CITY OF SILVERTON

CITY COUNCIL WORK SESSION – 6:00 p.m., February 26, 2018

Silverton Community Center – Council Chambers – 421 South Water St.

Americans with Disabilities Act (A.D.A.) *– The City of Silverton intends to comply with the A.D.A. The meeting location is accessible to individuals needing special accommodations such as a sign language interpreter, headphones, or other special accommodations for the hearing impaired. To participate, please contact the City Clerk at 503-874-2216 at least 48 hours prior to the meeting.*

A copy of the full packet is available for review Monday through Friday 8:00 am to 5:00 pm in the City Manager's Office at the Silverton City Hall, located at 306 South Water Street. All documents will be available on our website at www.silverton.or.us/agendacenter.

I. OPENING CEREMONIES – Call to Order, Pledge of Allegiance and roll call

II. DISCUSSION ITEMS

2.1 Discussion on public process for future of Eugene Field Property

2.2 Discussion on Public Works Standards for Traffic Control Devices
– Manual on Uniform Traffic Control Devices (MUTCD) standards
– Steelhammer Road stop sign

III. COUNCIL COMMUNICATIONS

IV. ADJOURNMENT

SILVERTON CITY COUNCIL STAFF REPORT
TO THE HONORABLE MAYOR AND CITY COUNCILORS

	Agenda Item No.:	Topic:
	2.1	Discussion on Public Process for Future of Eugene Field Property
	Agenda Type:	
	Discussion	
	Meeting Date:	
	February 26, 2018	
Prepared by:	**Reviewed by:**	**Approved by:**
Christian Saxe	Christy S. Wurster	Christy S. Wurster

Background:
As part of the City's due diligence investigation for purchase of the Eugene Field property, the City of Silverton contracted with Terracon Consulting to perform Phase 1/Phase 2 Environmental Assessments and a Hazardous Material Survey of the existing facility. The results of these reports indicated the presence of hazardous materials (asbestos and lead paint) in and on the structure as well as an external Underground Storage Tank (heating oil) which must be removed with the surrounding soils. Following these reports, the Public Works Department met on site with multiple abatement contractors in order to get informal pricing for the necessary work to address these environmental concerns. The initial estimates for the abatement of the asbestos are in the $150,000.00 range. Estimates for the removal and abatement of the Underground Storage Tank are in the $30,000.00 range.

Due to the excessive quantity and locality of lead paint that was shown in the hazardous material survey, all attending abatement contractors stated that it would be financially and physically unfeasible to remove all of the lead paint and as a result, declined to provide an informal proposal. Commercial demolition contractors are able to remove and dispose of the structure, without lead abatement, by utilizing a dedicated receiving station. Informal pricing on the demolition of the building without lead abatement are in the $7.00-9.00/SF price range. Based on the full facility square footage, including all ancillary structures, the estimated cost for demolition would be $330,000.00. The combined total for abatement and demolition is estimated at $510,000.00.

Additional due diligence documentation received from the Silver Falls School District included a copy of a Facility Evaluation dated January 14, 2014 performed by ZCS Engineering, Inc. outlining the condition of the building. That document addressed additional concerns that would also be applicable to the City's potential use of the facility such as adequacy for use as a City Hall/Police Station, exterior building condition, interior building condition, safety/building code issues, accessibility, mechanical system condition and electrical system condition. While these conditions may be able to be addressed, the City would still have a building that was constructed in 1921.

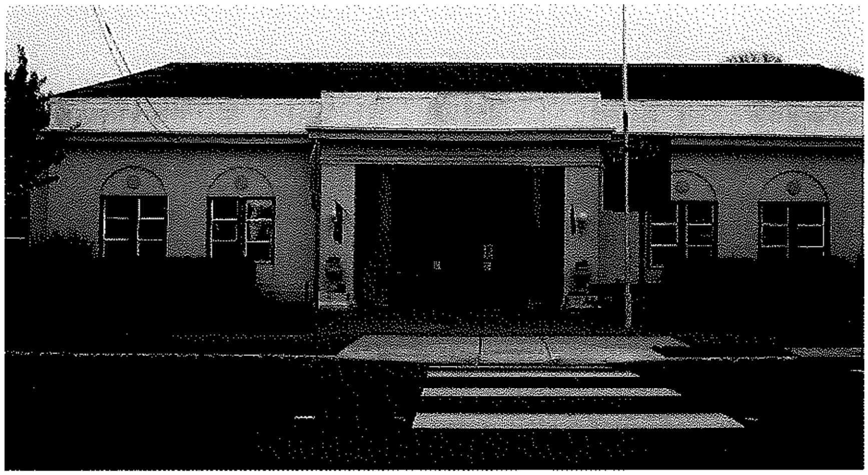
SILVERTON CITY COUNCIL STAFF REPORT
TO THE HONORABLE MAYOR AND CITY COUNCILORS

The City Council and staff recognizes that there should be a thoughtful public process to consider all financial and logistical considerations to ensure that there is support from the community on any decision addressing the future of the Eugene Field property. Therefore, staff recommends the following public process be implemented. We are seeking input from the City Council on this proposal before proceeding.

1) Activate the Community Voice module on the City's website to allow for public input and comment on the future of the Eugene Field School. This module allows an open forum and dialogue between administrators and the public. Ideas are able to be shared and can be captured and included in the public record and made part of future City Council packets. Questions could include, but not be limited to: A) Should the City of Silverton evaluate the re-use of the Eugene Field School for another purpose such as a new police station/civic center/city hall/or other use? B) Should the City demolish the Eugene Field School?
2) Advertise for public input in writing and allow for 30 minutes of public testimony on the future of the facility at the March 5, 2018 City Council meeting regarding whether the Eugene Field School should be repurposed or demolished.
3) Advertise for public input in writing and allow for 30 minutes of public testimony on future of the facility at the April 2, 2018 City Council meeting regarding whether the Eugene Field School should be repurposed or demolished.
4) Advertise for public input in writing and allow for 30 minutes of public testimony on the future of the facility at the May 7, 2018 City Council meeting regarding whether the Eugene Field School should be repurposed or demolished. Schedule a discussion by the Council on the May 7, 2018 City Council agenda for direction to staff on whether to continue to hear public testimony in future months, to secure further analysis of the facility, or to direct staff to proceed with estimates for removal of the facility or other.

Budget Impact	Fiscal Year	Funding Source
Not Applicable	17-18	Not Applicable

<u>Attachments:</u>
1. 01/14/2014 Facility Evaluation – ZCS Engineering Inc.



