

Oregon Seismic Status Report - 2016



Oregon law requires school districts and education service districts to provide DOGAMI with notice of construction projects that may affect a school's seismic risk.

This report was generated by DOGAMI from submitted data.

School District/ESD: Silver Falls 4j

County: MARION

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Structures Replaced? No

Name and Address:

Kind of Structure:

Type of Replacement:

Max Occupancy:

Date Occupied:

Structures Modified? Yes

Name and Address: Scotts Mills School 805 First St. Scotts Mills, OR 97375

Kind of Structure: Gymnasium, adjacent classrooms, cafeteria.

Type of Modification:

Full structural roof replacement and new roof to wall connections in gymnasium, structural reinforcement and connections of classrooms and cafeteria.

Date Re-occupied:

Optional:

Engineering Report? Yes *If yes, attachments are appended to this report.*

Cost of Rehab:

Method of Funding:

Seismic Rehabilitation Grant Program.

Notes:

Silver Falls School District

District Wide Seismic Evaluation - Marion County, Oregon

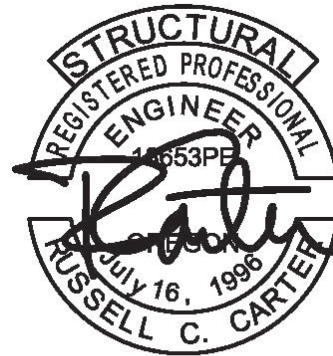
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1.0 Executive Summary

1.1 Background

The Silver Falls School District (District) is centrally located in Silverton, Oregon in Marion County, approximately 14 miles east of Salem, Oregon. The District operates out of thirteen schools located within the community, ten of which will be the subject of this evaluation.

The purpose of this report is to evaluate ten educational facilities of varied ages built in a high seismicity zone. The school facilities cover approximately 260,000 square-foot total, and are used for classrooms, administrative offices, and assembly areas. All of the school structures vary in style, age, condition, and use. All but one of the schools evaluated have received multiple additions. The schools studied as part of this planning effort include:

- Bethany Charter School
- Butte Creek Elementary School
- Central Howell Elementary
- Evergreen Elementary School
- Mark Twain Middle School
- Pratum Elementary School
- Robert Frost Elementary School
- Scotts Mills Elementary School
- Silver Crest Elementary School
- Victor Point Elementary School

The objective of this planning effort is to perform visual observations at each of the above mentioned schools to identify general structural deficiencies and perform a seismic performance expectation review of the structural systems in order to identify obvious deficiencies and necessary improvements. This study provides the District with recommendations and budgetary planning level construction values for each school along with specifically discussing the most significant deficiencies observed. It is recommended that the District use this report to prioritize improvements and determine interest in seeking grant funding through the seismic rehabilitation grant programs.

1.2 Observation Results

The following table summarizes the results of our observations and ranks each school based on the relative hazard severity of the observed deficiencies.

School	Relative Hazard Severity*	Recommended for Seismic Grant
Butte Creek Elementary School	High	Yes
Robert Frost Elementary School	High	Yes
Mark Twain Middle School	High	Yes
Scotts Mills Elementary School	High	Yes
Victor Point Elementary School	Moderate	Yes
Bethany Charter School	Moderate	Yes
Pratum Elementary School	Moderate	No
Silver Crest Elementary School	Moderate	No
Central Howell Elementary School	Moderate	No
Evergreen Elementary School	Low	No

**Relative Hazard Severity levels indicate perceived risk of substantial damage potential in the event of a seismic event based on our observations of the structural systems present and our past experience with similar structures and their performance during seismic events.*

**High relative hazard severities indicate buildings and/or portions of buildings that have a high collapse potential when exposed to loading from a code seismic event. It is our opinion that structures with a moderate relative hazard severity will experience structural damage during similar events, but the likelihood of collapse is reduced. Low relative hazard severities indicate buildings which will experience damage, but collapse is unlikely.*

1.3 Recommended Improvements

Below is a summary of the highest priority items observed during our review. Section 3.0 covers the specific deficiencies and subsequent recommendations observed in the seven schools listed below along with the deficiencies and recommendations at Central Howell, Evergreen, and Victor Point.

- Bethany Charter Elementary – Moderate Seismic Hazard
 - The exterior walls of the gymnasium are covered with lap siding rather than sheathing. The straight lap siding provides little lateral load resistance. Additionally, the roof is framed using bow-string trusses and 2x purlins. This type of roof structure is highly fragile and coupled with the large deflections expected with straight sheathed walls could result in substantial damage. The gymnasium walls can be sheathed with plywood relatively easy and retrofit solutions can be developed to increase the reliability of the bow-string trusses.
 - The original portion of the school was constructed over a rubble rock foundation. Current standards require that walls are attached to footings to

resist wind and earthquake loading. The existing rubble foundations should be retrofit or replaced utilizing cast-in-place concrete to ensure that the structure above is secured.

- Butte Creek Elementary – High Seismic Hazard
 - The original gymnasium roof is clearly deflecting under its own weight. Temporary shoring is highly recommended while a permanent solution is considered. It is our understanding that the deflections are monitored regularly and that limitations have been placed on the use of the original gymnasium when it snows. Failure of this roof while children are present could have catastrophic consequences and it is recommended that action is taken to shore up the roof structure at a minimum. Retrofitting the existing roof structure could be accomplished using new beams beneath the original beams.
 - Butte Creek Elementary - The walls of the original school structure are made of unreinforced masonry (URM) and are unreliable during seismic events. Additionally, the roof is straight sheathed and does not meet aspect ratios for existing structures. Retrofitting the existing walls to provide additional strength and installing plywood sheathing over the existing straight sheathed diaphragm are recommended.
- Robert Frost Elementary – High Seismic Hazard
 - The covered play area on the west side of the classroom pod structure was framed in the same manner as the rest of the pods and was intended to be infilled with classrooms as attendance increased. The classrooms were never added and the roof structure is supported solely with steel columns. This system does not provide a lateral load path to the foundation but can be retrofit using either infill shearwalls or cable bracing for relatively low costs.
- Mark Twain Middle – High Seismic Hazard
 - The front and rear elevations of the classroom wing almost exclusively consist of window packages. Gravity load bearing elements are located between windows; however, there is no lateral system at the exterior walls of the structure. This is coupled with a discontinuous diaphragm that was constructed with a roof step between the exterior and corridor walls. The lack of shearwalls can be rectified by infilling selective window panels. Additional analysis will be required to further evaluate and develop a solution to address the step in the roof diaphragm.
 - At the northern entrance to the school the canopy is supported by posts that, in our opinion, do not provide the resistance required to resist lateral loads. Further examination of the system can be performed, or additional posts with embedded footings can be installed to provide the required stability.
- Pratum Elementary – Moderate Seismic Hazard
 - The gymnasium is structurally independent from the rest of the school building and is constructed with tall concrete perimeter walls approximately 7 feet tall. From that point up, the walls are framed with 2x studs. This system creates a hinge part of the way up the wall and it does not appear to have been designed to withstand out-of-plane loading. Additional detailing can be

performed to ensure that the hinge is retrofit to support the required loading conditions.

