NELSON

FORENSICS + CONSULTING

Structural Distress Evaluation

PROJECT FILE NO.
19828

CLAIM NO.
E7K5861

STRUCTURE IDENTIFICATION
Linderman Gymnasium
Western States School Program
312 4th Avenue East
Polson, Montana 59860

PREPARED FOR
Diana Johnston
Travelers
7103 South Redwood Road
Suite 503
West Jordan, Utah 84084

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NELSON
FORENSICS

March 2, 2018

Diana Johnston
Travelers
7103 South Redwood Road
Suite 503
West Jordan, Utah 84084

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Western States School Program
312 4th Avenue East
Polson, Montana 59860

Nelson File No.:	19828
Claim No.:	E7K5861
Date of Loss:	1/2/2018

Dear Ms. Johnston:

Nelson Forensics, LLC is pleased to submit this report for the above-referenced file. By signature below, this report was authored by and prepared under the direct supervision of the undersigned professional.

Please contact us if you have any questions regarding this report.

With kindest regards,

NELSON FORENSICS, LLC
Montana Certificate of Authorization PEL-EF-LIC-48741

Timothy Todd Martin

Todd Martin, M.S., P.E.
Project Director

03.02.2018

Nelson: Report1-19828.doc.

REPORT

REPORT

INTRODUCTION

GENERAL INFORMATION

Date of Investigation:	February 6, 2018
Present at Investigation:	Todd Martin, M.S., P.E. (Nelson Forensics, LLC) Dan Giles (Maintenance Director-Polson School District) Paul Bishop (Paradigm v2 Architects)
Testing Performed:	Plumbness Survey

AUTHORIZATION AND PURPOSE

Nelson Forensics (Nelson) was authorized by Ms. Diana Johnston with Travelers (client) to evaluate the gymnasium located at 312 4th Avenue East in Polson, Montana (subject structure), determine the extent of distress related to a recent reported snow event, and provide associated remedial recommendations.

SCOPE OF INVESTIGATION

Nelson conducted a visual evaluation of the subject structure's exterior, interior, and accessible portions of the roof, while graphically and photographically documenting general site conditions and observed distress. Nelson performed a plumbness survey of the exterior brick masonry walls, the concrete columns and beams at the south elevation, and the exposed upper portion of the concrete columns at the north elevation. Additionally, Nelson reviewed received information provided to Nelson by the client. Destructive testing was outside the scope of this investigation and was not performed by Nelson.

This report was not prepared for use in a real estate transaction. It was prepared for the purpose and for the client as indicated above. Any and all usage or reliance upon this report by parties other than the client is expressly prohibited.

DESCRIPTION OF STRUCTURE

The subject structure was a school gymnasium, assumed to face **west** for discussion purposes. Elevation and annotated aerial views of the building are shown in **Figures 1-4**. Sets of remodel plans, dated May 16, 1991, and April 20, 2006, were made available to Nelson. Based on observations and a review of the remodel plans, the gymnasium generally consisted of the following:

Foundation:	Concrete footings, foundation walls, and slab-on-grade
Superstructure:	Bow-string trusses supported by 16"x24" concrete columns at the north and south elevations, with 16"x32" concrete beams at approximately the mid-height of the columns; and concrete/masonry bearing walls at the east and west elevations
Exterior:	Brick masonry
Interior:	Suspended acoustical panels, tiles, and gypsum board at the ceilings; gypsum board, tile, and unfinished and painted masonry at the walls; and carpet, tile, and wood finishes at the floors

Figure 1: West (front) elevation

Figure 2: South (right) elevation

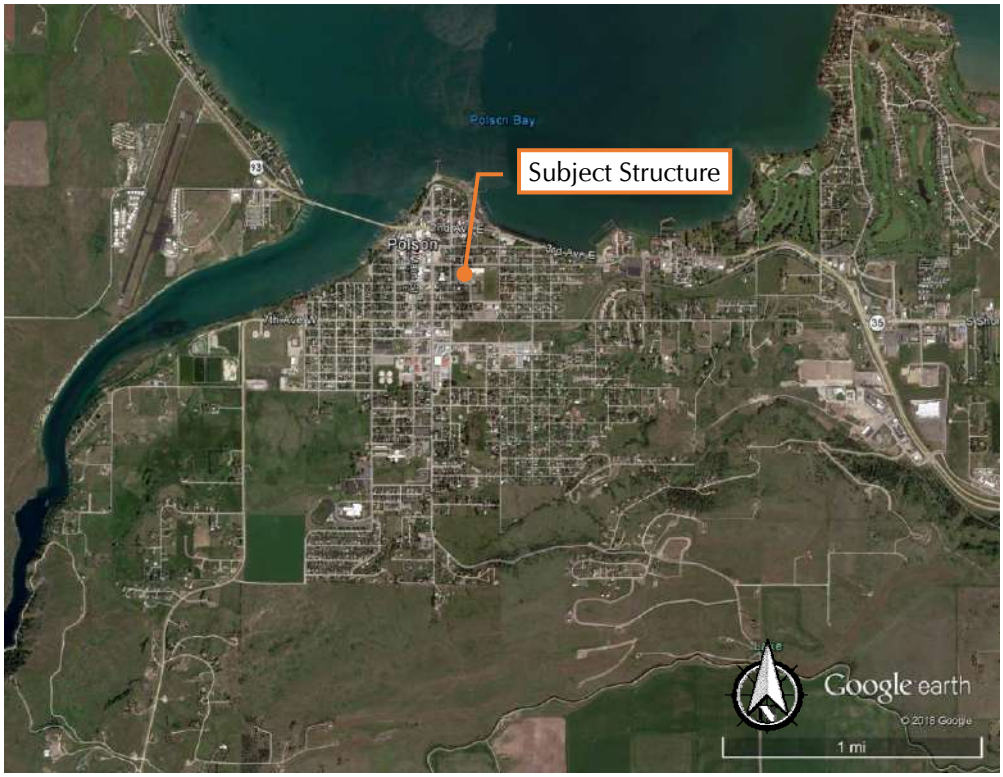


Figure 3: Approximate location of subject structure (Google 2018)

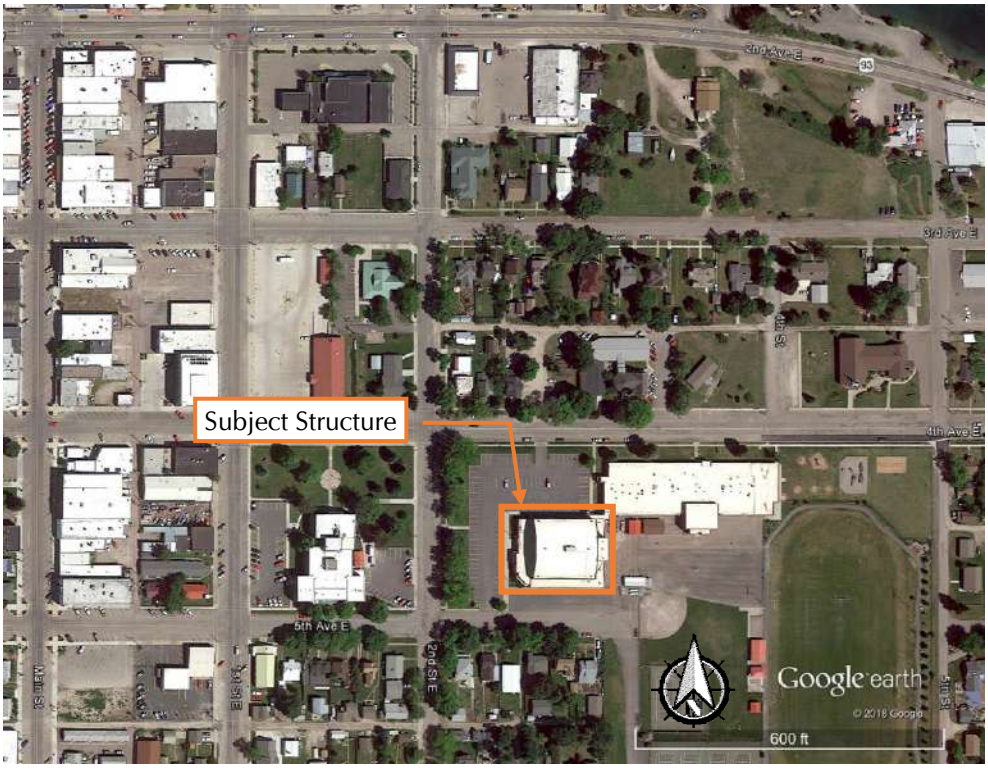


Figure 4: Location of subject structure (Google 2018)

REPORTED INFORMATION

Nelson conducted an informal interview with the owner's representative, Mr. Giles, and the owner's architect, Mr. Bishop of Paradigm v2 Architects, regarding background information pertaining to the structure and the reported distress. The reported information is the account of those interviewed and not Nelson's opinions or observations.

