elevated tanks in the attics of the buildings, from which it flowed by gravity to the other parts of the farmstead. Inside the barns the reservoirs were protected from freezing by the constantly rising heat of the livestock in the stalls below."[60] Manning concurred that "the primary function of the tankhouse was to provide the rural household with a relatively pure domestic water supply throughout the year." In addition, tanks maintained a ready supply of water to fight fires and could be used to water gardens.[61]

A substantial structure was needed to support an elevated water tank, which could hold 3,000 to 5,000 gallons when filled. Bergson noted that the Scandia barn's tower "may have contained a water tank as evidence indicates a heavy load being supported in the hay-loft space with timber cribbing below and heavy framing support adjacent and around" the tower. He adds, "There is a pipe (possibly 1" or more in diameter) that is installed within this space that may have been used to fill the water tank."[62]

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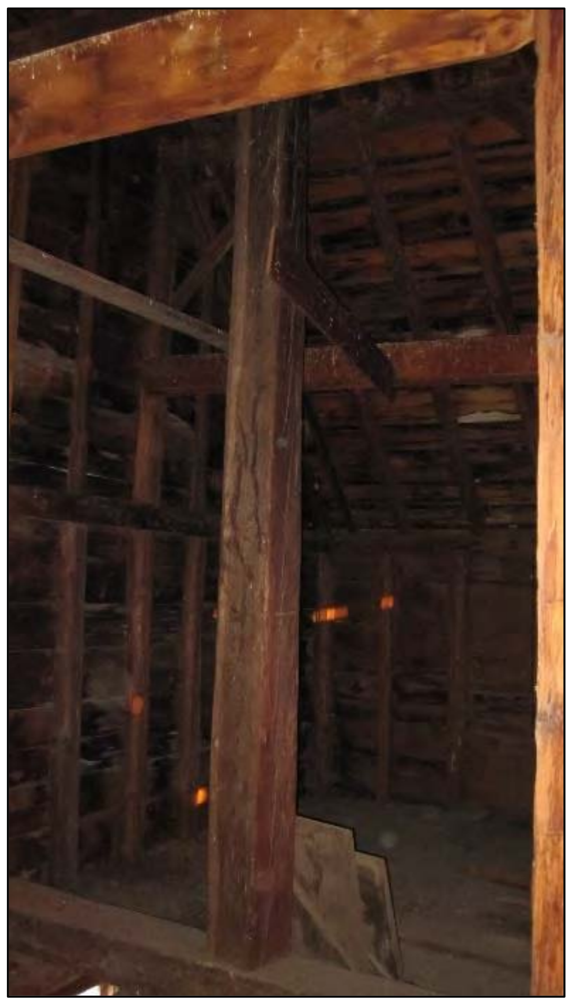
57 Manning, "Windmills and Tankhouses in California," 111.
58 Baker, *Field Guide*, 94-96.
59 Manning, "Windmills and Tankhouses in California"; Thomas Cooper, *Tankhouse: California's Redwood Water Towers from a Bygone Era* (Santa Rosa, Calif.: Barn Owl Pres, 2011).
60 Baker, *Field Guide*, 98-99.
61 Manning, "Windmills and Tankhouses in California," 91.
62 Manning, "Windmills and Tankhouses in California," 101; Bergson, "Inspection and Evaluation of the Hilltop Water Company Barn."

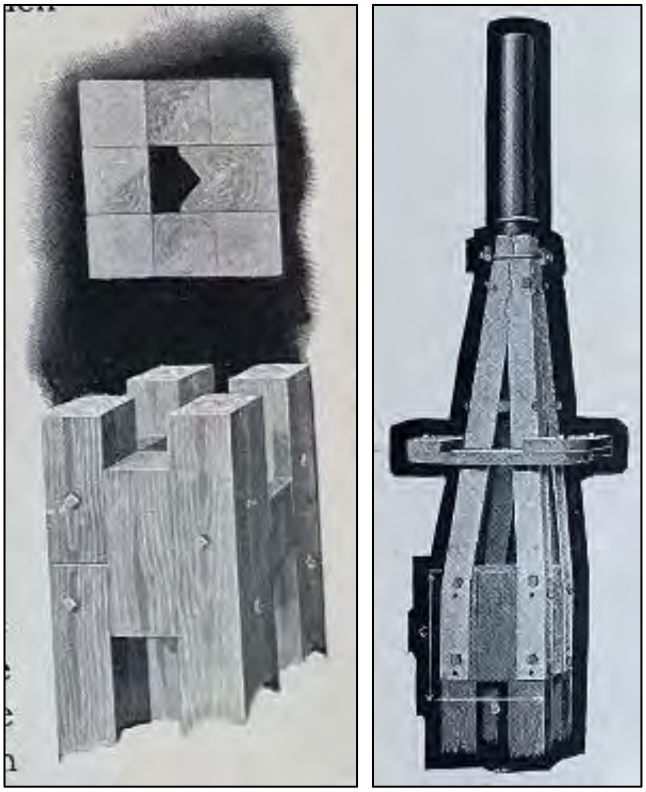
Left: The structure supporting the tank room was visible when the barn was disassembled. (Curt Richter photograph)

Below: The ladder going up to the tank room door (left) and the post below the center of the tank room (right). (Paul Bergson photographs)



Mast and platform

A mast supports a windmill on a structure other than a standard tower. It must be strong enough to carry the weight and resist the wind and must allow for the pump pole's vertical movement. A small platform near the top of the tower or mast, usually of wood even on steel towers, provides footing for those installing and maintaining the windmill.



Wood mast (left) and steel stub tower mounted on wood mast (right). (Aermotor Company, Aermotor Applications of Wind Power*, 15, 47)*

Aermotor offered to provide "plans for ornamental structures for supporting tanks and Aermotors . . . to purchasers who desire to build more expensive structures than we manufacture." Other companies also had various options for towers. There is no indication, though, that a windmill manufacturer designed the Scandia tower, which was likely the result of a design-build collaboration between Frank Lake and local craftsmen.[63]

The mast supporting the mill was similar to that described by Aermotor for the installation of a power mill on a barn. Aermotor recommended "a 4-post mast, . . . made of dressed 4-inch by 4-inch timbers for 12- and 14-foot mills, and of 6-inch by 6-inch timbers for 16-foot mills. Block the same size as the mast timbers is used to space the timbers every 4 feet where the bolts are placed." The mast should extend above the ridge of a barn by 12 feet for mills with 12- to 14-foot wheels. Attached to the top of the timber mast was a steel stub tower, which "gives the advantage of the celebrated Aermotor notched tower top and reduces the wind obstructions to a minimum behind the wheel."[64]

Because the Scandia tower held a tank, it was a more substantial structure than a simple enclosure around a mast, "a cupola with a roof sloping just enough to shed the rain." Aermotor explained that to erect a mast in that situation, "the mast is usually assembled on the barn floor; the bent steel stub tower and assembled motor are then attached, an opening is made through the roof and the mast raised to position with block and tackle." The Scandia installation might have followed that process or been hoisted into position from outside the barn.[65]

[63] Aermotor Company, *Aermotor Applications of Wind Power*, 28.
[64] Aermotor Company, *Aermotor Applications of Wind Power*, 15-16, 47.
[65] Aermotor Company, *Aermotor Applications of Wind Power*, 16.

The Scandia mast and platform are in red on the drawing above. The mill might have been attached directly to the mast, or to a metal stub tower as mocked up above by inserting a sketch of an Aermotor stub-tower at the top of the mast (not to scale). Richter noted that mast connections were bolted, not screwed. (Curt Richter deconstruction photographs and drawing; stub tower drawing from Aermotor Company, Aermotor Applications of Wind Power*, 47; photographs of plate by author)*

Richter found this round metal plate (top left) nailed to the top of the Scandia barn mast. The plate's underside (top right) has grooves that could accommodate metal tower legs. Mark Henry of Midwest Windmill Company, Kirksville, Missouri, identified the plate as a storm casting from an Ideal Steel pumping windmill. In an undated Ideal Steel parts list, the item is illustrated as "A-16" (bottom left), a "Combination Base Plate" (http://vintagewindmillpartslist.com/id16.html). A casting of this type is visible in a photograph (bottom right) of an Ideal Steel windmill (windmill-parts.com). The discovery of this casting on the Scandia mast supports the theory that an Aermotor windmill replaced an earlier windmill on the barn.

Metal towers had metal loops attached to one tower leg to serve as a ladder for the person charged with oiling the mechanism. The ladder ascended to a platform below the mill. Aermotor sold a square wood platform notched on one corner, which was oriented over the ladder to make the platform more easily accessible. Lester Rydeen's windmill in Scandia (13140 205th Street North, photograph below right) displays this type of platform.