- Scotts Mills Elementary – High Seismic Hazard
 - The gymnasium was originally designed as a pre-manufactured metal building with beam and column frame lines. When the building was constructed, the structural program was altered and the metal building roof system was utilized. In place of the steel columns, masonry walls and pilasters were constructed to support the steel girders. It is our opinion the metal roof diaphragm does not provide adequate out-of-plane support for the tall masonry walls and that no diaphragm to wall connections are present. To rectify this deficiency a structural steel system could be added to the perimeter walls to support the masonry under out-of-plane loading conditions.
- Silver Crest Elementary – Moderate Seismic Hazard
 - The 1970 addition to Silver Crest that houses the music room and library was framed utilizing a post and beam system with knee braces and rafters with collar ties. There was visible movement of the system, particularly at joints, and the connections are suspect. It is our opinion that this system would be unreliable during a code lateral event. Retrofitting the system or installing a new roof system is recommended.

At all schools with unreinforced masonry chimneys, replace the unreinforced masonry chimneys with a light-weight flue option.

1.4 Conclusions

Generally speaking, the condition of the District's schools was good based on their respective ages. The schools are, for the most part, well cared for buildings. The recommended improvements listed above reflect items that do not pose a substantial immediate risk to the life safety of occupants (unless noted otherwise) outside of code lateral events. It should be noted that structural deficiencies in schools of this age group are fully expected and the severity of the deficiencies noted above is not uncommon.

Many of these buildings started as small community schools and therefore the deficiency lists and recommended improvements may not be as large as expected. They were constructed in a redundant fashion using lightweight materials. Typically we start to see larger problems from a seismic standpoint when we come across heavy structures with few walls. Several of the schools with higher priority deficiencies listed above fall into this category. The smaller outlying schools have far less high priority deficiencies than the larger schools.

Construction costs to retrofit each of the schools observed will vary highly based on the degree of deficiencies being rectified. Seismic retrofit costs for structural improvements will likely range from \$5 to \$40 per square foot depending on the building being considered. These numbers are based on our experience retrofitting similar schools and cover both the highest priority deficiencies along with the lower priority deficiencies summarized for each building in Section 3.0.

It is clear based on the condition of the buildings that the District has invested in maintaining the buildings to get the most possible use out of each structure. To ensure that the District

continues to get the most out of their schools and provide a safe learning environment for the students, we would recommend generating a priority list for capital improvement projects to systematically address deficiencies as funds become available. Additionally, incremental improvements should be considered during projects that may make performing the work easier. For example, during a roof replacement project a good time to install connections from the roof diaphragm to the walls or a window replacement project is a good time to install shearwalls in place of windows in a wall line that does not have enough shearwall length.

Attention should be paid to the potential for upcoming seismic retrofit grant programs. Several of the schools noted above are good candidates for programs that can fund some or all of the expenses related to seismic retrofit of school buildings. Should the District be interested in pursuing grant funding for one or more schools, ZCS would be happy to provide proposals for assisting in the preparation of grant packages.

The balance of the report provides specific details regarding the construction of each school, observed deficiencies, and recommended repairs.

2.0 Project Overview

The Silver Falls School District is located in a high seismicity zone and contains multiple schools, ten of which are the focus of this evaluation. The objective of this planning effort is to perform visual observations at each of the above mentioned schools to identify general structural deficiencies and perform a seismic performance expectation review of the structural systems in order to identify obvious deficiencies and necessary improvements. This study provides the District with recommendations and planning level budgetary construction costs for each school along with specifically discussing the most significant deficiencies observed. It is recommended that the District use this report to prioritize improvements and determine interest in seeking grant funding through the seismic rehabilitation grant programs.

In order to accurately report the deficiencies for each school, a visit to each facility was required. During the visit to each facility, construction type and framing methods were noted along with any observed, obvious structural deficiencies.

The facilities covered by this evaluation total approximately 260,000-square-feet, and are used as elementary and middle schools. The age of each school and their additions are included and reflect the best information available. Each facility contained areas used for classrooms, administrative staff, assembly, etc. While each school was constructed differently, access to their structural systems was limited to observation only. Observed construction type for each school and a summary of each facility's additions and their respective construction types are located in Section 3.0.

2.1 Inspection Process and Participants

The following sections detail the inspection process and the individuals who participated in the inspections, and our methodology for review of deficiencies.

2.1.1 Inspection Process

Each school investigation was performed using a similar inspection process. The process was as follows:

- Compile all available documentation citing relevant information to be used on-site
- Review available as-constructed building information
- Arrive on-site
- Inspect the exterior of the school and note obvious deficiencies
- Begin inspections at the entrance of the school and document each observable deficiency. Comment on general condition of each building.
- Photograph each deficiency
- Document structural framing methods used for each building
- Advance through each structurally independent portion of the building and make observations
- Complete interior and exterior photographic documentation

2.1.2 Participants

In order to identify deficiencies, improvement needs, condition, and other qualities of the existing schools, a detailed inspection effort was planned utilizing several individuals offering different perspectives and areas of expertise. Inspections were performed on October 10th and October 11th 2013.

A list of those who participated in the inspection process is provided in the table below:

Name	Company
Sy Allen, PE	ZCS Engineering, Inc.
Zach Stokes, PE	ZCS Engineering, Inc.
Morgan Kruse	ZCS Engineering, Inc.
Bob Collins	Hill International, Inc.
Pete Paradis	Silver Falls School District

Additionally, custodial and maintenance staff were interviewed when available during the inspections regarding any concerns with their respective schools and the subject school's overall performance.

2.2 Building Deficiency Review

The report provides a brief description of the deficiencies observed during our on-site investigation for each school. Each of the deficiencies identified corresponds to the items outlined in *ASCE 31-03: Seismic Evaluation of Existing Buildings*. As a guideline for each of the inspections and the building review, checklists included in the document were reviewed for the structure types within each school. A summary of each building's structural systems and observed deficiencies is provided in Section 3.0.

Our observation focused specifically on items of known concern in buildings constructed around each school's time period and were based strictly on visual observation. Some deficiencies noted in Section 3.0 may not be present upon further exploratory inspection and evaluation. Additionally, there are other deficiencies that may be present upon further inspection despite our attempts to cover all areas of concern. Contingency values are recommended on top of the budgetary construction costs presented in Section 4.0 to cover these costs.