Mr. Giles reported the following:

- A recent snow storm event caused the gymnasium's south parapet wall to bow outward and eventually collapse onto the roof of the locker rooms located along the gymnasium's south wall. As a result, a portion of the locker room roof and walls were removed prior to Nelson's site visit;
- The collapse of the south parapet wall occurred on January 6, 2018;
- Pipe bracing was installed at the gymnasium's north and south elevations out of an "overabundance of caution;"
- After the storm event, some fractures were observed in the gypsum board at some doorway locations and separations in the brick masonry at the west doors of the gymnasium. He was unaware if the fractures/separations were present prior to the storm event;
- Fractures were observed in the mortar joints of the brick masonry at the southeast corner of the gymnasium;
- At some of the trusses, it appears that the column or brick masonry has moved, exposing a portion of the end of the truss that was covered by the brick masonry;
- After the collapse of the parapet wall, moisture stains were observed on the ceiling tiles adjacent to the north and south walls of the gymnasium. The moisture stains were not present prior to the collapse;
- There are fractures in the bottom chord of one of the bow-string trusses. However, the fractures pre-existed the storm event.

Mr. Bishop reported that when the concrete beam at the gymnasium's south elevation was exposed during removal of the locker room roof and walls, there were multiple fractures observed in the beam. Initially, there was concern that the fractures were the result of excessive snow load at the roof during the aforementioned storm event. However, they now believe that the fractures pre-existed the storm event and are unrelated.

RECEIVED INFORMATION

In addition to on-site observations, the opinions presented in this report may be based on the following information received by Nelson:

Field Report 01 from Paradigm v2 Architects (Paradigm), dated January 2, 2018;

Photographs and cross-sectional drawings of the subject structure from Paradigm, dated January 3, 2018;

Field Report 02 from Paradigm, dated January 4, 2018;

Field Report 03 from Paradigm, dated January 6, 2018;

Report from Mark Bradford, PE and Chris Schlegel, PE of DCI+bce Engineers, dated January 8, 2018;

Field Report 04 from Paradigm, dated January 23, 2018;

Field Report 05 from Paradigm, dated January 29, 2018;

Structural Conditions Assessment Report from Tom Beaudette, PE of DCI+bce Engineers, dated February 1, 2018.

O B S E R V A T I O N S

Photographic documentation and other field-obtained data of the structure are being maintained in Nelson's file. Select photographs are included within the body of this report and may be presented for information only or for a general representation of the condition of the structure. Schematic drawings indicating the general configuration of the structure, floor plan, areas of distress, and data collected are presented in the **Illustrations** section.

Nelson's observations relevant to the assignment described in the **Authorization and Purpose** section of this report include the following:

EXTERIOR

- Missing portion of the one-story structure along the south wall of the gymnasium (**Figure 5**);
- Missing parapet wall at the south side of the gymnasium roof, with tarps covering the openings in the wall where the parapet was located (**Figure 6**);
- No visible reinforcement at the top portion of the south masonry wall still in place;
- Stair-step separations in the mortar joints at the east and south exterior walls, at the gymnasium's southeast corner. The separations were located just below the parapet wall location and at the same approximate level as the upper gymnasium windows (**Figure 7**);
- Exposed concrete columns and beam at the location of the missing one-story structure (**Figure 8**);
- Fractures in the exposed concrete beams. The fractures were vertically and diagonally oriented, evenly spaced between the columns, and discontinuous. Additionally, the fractures were wider at the top of the beams (**Figures 9-10**);
- No fractures in the exposed lower portion of the south columns, nor fractures in the exposed portion of the concrete slab at the south side of the columns.

INTERIOR

- Concrete column/beam framing supporting the north and south bleachers;
- Separations and fractures in the ceiling and wall finishes at the following locations:
  - Door frame/wall interfaces at the southeast classroom, custodial room, and northeast entryway (**Figure 11**);
  - Two of the windows along the east library wall;
  - In the field of and at a wall-to-wall interface at the west library wall (**Figure 12**);
  - CMU wall/gypsum board wall interface at the south wall of the northeast locker room;
  - Ceiling adjacent to northwest locker room shower (**Figure 13**);
  - Interior concrete column for the bleachers and masonry wall interface at the northwest and southwest corners of the gymnasium (**Figure 14**);
  - Steel lintel/masonry interface over the west gymnasium doors (**Figure 15**);
- Stair-step mortar joint separations and fractures in the brick masonry at the east gymnasium wall, adjacent to the southeast corner. The fractures/separations corresponded to the location of the aforementioned exterior mortar joint separations (**Figure 16**);
- No visible separations at the south masonry/exterior column interfaces;
- Unpainted wood at the roof truss bottom chord/masonry interfaces. This condition was observed at the north and south ends of the first, fourth, and fifth trusses from the east gymnasium wall. There were no abrasions in the unpainted wood and the wood was aged in appearance (**Figures 17-18**);
- Checking in the bottom chord of the fourth truss from the east wall, with paint within the separations (**Figure 19**);
- Moisture-stained ceiling tiles at multiple locations along the north and south walls of the gymnasium (**Figure 20**).

Figure 5: Missing portion of structure at south side of gymnasium

Figure 6: View of parapet wall at southwest corner of gymnasium roof

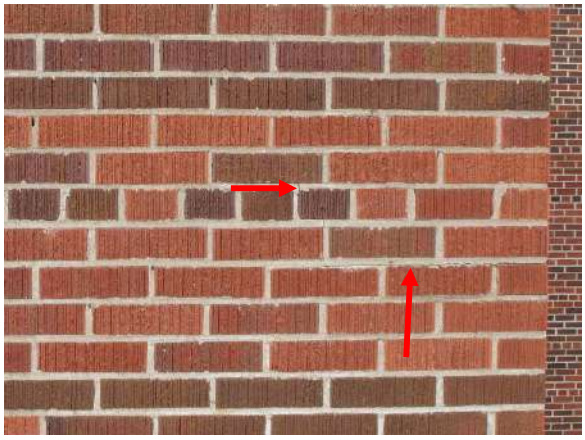


Figure 7: Close-up view of stair-step separations in mortar joints at south wall, southeast corner (annotated by Nelson)

Figure 8: Exposed concrete columns and beam near southeast corner of gymnasium

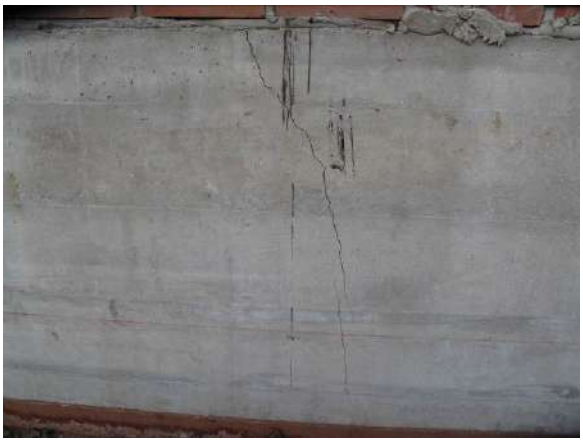


Figure 9: View of fracture in exposed beam near east end of south gymnasium wall

Figure 10: Closer view of top portion of fracture shown in Figure 9

Figure 11: Separation at door frame/wall interface at doorway to southeast classroom