Attachment 1 to
Agenda Item 2.1

Silver Falls School District

Eugene Field Elementary School - Facility Evaluation

January 14, 2014

Prepared for:
Andy Bellando
802 Schlador Street
Silverton, OR 97381
Tel: 503.873.5303
Fax: 503.873.2936

Prepared By:
ZCS Engineering, Inc.
524 Main Street, Suite 2
Oregon City, OR 97045
Tel: 503.659.2205
Fax: 503.659.2433

STRUCTURAL
REGISTERED PROFESSIONAL
ENGINEER
14653PE
OREGON
July 16, 1996
RUSSELL C. CARTER
EXPIRES: 12-31-15

Table of Contents

1.0 Executive Summary

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 thirteen schools located within the community including the property of interest, Eugene Field Elementary School. The District has retained ZCS Engineering, Inc. (ZCS) to perform a facility evaluation at Eugene Field Elementary School that provides the District with an objective, comprehensive analysis of the condition of the existing facilities on site.

Eugene Field Elementary School is located at 410 Water Street in Silverton, Oregon (Figure 1 – Vicinity Map). The campus houses several structures constructed between 1921 and 1973. They include the original 1921 school building and gymnasium, a classroom addition, a 1973 play structure, and a 1953 stand-alone boiler room. Additionally, three modular buildings are present on the site. For a large portion of the school's life major maintenance and capital improvements have been deferred so many of the original building systems are still in service.

The evaluation of the school indicates that substantial upgrades to the structure itself and interior and exterior building systems would be required to support long-term continued use of Eugene Field as a warm, safe, and dry learning environment. Current shortcomings at the existing campus include, but are not limited to:

- Deficient structural systems that would result in unsafe structural performance during a code seismic event
- Limited capacity for growth
- Lack of on-site parking and circulation
- Considerably less playground area than what is typically programmed for elementary schools of similar capacity
- Deterioration of exterior building envelope features
- Heavily worn residential grade restroom and kitchen fixtures
- Many building features do not comply with current accessibility regulations
- Lack of an air circulation system
- Insufficient power outlets considering current demand for technology in the classroom

The balance of the report provides specific details regarding the construction of the school and a system-by-system review of the school's current condition.

Cost budgeting models were prepared for the following options;

- Renovate Eugene Field to provide a safe, warm and dry environment that would satisfy the current facility needs of the District
  Planning Level Estimate: $10.9 million

- Replace Eugene Field with a new, but comparable facility
  Planning Level Estimate $12.4 million

- Replace Eugene Field with state-of-the art facility designed based on contemporary trends in teaching and learning space
  Planning Level Estimate: $14.7 million

While the cost of the major renovation is less than the cost of the two replacement options, the District would still be left with a school that was built in 1921, and the functional limitations that go along with it, for approximately 88% of the cost of a new school. Thoughtful consideration must be given by all stakeholders to the financial, logistical, and educational factors in planning for the future of this facility.

2.0 Project Introduction

Silver Falls School District (District) is centrally located in Silverton, Oregon in Marion County, approximately 14 miles east of Salem, Oregon. Eugene Field Elementary School is located at 410 Water Street in Silverton, Oregon (Figure 1 – Vicinity Map).

The District has retained ZCS Engineering, Inc. (ZCS) to perform a facility evaluation at Eugene Field Elementary School. The purpose of the evaluation is provide the District with an objective, comprehensive analysis of the condition of the existing facilities on site. This work was conducted at the request of Andy Bellando, Superintendent, under an engineering services contract between the District and ZCS.

2.1 Scope of Work

The scope of work for this project consists of the following tasks:

- Coordinate and attend kick-off meeting with District to determine facility needs
- Review original building construction drawings and perform facilities tour to visually evaluate building systems
- Perform code analysis (i.e. ADA, fire and life safety, etc.) and identify deficiencies
- Evaluate existing building envelope package (energy efficiencies, roofing, windows etc.) and identify deficiencies
- Evaluate existing building structural elements for adequacy (i.e. dead load, snow load, live load, wind/seismic loads, etc.) and identify deficiencies
- Perform cursory evaluation of mechanical, electrical, plumbing systems with building operations and maintenance staff and identify deficiencies
- Evaluate existing school functionality with respect to contemporary learning environments
- Review results of District supplied 'Thoughtstream' information and incorporate the perceived community values into the recommendations for Eugene Field
- Prepare three cost budgeting models for modifications and replacement
- Review cost budgeting models with a licensed contractor to develop final budgeting recommendations
- Provide final facilities evaluation and recommendations report for facility planning use by the District.

3.0 Structural Evaluation

3.1 Introduction

As a portion of the overall building evaluation, ZCS Engineering, Inc. (ZCS) was tasked with evaluating the lateral force resisting systems in the facility. The structures reviewed in our analysis include the original 1921 elementary school, the attached classroom addition, and the covered play structure that was built around 1973. The year the classroom addition was constructed is unknown.

Additional structures on site include three modular buildings and a stand-alone boiler room. The modular buildings have not been included in this portion of the report because modern modular structures are structurally independent, redundant in nature, and generally constructed in accordance with the intent of current building codes. The boiler room is a structurally independent building constructed using cast-in-place concrete for all structural elements. The boiler room structure was not included in the scope of this evaluation as it is not accessible to students.

3.2 Inspection Process

The following sections detail the inspection process:

- Compile all relevant information from District personnel for facility evaluation
- Review available as-constructed building information prior to site visit
- Compile relevant seismic checklists
- Organize site visit and inspection
- Arrive on-site and execute pre-inspection phase in order to understand facility layout and identify possible deficiencies
- Perform site inspection through each structurally independent portion of the building in order to obtain relevant information and note obvious deficiencies
- Photograph deficiencies and facility interior layout during site inspection
- Document structural framing methods used for each building during site inspection
- Perform facility exterior walk-around in order to obtain complete exterior photographic documentation
- Perform a seismic evaluation of the existing facility and determine deficiencies.

3.3 Building Summaries

The main structure consists of three separate systems of construction that were built at different times and/or were constructed using different materials and systems. For that reason, we have separated each portion of the building for our analysis. A fourth building, an outside covered play structure, was also evaluated and is a stand-alone building. The following section outlines each of the existing facilities, or portions thereof, based on their independent structural systems. The descriptions below were gathered from site observations on November 11, 2013 and the review of existing construction documents provided.