For the purposes of this report, deficiencies were categorized based on their severity and impacts to the structure and safety of occupants. High priority deficiencies include items where the likelihood of structural failure and collapse during a seismic event is substantial. Low priority deficiencies were considered to be lower hazard without possibility of structural collapse. Low priority deficiencies will, in our opinion, still damage a structure during a seismic event but they generally will only inflict damage into a localized area of a building, creating falling debris, but not blocking points of egress. Particular attention has been paid to high priority deficiencies in Section 3.0 and in the generation of the building rankings and planning level budgetary construction cost generation. Each school was ranked as either a high, moderate or low relative hazard based on the number and degree of deficiencies present.

3.0 Structure Summaries, Observed Deficiencies, and General Repair Recommendations

The information obtained through the on-site observations outlined in Section 2.0 is summarized below. A general summary of each structurally independent portion of the building is provided followed by a table summarizing the deficiencies observed. Lastly, a list of repair recommendations is provided.

3.1 Bethany Charter School – Moderate Seismic Hazard



Figure 1: Bethany Charter School

3.1.1 Structure Summary

The following summarizes the structural systems for each portion of Bethany Charter School:

- **Early 1900's Original:** The original single-story structure consists of wood framing with a flexible diaphragm. The foundation consists of floor joists above a crawl space with rock/rubble stem walls. The roof is framed with rafters and site-built trusses along bearing lines and the diaphragm consists of straight roof sheathing. This structure houses several classrooms and is approximately 3,600-square-feet.

- **1968 & 1974 Addition:** These buildings are two structures added with similar construction types at different times. The construction consists of 8-inch CMU walls with a flexible diaphragm. The foundation is a slab-on-grade with concrete stem walls, and the roof framing consists of open-web bar joists with steel bar cross bracing at bearing wall locations and a plywood diaphragm. These structures house administration offices, classrooms, bathrooms, a library, and are approximately 3,900-square-feet.
- **Gymnasium Addition (Estimated pre-1950):** The gymnasium consists of two wood framed structures constructed at different, but unknown, times. The foundation for both is slab-on-grade, and the roof rafters are supported by two bow-string trusses and perimeter bearing walls. The main gymnasium structure wall construction consists of straight lap siding and 2x4 walls. The gymnasium addition is supported by wood columns, and is framed with wood framed walls and roof purlins. Combined, the structures house a gymnasium, storage room, and overall are approximately 2,600-square-feet.
- **Covered Play Structure**

3.1.2 Observed Deficiencies

The following list summarizes the deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • LOAD PATH: Due to presence of rock/rubble stem walls, no lateral load path is present to grade. • URM CHIMNEYS: An unreinforced masonry chimney is present. • STRAIGHT SHEATHING: A straight sheathed roof diaphragm is present.
1968 & 1974	<ul style="list-style-type: none"> • TIES: Brick veneer is present on the front elevation and is not likely tied to structure.
Gymnasium	<ul style="list-style-type: none"> • LOAD PATH: The bow string truss load path is suspect. Bow string truss design has proven to be unreliable, particularly under high loads and/or seismic events. • FOUNDATION PERFORMANCE: The slab-on-grade is cracked, substantially in some locations. • SHEAR STRESS: The straight sheathing on the gymnasium walls exceeds the allowable stress for a straight sheathed wall.
Covered Play Structure	<ul style="list-style-type: none"> • LOAD PATH: The outside play area was constructed without lateral support on two sides. • DETERIORATION OF WOOD: The outside play area walls show signs of deterioration.

3.1.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** The rubble rock foundation supporting the original school building needs to be strengthened and solidified and the roof diaphragm may need strengthened. Recommendations include:
- Retrofitting the existing walls with cast-in-place concrete footings and stemwalls.
 - Provide attachment of the existing walls to the new foundation elements.
 - Install plywood sheathing above existing straight sheathed diaphragm.
- B)** The covered play area only has lateral resistance on two sides of the structure and is showing signs of deterioration on several structural members. Recommendations and alternates include:
- Add an embedded pole system or in-fill one bay in each direction with shearwalls to provide lateral resistance on all sides.
 - Remove and replace weather damaged structural elements with treated member.
- C)** The gymnasium structure is supported by two bow string trusses which have shown low reliability in the past. The walls are also constructed out of straight sheathing. Recommendations include:
- Retrofit the bowstring trusses to ensure they provide adequate strength during code events.
 - Sheath the walls with plywood sheathing and replace the siding.
- D)** Remove the URM chimney
- E)** The brick veneer present on the 1968 addition is likely not tied to structure. Additional inspection should be performed and if veneer ties are not present retrofit ties should be installed.

F) 3.2 Butte Creek Elementary



Figure 2: Butte Creek Elementary School

3.2.1 Structure Summary

The following summarizes the structural systems for each portion of Butte Creek Elementary School:

- **1949 Original:** The original school building consists of unreinforced masonry with a flexible wood diaphragm. The school roof is framed with rafters and straight roof sheathing. The original gymnasium was constructed with concrete walls and a flexible wood diaphragm. The foundation consists of slab-on-grade. A beam and pilaster system is present in the original gymnasium. The gymnasium shows significant signs of deflection under several beam lines and in one location an additional glulam beam was installed beneath an original beam line to help support the roof. This structure houses an administrative office, several classrooms, an assembly area, and is approximately 13,200 square feet.
- **1962 Addition:** Construction consists of light timber framing with a flexible diaphragm and brick veneer. The foundation is a slab-on-grade. This structure houses several classrooms, an administrative room, and is approximately 3,500 square feet.
- **1966 Addition:** Construction consists of light timber framing with a flexible diaphragm. The foundation is a slab-on-grade and the roof is constructed with

site-built trusses. One side of this addition has brick veneer. This structure houses several classrooms, and is approximately 3,700 square feet.

- **1968 Addition:** Construction consists of light timber framing with a flexible diaphragm. The foundation is a slab-on-grade and the roof is constructed with built-up TGI beams that cantilever over the exterior breezeway. 2x purlins are utilized in between the cantilevered beams. The breezeway was enclosed at some point after initial construction to provide an interior environment. This structure houses several classrooms, and is approximately 2,600 square feet.

1978 Addition: Construction consists of light timber framing with a flexible diaphragm at the portion of building containing classrooms. The gymnasium was constructed using concrete tilt-up panels. The foundation is a slab-on-grade. The roofs utilize manufactured TJI rafters with plywood roof sheathing in the portion of building containing classrooms, and steel joists with steel decking in the gymnasium. This addition houses several classrooms, a gymnasium, and is approximately 18,400 square feet.

Attached to the exterior of the gymnasium is a covered play structure consisting of two portions constructed at separate times. The newest portion of the play structure is a steel pre-manufactured frame canopy with steel decking and cable bracing. The older portion utilizes open-web joists bearing on an exterior wood framed wall and the tilt-up wall panels.