Figure 12: Wall-to-wall separation at west library wall

Figure 13: Fracture in ceiling finishes adjacent to showers of northwest locker room

Figure 14: Separation at concrete column/masonry wall interface, southwest corner of gymnasium

Figure 15: Separations at lintel/masonry interface of south doorways, west gymnasium wall

Figure 16: Stair-step mortar joint separations at east wall, southeast corner of gymnasium

Figure 17: Unpainted wood at south end of truss bottom chord, first truss from east gymnasium wall

Figure 18: Closer view of unpainted wood shown in Figure 17

Figure 19: Checking in bottom chord of fourth truss from east wall

Figure 20: Moisture-stained ceiling tiles along south gymnasium wall

TESTING PERFORMED

PLUMBNESS SURVEY

Nelson obtained plumbness measurements of the exterior walls, concrete columns at the north and south elevations, concrete beams at the south elevation, and the interior concrete columns supporting the bleachers with a Stanley® SmartTool™ level instrument. Plumbness measurements are indicated on **SE-1B**, **SE-2A**, and **SE-2B** in the **Illustrations** section. A reading of 90.0° indicates that the element is true and plumb with the vertical, whereas each 0.1° difference from 90.0° is equivalent to slightly more than 1/12" change over four feet (i.e. 89.7° is approximately 1/4" out-of-plumb over four feet). A summary of the plumbness measurements is shown in **Table 1**.

Table 1: Summary of Plumbness Measurements

Element Surveyed	Measurement Range	Notes
Ground Level Masonry	89.4° - 90°	No pattern of directional lean.
Concrete Columns at Bleachers	89.6° - 90°	No pattern of directional lean.
Upper Level Exterior Masonry – North Wall	89.2° - 90°	Oriented to indicate that the wall generally leans outward.
Upper Level Exterior Masonry – East Wall	89.4° - 90°	No pattern of directional lean.
Upper Level Exterior Masonry – West Wall	89.7° - 90°	Oriented to indicate that the wall generally leans outward.
Upper Level Exterior Masonry – South Wall	89.1° - 89.8°	Oriented to indicate that the wall generally leans outward.
Upper Level Interior Masonry – North Wall	89.5° - 90°	Oriented to indicate that the wall generally leans outward.
Upper Level Interior Masonry – South Wall	89.3° - 90°	Oriented to indicate that the wall generally leans outward.
Ground Level Concrete Columns – South Wall	89.5° - 89.8°	Oriented to indicate that the base of the columns generally lean outward.
Top of Concrete Columns – South Wall	89.3° - 90°	Oriented to indicate that the tops of the columns generally lean outward and to the east.
Top of Concrete Columns – North Wall	89.6° - 90°	Oriented to indicate that the tops of the columns generally lean outward and to the west.
Concrete Beams – South Wall	89.0° - 89.9°	Oriented to indicate that the faces of the beams generally lean outward.

When measurements were taken at the concrete beams, the level rocked about the mid-point of the beams. The plumbness measurements were taken when the level rested flush against the top half of the beam's south face.

WEATHER DATA

Nelson reviewed historical weather data to provide insight into the history of weather events in the vicinity of the subject structure and to supplement on-site observations. The information consisted of public information maintained and made available by the National Oceanic and Atmospheric Administration's (NOAA's) National Centers of Environmental Information (NCEI) and the National Weather Service's (NWS's) National Operational Hydrologic Remote Sensing Center (NOHRSC).

Reported weather events and/or estimates may not be directly comparable to those actually experienced at the structure. Weather can vary from site-to-site during a given storm, and site-specific investigation is important to determine the impact of a weather event at a given site.

NCEI REPORTED WEATHER

NCEI provides official documentation of historical weather information recorded at weather stations across the United States. Nelson queried weather information from the closest available weather station reporting daily snow fall and wind speed information, the Kalispell Glacier Airport weather station (Station ID USC00244558), located approximately 42.6 miles north of the subject structure. A summary of the reported weather data is shown in the tables located in the **Appendix** section of this report. The "Direction" column in the tables indicates the direction from which the wind originated.

NCEI Reported Snow

Nelson queried NCEI data for daily snowfall and snow depth information between December 2017 and January 2018, a time period with snow data leading up to and encompassing the date of the reported south parapet wall collapse. The weather station reports snowfall on 12 separate dates and snow depth totals on 21 separate dates during the considered time period prior to the reported parapet wall collapse. Snowfall was primarily reported between December 19 and 22, 2017 and between December 27 and 30, 2017 (NCEI 2018).

Between December 19 and 22, a total snowfall of 15.9 inches was reported. A coincident increase in snow depth was reported during this four day period, with a maximum snow depth of 13 inches reported on December 22.

Between December 22 and December 27, no snowfall was reported and there was a coincident decrease of 3 inches in the snow depth.

Between December 27 and 30, a total snowfall of 14.4 inches was reported, with a maximum snow depth of 16 inches reported on December 30.

From December 30, 2017 to January 6, 2018, there was a decrease of 6 inches in the snow depth.

NCEI Reported Wind

Nelson queried NCEI data for daily reported fastest 5-second wind speeds during the aforementioned considered time period. Between December 19 and December 22, wind speeds from 8.1 to 33.1 miles per hour (mph) were reported, with the fastest wind speeds originating primarily from the north. Between December 27 and December 30, wind speeds from 6.9 to 40.9 mph were reported, with the fastest wind speeds originating primarily from the north (NCEI 2018).

NOHRSC REPORTED SNOW

The NOHRSC's National Snow Analysis (NSA) provides daily comprehensive snow information based on modeled snow pack characteristics. The NOHRSC snow model utilizes available ground, airborne, and satellite observations of snow water equivalent, snow depth, and snow cover. Nelson queried NSA data for snow events during the aforementioned time period from the closest available station, KERM8-Polson Kerr Dam station located approximately 4 miles west-southwest of the subject structure and at the same approximate elevation.

During the aforementioned considered time period, snow depth observations were reported on six separate dates, with the most recent and largest snow depth of 7 inches reported on December 27, 2017.

Modeled snow depth and snow water equivalent (SWE) was reported during the considered time period, with the largest snow depth and SWE of 19 inches and 2.6 inches, respectively, reported on December 31, 2017.

The SWE is the depth of water if the ground snow were completely melted (NOHRSC 2018). Nelson used the modeled snow depth, modeled SWE, and the known density of water (62.4 lb/ft^3) to calculate an approximate maximum snow load of 13.5 psf.

The weight of fallen snow on the ground is not the same as the weight of snow on the roof. The density of snow is highly variable. The calculated snow weights do not account for drifting or unbalanced snow loads on the roof and are provided for information only.

REVIEW OF RECEIVED INFORMATION

FIELD REPORT 01

Nelson reviewed Paradigm's Field Report 01, dated January 2, 2018. The field report provides observations, discussions, and action items from an evaluation of the subject structure by Paradigm on the aforementioned date. The report indicates the following:

- The south parapet wall exhibited a visible outward bow. The same wall had been evaluated by Paradigm and Aegis Engineering during the previous summer, with no indication of why a previous evaluation had been conducted or what was observed during that evaluation;
- A drone was used to document the condition of the parapet wall and the amount of snow and ice located behind the wall. The drone images indicated that there was "very little" accumulation of snow/ice at the parapet wall;
- The locker rooms and music room located in the one-story structure along the south gymnasium wall and directly below the south parapet wall had been closed to use;
- There was no evidence of bowing or fractures in the north parapet wall;
- Tom Beaudette of DCI+bce had been engaged to provide remedial recommendations for the observed distress at the south parapet wall. Mr. Beaudette initially believed that stabilization and repair of the wall was feasible, and that removal and replacement of the parapet would not be required.