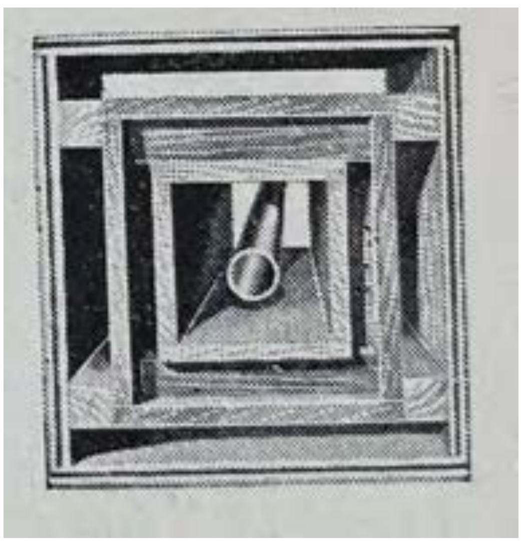
The Scandia barn had a more ornamental platform supported by brackets. There is not a clear indication of how the platform was accessed. Richter discovered metal loops in a wood box stamped "Scandia M[illegible]" and Copas, Minn." in the barn, but this type of ladder was not used on a wood structure. It seems likely that the roof of the barn's tower had a hatch close to the base of the platform and that the platform had an opening directly above the hatch. A photograph taken during deconstruction shows what appears to be an opening filled with a board on the platform's south side. This location makes sense because it would be the most protected from the prevailing north-northwesterly winds, particularly a factor in winter. Richter said the platform was made of wood, the diameter was about 6'–9", and the surface was flat.

Top right: Standard platform (Aermotor Company, Aermotor Applications of Wind Power*, 19)*
Center right: Lester Rydeen's Aermotor windmill and platform.
Lower right: Metal ladder loop and shipping box found in Scandia barn.
Below: South (left) and east (right) slopes of tower roof. What appears to be an opening was on the platform's south side. (Curt Richter photograph)

Tank room

The pump filled a tank in the tower. In California, "The tank story . . . has air vents, commonly small and louvered although sometimes ventilation was provided by a gap between the roof and the walls, which was screened to keep birds and insects out."[66] In Minnesota, keeping the tank from freezing was a higher priority than ventilation.

To insulate the Scandia tank room, the builders might have adapted Aermotor's instructions for making frost boxes to protect pipes. The instructions use the nautical term "ceil," which is "to furnish (something, such as a wooden ship) with a lining" according to Merriam-Webster. The first step in creating a frost box was to "build a box around the pipe"—or in the case of the barn, the tank room—and "ceil this box with tarpaper on the outside, then run trimmers around this box to carry another box around the first one, leaving a two-inch air space. This second box may now be ceiled with tarpaper; another two-inch air space is allowed for, and the third or outer box is put on of matched boards or shiplap, allowing a two-inch air space as above."[67]



Top left: Section drawing of a frost box. (Aermotor Company, Aermotor Applications of Wind Power*, 53)*
Left and above: A similar method was used to construct a "frost box" around the tank room. The structure was exposed during the disassembly. (Curt Richter photographs)

[66] Manning, "Windmills and Tankhouses in California," 105.
[67] Aermotor Company, *Aermotor Applications of Wind Power*, 53.

Richter believed the Scandia tank room walls were about 11'-4" long on the interior about 12' long on the exterior, but those dimensions are not exact. Photographs taken during the deconstruction show a multilayered structure that incorporated tarpaper.

A low opening below the ridge of the barn's gable roof provided access to the tank room. Because heat rose from animals in the barn, less insulation was provided at that opening, which was outfitted with a makeshift beadboard door.

From the tank room, someone tasked with lubricating the mill had to climb through a trap door in the ceiling to reach the attic below the roof where the controls were located. From there, it was another climb, this time through a panel in the roof, to get to the platform below the mill.

The tank room door (top) was below the barn roof's ridge (center). A trap door in the tank room's ceiling (right, top arrow) led to the control room beneath the tower's roof. The purpose of an opening high in the tank room's north wall (bottom arrow) is not known. On the exterior, the clapboards do not show any indication of an opening in this location. (Curt Richter photographs)

Sheets of galvanized metal with standing seams covered the tank room floor. These photographs were taken from the tank room doorway facing north before (left) and during (right) disassembly. (Photographs by Paul Bergson, left, and Curt Richter, right)

Aermotor encouraged the installation of "an open wood or galvanized steel tank . . . in the attic of a house or barn," but warned that it "should always be provided with an overflow pipe, and should rest in a galvanized iron tank pan to prevent damage to the building in case of accidental leakage or overflow." The builders of the Scandia barn concurred, installing a galvanized-metal, standing-seam floor in the tank room. Bergson noted "a pipe (possibly 1" or more in diameter) that is installed within this space" and speculated that it "may have been used to fill the water tank." It could also have been an overflow line.[68]

In addition to supplying water for domestic use, tanks met other needs of the household and community. This was also the case in Scandia, according to the McGinleys. "The boom high on the north side of the water tower allowed a horse-drawn water wagon—a huge wooden barrel on spoke wheels—to pull up underneath to fill and haul fresh water throughout the area. The driver made deliveries to the homes and farms in the area and would fill the cisterns of those without wells." In addition, the water wagon was outfitted with a sprayer to reduce dust from the dirt roads, and the tank also supplied wagons of the local fire department. [69]

The use of horse-drawn water tanks to reduce dust in other Minnesota communities has been documented, and it is plausible that this occurred in Scandia. The wheeled tanks would have been filled on the north side of the water tower, the only side that would have been readily accessible. The clapboard on the tower's exterior, though, showed no sign of an opening for a spout, and a spout would have been exceptionally long to stretch from that elevation to the height of a wagon (see images on next page). Typically, tank spouts were only slightly inclined when delivering water. On the interior, the north wall of the tank room has what appears to be a filled-in opening (see photograph on previous page), but it seems too high to allow water to flow from the tank by gravity unless the tank was quite full.

[68] Manning, "Windmills and Tankhouses in California," 101; Bergson, "Inspection and Evaluation of the Hilltop Water Company Barn."
[69] McGinley, "Frank J. Lake," Part I.

Above: Bemidji Street Department's horse-drawn water tank, ca. 1948 (Minnesota Historical Society)
*Top right: Tank with spout from catalog of W. E. Caldwell Company, 1906 (*Tanks, Towers, and Tubs*, 17, Northwest Architectural Archives, University of Minnesota)*
Bottom right: Railroad water tank with raised spout to right, circa 1896. (Minnesota Historical Society)
Below: A cable (perhaps from a lightning rod; highlighted with an arrow) bisects the north (left) side of the tower, but the clapboards show no sign of an opening.

Controls

The relationship of the wheel and vane modulates the mill's speed. A spring effectively governs the wheel under normal wind conditions. A brake or a furling device allows the mill to be stopped if winds became excessive or if pumping is not needed. In setups where water is stored, a float can activate a regulating device to automatically control operation of the windmill.

Windmill design was a balance between taking advantage of a light wind and avoiding destruction from a gale. A report published by the U.S. Geological Survey in 1901 emphasized that wind was a fickle power source, "constantly changing in velocity as well as in direction, and if the load on the mill is constant the speed of the mill and of the [pump] which it operates will change with it. If the speed is to be kept nearly constant, some device is needed to reduce the wind pressure on the wheel when the wind velocity reaches a certain amount."[70]

TABLE OF VELOCITY AND FORCE OF WIND IN POUNDS PER SQUARE FOOT.

Miles per hour.	Feet per second.	Force per sq. ft. in lbs.	Common Appellation.
1	1.47	0.005	hardly perceptible
3	4.4	.02	gentle pleasant breeze
7	10.2	.24	fair breeze
14	20.5	.50	fair wind
16	23.45	1.25	brisk wind
20	29.3	1.97	AERMOTOR regulating wind
25	36.6	3.	
30	44.01	4.4	
35	51.34	6.03	very brisk wind
40	58.7	7.87	high wind
50	73.8	12.3	very high wind
60	88.	17.7	storm
70	102.5	24.1	great storm
80	117.4	31.5	hurricane
100	140.	50.	tornado

Aermotor Company, Aermotor Applications of Wind Power*, 64.*

To control speed, the large blades of the European mills could be furled to reduce the area exposed as wind velocity increased, with the process reversed as the velocity dropped. This was not practical with the numerous small blades of an American mill. There was, though, another feature of the European mills that American manufacturers adopted, the ability to pivot towards or away from the wind. Many American mills, including Halladay's, had "sections of the wheel revolving about an axis which places each sail at an angle to the direction of the wind less than 90^o."[71]

Aermotor took another approach, "placing the axis of the wind wheel eccentric to the axis of the tower, so that the wind pressure on the wheel will cause it to revolve around the axis of the tower." In other words, the wheel was mounted slightly off-center from the vane and, because the wheel and vane were not rigidly connected, the wheel naturally turned away from a rising wind. As less of the blade surface was oriented to the wind, the wheel maintained a relatively steady speed. The rotation around the axis was counterbalanced by a spring connecting the wheel and vane, which pulled the wheel back into the wind as the wind's velocity decreased. The 1901 study, which tested pumping and power mills from a number of manufacturers, found Aermotors to be the most efficient of the lot. The study did, though, criticize the mill's use of a spring rather