3.2.2 Observed Deficiencies:

The following list summarizes the deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • URM: Unreinforced masonry walls are present and have shown to be unstable during seismic events. • NARROW WOOD SHEAR WALLS: More openings than shear wall indicate additional shear wall may be required. • URM CHIMNEYS: An unreinforced masonry chimney is present. • SPAN: Straight sheathed diaphragm spans farther than 24 feet. • DETERIORATION: The gymnasium roof appears to be yielding due to its own self-weight. • LOAD PATH: Drag elements above the cafeteria windows appear to be suspect. This could prevent load from reaching the shear walls. • STRAIGHT SHEATHING: A straight sheathed roof diaphragm is present.

1962 Addition	<ul style="list-style-type: none"> • NARROW WOOD SHEAR WALLS: More openings than shear wall indicate additional shear wall may be required. • TIES: The brick veneer is likely not tied to stud framing.
1966 Addition	<ul style="list-style-type: none"> • DETERIORATION: The exterior roof fascia is deflecting due to its own self-weight. • TIES: The exterior brick veneer is likely not tied to stud framing. • DETERIORATION: The brick veneer shows signs of fatigue and weathering.
1978 Addition	<ul style="list-style-type: none"> • LOAD PATH: The original portion of the exterior canopy is likely not connected properly for out-of-plane loading to the concrete tilt-up panel walls of the gymnasium. • PANEL-TO-PANEL CONNECTIONS: Joint filler present between tilt-up concrete panels shows signs of deterioration. • ADJACENT BUILDINGS: The gymnasium and the adjacent classroom building do not meet the required clear distance.

3.2.3 Recommendations:

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** The walls of the original school structure are made of unreinforced masonry and are unreliable during seismic events. The roof is straight sheathed and does not meet aspect ratios for existing structures. The gymnasium roof appears to be yielding beneath its own weight and needs to be shored and rehabilitated. Recommendations include:
- Retrofit existing URM walls with reinforced masonry or wood framed walls sections to provide increased reliability.
 - Add plywood sheathing over the top of the existing straight sheathing.
 - Remove and replace damaged portion of original gymnasium roof or strengthen the existing system with new underslung beams.
 - Install a continuous load path element above the existing windows in the gymnasium to drag lateral loads into the shear walls below.
 - Remove the URM chimney.
- B)** The 1962 addition has brick veneer that likely does not have ties to the supporting framing. There are also isolated locations where the brick veneer is damaged. This addition does not have much shear wall length available. Recommended improvements include:
- Add brick veneer ties to existing brick veneer.
 - Replace brick veneer in locations damage is present.

- Selectively in-fill windows to provide adequate shear wall length.
- C)** The 1966 addition is generally in good condition. The roof on one end of the structure is currently sagging where it overhangs at an egress location. Additionally, the brick veneer likely does not have veneer ties to framing and some of the bricks appear to be damaged. Recommendations for improvements include:
- Repair or retrofit roof where fascia elements are sagging.
 - Add brick veneer ties to existing brick veneer.
 - Replace brick veneer in locations damage is present.
- D)** The 1978 addition appears to be in good condition. At some point an outdoor covered play area was added and attached to the structure. The attachment at the top of the concrete tilt-up panels is of concern and needs to be investigated and/or retrofit. Additionally, some of the concrete tilt-up panels have deteriorated joint sealant. The gymnasium is directly adjacent to nearby classrooms constructed using different construction materials. The gymnasium is also much taller than the adjacent classrooms. The difference in materials and height could cause problems with pounding during a seismic event. Recommendations include:
- Provide out-of-plane connections as required from covered play structure to top of concrete tilt-up panel at the newer gymnasium addition.
 - Provide new joint filler and epoxy between tilt-up concrete panels.
 - Provide strapping between the gymnasium and adjacent building to limit effects of pounding.

3.3 Central Howell Elementary



Figure 3: Central Howell Elementary School

3.3.1 Structure Summary

The following summarizes the structural systems for each portion of Central Howell Elementary School:

- **1923 Original:** The original building consists of wood framing with a flexible diaphragm. This is a single story structure over a partially exposed basement with a slab-on-grade foundation and concrete retaining walls. The floor is framed with joists, heavy timber beams, heavy timber posts, and straight sheathing. The roof uses a rafter and beam system with collar ties and plywood sheathing over 1x straight sheathing. The ceiling has plaster finishes. This structure houses an administrative office, several classrooms, and is approximately 5,000 square feet.
- **1955 & 1966 Addition:** These buildings are identical, standalone pod-like structures constructed at different times. Construction consists of light weight wood framing with a flexible diaphragm. The foundation is a slab-on-grade floor with concrete stem walls and the roof framing consists of 2x12 rafters and glulam beams. This structure houses several classrooms and bathrooms and is approximately 6,600 square feet. Attached to one end of the structure is a flexible canopy with wood purlins and steel beams supported by steel pipe columns.

- **1974:** This addition consists of 6” concrete tilt-up panels with a flexible diaphragm. The concrete panels were constructed full height with top chord bearing open-web joists and a plywood sheathing diaphragm. One small portion of a northern panel has spalled, potentially as a result of panel displacement from foundation settlement combined with water intrusion at the joint. Additionally, the interior concrete slab-on-grade has experienced significant settling around the perimeter. This structure is standalone and houses a gymnasium, storage room, and is approximately 5,000 square feet.
- **1995 Addition:** This addition consists of light weight wood framing with a flexible diaphragm and is an addition to the original structure. The foundation is a slab-on-grade and the walls are constructed with 2x6 studs and plywood sheathing. Roof framing is manufactured trusses with plywood sheathing. Wall finishes consist of gypsum board and horizontal lap siding. Roof finishes consist of asphalt composition roof shingles and a suspended ceiling system on the interior. This structure houses an administrative office, and is approximately 1,000 square feet.

3.3.2 Observed Deficiencies:

The following list summarizes the deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • NARROW WOOD SHEAR WALLS: More openings than shear wall indicate additional shearwall may be required. • URM CHIMNEYS: An unreinforced masonry chimney is present.
1955 & 1966 Addition	<ul style="list-style-type: none"> • NARROW WOOD SHEAR WALLS: More openings than shear wall indicate additional shear wall may be required. • LOAD PATH: The covered play structure at south end of the building is likely not adequately laterally supported.
1974	<ul style="list-style-type: none"> • PRECAST CONCRETE WALLS: Signs of deterioration between concrete panels are present. • PANEL-TO-PANEL CONNECTIONS: Adjacent wall panels show signs of distress. • FOUNDATION PERFORMANCE: The perimeter of the slab-on-grade shows signs of significant settlement. • WALL ANCHORAGE: Out-of-plane connections at the top of wall are required.
1995 Addition	<ul style="list-style-type: none"> • LAY-IN TILES: Ceiling panels are not seismically braced.