The current building known as Eugene Field Elementary School was originally constructed around 1921. The original facility consists of a main classroom wing with an approximate footprint of 17,770 square feet and a gymnasium with an approximate footprint of 7,230 square feet. This facility underwent one major classroom wing addition at an unknown time with an approximate footprint of 9,990 square feet, and a structurally independent play structure was added adjacent to the gymnasium around 1973 with an approximate footprint of 9,380 square feet (Figure 2 – Aerial Image).

Information provided during the pre-inspection phase suggested that needed maintenance and improvements were not performed for a substantial portion of the life of each building. The lack of maintenance has yielded an aging facility that is now in need of attention.

3.3.1 Original Classroom Wing – Building A (1921 Elementary School)

The classroom wing of the original structure is a single story building with an approximate footprint of 17,770 square feet (Figure 3 – Classroom Wing Front Elevation). The building currently houses classrooms, the school office, principal's office, storage, and restrooms.

The building is constructed with 8-inch thick unreinforced clay tile (URM) walls. The roof framing consists of dimensional lumber rafters and straight sheathing (Figure 4 – Typical Classroom Framing). The mansard roof framing is supported by a combination of URM exterior bearing walls, wood framed interior bearing walls, and posts to ceiling joists below. The majority of the exterior walls contain windows that run from approximately 3-feet above finished floor to the underside of the roof structure. These windows are present along the majority of the exterior wall lines.

The structure's gravity load elements bear on a cast-in-place concrete foundation around the perimeter and a post and beam system with dimensional lumber floor joists and concrete footings between bearing lines within the building footprint.

Two additional classrooms, which are not depicted in the original construction documents, are present at the end of the structure. Typical evidence of building addition efforts were not observed suggesting that the floor plan may have been expanded during construction and not formally documented upon completion.

3.3.2 Original Gymnasium – Building B (1921 Elementary School)

The gymnasium was built during the same period of time with similar construction materials and methods as the immediately adjacent classroom wing (Figure 5 – Gymnasium). The structure is approximately 7,230 square feet and has a mezzanine along the full length of two of the perimeter walls. On the ground floor, the gym can be accessed from the adjacent classroom building or from the outside play area. A stage is located at the south end of the structure, and has its own access into the adjacent classroom building. There is a partial basement located beneath the stage, which houses storage and the custodial office. The walls in the gymnasium are substantially taller than the roofs of the adjacent buildings.

The roof of the gymnasium consists of built-up dimensional lumber girder trusses. The built-up trusses clear span the width of the gym and support dimensional lumber purlins and straight sheathed decking (Figure 6 – Gymnasium Framing). The roof framing at the stage consists of a similar system but with a tighter truss spacing and a slightly different truss design. The perimeter walls consist of 16-inch thick URM walls and the roof trusses are individually supported by URM pilasters along the east and west walls. Window openings exist between the pilasters. The east wall window bays have been in-filled with light timber framing, while the western window bays have not.

The floor framing consists of dimensional lumber floor joists with diagonal sheathing. The floor joists are supported by a post and beam system. Concrete stemwalls with continuous concrete footings are present along the perimeter. The mezzanine floor is framed with dimensional lumber and also forms the ceiling for the classroom wing corridor. Along the north side of the gymnasium, the mezzanine is suspended over the gymnasium floor; this portion of mezzanine is supported by one of the roof trusses above.

3.3.3 Classroom Wing Addition – Building C (Date Unknown)

The addition to the school is located the north side of the original classroom building and gymnasium (Figure 7 – Classroom Wing Addition). The addition consists of approximately 9,990 square feet of classrooms, restrooms, storage, library, and connecting hallways. This addition houses a partial basement of approximately 4,340 square feet, which consists of a learning area, offices, special education resource room, and kitchen space. The basement can be accessed via an interior stairwell or from an exterior covered ramp that is located near the outside playground.

The roof is constructed in a manner similar to that of the original classroom portion of the school. Roof framing members are made up of dimensional lumber rafters and straight sheathing and are supported by cast-in-place concrete bearing walls (Figure 8 – Classroom Wing Addition Framing). The concrete bearing walls are approximately 14-feet tall and 10-inches thick. The new addition attempts to match the window pattern present on the original school which has large window bays along the exterior wall lines.

The foundation consists of concrete footings, stemwalls, and at the basement, concrete retaining walls. The basement floor is slab-on-grade, while the upper story and remainder of the addition are constructed with a post and beam system and dimensional lumber floor joists similar to the original building.

As part of the original design of the addition, the northeastern-most wall was constructed out of timber in order to accommodate a future extension of the building that was never constructed.

3.3.4 Play Structure (1973 Addition) – Building D

The covered play structure is approximately 9,380 square feet in area and is located roughly 12-feet northeast of the gymnasium (Figure 9 – Covered Play Area). One corner of the play structure is in-filled with wood studs between post bays, creating a storage shed.

Roof framing members consist of a built-up 2x dimensional lumber beam and truss hybrid system, along with 2x roof purlins supporting straight sheathed decking. The built-up roof beam-truss system bears on posts below (Figure 10 – Covered Play Area Framing). Additional diagonal braces have been added in an attempt to strengthen the lateral system and reduce the stresses in the beams and truss bottom chords.

The structure has an exterior pavement floor surface and is supported below grade with concrete footings.

3.4 Structural Evaluation

The following outlines an evaluation of the existing structural components of the building. The evaluation includes site observations of the existing structural elements and follows the guidelines outlined in the American Society of Civil Engineer's "Seismic Evaluation of Existing Buildings – ASCE 31-03". This manual is accepted by the Oregon Structural Specialty Code (OSSC) as an evaluation tool for existing buildings per section 3401.5 - Alternative Compliance and Statewide Alternate Method No. OSSC 08-05. Per ASCE 31-03 a Tier 1 evaluation has been performed. The purpose of a Tier 1 evaluation is to provide "Quick Checks" to properly evaluate a building and determine deficiencies related to the lateral resisting elements.

It is the intent of the District, as part of this study, to determine the structural deficiencies of the building as compared to current prescribed loading and detailing requirements for lateral (wind/seismic) loading. Section 3.4.1 outlines the existing lateral structural systems and is followed by Section 3.4.2, which outlines the structural deficiencies found during the evaluation.

Lateral resisting systems work in conjunction with gravity framing systems. As such, the existing gravity framing system was also evaluated for structural deficiencies. Section 3.4.3 outlines the existing gravity system and its structural deficiencies found during the evaluation.

3.4.1 Lateral Resisting Systems

As described in Section 3.3, the structures on the site have been broken into four buildings for the purpose of analysis. In addition to the main elementary school building, the covered play structure has been evaluated. The following outlines the structural lateral resisting systems for each portion of the facility.