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[70] Edward Charles Murphy, *The Windmill: Its Efficiency and Economic Use, Part II*, Water-Supply and Irrigation Papers of the United States Geological Survey, No. 42 (Washington, D.C.: Government Printing Office, 1901), 142.
[71] Murphy, *The Windmill, Part II*, 142.

than a weight as a counterbalance for the wind wheel. "The tension of a spring cannot readily be changed when desired but may gradually lose its tension."[72]

In a 1905 publication, Aermotor asserted: "If well erected, an Aermotor outfit will take care of itself, whether furled or working, in any straight wind less than a tornado." If the wind became too strong for safe operation or pumping was not needed, though, the mill could be manually stopped with a furl wire. When pulled, the wheel turned parallel to the vane and was no longer caught by the wind. A brake on the hub stopped the wheel from twisting to the point where wind would hit its back.[73]

Windmill systems with a tank could be equipped with an automatic regulator to stop and start pumping as the water level rose and fell. The regulator was controlled by a float in the tank. Aermotor offered floats made of copper or galvanized iron. As a catalog for Monitor windmills explained, the regulator turned the "mill into the wind when the water in the supply tank gets below a fixed limit, and it throws the mill out of the wind when the height of the water reaches a certain point," preventing the tank from overflowing. Not only did a full tank provide a ready supply of water but the wood staves were less prone to leaking if saturated. The regulator had a rack and pump pole lever with a "dog" that operated the notched bar. Monitor advised: "Always place the regulator in corner of tower nearest to float in tank, and arrange the mill so that the regulator occupies the corner of the tower otherwise used for the pull-in lever."[74]

Examples of regulating mechanisms follow.

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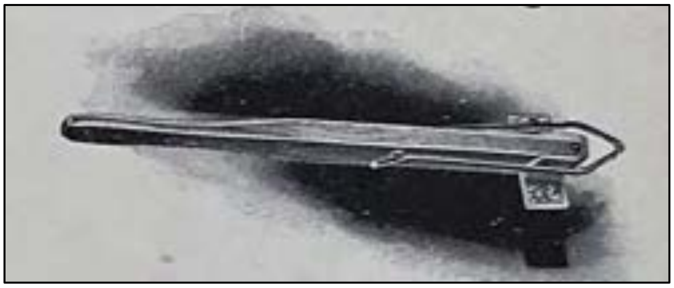
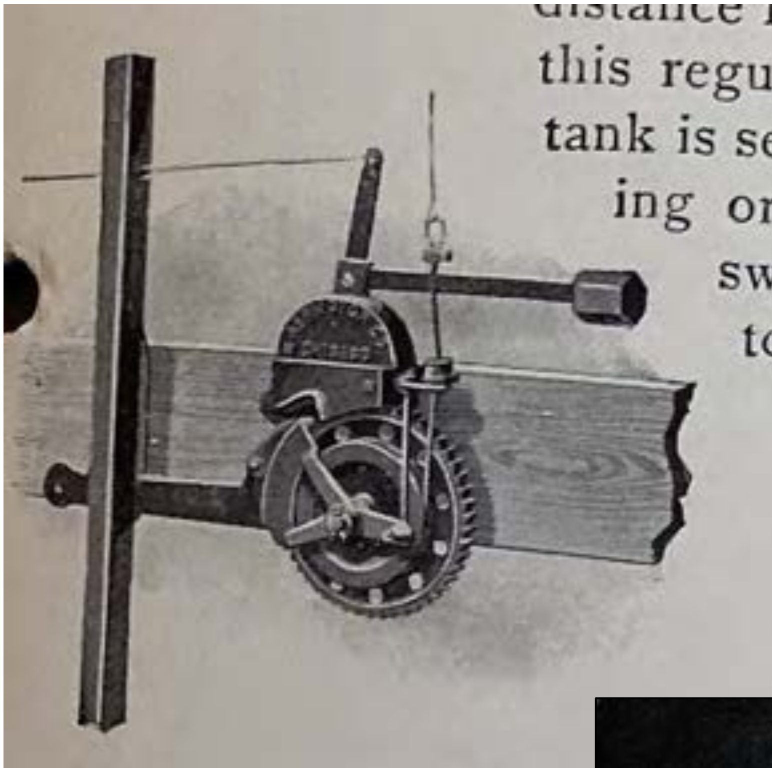
[72] Murphy, *The Windmill, Part II*, 142; Baker, *Field Guide*, 38.
[73] Aermotor Company, *Aermotor Applications of Wind Power*, 11-12, 14, 64.
[74] Baker Manufacturing Company, *Monitor Windmill Catalogue No. 50*, 43.



Left: Illustration of a furl handle. (Aermotor Company, Aermotor Applications of Wind Power*, 64)*

Left: The wood furl handle on the windmill at Vincent Maefsky's farm.
Below: Items salvaged from the Scandia barn that might have been associated with the mill's furling mechanism or float..



Left: An automatic regulator used with a float. (Aermotor Company, Aermotor Applications of Wind Power*, 64)*

Below left: A salvaged mechanism, perhaps a regulator that controlled the float in the tank. A label cast into the casing reads: "6-8-9-10 Ft. Mills."

Below: Photographs of the tank room with a galvanized-metal float. (Paul Bergson, top; Curt Reichert, bottom)

Above: Some mechanisms in the tower attic as they appeared during the barn's deconstruction. The metal bars in the left photograph were attached to a mid-twentieth-century "Monitor" power-driven operator (see "Other Salvaged Equipment" section).

Below: This component, probably part of a control mechanism for the first mill on the tower, was produced by the "Stover Mfg. Co., Freeport, Ill. U.S.A." The Stover Manufacturing Company was established in 1881 and manufactured barbed wire and agricultural equipment. It introduced the Ideal Solid Wheel mill, which had a wood wheel, in 1883 and the Ideal Steel windmill in 1892. The firm was consolidated into the Stover Manufacturing and Engine Company around 1916. (Baker, Field Guide*, 298-301)*

Tank

The most durable woods for the staves and base of a tank are cypress and redwood. A more economical alternative is white pine, which is also long-lasting. Galvanized-steel hoops secured the staves. The distance from the water's natural elevation to the elevation where it is pumped is known as the head.

In addition to windmills, the Aermotor Company sold tanks made of cypress, pine, and steel. Wood tanks were available from 4 to 24 feet in diameter and 2 to 24 feet in height. They were ringed by galvanized, flat, steel hoops secured with steel, single-bolt lugs. The company also provided covers in wood and steel. It recommended that "every storage tank set up in a house or barn should have a cover, a large overflow pipe protected from frost, and a galvanized steel tank pan under it" to catch condensation that "could be drained off without damaging floors and ceilings." When installed, "Wood tanks should always rest on joists or sills under the bottom of the tank. None of the weight of the tank should be allowed to come on the ends of the staves which extend below the bottom."[75]

Wood tank with steel hoops. (Aermotor Company, Aermotor Applications of Wind Power*, 27)*

As with windmills, some assembly was required for the tanks. "In putting the tank together the staves should be driven up to the bottom until the bottom completely fills the chime, and the staves should be snug up to each other when so driven up. *You should not trust to the hoop drawing the staves up onto the bottom;* they must be driven up before the hoop is put on. If you have not made the tank tight and got the staves in place before you put the hoops on, you will never get it tight. The hoops are there to hold the tank in place—the swelling of the lumber will do the rest."[76]

The tank in the Scandia barn's tank room was apparently removed long ago but, as mentioned above, the room had a galvanized-metal floor covering as Aermotor recommended.

The means of distribution and the facilities that received water from the tank are not documented, but it seems reasonable to assume that the system served the Mercantile and Lake's house and perhaps other buildings in the vicinity. Scott Kaiser reported that when Hilltop Water Company replaced underground water pipes to homes and businesses associated with the Water Tower Barn in the late twentieth century, they found some old wood pipes still in use. Water flowed through a linear, cylindrical opening bored inside a pipe. Pipe sections were about 8 feet long. He noted that sections of wood pipe exist in the basement of the Mercantile, reused as structural supports.

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[75] Aermotor Company, *Aermotor Applications of Wind Power*, 27-28.
[76] Aermotor Company, *Aermotor Applications of Wind Power*, 28.

Other salvaged equipment

Items illustrated below were salvaged from the barn and appear to date from the late nineteenth or early twentieth centuries, but most had no identifying marks and their function was difficult to determine. Information on two mid-twentieth-century items is on the following page.

Left: The number on the lever is difficult to read. The other piece, a metal plate, was not labeled.