PARADIGM PHOTOGRAPHS AND DRAWINGS

Nelson reviewed photographs and cross-sectional drawings from Paradigm, dated January 3, 2018. The photographs and drawings provide Paradigm's opinions regarding the cause of the outward bowing at the south parapet wall. The photographs/drawings indicate that snow accumulated on the roof during a recent snow event. The slope of the roof to the north of the parapet in conjunction with wind from the north caused snow to pile up behind the parapet. Additionally, movement of the snow down the roof slope and into the parapet wall caused the snow to curl, indicating dynamic movement of the snow against the parapet wall. Representative photographs and drawings are shown in **Figures 21-23**.

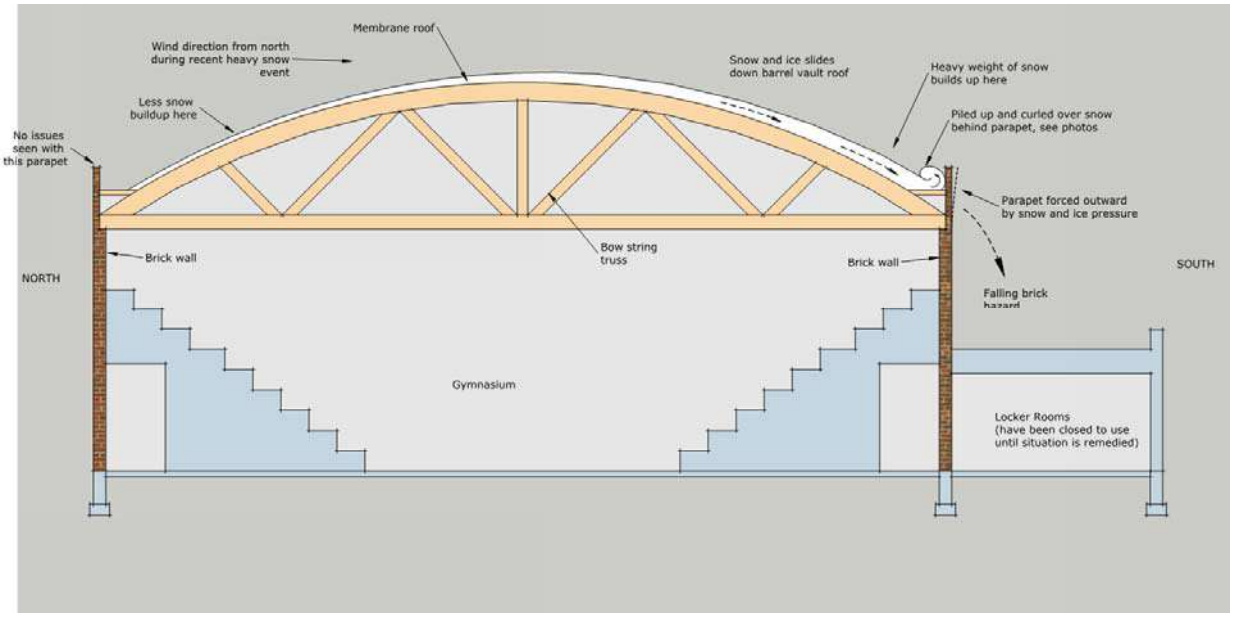


Figure 21: Building section showing Paradigm's opinions regarding cause of outward bowing of south parapet wall (Paradigm 2018)

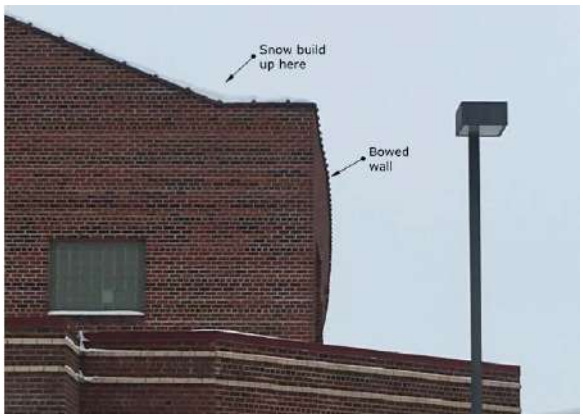


Figure 22: Paradigm photograph showing outward bow at parapet wall (Paradigm 2018)

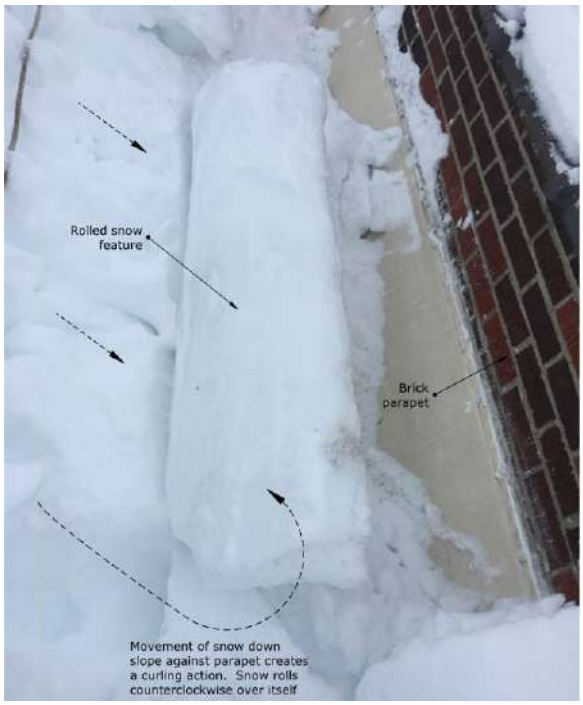


Figure 23: Paradigm photograph showing "curling action" of snow at parapet wall (Paradigm 2018)

FIELD REPORT 02

Nelson reviewed Paradigm's Field Report 02, dated January 4, 2018. The field report provides a brief summary of observations and action items since the January 2, 2018, site evaluation. The report indicates that on January 3, 2018, Dan Giles with the Polson School District had gained access to the roof and observed "significant" snow buildup at the south parapet, and "evidence of snow movement and curling against the parapet." Additionally, Mr. Giles observed tearing damage to the roof membrane at a scupper location. The report opines that the bowing of the south parapet wall is the result of horizontal pressures from the aforementioned snow movement.

FIELD REPORT 03

Nelson reviewed Paradigm's Field Report 03, dated January 6, 2018. The field report provides observations, discussions, and action items from an evaluation of the subject structure by Paradigm on the aforementioned date. The report indicates the following:

- The south parapet wall had collapsed onto the locker room roof directly below the parapet wall, subsequently causing the locker room roof to also collapse;
- As a result of the aforementioned collapse, "there is considerable roof and wall damage" at the locker room location and the locker room structure is now "a complete loss;"
- Due to the parapet wall collapse, a visual evaluation of the rest of the gymnasium structure was conducted;
- No "deformation, cracking, or other structural issues" were observed at the north parapet wall;
- The bow-string trusses at the gymnasium roof "were still in position on their concrete supports," there was no visible damage to the concrete columns, and the main gym structure "was at least stable."

DCI + bce REPORT

Nelson reviewed DCI + bce's report, dated January 8, 2018, regarding the parapet wall collapse. The field report provides a brief discussion of the gymnasium roof and locker room roof framing and observation regarding the parapet wall collapse. Additionally, the report indicates the following:

- A 6' level was placed along the tops of the south concrete columns and indicated that the columns were consistently 1/2" out-of-plumb towards the south;
- The north concrete columns were similarly measured and determined to be plumb;
- A 4' level was placed near the top of the gymnasium's remaining south brick masonry wall between the columns and the measurements taken indicated that the two middle bays were 1/2" out-of-plumb;
- Recommendations were also provided for stabilization of the south gymnasium wall.

FIELD REPORT 04

Nelson reviewed Paradigm's Field Report 04, dated January 23, 2018. The field report provides observations during demolition and removal of the locker room structure. Additionally, the report indicates observed conditions at the concrete columns and beams, which had been exposed during demolition operations. The report indicates that there were no cracks in the columns or separations at the visible control joints in the columns. Multiple cracks were observed in the span of the beams between the concrete columns. The report also indicates that plumbness measurements were obtained at the concrete columns before and after demolition operations and no change was noted in the plumbness measurements.