Building A

The lateral resisting system for the classroom portion of the original building consists of unreinforced clay tile (URM) perimeter shearwalls supporting dimensional lumber roof rafters and straight sheathing. The URM perimeter walls contain a substantial amount of windows, leaving narrow shear piers to resist the lateral forces. The roof diaphragm consists of straight sheathed 1x decking. Interior wood framed corridor and classroom separation walls also provide lateral resistance. Attachments of the roof framing to the perimeter walls, which prevents the walls from separating from the roof framing and transfer in-plane forces into the walls, are not present.

Building B

The lateral load resisting system for the gymnasium consists of unreinforced clay tile (URM) shear walls and light timber roof and floor diaphragms. The roof diaphragm consists of straight sheathed 1x decking supported by purlins and site-built girder trusses. The attachment of the roof framing to the perimeter URM walls that prevents the walls from separating from the roof framing is present at the attachment of the truss connection points but is not present continuously along the diaphragm boundaries. Additionally, no in-plane connections are present to transfer diaphragm forces into the URM walls. The floor diaphragm consists of ¾-inch diagonal sheathing. Attachment of the diaphragm to the perimeter bearing walls could not be verified through visual inspection or through review of the as-constructed documents.

Building C

The lateral load resisting system for the majority of the classroom addition consists of cast-in-place concrete walls in the north-south direction. In one location along the east wall an exterior, wood-framed plywood shearwall is present. Interior wood-framed shearwalls also provide lateral resistance. All shear walls support a timber roof diaphragm. The roof diaphragm consists of straight sheathed 1x decking. The connection between the roof diaphragm and the top of wall plate to resist in-plane loading was not observable and was not noted in the as-constructed plans; however, a direct in-plane attachment from the wall top plate to the top of wall was observed and also noted in the drawings. At the connection to the existing gymnasium a wood ledger bolted to the gym wall provides attachment of the diaphragm. Out-of-plane attachment of the roof framing to the perimeter walls, which prevents the walls from separating from the roof framing, is not present.

Building D

The lateral load resisting system for the covered play structure consists of knee braced posts that have been strengthened with plywood gusset plates. The roof diaphragm consists of 1x6 straight sheathing nailed perpendicularly to 2x8 rafters. The roof diaphragm is attached to roof beams and laterally braced posts. It appears that this system was intended to resist lateral forces. However, there does not appear to be an adequate connection between the knee braces and gravity framing elements.

3.4.2 Lateral Resisting Element Deficiencies

The following lateral resisting element deficiencies are based on visual observations of the existing structural elements and the structural analysis performed during the Tier 1 check of the ASCE 31-03. The Tier 1 checklists are attached in Appendix B. The following outlines the deficiencies for each portion of the facility.

Building A

The building is located directly adjacent to the gymnasium (Building B), which is taller but was constructed similarly. This will result in the two buildings moving independently of one another, and in different magnitudes, during a seismic event. This typically results in damage from building impact along the marriage line. The taller building will have a higher story drift than the shorter building, which will cause the walls of the taller building to collide with the roof structure of the lower building. The walls, as currently constructed, are not detailed to resist this action, which can result in structural collapse.

The URM walls do not provide adequate strength to resist seismic forces. The exterior walls have a large number of window bays increasing the necessary shear resistance in the wall panels present. URM walls are extremely limited in the amount of shear stress that they can resist. As such, this building is not within code allowable limits for shear resistance as shown in the Tier 1 checklist. As a result, the original building does not possess a reliable lateral force resisting system. Additionally, the URM walls show signs of distress along the southeast exterior wall.

The URM wall's height- to-thickness ratios do not fall within the allowable proportional limits for non-slender walls. Allowable proportional limits are set to indicate if a wall is slender or non-slender. Slender URM walls are particularly susceptible to out-of-plane collapse, thus not permitted by code.

The roof framing is not properly anchored to the URM walls to resist out-of-plane shaking forces which could result in the walls separating from the roof framing and partial roof collapse.

Direct in-plane connection of the shear walls to the diaphragm was not able to be verified through the construction drawings, nor verified in the field. A code event could result in the walls and diaphragm moving independently of one another, resulting in a partial roof collapse.

The roof diaphragm does not have continuous cross ties between diaphragm chords in either direction due to the mansard construction and stepped ceiling heights. The roof rafters are not continuous across the width of the building and strapping at splice locations is not present. There is no blocking perpendicular to the roof rafters.

The straight sheathed roof diaphragm does not meet the prescribed span requirements to provide a reliable lateral resisting system. The roof may deflect more than intended which could result in serious wall damage.

There is observable water damage to portions of the roof, resulting in deterioration of roof diaphragm components.

The exterior longitudinal URM walls are supported using timber shear walls. For walls greater than 12-feet this is not an acceptable practice. The timber shear walls do not provide adequate support to resist the loading induced by the heavy URM walls.

Interior shearwalls in the transverse direction are not supported by an adequate foundation, forcing the floor diaphragm to carry the shear loads. The floor diaphragm cannot support these loads at its current span, resulting in partial structural collapse.

Building B

This building is located directly adjacent to Building A and Building C. The gymnasium is taller than both adjacent buildings and was constructed in a different manner than Building C. The differences in height and construction will result in the buildings moving independently of one another, and in different magnitudes, during a seismic event. This will cause the walls of the gymnasium to collide with the lower roofs. The walls, as currently constructed, are not detailed to resist this action which can result in structural collapse.

The URM wall's height-to-thickness ratios do not fall within the allowable proportional limits for non-slender walls. Allowable proportional limits are set to indicate if a wall is slender or non-slender. Slender URM walls are particularly susceptible to out-of-plane buckling and collapse, and thus are not permitted by code.

Large corridor and door openings along the perimeter of the structure have resulted in the presence of very narrow wall sections adversely affecting the structure's ability to resist lateral loads.

The main floor has a significant number of windows around the perimeter, preventing the building from meeting allowable Tier 1 shear stress requirements. Lack of shear stress resistance will cause the brittle URM walls to crack and fail during a lateral event.

The roof framing is not properly anchored to the URM walls to resist out-of-plane shaking forces which could result in the walls separating from the roof framing, resulting in structural collapse.

Direct in-plane connection of the shear walls to the diaphragm was not able to be verified outside of the truss connections through the construction drawings or through observation. A code event could result in the walls and diaphragm moving independently of one another, resulting in roof collapse.

The straight sheathed roof diaphragm does not meet the prescribed span requirements, nor does it meet the prescribed length-to-width ratio required in order to provide a reliable lateral resisting system. The roof may deflect more than intended which could result in serious wall damage.