Richter salvaged these items from the tower's attic, above the tank room. The patents noted on the "Monitor" piece were filed in April 1951 for a "motion converting mechanism" and a "power-driven operator." The Fairbanks-Morse "Type C-39 No. 8 D.W. Head" probably dates from the same period.

This equipment was part of the water supply system after the windmill's removal. The windmill was apparently gone by the 1940s, so the water supply system must have been served by another generation of equipment between the time the windmill was removed and the salvaged pieces were installed.

Conclusions

The Barn's History

Historical information on the barn is limited. Conditions documented before the building was disassembled and items salvaged from the building do not present a complete or consistent story. Nevertheless, some conclusions seem warranted.

Lake bought the barn site in September 1895, during harvest season and shortly before the onset of winter. Assuming he built the barn soon after acquiring the property, construction could have been completed that fall or the following year. Some of the material for the barn was recycled from another structure. The barn's construction sequence remains a matter of debate. The argument for the west section being a later addition is bolstered by the preponderance of hand-hewn timbers in the east section and milled lumber in the west section, as well as the appearance of cut nails in the east section and wire nails in the west section. On the other hand, the treatment of the rafters in the area where the east and west sections join suggests that both were built at the same time. This hypothesis is also supported by the exterior purlin brackets, rafter tails, and clapboard siding, and it seems the most viable.

Salvaged materials related to the windmill and water supply system leave many questions, including whether or not these materials were installed as part of the system or were simply stored in the barn. Several items described in the previous section—the Ideal Steel storm casting, Stover Manufacturing Company casting, Aermotor wind wheel arms and blades, and Aermotor Part 327—reinforce a mid-1890s construction date for the barn but suggest conflicting narratives about the barn's windmill.

Top to bottom: Ideal Steel storm casting, Stover Manufacturing Company casting, Aermotor wheel arms and blades, Part 327

The salvaged Aermotor parts were produced in different years. The wind wheel arms were made prior to 1898 while Part 327 came from an 1898 motor. In the absence of the Ideal/Stover parts, this might indicate that the original windmill was an Aermotor, and that this mill's motor was replaced when an improved model was introduced in 1898.

Based on Richter's discovery of the Ideal Steel storm casting on the top of the tower, though, it appears that an Ideal Steel windmill was originally installed on the barn. These windmills were first manufactured in 1892. Within a few years, improvements introduced by Aermotor made that company's windmill the gold standard. Many who had installed other brands replaced the motor with the latest Aermotor model, retaining other components of the earlier mill. This practice was encouraged by an Aermotor advertisement in the *Stillwater Messenger* in April 1898.

The Scandia store sold Aermotor windmills according to local informants and the presence of Aermotor windmills on area farms supports this claim. The Aermotor parts salvaged from the barn might have been part of the store's stock and never installed on the barn. It seems unlikely, though, that Lake, a progressive entrepreneur and community leader, would have kept the inferior Ideal mill while selling Aermotors, particularly given the barn's prominent location in the village. A possible scenario is that he got a state-of-the-art Aermotor motor in 1898; appropriated an Aermotor wind wheel, produced a year or two earlier, from his inventory; and retained other parts from the Ideal mill. This would be in line with the thrifty practices of the time and place as reflected in various items that survive from the barn and mill. Rather than starting from scratch when a building or piece of equipment became obsolete, components were adapted for a new use or retained for their original function, be they structural timbers or metal castings. This historical pattern will be continued by the planned reconstruction of the Scandia barn.

National Register Eligibility

When studying the Scandia barn in 2013, Two Pines searched for other extant tankhouses in Minnesota and found none, concluding that "not only is the Scandia Tower Barn a rare surviving example of this technology, but it may be a unique structure within the state. Furthermore, while most water systems are held by a municipality, the history of this structure as a private, cooperative water system is also significant."[77]

Two Pines recommended that "the Tower Barn is potentially eligible for listing in the National Register of Historic Places under Criterion A for its association with the historical development of Scandia's commercial and residential core. It is also potentially eligible under Criterion C as a unique water tower that used a windmill and elevated tank system incorporated into a barn to supply water to a town center."[78]

Documentation of the property's significance under Criterion A is sparce. The system is briefly noted in *Scandia—Then and Now*, which included a sketch of the barn: "The barn contained a tower and also housed a well, supplying water not only to the store but to a number of residences in the immediate vicinity." There might have been references to the water service in early local newspapers, but these publications were not available. A digital search in late nineteenth- and early twentieth-century issues of the *Stillwater Messenger*, accessible through the Minnesota Historical Society's website, turned up nothing.[79]

This dearth of documentation, though, is not surprising. Water systems are not a subject that routinely attracts attention from the press, and private operators of a small system, like Lake and later owners, were unlikely to prepare and retain detailed records. Documentation of the system's operation was minimal even after the Hilltop Water Company was formed in 1972. While the water utility stayed out of the spotlight, common sense argues that the system was, indeed, beneficial to those it served and an asset for the evolving community.

Justification for the property's significance under Criterion C in the area of engineering is stronger. The barn was built in the late nineteenth century, just as steel windmills were becoming widely available. The Chicago World's Fair in 1893, shortly before Lake built the barn, was ideally timed for promoting this innovative product. The pumping technology transformed life for people on farms and in small, rural communities. Windmills remain an important means of obtaining water, particularly for livestock, in some rural areas today. Many of the machines were displaced, though, after electrification was extended to most rural areas in the 1930s. The mills, once common landmarks on the prairie, were abandoned, deteriorated, and disappeared.

Power mills rather than pumping mills were most often incorporated into barns in rural settings where grinding and sawing were primary functions of a farm's operations. In a village like Scandia, a barn's primary functions were sheltering animals, including horses for transportation, and storage. Frank Lake used horses to haul goods in wagons from the Copas rail station. Heat from the horses helped keep the barn's water tank from freezing during Minnesota's harsh winters, which maintained water service to the store and houses in the vicinity.

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[77] Two Pines, "The Hilltop Water Company's Tower Barn," 4.
[78] Two Pines, "The Hilltop Water Company's Tower Barn," 4.
[79] Anna Engquist, *Scandia—Then and Now* (Stillwater, Minn.: Croixside Press, 1974), 70-80.

This circa 1910 windmill was mounted on a barn and furnished power for sawing and grinding as well as pumping. (Minnesota Historical Society)

Research conducted for the present report confirms that the Scandia structure is a rare surviving example of a late nineteenth-century tank barn in Minnesota. The collections of the Minnesota Historical Society contain some photographs of windmills on buildings but they are unlikely to be standing today. While captions rarely provide the location of the photographs, none of these windmills appear to be in the State Historic Preservation Office's inventory, the product of extensive architectural-historical surveys throughout the state over the last five decades.

Pumphouse at the Ray R. Jones Farmstead in Utah (HABS No. UT-134-B)

Recent studies and historic sources, such as the 1905 Aermotor publication, indicate that power windmills, rather than pumping mills, were typically installed in rural barns, further distinguishing the Scandia structure. Documentation reports in the Historic American Buildings Survey (HABS), archived in the Library of Congress, show that tankhouses were usually simple structures like the two-level example at the Ray R. Jones farmstead in Utah. The Engle Farm structure was larger and more complex, supporting both power and pumping operations. It held three rooms, according to the HABS report: "the workshop, the millroom, and the tank house. In the tower, the original wood tank . . . that fed water to the . . . house still remains." The report did not indicate the location of the windmill, but a pole projecting from the top of the tower suggests it was mounted there. The same appears to be true for the Kineth Farm tank house. Both are in Island County, Washington.[80]

Engle Farm tankhouse, Island County, Washington (HABS No. WA-247-E)

While the Engle and Kineth towers are not completely free-standing, they are not integrated into a building the way the Scandia tower was. An

[80] Michael R. Polk, "Ray R. Jones Farmstead, Tankhouse," HABS No. UT-134-B, ca. 1995, prepared by Sagebrush Archaeological Consultants; Anne E. Kidd, "Engle Farm, Tank House," HABS No. WA-247-E, 2006; Anne E. Kidd, "Kineth Farm, Barn," HABS No. WA-248-A, 2006.

example of an integrated windmill, on a massive scale, is the Littleton (Kingen) Round Barn in Indiana. Built between 1890 and 1895, it is a contemporary of the Scandia tank barn. The Scandia structure is not as grandiose, but, like other tankhouses, it reflects the building traditions of its locale. With its bracketed gable ends, clapboard sheathing, two-over-two windows, and simple form, it shares design characteristics with the 1894 Scandia Creamery, which Lake helped establish.[81]