FIELD REPORT 05

Nelson reviewed Paradigm's Field Report 05, dated January 29, 2018. The field report provides observations during a ground penetrating radar (GPR) survey of the south concrete columns and beams conducted by A-Core. The GPR survey indicates that there is a rebar cage consisting of vertical reinforcing bars and horizontal ties in the columns. Additionally, there were horizontal reinforcing bars extending from the column reinforcing cage approximately 12" into the concrete beams at either side of the columns. However, no other reinforcing was detected in the concrete beams.

DCI + bce STRUCTURAL ASSESSMENT REPORT

Nelson reviewed DCI + bce's report, dated February 1, 2018, regarding a structural assessment of the gymnasium structure. The report provides summary of the overall construction of the gymnasium structure. Additionally, the report opines that structural distress related to the south parapet wall collapse is limited to the south brick masonry wall and concrete columns and beams. The report further opines that the structural distress at the south concrete columns and beams is limited to outward leaning or out-of-plumbness of the columns and beams. The report also recommends testing of the remaining masonry walls to determine the capacity of the masonry walls. The report also recommends that tie backs be installed at the north parapet wall to prevent a similar failure from occurring at the north side of the structure.

ANALYSIS

In Nelson's opinion, the collapse of the south parapet wall, outward lean of the south masonry wall, and the fractures/separations in the masonry wall mortar joints are the result of overturning of the south masonry wall as the result of snow movement during recent snow storm events. Weather data indicates that snow accumulation likely occurred at the roof in conjunction with winds originating from the north prior to the reported date of loss. The slope of the barrel-vaulted roof in conjunction with the aforementioned winds would have caused southward movement of the snow, applying horizontal, out-of-plane forces at the parapet wall. Overturning occurs when these horizontal loads impose an out-of-plane rotational force (overturning moment) which is greater than the element is capable of resisting. At brick masonry elements such as the gymnasium's south brick masonry wall, overturning moments induce tensile stresses, which are typically resisted by reinforcing bars spaced at regular intervals in the brick masonry wall. However, no reinforcement was observed by Nelson at the remaining top portion of the masonry wall. As a result, the tensile forces from the overturning moment were resisted by the bond of the brick masonry mortar, which is relatively weak in tension. The tensile forces from the aforementioned snow movement induced overturning moment exceeded the capacity of the mortar, which caused the outward lean of the wall, the observed fractures/separations at the mortar joints adjacent to the structures southeast corner, and the subsequent collapse of the parapet wall.

In Nelson's opinion, the moisture stains at the gymnasium ceiling are the result of the south parapet wall collapse. The roofing membrane would have been anchored to the inside face of the parapet wall and would have been pulled by the parapet wall as it leaned outwards and when it eventually collapsed. This would have allowed the roofing membrane to tear as tensile forces from the parapet wall movement exceeded the capacity of the membrane. Further, Nelson's review of received information indicates that tears were observed in the roofing membrane after out-of-plane movement of the south parapet wall was first observed. Tears in the roofing membrane as the result of movement of the south masonry wall would create openings in the gymnasium's roof, and would provide a direct pathway for moisture to the gymnasium's interior.

In Nelson's opinion, the concrete columns at the south gymnasium wall were unaffected by the aforementioned snow events and outward lean and subsequent collapse of the south brick masonry wall. The plumbness measurements obtained by Nelson at the concrete columns indicate that the columns are relatively plumb. Additionally, plumbness measurements of the interior face of the south masonry wall indicates that the interior side of the masonry wall is plumb in proximity to the columns. If outward movement of the concrete columns had occurred, Nelson would have expected to see separations at the column/masonry interfaces. Further, Nelson would have expected to see fractures or spalling of the concrete slab-on-grade where the slab abutted the columns.

In Nelson's opinion, the fractures and out-of-plumbness measurements at the south concrete beams are unrelated to the aforementioned snow event and outward lean/collapse of the south brick masonry wall. Roof loads such as from the accumulation of snow at the parapet wall are carried by the concrete columns, not the beams. Reviewed information indicates that the beams are unreinforced, making them susceptible to cracking from shrinkage and thermal movement. Further, the observed fractures are not consistent with overstressing of the beams as the result of vertical loading or twisting of the beam as the result of outward movement of the supported masonry. The out-of-plumbness measurements are consistent with as-built conditions and not outward movement of the supported masonry wall. If the out-of-plumbness measurements had been the result of movement of the south wall, Nelson would have expected corresponding out-of-plumbness measurements at the columns. Additionally, Nelson observed that the level rocked about the centerline of the beam when plumbness measurements were obtained at the beam locations, which is characteristic of inadequate forming construction when the concrete for the beams was placed. Inadequate construction of the concrete forms for the beam would have allowed concrete pressures during placement of the concrete to rack the forms, resulting in the observe out-of-plumbness measurements.

In Nelson's opinion, the unpainted/exposed wood at the ends of some of the trusses is unrelated to outward lean/collapse of the south brick masonry wall. If the aforementioned condition had been the result of movement of the masonry wall, Nelson would have expected to observe unpainted/exposed wood to be isolated to the south end of the trusses and be present at all truss locations. Nelson would have also expected to see abrasions in the unpainted/exposed wood if movement of the masonry wall/trusses in relation to one another had occurred. The exposed unpainted/exposed wood is at both ends of the affected trusses, which is consistent with inward movement of the truss heels. Long-term deflection of the trusses and/or slip of the mechanical connections at splice locations would have caused/allowed the aforementioned inward movement to occur. Additionally, the trusses are located adjacent to the east and west parapet walls and are more susceptible to drift loads. Repeated loading and unloading of the trusses due to multiple snow events since the construction of the gymnasium would have contributed to long-term deflection of the affected trusses.

In Nelson's opinion, the fractures/separations observed at door and window opening locations, ceiling finishes, and wall-to-wall interfaces are unrelated to the aforementioned snow event and outward lean/collapse of the south brick masonry wall. The aforementioned distress locations were isolated from one another and were not in direct proximity to the south brick masonry wall. Additionally, there is no clear load path connecting the observed distress to the outward lean/collapse of the south masonry wall.

CONCLUSIONS

Based on reported information, observed conditions, testing performed, weather data, received information, and analysis, Nelson is of the following opinions regarding the reported and/or observed distress:

- The collapse of the south parapet wall, outward lean of the south masonry wall, and the fractures/separations in the masonry wall mortar joints are the result of overturning of the south masonry wall as the result of snow movement during recent snow storm events;
- The moisture stains at the gymnasium ceiling are the result of the south parapet wall collapse;
- The concrete columns at the south gymnasium wall were unaffected by the aforementioned snow events and outward lean and subsequent collapse of the south brick masonry wall;
- The fractures and out-of-plumbness measurements at the south concrete beams are unrelated to the aforementioned snow event and outward lean/collapse of the south brick masonry wall;
- The unpainted/exposed wood at the ends of some of the trusses is unrelated to outward lean/collapse of the south brick masonry wall;
- The fractures/separations observed at door and window opening locations, ceiling finishes, and wall-to-wall interfaces are unrelated to the aforementioned snow event and outward lean/collapse of the south brick masonry wall.

RECOMMENDATIONS

Nelson recommends removal and resetting of the south masonry wall that is still in place and replacement of the brick masonry where collapse of the parapet wall occurred.

After remediation of the south masonry wall has been completed, the roofing membrane should be evaluated to determine whether the membrane can be repaired or should be replaced.

While unrelated to recent snow storm events and the outward lean/collapse of the south masonry wall, the concrete beams should be retrofitted with reinforcement to prevent further exasperation of the observed fractures and/or additional fracturing from occurring. The installation and proper attachment of a steel member, such as a steel channel, to the north and south sides of the concrete beams is a potential method of retrofit reinforcement of the beams. The steel member and corresponding attachment should be designed by a design professional licensed in the state of Montana.