3.3.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** The walls of the original school structure have limited available shear walls and may not provide enough lateral resistance during a seismic event. Recommendations include:
- Selectively in-fill windows and provide additional available shear wall length as required.
 - Remove the existing URM chimney.
- B)** The 1955 and 1966 additions are pod-like structures that have an identical floor plan but were built at different times. These buildings appear to be in good condition but they do not have any shear resistance on the west elevation. Additionally, a covered play structure was installed adjacent to the southern pod and it does not appear to have any lateral resistance system in place. Recommendations for improvements include:
- Provide embedded poles to support the covered play structure for lateral loads.
 - Selectively in-fill windows to provide additional shear wall length as required.
- C)** The 1974 addition was constructed using concrete tilt-up panels. Over time, the foundation supporting the panels appears to have settled and caused the perimeter of the slab to slope to the exterior walls. A chunk of concrete has spalled on the exterior of the north end of the structure. In our opinion, this was caused by panel separation and water intrusion following failure of the joint filler between the panels. Also of concern is that the connection between panels may potentially be damaged due to the separation of the panels. Recommendations for improvements include:
- Investigate the connections from the roof to the top of the wall. If deficiencies are present, retrofit with in-plane and out-of-plane ties.
 - Investigate the connections between panels and determine if a connection retrofit is necessary. Provide new joint filler and epoxy between panels.
 - It is our understanding that the building has stopped moving, if this is not the case the foundation should be monitored for additional settlement. If no additional settlement occurs, repair the interior slab where feasible and repair the spalled tilt-up panel. In the event that movement is still present, a geotechnical engineer should be consulted for further evaluation and retrofit solution recommendations.

3.4 Evergreen Elementary



Figure 4: Evergreen Elementary School

3.4.1 Structure Summary

The following summarizes the structural systems for each portion of Evergreen Elementary School:

- **1920's Original:** The original building consists of wood framing with a flexible diaphragm. This is a single story structure over a partially exposed basement with a slab-on-grade foundation and concrete retaining walls. The floor is framed with joists, heavy timber beams, heavy timber posts, and straight sheathing. The roof is framed using a rafter and beam system with a straight sheathed roof diaphragm. The ceiling utilizes 1'-0" x 1'-0" tile grid finish system. This structure houses an administrative office, several classrooms, and an assembly area. The basement contains a kitchen and classrooms. Both stories combined are approximately 5,600 square feet.
- **1950 Addition:** This addition consists of light weight wood framing with a flexible diaphragm. The construction consists of a slab-on-grade foundation. This structure houses classrooms and storage and is approximately 1,500 square feet.

- **1974:** This addition is a covered play structure that consists of a pole barn framing system with a flexible diaphragm. The foundation consists of a slab-on-grade, while the roof framing is constructed with 2x purlins and metal roofing. This structure is standalone and approximately 2,500 square feet.

3.4.2 Deficiencies:

The following list summarizes the structural seismic deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • DETERIORATION OF WOOD: The existing beam above the front of the stage is visibly deflecting. • NARROW WOOD SHEAR WALLS: More openings than shear wall indicate additional shear wall may be required. • URM CHIMNEYS: An unreinforced masonry chimney is present. • CONNECTION: Post to beam connections may be deficient. • STRAIGHT SHEATHING: A straight sheathed roof diaphragm is present.
1950 Addition	<ul style="list-style-type: none"> • NARROW WOOD SHEAR WALLS: More openings than shear wall indicate additional shear wall may be required. • GEOMETRY: Horizontal irregularities along north end of building are present.

3.4.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** The original structure contains a stage on one end of the upper floor and the beam running across the front end of the stage is showing signs of deflection. Additionally, the front of the structure does not have much wall length available for shear walls and there is not an observable connection from the posts to the beams that bear on them in the basement. Recommendations for improvements include:
- Strengthen, shore, or remove and replace the beam above the stage.
 - Selectively in-fill windows to provide additional shear wall length as required.
 - Remove the URM chimney.
 - Provide post-to-beam connections where applicable.
 - Add plywood sheathing over the top of the existing straight sheathing.

B) The 1950 addition to the school has a horizontal irregularity on one side of the structure. The same side of the structure also has a solid line of windows. Recommendations for improvements include:

- Rectify the horizontal irregularity by adding an embedded post to one end of the existing overhang.
- Selectively in-fill windows to provide additional shear wall length as required.

3.5 Mark Twain Middle School



Figure 5: Mark Twain Middle School

3.5.1 Structure Summary

The following summarizes the structural systems for each portion of Mark Twain Middle School:

- **1957 Original:** The original building consists of wood framing with a flexible diaphragm. This is a single story structure with a slab-on-grade. The roof is framed with rafters, glulam beams, and tongue and groove decking. The gymnasium was constructed with glulam arch beams and wood purlins beneath tongue and groove decking. The original school structure houses administrative offices, classrooms, assembly areas, and is approximately 30,000 square feet.
- **1958 Addition:** This addition consists of wood framing with a flexible diaphragm. The structure is single story with a slab-on-grade foundation. The roof is framed with rafters, glulam beams, and tongue and groove decking. This addition houses classrooms and is approximately 2,500 square feet.
- **1959 Addition:** This addition consists of wood framing with a flexible diaphragm. The structure is one story with a basement with a slab-on-grade foundation and concrete retaining walls. The floor is framed with 2x joists and diagonal sheathing, and the roof is framed with rafters, glulam beams, and tongue and groove decking. This addition houses classrooms and is approximately 9,800

square feet.

There is also an exterior wood framed canopy attached to the structure and supported by steel pipe columns. The canopy is approximately 500 square feet and is located above an exit.

- **1966 Addition:** This addition consists of wood framing with a flexible diaphragm. The structure is single story with a slab-on-grade foundation. The interior walls are constructed with 8" masonry block. The roof is framed with rafters, beams, and tongue and groove decking. This addition houses classrooms and is approximately 4,000 square feet.

3.5.2 Observed Deficiencies:

The following list summarizes the deficiencies observed during our visual inspections:

Building	Deficiency
Original & 1959 Addition	<ul style="list-style-type: none"> • LOAD PATH: Due to diaphragm irregularities, the interior shear walls do not provide a load path from the roof connected to the exterior walls. • OPENINGS: More than 80% of the exterior wall length consists of openings and are not braced by wood structural panels. • URM CHIMNEYS: An unreinforced masonry chimney is present. • DIAPHRAGM CONTINUITY: The diaphragm is composed of split levels. • DETERIORATION: The exterior canopy posts show signs of deterioration. • LOAD PATH: The exterior canopy does not have a lateral load path. • STRAIGHT SHEATHING: A straight sheathed roof diaphragm is present.
1966	<ul style="list-style-type: none"> • LOAD PATH: The interior CMU walls may require additional bracing to develop earthquake loading into the structure.

Note: In order to prevent future problems with the glulam arch beam located externally to the gymnasium, routine maintenance will help prevent rot from occurring at the base of the beam and prevent future problems.

3.5.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** This school contains an original structure and two substantial additions. The two substantial additions did not have any observable deficiencies for recommended improvements. However, it appears additional detailing and retrofit are required to properly attach the interior CMU walls to the timber structure in the 1960 addition.