Windmill technology was simple enough to be mass-produced and versatile enough to be adapted to the needs in a given setting. This is exemplified by Scandia's tank barn, which is both a representative example of a technology that went from cutting-edge to common in a few short decades and a creative installation of that technology. As such, if reconstructed in conformance with the Secretary of the Interior's Standards, the property merits National Register designation under Criterion C.
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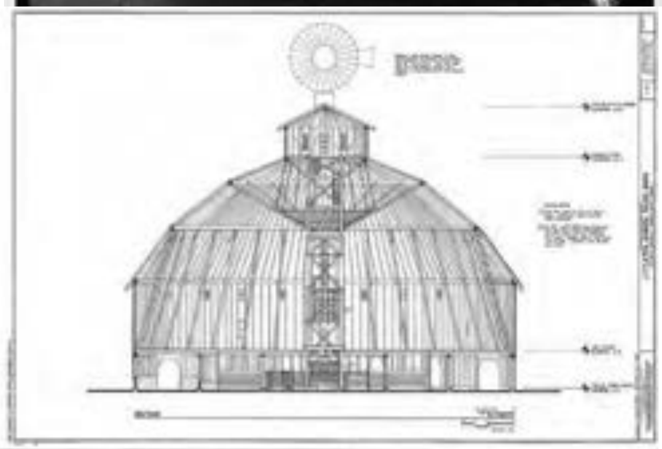

Top: The Kineth Farm Barn (2006) Island County, Washington (HABS No. WA-248-A)
Center: Littleton (Kingen) Round Barn, Hancock County, Indiana (HABS No. IN-159)
Bottom: Scandia Creamery, 1894 (Minnesota Historical Society)

[81] "Littleton Round Barn (Kingen Round Barn)," HABS No. 159, n.d. This barn was listed in the National Register of Historic Places (Reference Number 93000184) in 1993 as part of a multiple property submission for "Round and Polygonal Barns of Indiana" (Reference Number 64500218).

Resources

The main structural components of the barn were marked when the building was dismantled and are in storage. The contractor who completed that project is confident that the barn can be reassembled from these components, a process that should be done in consultation with a historic architect.

Subject experts can supply additional advice as well as locate replacement parts and give direction on how to set up the windmill system. Businesses specializing in repairing, replicating, and installing historic windmills are below, followed by information on organizations, publications, and museums interested in windmills.

Businesses

- Aermotor Windmill Company, 4277 Dan Hanks Lane, San Angelo, Texas 76904; 800-854-1656; https://aermotorwindmill.com/
  - The company continues to manufacture new windmills but recommended Midwest Windmill Company as a contact for historic windmill repair or replacement.

- Dakota Windmills and Supply, 28043 SD Highway 19, Hurley, South Dakota 57036; 866-403-9228; http://dakotawindmill.com/
  - Since 1993, Dakota Windmills has specialized in rebuilding and installing water-pumping windmills, particularly Aermotor 602 and 702 models.[82]

- Great Plains Windmill Service, Kinross, Iowa; 319-325-2467; https://greatplainswindmills.com/
  - Authorized Aermotor dealer. According to their website, "We specialize in the installation of new and used windmills, servicing, relocating, painting and full restorations."

- Midwest Windmill Company, Kirksville, Missouri 63501; 660-341-8951; https://www.facebook.com/Midwest-Windmill-Company-102549730092911/
  - Brad at Aermotor suggested contacting Mark Henry at Midwest. Mark buys a lot of parts from Aermotor, restores old mills, and installs new ones.[83]

- Muller Industries, 1102 West Twenty-first Street, Yankton, South Dakota 57078; 800-316-2727; http://mullerwindmill.com/index.php
  - Founded in 1979, the company started as a repair shop for agricultural equipment and soon began repairing windmills, making parts when original parts were not available. "The company markets its windmills primarily under the Muller

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[82] See also Michael Zimmy, "The Windmill Man," *South Dakota Magazine*, October 7, 2020, accessed March 10, 2022, https://www.southdakotamagazine.com/the-windmill-man.

[83] Author's phone conversation with Brad (who declined to give his last name) at Aermotor Windmill Company, March 14, 2022.

Windmill brand, as well as under the Aermotor Company of Chicago brand name for rebuilt windmills."

- Verdun Company, Hutchinson, Kansas; 620-662-8502; http://monitorwindmillparts.from-ks.com/
  - This company was recommended by Baker Manufacturing Company. According to the limited content on this webpage, Verdun appears to specialize in Monitor windmills.

- Windmill-Parts.com; 940-597-7735; windmill.parts@juno.com
  - An on-line business that "specializes in collectable, antique, vintage and used water pumping windmills, towers, accessories and vintage windmill parts. We sell complete mills or individual pieces for most post WWI windmills including Aermotor." The company also has materials on pre-WWI windmills. The business is "dedicated to helping others preserve and restore big or small country farm-style windmills at affordable prices. We also offer factory new windmills, towers and water pumping accessories at prices well below list."

Education

- New Mexico State University's College of Agricultural, Consumer, and Environmental Sciences (https://aces.nmsu.edu/ces/windmill/) has a Windmill Technology Center at its Las Cruces campus. Its mission is to help "preserve the legacy of wind-millers and an icon of the American West" "through training in windmill erection, repair and wellhead protection." Since 1975, the center has offered training on various aspects of windmill installation, maintenance, and restoration. The 2022 Windmill Technology Certification Workshop, scheduled for June 1-4, is sponsored by the Aermotor Windmill Company, San Angelo, Texas.

- *Windmillers' Gazette*, http://windmillersgazette.org/
  - This quarterly publication is dedicated to "the preservation of America's wind power history and heritage." It was started in 1982 by T. Lindsay Baker, one of the country's leading authorities on the history of windmills. In 2015, Baker turned over responsibility for editing and publishing the newsletter to his protégé, Christopher Gillis, author of a 2015 history of Aermotor windmills.

Organizations

- Society for Industrial Archaeology; https://www.sia-web.org/
  - Based at Michigan Technological University in Houghton, Michigan, SIA has an annual spring conference and fall tour and publishes newsletters and journals. Windmills are featured occasionally. For example, the newsletter's Issue 48, no. 4 (2019) had an article titled "The Aermotor Company," and Issue 27, no. 1 (2001) featured "North American Windmill Manufacturers' Trade Literature: A Descriptive Guide," edited by T. Lindsay Baker.

- Society for the Preservation of Old Mills; https://spoom.clubexpress.com/content.aspx?page_id=0&club_id=664666
    - Organized in Maine in 1972, this group appears to be mostly interested in historic water-powered mills. Its website states that its mission is to "promote interest in old mills and other Americana now quickly passing from the present scene. It reports to its members through a quarterly magazine. SPOOM maintains files and maintains a library on mills . . . and acts as a clearing house on milling information among all those interested."
    - Great Lakes Chapter: https://spoom.clubexpress.com/content.aspx?page_id=22&club_id=664666&module_id=276271. The president of the chapter is Craig Wiley, 137 West Congress Street, Polk, Ohio 44866; 419-945-2747; craigtwiley@frontier.com.

Museums

There are private collections of windmills, such as one on a rural property about a mile north of Jasper, Minnesota, on Fortieth Avenue, east of Highway 23, which has dozens of windmills on a ten-acre site. The locations listed below, on the other hand, are open to the public and operated by nonprofit or government agencies for educational purposes.[84]

- American Windmill Museum, 1701 Canyon Lake Drive, Lubbock, Texas; 806-747-8734; https://windmill.com/
    - Located on a 25-acre site in Lubbock, Texas, it claims to be "the largest windmill museum in the world." The Spring 2020 issue of *Windmillers' Gazette* has a brief article on the museum's collection of Aermotor windmills.

- Homestead National Historical Park, 24405 SW 75th Road; Beatrice, NE 68310; https://www.nps.gov/home/index.htm
    - Operated by the National Park Service, this facility has the records (approximately 300 linear feet) of the Dempster Mill Manufacturing Company, which produced windmills from 1879 to 2010. An overview of the company's history is on the National Park Service's website: https://www.nps.gov/places/dempster-mill-manufacturing-company.htm.

- Mid-American Windmill Museum and Historical Society; 732 S Allen Chapel Road, P.O. Box 5048, Kendallville, Indiana 46755; 208-347-2334; https://www.midamericawindmillmuseum.org/about
    - This organization was founded in 1992 in Kendallville, Indiana, by C. Russell Baker and others. It focuses primarily on windmills manufactured by Flint and Walling, which began operation in Kendallville in 1866. The company continues to produce pumps but has discontinued its windmill line. The museum displays over fifty restored windmills of various types including three Aermotors (two 8-foot and one 12-foot mills). Displays, a theater, and gift shop are housed in a

[84] "Jasper, Minnesota: Outdoor Collection of Windmills," Roadside America, https://www.roadsideamerica.com/tip/18642.

historic bank barn that has been relocated to the property. Baker Hall, opened in 2001, is an event center.

- Windmill State Recreation Area, Interstate Highway 80 near Gibbon, Nebraska; https://nebraskastateparks.reserveamerica.com/camping/windmill-sra/r/campgroundDetails.do?contractCode=NE&parkId=230196
    - The grounds hold a collection of windmills that have been relocated to this site and restored to working order. The oldest, manufactured in 1880, pumped water needed for railroad locomotives.