Recommended repairs are provided as a basis for an opinion of probable construction cost of repair (cost estimate). Each repair item may require unique design/construction expertise, and some items may require construction documents prepared by a design professional.

LIMITATIONS

The items observed and documented in this report are intended to be representative of the structural conditions at the subject structure. No attempt has been made to document the condition of every structural and nonstructural element. Only visible items were observed and documented. Destructive testing was not performed by Nelson.

This document is the rendering of a professional service, the essence of which is the provision of advice, judgment, opinion, or professional skill.

This report was prepared in order to document distress observed at the structure. The opinions presented herein are based on site observations, field information and measurements taken, written and verbal information, and experience, where applicable. No complete review of this structure's conformance to current or previously applicable building codes was performed. However, specific items that may be at issue with the applicable building code requirements may be noted.

This report should not be construed as an assessment of total damages to the structure at the time of site observation. In addition to the observed and documented items of distress, hidden defects may exist that were not readily visible. Also, some damaged areas may have been previously repaired and, unless otherwise noted, were not visible at the time of observation. However, these areas may experience future distress. No representation, guarantee, or warranty as to the future performance of this structure is made, intended, or implied.

This report has been prepared as a basis for an opinion of probable construction cost of repair and for the purpose of evaluating a claim. Additional construction documents prepared by a design professional may be required and are beyond the scope of this assignment.

In the event that additional information becomes available that could affect the conclusions reached in this investigation, this office reserves the right to review, and, if required, change the opinions presented herein.

This report has been prepared for exclusive use of the client and its representatives. No unauthorized re-use or reproduction of this report, in part or whole, shall be permitted without prior written consent.

Alteration of this document or its companion illustrations in any way by anyone other than the professional whose seal appears thereon, in either hard copy or electronic form, is strictly prohibited and may constitute a violation of state and/or federal laws.

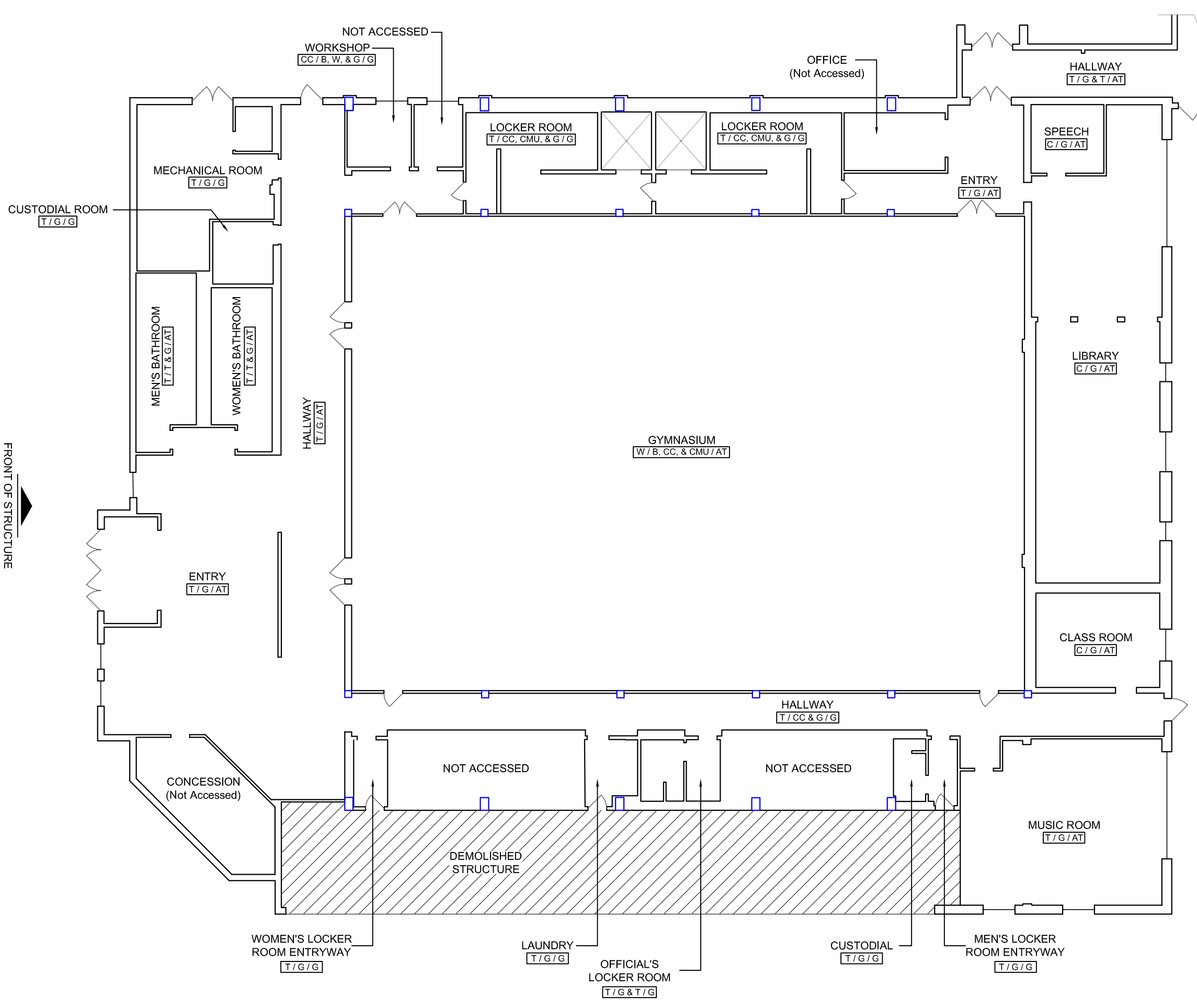
REFERENCES

Google. 2018. *Google Earth Pro*. Version 7.1.5.1557.

National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI). 2018. *Climate Data Online Search*. Accessed February 2018. http://www.ncdc.noaa.gov/cdo-web/search.

National Oceanic and Atmospheric Administration (NOAA), National Operational Hydrologic Remote Sensing Center (NOHRSC). 2018. *NOHRSC*. Accessed February 2018. http://www.nohrsc.noaa.gov/.

ILLUSTRATIONS



GROUND FLOOR LAYOUT

INTERIOR FINISH LEGEND	
X / X / X	FLOOR / WALL / CEILING FINISHES
AT	ACOUSTIC TILE
B	BRICK
C	CARPET
CC	CONCRETE
CMU	CONCRETE MASONRY
G	GYPSUM BOARD
T	TILE
W	WOOD
X	NO FINISH

NELSON

MONTANA CERTIFICATE OF AUTHORIZATION NO. PEL-EF-LIC-48741
EXPIRATION 10/01/2018

MONTANA
TIMOTHY TODD MARTIN
No. 43383 PE
LICENSED PROFESSIONAL ENGINEER

2 _____
1 _____

ISSUE DATE:
March 2, 2018

SCALE: 1/16" = 1'-0"
0 6' 12' 18' 24'

THIS DRAWING WAS PREPARED IN COLOR TO AN ESTIMATED ACCURACY OF ±10" AND SHALL BE FIELD VERIFIED. IF THIS NOTE IS NOT IN COLOR, THE DRAWING SHALL NOT BE USED.