B) The most notable deficiencies were the step in the diaphragm located down the center of the classroom wing and the lack of shearwalls along the exterior longitudinal walls. The roof that is attached to the exterior walls spans to an interior glulam beam, which runs parallel with the exterior walls and is located between the exterior walls and the interior corridor walls. The glulam beam creates a step in the roof. The step coupled with the lack of exterior wall line shearwalls is a major deficiency. The lower portion of the diaphragm cannot cantilever into the interior shear walls. Recommendations for improvements include:

- Selectively in-fill windows to provide additional shear wall length as required.
- Provide additional detailing and connections to improve the load transfer between the diaphragm levels.
- Remove the URM chimney.
- Remove deteriorating canopy framing and replace with similar framing.
- Install embedded posts to support lateral loads imposed on the canopy at the north end of the building.
- Add plywood sheathing over the top of the existing straight sheathing.

3.6 Pratum Elementary



Figure 6: Pratum Elementary School

3.6.1 Structure Summary

The following summarizes the structural systems for each portion of Pratum Elementary School:

- **1928 Original:** The original building consists of wood framing with a flexible diaphragm. This is a single story structure with a partially exposed basement and a slab-on-grade foundation with concrete retaining walls. The floor is framed with joists, timber beams, timber posts, and diagonal sheathing. The roof framing consists of site-built trusses with 1x sheathing overlaid with plywood. This structure was added onto the east end at an unknown time and it appears that the addition was constructed in a similar manner. This structure houses an administrative office, several classrooms, and is approximately 5,300 square feet.
- **1996:** This addition consists of light timber framing with a flexible diaphragm. Construction consists of slab-on-grade foundation with tall concrete stem walls and light timber framed walls constructed with 2x8 studs and plywood sheathing. Wall and roof finishes consist of manufactured metal siding. This standalone structure houses a gymnasium and storage room and is approximately 4,300 square feet.

3.6.2 Observed Deficiencies:

The following list summarizes the structural seismic deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • NARROW SHEAR WALLS: More openings than shear wall indicate additional shear wall may be required. • DETERIORATION: The stem wall at the front of the structure shows signs of deterioration. • URM CHIMNEY: An unreinforced masonry chimney is present.
1996 Addition	<ul style="list-style-type: none"> • LOAD PATH: Tall concrete stem walls and wood framed walls may form a hinge in the wall and may not provide required out-of-plane lateral resistance. • SOFT STORY: Stiffness in west wall of gymnasium appears inadequate.

3.6.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** Some cracking is present on the exterior of the stemwalls on the original building. Additionally, the front elevation of the school appears to not have enough shear walls. Recommendations for original school include:
- Selectively in-fill windows to provide additional shear wall length as required.
 - Repair the deterioration in the foundation using joint filler and epoxy to prevent future deterioration.
 - Remove the URM chimney.
- B)** The gymnasium has an observable hinge partway up the walls. The lower portion of the wall is a tall concrete stem wall and the upper portion is wood framed. The connection between these two construction methods forms a hinge which, in our opinion, is unable to resist code out-of-plane forces. Also, the west wall of the gymnasium was a large opening that may affect the ability of the structure to transfer in plane loading to the foundation. Recommendations and alternates for the 1996 addition include:
- Improve the out-of-plane connections for the gymnasium wall the concrete to wood wall interface.
 - Reinforce the opening in the gymnasium wall to prevent soft story failure by improving the load path connections between the beam and the wall.

3.7 Robert Frost Elementary



Figure 7: Robert Frost Elementary School

3.7.1 Structure Summary

The following summarizes the structural systems for Robert Frost Elementary School:

- 1970 Original:** The original building consists of light weight wood framing beneath brick veneer with a flexible diaphragm. The foundation is slab-on-grade with concrete stem walls. The walls frame consists of 2x framing with plywood sheathing and the brick veneer is reinforced and attached to the supporting framing. The roof framing consists of manufactured trusses and glulam beams. This structure houses classrooms, administrative offices, assembly areas, a covered play area, and is approximately 51,600 square feet.

3.7.2 Observed Deficiencies:

The following list summarizes the deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> LOAD PATH: The north-west covered play area lacks a lateral load path to the foundation. DETERIORATION: The ceiling in the gymnasium has a visible belly in the ceiling finishes.

-
- DETERIORATION: The roof framing members at the north-west covered play area are severely weathered.
-

3.7.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

This school does not have any additions or expansions like the rest of the district's schools. The overall condition of the school was good but there was one notable deficiency. The covered play area, which has a roof structure that is framed in the same manner as each of the other classroom pods, was intended to be enclosed and converted into classroom space. However, the classrooms were never added and now the roof structure is supported by steel pole columns which have no lateral load path to the foundation. The recommended improvements include:

- Retrofit the play structure using cable bracing or shearwall infill to provide adequate lateral load transfer to the foundation.
- Protect and monitor the performance of lightly weathered wood to ensure decay does not affect their structural integrity.

The slight belly in the ceiling of the gymnasium should be monitored for additional movement. In the event that additional movement occurs a registered engineer should be consulted to perform further evaluation.

3.8 Scotts Mills Elementary



Figure 8: Scotts Mills Elementary School

3.8.1 Structure Summary

The following summarizes the structural systems for each portion of Scotts Mills Elementary School:

- **1966 Original:** The original building consists of light weight wood framing with a flexible diaphragm. The foundation is slab-on-grade. The roof framing consists of manufactured plate trusses. This structure houses classrooms and is approximately 6,900 square feet.
- **1974 Addition:** This addition consists of 8" masonry block walls with a flexible diaphragm. The floor is a slab-on-grade and the roof was constructed using manufactured wood trusses with plywood roof sheathing. The gymnasium roof was constructed using prefabricated steel roof beams, purlins, and metal roofing, and the walls were constructed using 8" masonry block and masonry pilasters located at each steel beam. Additionally, a storage room was added to the east of the gymnasium with CMU walls and light timber roof framing. These structures house classrooms, a gymnasium, a storage room, and are approximately 11,300 square feet.

- **1979 Addition:** This addition consists of 8" masonry block walls with a flexible diaphragm. Floor construction consists of a slab-on-grade foundation and the roof is constructed with rafters, beams and bearing walls. This structure houses a library, administrative office, storage room, and is approximately 1,900 square feet.

3.8.2 Observed Deficiencies:

The following list summarizes the deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • DETERIORATION: The posts at the exterior breezeway show signs of decay.
1974 Addition	<ul style="list-style-type: none"> • LOAD PATH: The roof overhang at the storage room is supported by a steel pipe column which does not provide adequate gravity load path to the foundation. • LOAD PATH: The steel roof system on top of the gymnasium likely does not have a lateral load path through the masonry pilasters to the foundation. • LOAD PATH: Because of the differing roof and wall construction types, out-of-plane connection at the top of the masonry walls is not present and results in an unstable system during a code event. • DETERIORATION: The masonry units in the gymnasium are showing signs of deterioration and weathering.