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One of the leading authorities on the American windmill (see Baker's *A Field Guide*), the author has compiled an impressive array of historic photographs from a number of sources, including his own substantial collection.

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In an introduction, Donald Green calls the book "more than a guide": "Not only may one use it for obtaining information about the history and technology of any specific mill or windmill company, but also the narrative is the most detailed, comprehensive treatment of American windmill history ever done." Extensive annotations back up information presented in the text and a lengthy bibliography is helpfully arranged by source type (e.g., archival materials, interviews, books). Baker was fascinated by windmills as a child growing up on a Texas farm, then gained an academic base in the subject while completing his formal education, which culminated in a Ph.D. at Texas Tech University. Baker has passed away but his papers are at Texas Tech's Southwest Collection/Special Collections Library. A finding aid is at https://swco.ttu.edu/. The library also has collections of materials on windmills, 1920-1975, and windmill trade literature, 1875-1992.

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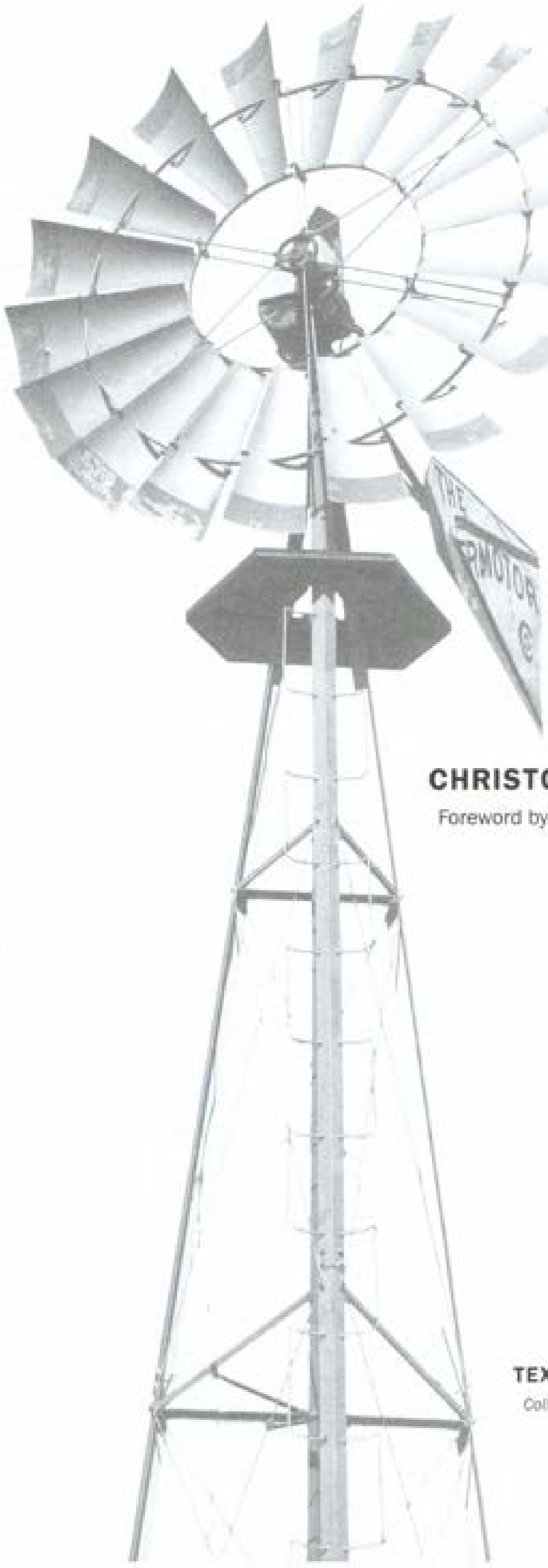
Northwest Architectural Archives, University of Minnesota, Minneapolis.

Saint Croix Room, Stillwater Public Library, Stillwater, Minnesota.

Attachment A: Glossary

From Christopher Gillis, *Still Turning: A History of Aermotor Windmills*



STILL TURNING

A HISTORY OF AERMOTOR WINDMILLS

CHRISTOPHER C. GILLIS

Foreword by T. Lindsay Baker

TEXAS A&M UNIVERSITY PRESS

College Station 2015

GLOSSARY

Due to the variety of local, regional, technical, and corporate terminology that has evolved in 150 years of windmill manufacture and use, this glossary provides only a summary of key words and definitions related to this history and the Aermotor windmill. Sources include Aermotor trade literature and definitions compiled from the *Windmillers' Gazette*.

TYPES OF WINDMILLS

Back-geared windmill Windmill mechanism designed so that more than one revolution of the wheel was required to produce a single pump stroke; from the outset Aermotor produced a back-geared windmill with a variable stroke.

Combination outfit Windmill installed on top of a stand-alone tower supporting a large wooden or steel water tank with a cover. Water was piped up from the ground into the tank by the action of the windmill's pump rod and pole. Hydrostatic (gravity) pressure was used to deliver water from the tank to its intended use.

Direct-stroke windmill Windmill with a mechanism that resulted in one complete pump stroke with each revolution of the wind wheel, a typical setup for most early commercially available and homemade water-pumping windmills.

Homemade windmill Wind-driven device often made with wooden paddles and shaft supports and held together with various recycled materials, such as leather and nails, or produced locally by blacksmiths and carpenters; for pumping water or operating small farm machines. Developed by frugal farmers, these windmills coalesced around several basic designs and were given colloquial names such as "ground tumbler," "battle-axe," and "merry-go-round."

Oil-bath windmill Windmill with moving mechanical parts that are partially submersed in oil for continuous lubrication during operation; also called "self-oiling."

Open-gear windmill Back-geared windmill in which the gears were exposed and open to the weather, requiring weekly lubrication. This was the common construction of the earliest back-geared US water-pumping windmills.

Outfit Combination windmill and tower.

Power windmill Windmill geared to rotate a shaft that was then geared near ground-level to operate light machinery such as feed grinders and wood saws.

Pumping windmill Windmill that drove a reciprocating shaft for a piston-type water pump.

Railroad outfit Windmill system designed to provide water for steam locomotives, which consisted of a large-diameter windmill on its own tower; a large wooden or steel water tank tower next to the windmill received the water and fed it via a spout into locomotive tenders.

Sectional-wheel windmill Windmill with a governing device to protect it from turning too quickly in high winds; individual sections of the wind wheel pivoted inward with increasing wheel speed or wind pressure to reduce the surface area exposed to the wind. Sectional-wheel windmills may or may not have had vanes.

Self-regulating windmill Windmill that automatically swiveled to face the wind and at the same time employed a governing mechanism to protect it from self-destruction due to centrifugal forces during high winds.

Suburban outfit Windmill water system that consisted of a windmill on a tower and a wooden or steel water tank mounted within the tower legs; it used hydrostatic pressure to deliver water for household and agricultural purposes.

Vaneless windmill Windmill with no vane to direct its wheel into the wind, but instead operated downwind, using a wheel on the leeward side of the tower. These windmills may or may not have incorporated a counterbalance weight to keep them balanced on top of the towers.

AERMOTOR WINDMILL PARTS

Bearings A device that allowed two mechanical parts to move in proximity with minimal friction. Aermotor oil-bath windmills had two removable bearings, either made of babbitt (for Models 502, 602, and 702) or Garlock (for Model 802), that permitted wind wheel shafts to rotate freely in the main-frame castings; also known as boxings and journals. The 502s and 602s had nonremovable bearings poured into the castings.

Furling device A mechanism that turned the windmill on or off. Aermotor had an external furling device, whereas it was more common among other makes of mills to use a pull-out chain that ran inside the mast pipe.

Gears Oil-bath Aermotor windmills had four gears; two small pinion gears were attached to the horizontal wind wheel shaft and transferred their circular motion to two large crank gears, which drove the pitman arms and reciprocal pump rod in a ratio of about three wind wheel revolutions to one pump stroke.

Helmet A galvanized sheet-metal covering over the motor that kept out moisture and dirt and also prevented oil from splashing out of the mainframe; also known as a hood.

Hub Cast iron cylinder in front of the motor to which the steel arms of the wind wheel blade sections connected; attached to a steel shaft that drives the gears of the motor.

Mainframe Main casting of the windmill, which supported its parts and held lubrication; also known as the main casting.

Mast pipe A metal pipe attached through the base of the mainframe and secured in the center of the tower top. For Aermotor, this was a stationary upright member on which its windmills swiveled to face changing wind directions. Other makes had the mast pipes attached to the underside of the working mill head, where it rotated as the mill yawed.

Motor All the working parts of a windmill, including the hub and gears, which translated the circular motion of the wind wheel to reciprocating movement of a pump rod or rotary motion of a vertical shaft; also known as the head or engine.