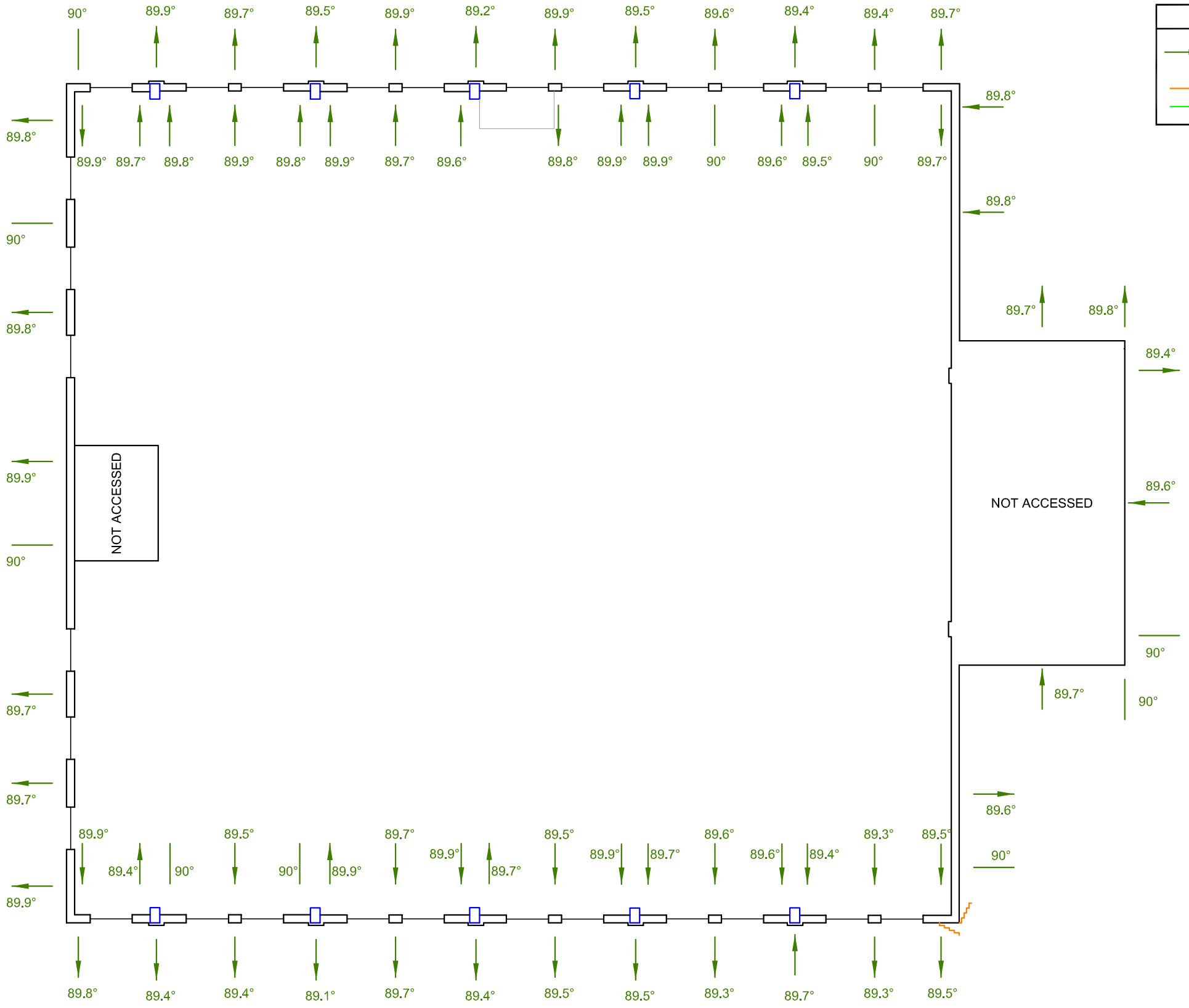
STRUCTURE IDENTIFICATION:
Linderman Gymnasium
312 4th Avenue East
Polson, Montana 59860

SURVEY DATE:
February 6, 2018

FILE NUMBER: 19828

P.E. : TTM

SHEET NUMBER: SE-1A



FRONT OF STRUCTURE

UPPER GYMNASIUM LAYOUT, DISTRESS MAPPING, AND BRICK MASONRY PLUMBNESS SURVEY

LEGEND
VERTICAL PLUMBNESS AT GYMNASIUM UPPER WINDOW LEVEL OF EXTERIOR MASONRY
VENEER DISTRESS
WALL DISTRESS

NELSON

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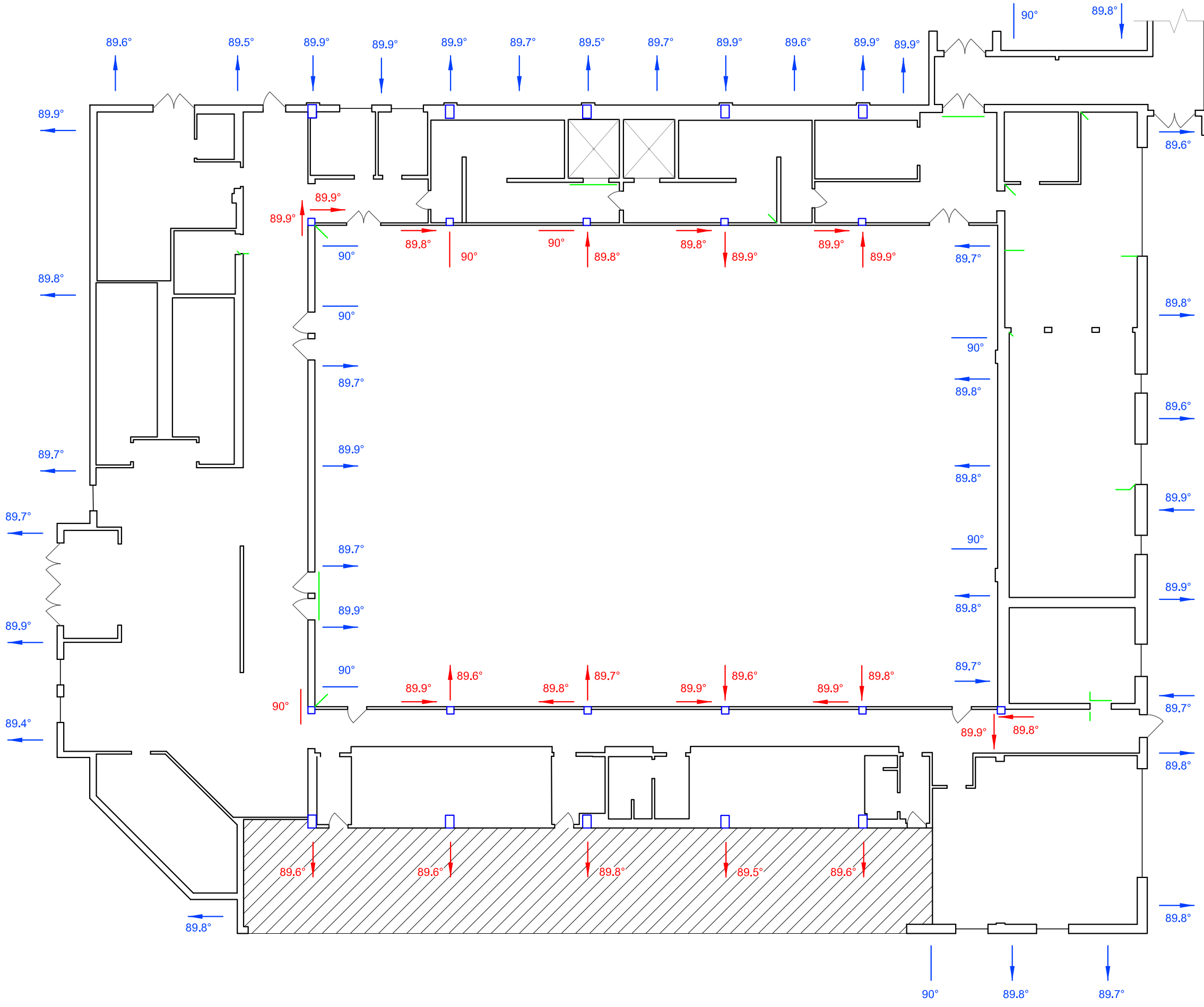

DISTRESS MAPPING AND PLUMBNESS SURVEY

LEGEND

- VERTICAL PLUMBNESS AT GROUND FLOOR LEVEL OF EXTERIOR MASONRY
- VERTICAL PLUMBNESS AT GROUND LEVEL OF CONCRETE COLUMNS
- VENEER DISTRESS
- WALL DISTRESS

NELSON

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312 4th Avenue East
Polson, Montana 59860