3.8.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** Several of the buildings on the campus have similar framing methods even though they were constructed at different times. The observed condition of these buildings was good. Recommendations for the original structure include:
- Remove and replace all deteriorated posts supporting the exterior breezeway.
- B)** The gymnasium was originally designed as a steel building with steel columns and steel girders. When this building was constructed, the steel roof was used but it was built with masonry walls and masonry pilasters beneath the steel girders. The addition to the gymnasium appears to be a storage room onto the end of the structure. The storage room addition has a diaphragm that appears to cantilever over the bearing walls, creating an overhang on one side of the building. This overhang is supported only by a

steel column, which does not appear to provide adequate support. Recommendations for the 1974 addition include:

- Retrofit the existing CMU and metal building hybrid system to accommodate in-plane and out-of-plane loading. Provide connections to transfer loads to shearwalls and add cable bracing to develop diaphragm forces.
- Provide a beam and column line as required to support the cantilevered end of the storage room overhang.
- Install a concrete pad beneath the tank located outside of the gymnasium.

3.9 Silver Crest Elementary



Figure 9: Silver Crest Elementary School

3.9.1 Structure Summary

The following summarizes the structural systems for each portion of Silver Crest Elementary School:

- **1947 Original & 1950 Addition:** The original building consists of wood framing with a flexible diaphragm. This is a single story structure with a partially exposed basement with a slab-on-grade foundation and concrete retaining walls. The floor is framed with joists, timber beams, timber posts, and diagonal sheathing. This structure houses an administrative office and several classrooms and is approximately 8,700 square feet.
- **1970:** This standalone addition consists of wood framing with a flexible diaphragm. This is a barn-like structure with a slab-on-grade foundation. The roof is framed with rafters, collar ties, and a post and beam system. The exterior finishes are metal siding and roofing consistent with a barn. This structure houses a library and music room and is approximately 3,800 square feet.
- **1975 & 1978:** These standalone additions consist of wood framing with a flexible diaphragm. These buildings were built in a similar manner with a slab-on-grade foundation. The roofs are framed with manufactured plate trusses. The exterior finishes consist of horizontal lap siding. Interior finishes consist of gypsum board

wall finishes and a tile grid ceiling. These structures house several classrooms and cover approximately 8,600 square feet.

- **1987:** This standalone addition consists of wood framing with a flexible diaphragm. The foundation is a slab-on-grade. The walls are framed with 2x8 studs with plywood sheathing, and the roof framing consists of site-built trusses with plywood roof sheathing. The exterior wall finishes are metal siding. This structure houses a gymnasium and lockers rooms, and is approximately 7,600 square feet.

3.9.2 Observed Deficiencies:

The following list summarizes the structural seismic deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • MISCELLANEOUS: The fish tank adjacent to a path of egress could create a hazard if not properly attached during a seismic event. • DETERIORATION: Damage to the stem wall at the exterior of the building is present. • URM CHIMNEYS: An unreinforced masonry chimney is present.
1970	<ul style="list-style-type: none"> • DETERIORATION OF WOOD: The ridge beam shows signs of distress. • DETERIORATION OF WOOD: The interior posts and connections show signs of deflection. • LOAD PATH: The collar tie system may be inadequate and creating large loads at the top of the walls that cannot be supported.

3.9.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

- A)** This school has several additions and the original structure. Recommendations for improvement to the original structure include:
- Remove the URM chimney.
- B)** The gymnasium and barn structure had the main observable deficiencies. The ridge on the roof of the barn and some of the interior posts are visibly deflecting. The collar ties providing support for the roof are also suspect. Recommendations for improvements to the 1970 addition include:
- Replace the roof system or retrofit existing components to increase reliability during lateral events and high gravity loading events.

- C)** Another notable concern at the school was the large fish tank located in the office. The fish tank weighs approximately one ton and could potentially cause damage or block the exit during a seismic event. Miscellaneous recommendations include:
- Move the fish tank or restrain it from moving laterally.

3.10 Victor Point Elementary



Figure 10: Victor Point Elementary School

3.10.1 Structure Summary

The following summarizes the structural systems for each portion of Victor Point Elementary School:

- **Original (1947, 1956, 1966):** The original building and the listed additions were built at different times but all appear to have similar construction. Each portion consists of cast in place concrete walls with a flexible diaphragm. The foundations are slab-on-grade and the roofs are framed with rafters and straight sheathing. A suspended ceiling system is present throughout the school. The original structure houses an administrative office, a library, several classrooms, and is approximately 5,000 square feet. The 1956 addition houses several classrooms, and is approximately 1,250 square feet. The 1966 addition houses several classrooms, and is approximately 4,400 square feet.
- **1975 Addition:** This addition houses the gymnasium and stage and is a pre-manufactured metal building system with a slab-on-grade foundation. This structure is approximately 6,600 square feet.
- **1989 Addition:** This addition consists of 8" concrete masonry units with a flexible diaphragm. The foundation is a slab-on-grade and the roof utilizes open-web bar joist rafters with plywood sheathing. This structure houses several

classrooms, computer and science labs, an administrative room, and is approximately 4,100 square feet.

- **Play Shed (date unknown):** This addition consists of 8" concrete masonry block with a flexible diaphragm. This structure houses an enclosed play area and storage, and is approximately 3,000 square feet.

3.10.2 Deficiencies:

The following list summarizes the structural seismic deficiencies observed during our visual inspections:

Building	Deficiency
Original	<ul style="list-style-type: none"> • URM CHIMNEYS: An unreinforced masonry chimney is present. • NARROW SHEARWALLS: More openings than shear walls indicate additional shearwalls may be required. • WALL ANCHORAGE: Out-of-plane connections at the top of wall are required. • STRAIGHT SHEATHING: A straight sheathed roof diaphragm is present.
Play Shed	<ul style="list-style-type: none"> • DETERIORATION: The west wall is showing signs of deterioration on the masonry units. • GEOMETRY: Horizontal irregularities are present along the east wall of the structure. • WALL ANCHORAGE: Out-of-plane connections at the top of wall are required.

3.10.3 Recommendations

The following are rehabilitation recommendations to address the observed deficiencies and achieve adequate standards for Life Safety. Alternate repair strategies may be presented.

A) This school consists of several additions but they were constructed using the same or similar materials. In our opinion, the additions will function together well in the event of an earthquake. The overall condition of the school appears to be good. The east wall line of the existing structure appears to be lacking enough shear wall length to provide adequate lateral resistance. Recommendations for the original school include:

- Investigate the connections from the roof to the top of the wall. If deficiencies are present, retrofit with in-plane and out-of-plane ties.
- Remove the URM chimney.
- Add additional shearwall length by selectively infilling windows to create more shear wall length as required.
- Add plywood sheathing over the top of the existing straight sheathing.