Pitmans Steel arms attached to two large gears in the mainframe, which helped facilitate the conversion from circular motion of the wind wheel and shaft to reciprocating motion to drive the pump rod. The pitman arms of the oil-bath Aermotor offered both long- and short-stroke capability, with the short-stroke position increasing the pumping depth by one-third but decreasing the pumping capacity by 25 percent.

Pump rod A steel rod that fastened to the moving parts in the motor and extended downward in the tower to transmit the reciprocating motion to a swivel connector attached to the wooden pump poles that passed farther down to the pump in the well.

Vane Sheet A flat piece of galvanized sheet metal attached to a steel tailbone and governor spring that directed the wheel into the wind, helped control operating speed, and counterbalanced the weight of the wheel.

Wind wheel A set of eighteen galvanized, contoured, trapezoidal blades or sails that were held together and evenly spaced by steel outer and inner rims; a series of steel arms secured the blade sections to the hub. Aermotor maintained eighteen sails for all its windmill sizes, whereas other makers often varied the number of sails with different wind wheel sizes.

WELLS AND PUMPS

Bored well A relatively small-diameter hole placed into the ground by special drilling machinery for the purpose of entering water-bearing strata and giving access to it from the surface; also referred to as a "drilled well."

Casing The pipe used to line a bored well to prevent the sides from caving in.

Driven well Well created by manually driving special boring tools into the ground to reach water at relatively shallow depths.

Drop pipe Pipe that hung in the well to which the cylinder was connected and encased the sucker rod, which drove the pump and channeled the water to the surface.

Hand pump A hand-activated device placed over an open or bored well, which through varied mechanical means lifted water to the surface; water exited a spout and was collected in buckets for household purposes, livestock watering, and garden irrigation.

Head The vertical distance, usually measured in feet, from the lowest level at which water held in a well to the highest point to which it was elevated; the computation of the head often included the additional factor of the friction of the water within the pipes or pump.

Open well A hand-dug well usually several feet in diameter and excavated to various depths depending on where the water-bearing strata was reached; this hole in the ground was generally lined with bricks, stone, timber, or concrete to prevent the walls from caving.

Pumping cylinder The cylindrical chamber that contained the moving parts of a simple single-stroke-action piston pump typically used in wells under windmills; also known as a cylinder.

Stuffing box A brass cap over the top of the drop pipe of the well that was used to create pressure with conduits leading from the well to points higher in elevation, which thus allowed the pumping cylinder in the well to force water higher than the ground surface.

Sucker rod A rod made of wood, steel, or fiberglass and produced in standard or various lengths; when screwed together, they reached from the surface down to the plunger valve in the cylinder.

AERMOTOR TOWERS

Anchor posts Metal or wooden posts that extended typically five to six feet underground on which the corner posts of the windmill tower were fastened.

Corner posts Individual legs or posts of a windmill tower.

Four-post tower Windmill tower that consisted of four legs or posts, the most common style in North America.

Looped ladder A series of steel rod steps that were bolted top to bottom to alternate sides of a single tower leg. It was introduced to Aermotor towers in 1899.

Platform A wooden or steel table-like platform attached near the top of a tower that offered footing during maintenance and repair of a windmill.

Pump pole guides Attachments in the center of the windmill tower that kept the wooden pump pole in line with the pump in the well so that the sucker rods did not become unscrewed.

Stub tower A short steel tower mounted beneath the windmill that adapted the windmill for installation on either a wood or a steel tower.

Suburban tower A windmill tower designed to support at some elevation within its legs a wooden or steel tank to store water under hydrostatic pressure for domestic use.

Tilting tower Steel or wooden windmill tower made with hinges near the center, which allowed for the windmill motor to be lowered to the ground for convenience in lubrication and other maintenance.

Tripod tower A windmill tower supported by three legs; also known as a three-post tower.

Wide-spread tower A windmill tower designed with its base extra wide to provide additional stability in high-wind areas; one side of the tower base could be left open of girts for laying out pipe and rod in large numbers for deep wells.

AERMOTOR WINDMILL ACCESSORIES

Crab A steel geared device, which, combined with block and tackle and rope or steel cable and cranked by hand, allowed for the erection of a preassembled windmill tower.

Foot gear A gear mechanism that translated the vertical movement of the upright shaft of a power windmill into horizontal rotary motion to operate machinery more conveniently.

Regulator A device designed for use with windmills to turn them on or off according to the level of water in storage tanks or troughs; wires typically connected the regulating device with floats on the surface of the water; similar in principle to how a modern-day bathroom toilet operates.

Stock tank A steel or wooden structure, usually circular or rectangular in shape, into which water was pumped by a windmill to provide a watering trough for livestock.

Triangles Three-sided metal templates, operated in pairs and connected with two heavy wires, which transmitted the reciprocating motion of a windmill's pump rod to a pump from some distance away.

Attachment B: Architect's Statement by Charles D. Liddy

"Statement in Support of the Historical Uniqueness and Distinct Design of the Scandia Water Tower Barn," prepared by Charles D. Liddy, FAIA Emeritus, June 2022

STATEMENT IN SUPPORT OF THE HISTORICAL UNIQUENESS & DISTINCT DESIGN OF THE SCANDIA WATER TOWER BARN
21083 Olinda Trail, Scandia, Minnesota
Prepared by
Charles D. Liddy, FAIA Emeritus
Principal Emeritus (retired), Miller Dunwiddie Architects
June 2022

Introduction

I am writing this report in support of efforts to place the Scandia Water Tower Barn in Scandia, MN on the National Register of Historic Places (NRHP), as administered by the National Park Service (NPS). The building and equipment could then be appropriately reconstructed/restored/rehabilitated at a newly created Scandia Heritage Center within the city. To facilitate my report the barn's owner, Scandia Heritage Alliance, and/or its historical consultant, Charlene Roise, have provided me with the following:

- *Inspection and Evaluation of the Hilltop Water Company Barn*; by Paul M. Bergson, MS PE (2010)
- *The Hilltop Water Company's Tower Barn, 21083 Olinda Trail, Scandia, Minnesota, Preliminary Assessment of Historical Significance*; by Two Pines Resource Group, LLC (2013)
- *Frank J. Lake: From Peddler to Prominent Businessman, Founder of Scandia's Commercial Center*; by Mark and Dawn McGinley (2019)
- *Appraisal for Tower Barn Components*, by Derek Jones, Appraiser, The Project Company (2021)
- *Scandia Water Tower Barn Heritage Center Master Plan;* prepared by Rylaur LLC, Architect; Anderson Engineering, Civil Engineer; and Abrahamson Nurseries, Landscape Designer (2021)
- *Scandia Water Tower Tank Barn: A Historical Investigation, Scandia, Washington County, Minnesota*; Prepared for the Scandia Heritage Alliance by Charlene Roise, Historian (2022)
- *Scandia Heritage Alliance: Raise Our Historic Water Tower Barn*; by The Scandia Heritage Alliance (SHA) (Undated)
- Numerous photos and CAD diagram drawings of the barn taken or drawn by Curt Richter, the carpenter who dismantled the barn in 2014.

I never saw the barn when it was standing. I have only been able to rely on the documentation provided, as well as a visit to Scandia on May 22, 2022, to view materials in storage.

Brief Scandia Water Tower Barn Description and Existing Conditions

The Scandia Water Tower Barn was a distinctive building located near the city's main intersection of Olinda Trail (historically Two Church Road) and Oakhill Road (historically Boney Lake Road). In 2014 its then-owner, Hilltop Water Company, hired Rustic Innovations carpenter, Curt Richter, to dismantle it, because the building could not be connected to Scandia's sewer system and thus had limited reuse. A proponent of preserving the barn at a new location, Susan Rodsjo, purchased the pieces and, with other local residents, founded the Scandia Heritage Alliance.

The building was T-shaped with a 2.5-story, north-south oriented, timber-framed section at the east and a 1.5-story, east-west oriented, stick-framed portion at the west. The stick-framing consisted of dimension lumber. Curt Richter recalls that the lumber was actual-sized or close to that, i.e., a two-by-four was actually 2" x 4". Sizes of dimension lumber can help date buildings. (Contemporary dimension lumber would be 1.5" x 3.5".)

Although specific historical documentation has not been found as to when and how the Water Tower Barn was constructed, there is conjecture that the timber-framed east portion was of a typical Swedish-influenced design; and that it had been previously built at the site or in the vicinity using locally sourced, peeled, and only partially milled tamarack (aka larch) and/or pine/fir logs. When the desire arose for a wind-powered water pumping, storage, and distribution facility, it was either moved to or within the site or modified in place to support the windmill and water tank. At the same time, the west portion was built using (mostly) stick-framing techniques utilizing dimension lumber plus some re-purposed heavy timbers likely from the east section. This took place circa 1895 by Frank Lake.