SURVEY DATE:
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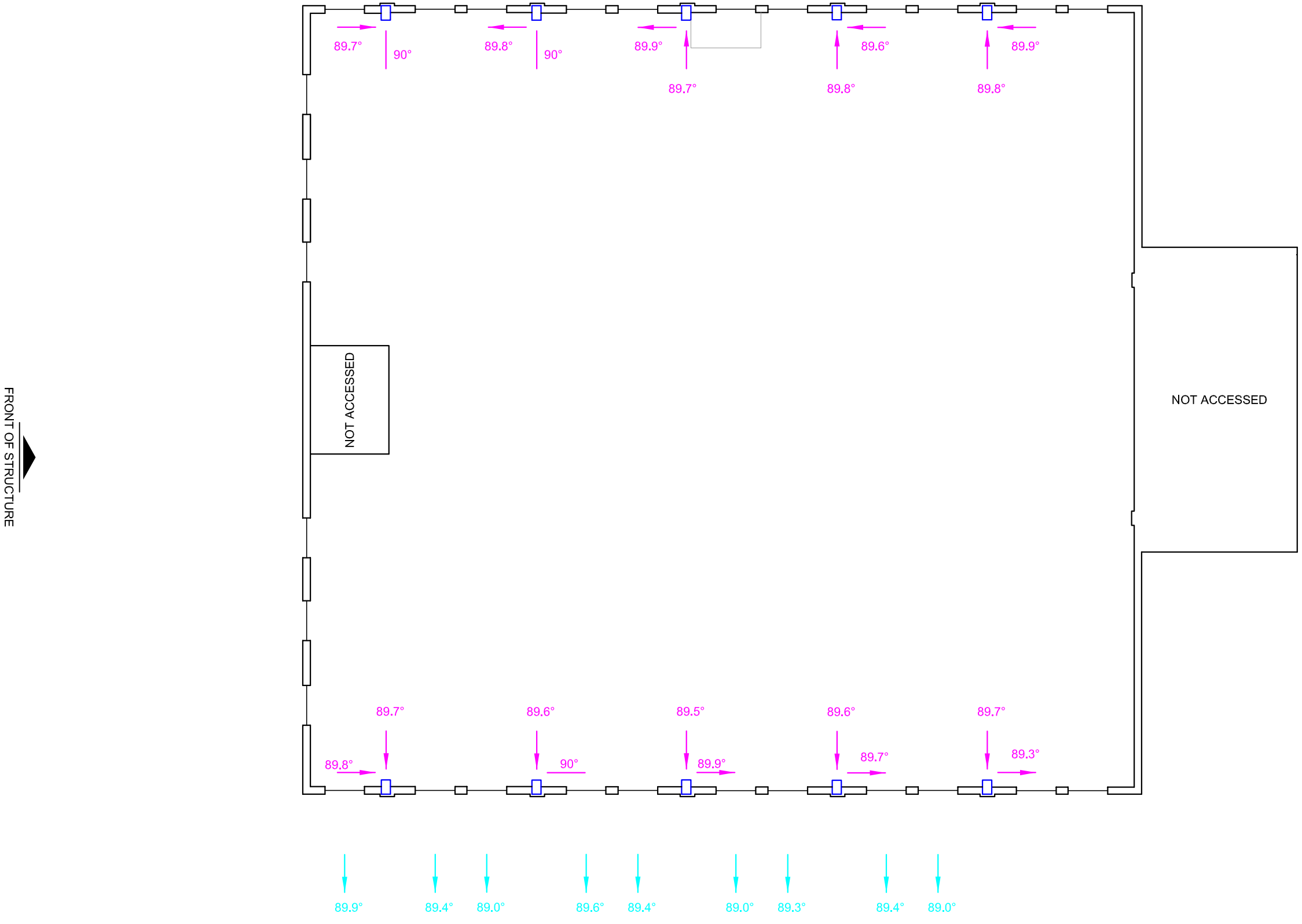
FILE NUMBER:	SHEET NUMBER:
19828	SE-1B
P.E. : TTM	



FRONT OF STRUCTURE

CONCRETE BEAM AND COLUMN PLUMBNESS SURVEY

LEGEND
VERTICAL PLUMBNESS AT TOP OF CONCRETE COLUMNS
VERTICAL PLUMBNESS AT CONCRETE BEAM

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APPENDIX

Daily Reported Snowfall, Snow Depth Totals, and Wind Information for the month of December 2017 (NCEI 2018)

Date	Snow Fall (inches)	Snow Depth (Inches)	Wind Speed (mph)	Direction
12/01/2017	0.00	0.00	13.0	SSE
12/02/2017	0.00	0.00	15.0	S
12/03/2017	0.00	0.00	11.0	N
12/04/2017	0.00	0.00	11.0	SSW
12/05/2017	0.00	0.00	12.1	SSW
12/06/2017	0.00	0.00	8.9	N
12/07/2017	0.00	0.00	6.9	NW
12/08/2017	0.00	0.00	8.1	W
12/09/2017	0.00	0.00	6.9	NNE
12/10/2017	0.00	0.00	6.9	N
12/11/2017	0.00	0.00	8.1	NW
12/12/2017	0.00	0.00	8.1	NNE
12/13/2017	0.50	0.00	8.9	W
12/14/2017	0.00	0.00	6.9	E
12/15/2017	2.00	0.00	8.1	SSW
12/16/2017	0.00	2.00	15.0	SW
12/17/2017	0.00	2.00	17.0	S
12/18/2017	0.00	2.00	19.9	SSE
12/19/2017	8.40	0.00	25.9	NNE
12/20/2017	3.00	11.00	31.1	N
12/21/2017	3.00	11.00	8.1	SSW
12/22/2017	1.50	13.00	33.1	NNE
12/23/2017	0.00	10.00	21.9	NNE
12/24/2017	0.00	10.00	8.9	WNW
12/25/2017	0.00	10.00	15.0	N
12/26/2017	0.00	10.00	6.9	N
12/27/2017	2.20	11.00	6.9	SW
12/28/2017	5.50	12.00	10.1	SW
12/29/2017	4.00	14.00	40.9	NNE
12/30/2017	2.70	16.00	35.1	NNE
12/31/2017	0.00	15.00	6.9	NNE

Daily Reported Snowfall, Snow Depth Totals, and Wind Information for the month of January 2018 (NCEI 2018)

Date	Snow Fall (inches)	Snow Depth (Inches)	Wind Speed (mph)	Direction
01/01/2018	0.00	15.00	8.10	N
01/02/2018	0.00	15.00	6.00	SE
01/03/2018	0.20	14.00	6.00	S
01/04/2018	0.00	10.00	16.10	E
01/05/2018	0.20	10.00	6.00	SE
01/06/2018	0.00	10.00	19.00	SSE
01/07/2018	0.00	9.00	19.00	SSE
01/08/2018	0.00	8.00	6.00	SE
01/09/2018	0.00	8.00	12.10	S
01/10/2018	0.00	7.00	21.90	S
01/11/2018	2.70	7.00	16.10	SSW
01/12/2018	2.30	11.00	10.10	NW
01/13/2018	0.00	13.00	8.90	SW
01/14/2018	0.00	7.00	8.90	N
01/15/2018	0.00	7.00	14.10	NNE
01/16/2018	0.00	7.00	13.00	SSW
01/17/2018	0.00	7.00	13.00	W
01/18/2018	0.00	7.00	19.90	SSE
01/19/2018	0.00	6.00	16.10	SW
01/20/2018	0.00	6.00	21.90	SE
01/21/2018	0.00	6.00	18.10	SSE
01/22/2018	0.00	6.00	16.10	SSE
01/23/2018	0.00	6.00	12.10	S
01/24/2018	1.00	7.00	19.90	SSE
01/25/2018	0.00	6.00	21.00	S
01/26/2018	0.20	5.00	25.90	W
01/27/2018	3.90	6.00	21.90	SSE
01/28/2018	0.00	10.00	12.10	S
01/29/2018	0.00	9.00	17.00	S
01/30/2018	0.00	8.00	38.00	SW
01/31/2018	0.00	7.00	23.00	W

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