Water infiltration was observed at the roof diaphragm decking, which may result in damage to the roof diaphragm if left unrepaired.

Deterioration of URM wall units was observed, which may result in lower performance levels during a seismic event. The mortar between units is easily scraped away in locations adjacent to windows, which indicates that the bond strength between units is weakening.

The interior mezzanine is not laterally braced, nor is it properly attached to the URM walls of the gymnasium. This will result in potential structural collapse of the mezzanine during a seismic event. Note that collapse would block the main corridor at the entry of the school that provides one of the primary egress routes.

Building C

The building is located directly adjacent to Building A and Building B. Both Buildings A and B were constructed using different materials than Building C. Building B is also taller. This will result in the buildings moving independently of one another, and in different magnitudes, during a seismic event. This can result in damage from building impact, or pounding, along the marriage line. The walls, as currently constructed, are not detailed to resist this action which can result in structural collapse.

The roof and floor framing are not properly attached to the cast-in-place concrete walls to resist out-of-plane shaking forces, which could result in the walls separating from the roof and floor framing resulting in structural collapse.

The straight sheathed roof diaphragm does not meet the prescribed span requirements to provide a reliable lateral resisting system. The roof may deflect more than intended which could result in serious wall damage.

The connection between the roof diaphragm and the top of wall plate to resist in-plane loading was not observable and was not noted in the as-constructed plans. A code event could result in the walls and diaphragm moving independently of one another, resulting in partial roof collapse.

The roof diaphragm does not have continuous cross ties between diaphragm chords in either direction due to the mansard construction and stepped ceiling heights. The roof rafters are not continuous across the width of the building and strapping at splice locations is not present. There is no blocking present perpendicular to the roof rafters.

A lateral resistance system in the transverse direction along the marriage line between the addition and the gymnasium is not present. This will result in additional forces migrating to the gymnasium walls and potentially overloading them. Additionally, the diaphragm is not properly attached to Building A or B to accommodate out-of-plane forces.

The cast-in-place concrete walls of the addition are supported along the northeast wall line using timber shear walls. For walls greater than 12-feet this is not an acceptable practice due to the flexible nature of timber shear walls which do not provide adequate support to resist the loading induced by heavy concrete walls.

Interior shearwalls in the transverse direction are not supported by an adequate foundation, forcing the floor diaphragm to carry the shear loads. The floor diaphragm cannot support these loads at its current span resulting in partial structural collapse.

The basement has two main points of egress. The exit that discharges directly to the exterior ramp has had a cover constructed along its length to protect occupants from weather. The cover is constructed out of dimensional timber studs and rafters, and straight sheathed decking has been applied to the roof. The egress cover is not braced laterally and is not attached to the existing walls of Building C adequately. There also appears to be splitting in some of the roof framing members. In the event of a code seismic event, this cover will likely collapse and block a point of egress.

Building D

The lateral load resisting system does not have an adequate load path to the foundation. This could result in the roof framing system moving independently of the post and beam system below causing structural collapse during a seismic event.

There is observable deterioration of wood at the base of some of the posts which will compromise the lateral system if induced with lateral loading.

Direct in-plane attachment between the diagonal braces and post and beam system is inadequate. A code event could result in the posts and beams moving independently of each other.

3.4.3 Gravity Resisting Systems and General Observations

The following gravity resisting deficiencies are based on visual observations of the existing structural elements. No formal structural analysis was performed during this evaluation of the gravity resisting elements. However, preliminary quick checks were performed on suspect elements.

On-site observations and as-constructed documents suggest that Building A and Building C both have similar framing systems as detailed in Section 3.3. Preliminary evaluation of the roof and floor systems show that the roof rafters and corridor stud walls are only marginally overstressed, whereas the ceiling joists, floor beams and interior spread footings are significantly overstressed. While these elements have shown no observable signs of cracking, splitting, or other signs of distress, a seismic event could potentially overstress these elements to the point of failure and structural collapse.

Building A has observable signs of water infiltration to areas of roof decking and framing members along all perimeter, sloped sections of the mansard roof. Roof rafters that frame into one of the attic fire walls also display signs of deterioration where they attach (Figure 11 – Water Infiltration).

Limited crawlspace clearances in Building A and Building B indicate that the floor framing is in close proximity to the ground. These conditions can encourage deterioration if left unchecked. Reports of standing water in the crawl space and poor drainage away from the building elevate the potential for decay.

Building B has observable signs of water infiltration to areas of roof decking and framing members in one corner of the building (Figure 11 – Water Infiltration).

Building B is framed with built-up dimensional lumber roof trusses that are suspect. These roof trusses have long spans, carry heavy loads, and their connections appear to be inadequate.

Building C has experienced water intrusion into portions of the basement (Figure 11 – Water Infiltration). It is likely that appropriate foundation drainage elements are not present to move groundwater away from the retaining walls.

Building D has observable deflection in the beam-truss framing system. The observable deflections indicate that the roof framing system is overstressed.

4.0 Building Systems Evaluation

In order to provide the District with the most useful information, ZCS retained BLRB Architects (BLRB) to assist in the evaluation of the school from a non-structural building systems standpoint. BLRB is an architecture firm specialized in educational architecture, historic building assessment, documentation, and preservation and restoration. BLRB's unique skill set was an appropriate match for this project as their extensive history in working with older school facilities helped to provide special insight into the comprehensive evaluation of Eugene Field Elementary.

The full BLRB report covering the following topics is attached for reference in Appendix C:

- Architectural Overview covering building size, enrollment, and capacity
- Site Condition
- Exterior Building Condition
- Interior Building Condition
- Safety/Building Code
- Accessibility Provisions
- Mechanical System Condition
- Electrical System condition
- Low Voltage System Condition
- Instructional Adequacy
- Contemporary Learning Environments

5.0 Cost Budgeting

Based on the information provided in this report, ZCS and BLRB have developed three cost budgeting models for use in evaluating the most appropriate course of action. The information is based on historic educational facility construction costs. Each of the cost budget models is located in Appendix D. In addition to construction costs, the budget models address development costs which include consultant fees, permit fees, and contingencies. Following generation of the budget models they were reviewed with an Adroit Construction (Adroit) representative who has participated in similar construction projects. Adroit is a commercial contractor that has worked on multiple educational facilities and performed seismic retrofits to existing structures. Adroit reviewed the values presented in the cost budget models and provided insight into current construction costs from a contractor's perspective.