B) The play shed along the west side of the property is showing signs of deterioration and the east wall of the structure has a large opening that has been covered with metal siding. Posts are present to support the roof but additional shearwall is necessary. Recommendations for improvement include:

- Repair or replace the deteriorated masonry units on the play shed.
- Infill one bay toward the south end of the structure with a CMU shear wall.
- Investigate the connections from the roof to the top of the wall. If deficiencies are present, retrofit with in-plane and out-of-plane ties.

4.0 Building Condition Summary

The following section summarizes the building deficiency information presented above for each of the schools reviewed in Section 3.0. Each school was ranked as either a high, moderate or low relative hazard based on the number and degree of deficiencies present. A table is provided listing the relative hazard severity at each of the ten schools.

4.1 Building Deficiencies Summary

Throughout the inspections there were two observable types of deficiencies. High priority deficiencies were generally considered to increase the likelihood of structural failure and collapse during a seismic event. Low priority deficiencies were considered to be items that result in the building being less equipped to handle the effects of seismic events but would not lead to structural collapse without other deficiencies present. Low priority deficiencies will still damage a structure during a seismic event but they generally will not result in structural failure alone. In addition to the observed deficiencies it is assumed that unseen deficiencies such as the following are present in many of the schools:

- Roof and floor-to-wall connections
- Wall-to-foundation attachments
- Seismic bracing for conduits, ductwork, HVAC, and other non-structural items

4.2 Observed Deficiency Ranking

After assembling a list of deficiencies in Section 3.0, the table below was created to illustrate the results of this study and identify the schools with the highest level of concern. The ranking for each school was based on the presence, severity, and quantity of high and/or low priority hazards. Low priority deficiencies include items such as brick veneer without wall ties and the presence of unreinforced masonry chimneys. High priority deficiencies included items such as unreinforced masonry walls and a lack of lateral load path to the foundation which increase the collapse potential.

The building inspections performed for this report were limited to observation only. As such, the deficiencies listed above are not expected to be all-encompassing. Previous seismic investigations and knowledge of construction methods during the eras in which the ten schools were built have allowed us to consider expected deficiencies that were unobservable given the scope of our investigation. These deficiencies are common and their inclusion is useful in ranking and determining a rough cost for improvements at each school.

Using the above deficiencies with life safety in mind, the following table was developed to provide a school-by-school comparison of observable hazards when each school is considered under loading conditions from a code seismic event:

School	Relative Hazard Severity*	Recommended for Seismic Grant
Butte Creek Elementary School	High	Yes
Robert Frost Elementary School	High	Yes
Mark Twain Middle School	High	Yes
Scotts Mills Elementary School	High	Yes
Victor Point Elementary School	Moderate	Yes
Bethany Charter Elementary School	Moderate	Yes
Pratum Elementary School	Moderate	No
Silver Crest Elementary School	Moderate	No
Central Howell Elementary School	Moderate	No
Evergreen Elementary School	Low	No

**Relative Hazard Severity levels indicate perceived risk of substantial damage potential in the event of a seismic event based on our observations of the structural systems present and our past experience with similar structures and their performance during seismic events.*

**High relative hazard severities indicate buildings and/or portions of buildings that have a high collapse potential when exposed to loading from a code seismic event. It is our opinion that structures with a moderate relative hazard severity will experience structural damage during similar events, but the likelihood of collapse is reduced. Low relative hazard severities indicate buildings which will experience damage, but collapse is unlikely.*

5.0 Planning Level Budgets

In order to assist the District in maintenance and improvement planning, planning level budgetary construction costs have been developed for each school as detailed in this report. These rough order of magnitude costs are an estimate of the costs associated with structural improvements based on the visual observations and assumptions included in this report and our prior experiences. These values are not to be used for specific project planning purposes, but are meant to assist the District in planning processes.

5.1 Budgetary Construction Costs

Retrofit solutions for each school have not been developed or hard quoted and as such these values are subject to change as projects are developed and further evaluation and design is performed. These costs are related to rectifying the deficiencies noted in Section 3.0, but do include anticipated costs for incidental work required to complete the upgrades. In addition to the hard costs noted below, an additional 15% for soft costs such as engineering and permitting and 25% for contingency should be included for each project the District pursues. If the District decides to advance specific projects, the contingency percentage may be reduced as the design is advanced. The table below provides a summary of the planning level budgetary construction costs developed for each of the schools reviewed:

School	Budgetary Costs
Bethany Charter	700,000
Butte Creek	1,900,000
Central Howell	650,000
Evergreen	270,000
Mark Twain	1,800,000
Pratum	240,000
Robert Frost	60,000
Scotts Mills	360,000
Silver Crest	290,000
Victor Point	920,000

Please note that while total costs are presented for individual schools above, additional divisions may be practical to separate projects at each school. This may be particularly useful at schools with localized high deficiency areas such as the gymnasium at Scotts Mills.

6.0 Conclusion

The findings described in this report have been limited to the seismic lateral force resisting structural systems present at each school and were the result strictly of visual observations. Generally speaking, the condition of the District's schools was good based on their respective ages. The schools are, for the most part, well cared for buildings. The recommended improvements listed above reflect items that do not pose a substantial immediate risk to the life safety of occupants (unless noted otherwise) outside of code lateral events. It should be noted that structural deficiencies in schools of this age group are fully expected and the severity of the deficiencies noted above common.

It is clear based on the condition of the buildings that the District has invested in maintaining the buildings to get the most possible use out of each structure. To ensure that the District continues to get the most out of their schools and provide a safe learning environment for the students, we would recommend generating a priority list for capital projects to systematically address deficiencies as funds become available. Additionally, incremental updates should be considered during projects that may make performing the work easier. For example, during a roof replacement project is a good time to install connections from the roof diaphragm to the walls and rectify deficient roof sheathing. Similarly, a window replacement project is a good time to install shearwalls in place of windows in a wall line that does not have enough shearwall length.

Attention should be paid to the potential for upcoming seismic retrofit grant programs. Several of the schools noted above are good candidates for programs that can fund some or all of the expenses related to seismic retrofit of school buildings. Should the District be interested in pursuing grant funding for one or more schools, ZCS would be happy to provide proposals for assisting in the preparation of grant packages.

Based on our visual observations, we find the school structures to be in good condition and generally safe for occupancy. It should be noted that we recommend immediate attention be paid to the cafeteria at Butte Creek Elementary. It is our understanding that temporary shoring and repair recommendations have been developed in the past by Dana Smith, PE. We would recommend further evaluation of the situation at this school or activation of the existing repair recommendations on file.

Given the current condition of the structures, the code governing existing buildings does not mandate that upgrades are required unless the building is scheduled for repairs, alterations, additions, or a change in occupancy. However, voluntary seismic upgrades are permitted and encouraged.

Please contact our office if you would like to discuss our findings.