The resulting building was a larger eastern section housing the windmill and water tower equipment with a smaller western portion for storage and other uses, either related or not related to the water enterprise. Based on my review of the available information, I believe that this is a reasonable assumption for how it was constructed. In particular are the facts that the west roof eave of the timber-framed (east) portion of the building exists within the attic space of the west portion, and both portions of the building share timber-framed and dimension lumber members.

Both sections of the building had gable roofs with decorative rafter tails or eave supports. A prominent feature of the building was the water tank tower with a flared hip roof located at the north end of the east portion. It was capped by a windmill platform that rose an additional story above the roof ridge. The gable at this end was a "clipped" design below the windmill platform.

The east and west sections both had tie-lock (or t-lock) asphalt shingles. Asphalt shingles were first developed in the late 1890s and early 1900s, but the locking type shingles were developed later to resist high winds, particularly in rural areas. It is therefore unlikely that the shingles existing in 2014 were original. The original 1895 shingles were most likely locally sourced wood (cedar, pine, or fir), which would be consistent with Swedish influenced construction techniques.

The west façade of the building had two barn doors with a loft door centered above. The south facade had two windows in the west section; and at the east section, a single doorway flanked by windows was centered on the façade with a loft access opening above. The north façade had two windows in the west section matching the southern façade, and the east section had a door flanked by windows in a similar fashion, but not exactly like, the south façade. The east façade had no openings. At the exterior, the building had narrow wood clapboard siding painted green with trim (door and window frames, eaves, barge boards, rafter tails, etc.) painted brownish-red.

When the Water Tower Barn was dismantled in 2014, there was evidently no plan at that time to reconstruct it. Nevertheless, major portions of were salvaged, carefully marked, and stored. All of the timber-framing members were in an unheated barn at one location, and siding and interior sheathing boards are at Curt Richter's property stored on a trailer in an unheated shed.

At the first location I saw the timber-framing members, a complete barn door (green with brownish-red trim), two loft doors from the gables, and miscellaneous other pieces. I did not see any portions of the windmill materials, but I was told they are also safely stored; and there are photos of some of them in Charlene Roise's report.

The *Appraisal for Tower Barn Components* mentions that the timber-framing members "have had nails/fasteners removed and cleaned with a pressure washer." I examined the surfaces of a number of the members and did not see significant damage caused by cleaning. The finishing on the wood members was readily visible and revealed that they were both earlier-era hand-hewn (with adze marks) or later-era milled (with machine saw marks). This supports the conclusion that the two parts of the building were constructed at the same time. I could not determine if the wood was tamarack, but that could be determined with testing and analysis. The appraisal has excellent photos identifying the pieces, as well as a table showing types and dimensions.

At the Richter property, there was approximately 2,000 lineal feet of siding and some interior sheathing boards, all sitting on a flatbed trailer that had been in a shed for protection from the elements. The siding appears to have three distinct colors of paint. The most recent is the green. Next is a white/off-white layer and brownish-red appears to be the original color. Additional paint analysis could determine the exact colors and number of layers. The interior sheathing is unfinished. The siding and sheathing were not marked as to their original location. Many of the pieces had been cut down from longer ones. Curt Richter said that he had cut off portions that were cracked or unusable.

The Scandia Water Tower Barn – Historical Uniqueness and Distinct Design

In the second half of the 19th Century, cities, railroads, and other entities used windmills with elevated water tanks to pump and store water. Research by Two Pines, Charlene Roise, and others did not find any extant combination water tower/windmill structures in Minnesota, and very few elsewhere in the United States. This speaks to the uniqueness of the Scandia Water Tower Barn.

In addition, the water tower barn is a truly distinct design, which is supported by the following factors:

- The building was built specifically to house a water supply system. This could have been done with a simple windmill and elevated tank but using an existing barn and adding more space gave entrepreneur Frank Lake storage space for his other nearby commercial endeavors.
- Enclosing a tank within a barn offered the advantage of protecting the water from freezing, due to the rising heat from the animals. The water tank in Scandia was also within a "frost box", a structure with alternating layers of wood and air that helped insulate the tank. This would have been additional protection to keep the water from freezing when animals were not below or when the space was later converted for other purposes.
- Scandia area Swedish immigrants were familiar with constructing timber-framed buildings out of tamarack, which was widely available in Sweden. It, pine, and fir were also abundant around Scandia and had excellent rot-resistance and workability characteristics.
- Barns were utilitarian structures. When hand-built, usually only those portions of the logs that needed to be cut or shaped were worked. The Water Tower Barn exhibits this; the logs were peeled and flattened or shaped only on the side(s) that supported roof or floorboards, sat atop beams, or were mortise and tenoned to fit together.
- In the 19th century, it was common for buildings to be repurposed. Materials could be expensive and/or scarce. History records many instances of even relatively new buildings being moved, having their facades altered, having floors added or removed, or other major modifications. It is not

surprising that a barn would be dismantled and reconstructed in Scandia and/or expanded to become the Water Tower Barn.

- The building was a transitional structure, having been built at the end of the mostly wood, site-specific windmill era and the beginning of the mass-produced metal windmill era.
- The Scandia Water Tower Barn endured for over 100 years. If reconstructed and restored, it would be an example of a rare building type from 19th century rural America.
- Two Pines and Charlene Roise have both found that the Scandia Water Tower Barn was potentially eligible for listing in the NHRP. Two Pines thinks it could qualify under Criterion A ("association with the historical development of Scandia's commercial and residential core") and Criterion C ("a unique water tower that used a windmill and elevated tank system incorporated into a barn to supply water to a town center"). Charlene Roise feels that historical documentation for Criteria A is "sparse", but she does not discount it entirely. Additional research may be able to strengthen that case. However, she agrees that seeking NHRP listing is stronger under Criteria C "in the area of engineering."

Opportunities and Challenges

The Scandia Water Tower Barn is a unique building with a distinct design that is worth reconstructing and restoring at a new site as the Scandia Heritage Center. There are many opportunities and challenges with such an undertaking, including:

- The most crucial step is securing listing in the NRHP. In addition to the prestige that comes with that, this may make available various sources of funding. (See below.)
- When the building was dismantled, there was no plan to try to accomplish what is now being pursued. However, some actions taken at that time may make it more difficult for NRHP listing. For example, securing listing under Criteria A may be difficult because the west portion of the building was not salvaged when it was dismantled and would need to be totally reconstructed with new materials. Also, the Water Tower Barn would be placed on a new site. This often makes a building ineligible for NHRP listing; however, the barn was previously moved, so that can work in its favor.
- Listing the building under Criteria C may be easier and still express the unique and distinct historic story that the Water Tower Barn can convey. All existing pieces of the water pumping and storage system would need to be restored, missing pieces found or replicated, and the entire apparatus reconstructed in the Water Tower Barn.
- Listing the building in the NRHP cannot begin until all or significant portions of the building have been reconstructed. Based on a conversation I had with an NPS historic architect, the wood framing alone is not enough. The general NPS rule is that there needs to be walls and a roof.
- Under the SOI's Standards for the Treatment of Historic Properties, the "treatment(s)" that would be used for the Water Tower Barn would be Reconstruction (The missing west building and disassembled east building), Reconstruction/Restoration of the of the windmill and water tower portions (Those portions eligible under Criteria C), and Rehabilitation (The entire completed building would be put to a new use, i.e. the Heritage Center).
- Potential sources of funding or advice on available resources include:
    - Minnesota Historical Society Legacy Grants
    - Jeffris Foundation Grants
    - National Trust for Historic Preservation Grants
    - Rethos (Formerly the Preservation Alliance of Minnesota.)
    - The Victorian Society in America
    - The American Association for State and Local History (AASLH)

- The American Swedish Institute (ASI)
- Other to-be-identified foundation grants
- Web-based crowd-source funding.

Federal and State Historic Tax Credits have been mentioned as a potential funding source. However, once again, a building must exist before this process can be pursued. More importantly, only *buildings* qualify for historic tax credits. Treasury Regulation 1.48-1(e) defines a building as "any structure or edifice enclosing a space within its walls, and usually covered by a roof, the purpose of which is, to provide shelter or housing, or to provide working, office, parking, display, or sales space." Under this rule, tax credits could not be used for work on the windmill, water tank, and related equipment.

See the following pages for photographs.

Figure 1 – Dimension lumber barn member showing machine milled saw marks.

Figure 2 – Timber barn member showing hand-hewn adze marks.

Figure 3 – One of the west barn doors.

Figure 4 – Detail of barn door paint.

Figure 5 – Timber members showing hand-hewn notches.

Figure 6 – Timber members stacked in storage.

Figure 7 – Loft door.

Figure 8 – Loft door.

Figure 9 – Clapboard siding and interior sheathing boards on trailer.

Figure 10 - Clapboard siding and interior sheathing boards on trailer.

Figure 11 – Detail of siding showing color layers.