The first model reflects a complete renovation including seismic retrofits and interior and exterior improvements that would allow the continued use of Eugene Field as currently utilized. In this model, the deficiencies in building systems are addressed, but items that are not deficient will not be replaced. For example, the current radiant heat system is not included as an item to be replaced but a mechanical ventilation system is included to provide air movement through the building. For the purposes of this model, the gymnasium is recommended to be replaced. The retrofit to the existing structure would be very invasive and result in significant costs for structural work alone. Additional dollars would be required on top of that to address the other non-structural building systems. This model reflects a total estimated project cost on the order of $10.9 million.

The second cost budget model reflects direct replacement of Eugene Field on the same site and serving the same functionality as the current school. This does not address items such as limited space on the current site, potential capacity issues, or the lack of on-site circulation. This model reflects a total estimated project cost on the order of $12.4 million.

The last cost budget model is similar to the second, but reflects the replacement of Eugene Field configured based on current recommended educational standards. This would result in an increase of approximately 7,000 square feet and a total estimated project cost on the order of $14.7 million.

While these budgeting models are based on historic values and preliminary information, they provide a basis for comparison of the three available alternatives. To perform a complete renovation of Eugene Field as needed to provide students with a warm, safe, and dry learning environment would cost approximately 88% of a reconstructed school.

6.0 Conclusion and Recommendations

The intent of the information presented in this report is to provide the District with adequate information to properly consider the future of Eugene Field Elementary School. While the condition of the school as presented above may seem overwhelming, it should be noted that the building functions daily in its current state. The structural deficiencies outlined in Section 3.0 are serious, but outside of code events the school is generally safe to occupy and there were no obvious signs of imminent structural failure. The construction present in each of the buildings on the campus and the deficiencies noted are characteristic of the era during which they were constructed.

The condition of the school is not compliant with the intent of current educational facility standards. The lack of a mechanical ventilation system affects the student's ability to focus in the classroom and increases the likelihood of illness spreading among the occupants. The limitations on the electrical system prohibit teachers from utilizing technology available to their peers. The limited accessibility features throughout the school expose the District to ADA violation liability. The likelihood of collapse is very high when considering exposure to a code prescribed seismic event. It is the opinion of the evaluation team that the school is due for significant renovation in order to provide the teachers and students with an environment that meets their current needs and expectations. At a minimum, funding for seismic retrofit of the existing structure should be pursued if renovation or replacement is not planned. Schematic seismic retrofit drawings have been prepared and are attached in Appendix E for use in potential grant applications.

Through discussions with the Task Force and review of the District supplied "Thoughtstream" results it is clear that Eugene Field Elementary School is an important part of Silverton and consideration should be given in regards to its service to the community. Costs for renovation of the structure to current building codes and construction standards are very close to costs for complete reconstruction of a new school on the existing site. Should the District elect to renovate, functional issues associated with space limitations, modular classroom usage, use of the gymnasium as a cafeteria, and daily logistical challenges such as the need to transport food from the kitchen in the basement to the gymnasium at meal times would likely still exist and continue to impact school operations. However, the demolition and replacement of Eugene Field Elementary may not necessarily be the best course of action if community sentiment towards the existing facility is a significant factor. Options such as replacement of the school while preserving the existing facades on Water Street and Park Street may be a feasible alternative that could satisfy a community desire to retain the presence of the original facility within the District. It should be understood that optimum efficiency in construction and flexibility in building functionality design can only be achieved through complete replacement of the school.

APPENDIX - A
Figures

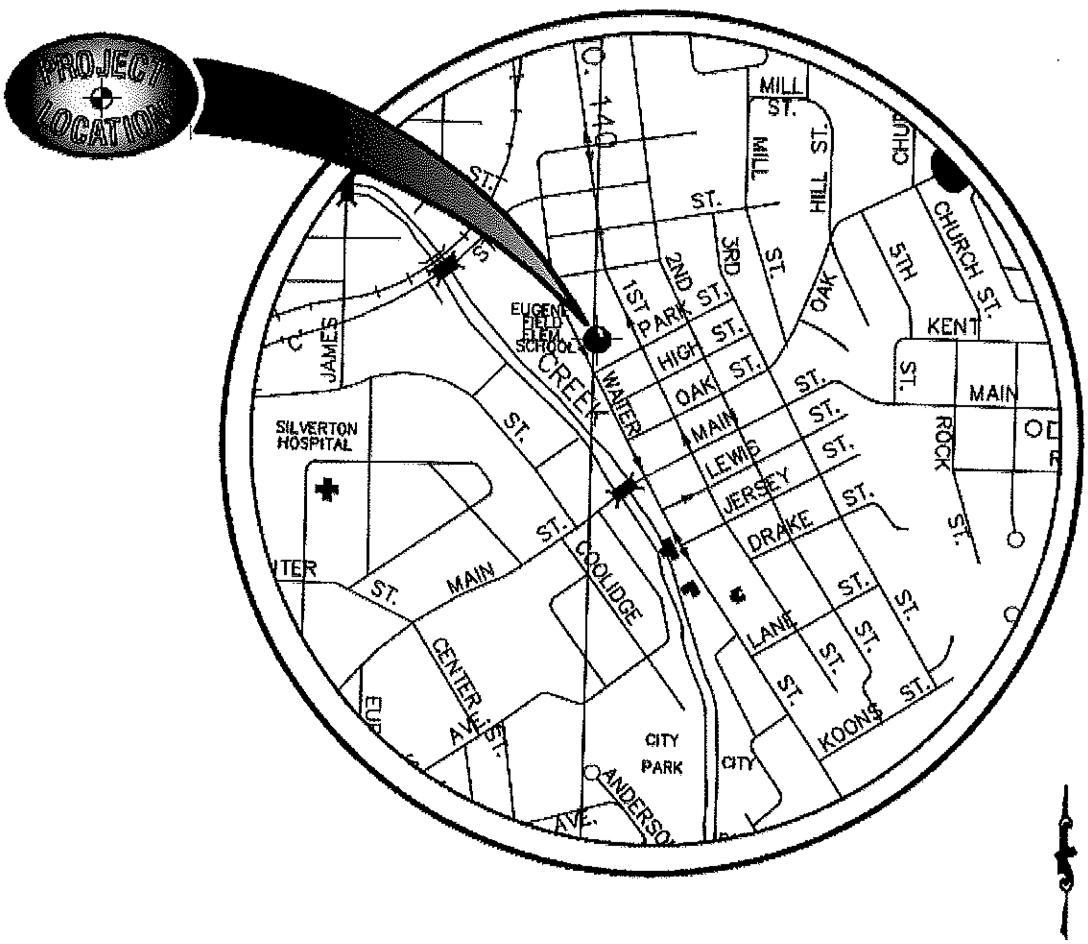


Figure 1: Vicinity Map

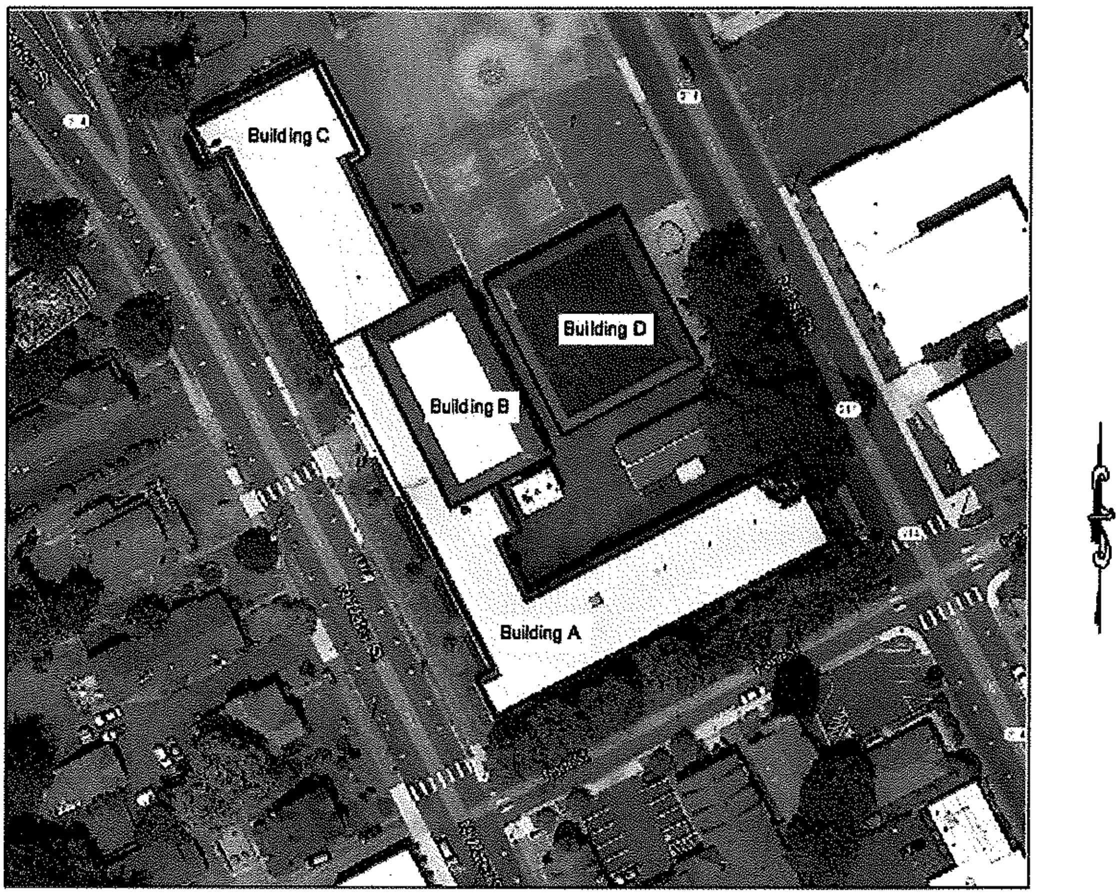


Figure 2: Aerial Image

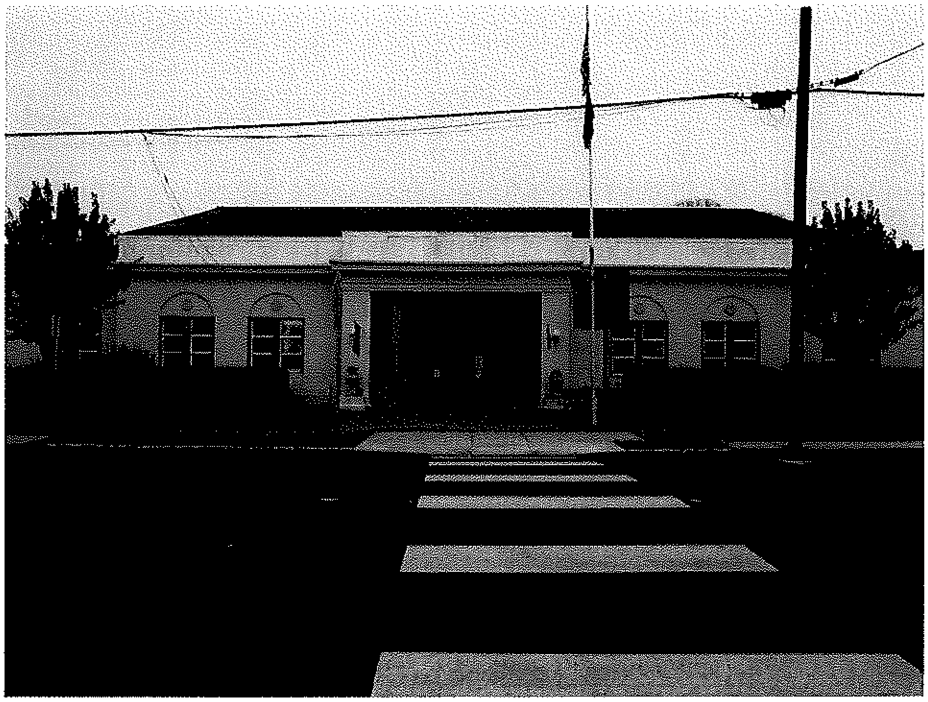


Figure 3: Classroom Wing Front Elevation

Figure 4: Typical Classroom Framing

Figure 5: Gymnasium

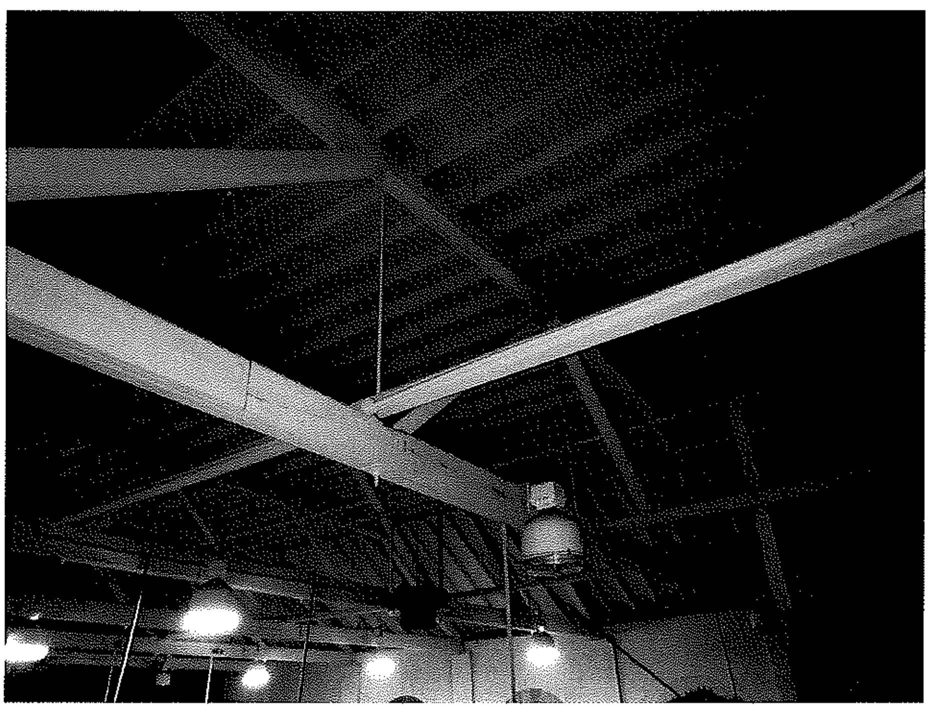


Figure 6: Gymnasium Framing

Figure 7: Classroom Wing Addition

Figure 8: Classroom Wing Addition Framing

Figure 9: Covered Play Area

Figure 10: Covered Play Area Framing

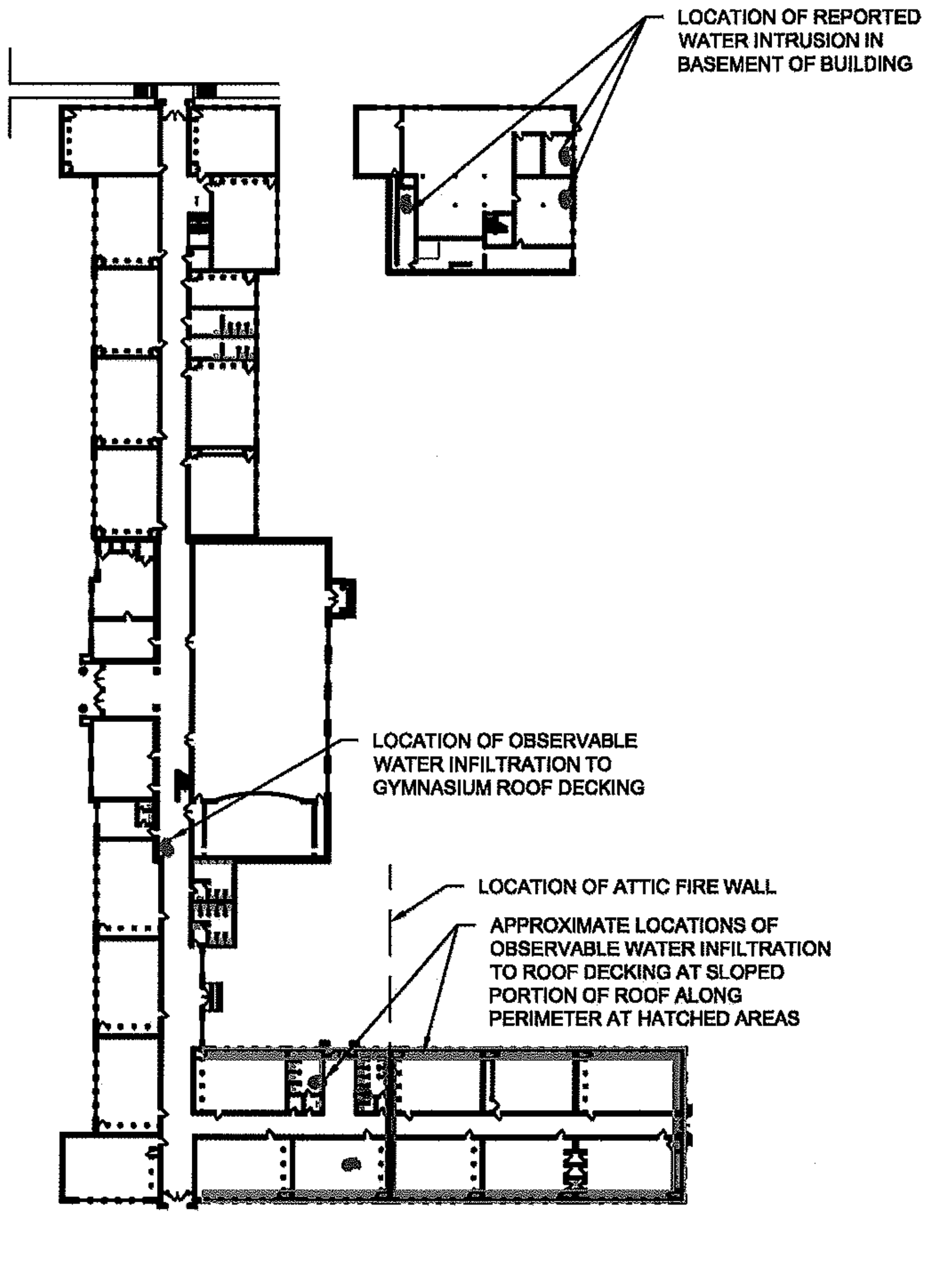


Figure 11: Water Infiltration

APPENDIX - B
Structural Tier 1 Check Sheets

 ORIGINAL CLASSROOM WING

3.7.15 Basic Structural Checklist for Building Type URM: Unreinforced Masonry Bearing Walls with Flexible Diaphragms

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the Tier 2 Special Procedure for Unreinforced Masonry or the Tier 3 Evaluation Procedure.

C3.7.15 Basic Structural Checklist for Building Type URM

These buildings have bearing walls that consist of unreinforced (or lightly reinforced) brick, stone, or concrete block masonry. Wood floor and roof framing consists of wood joists, glulam beams, and wood posts or small steel columns. Steel floor and roof framing consists of steel beams or open web joists, steel girders, and steel columns. Lateral forces are resisted by the brick or concrete block masonry shear walls. Diaphragms consist of straight or diagonal lumber sheathing, structural wood panels, or untopped metal deck, and are flexible relative to the walls. Foundations consist of brick or concrete spread footings or deep foundations.

Building System

(C) NC N/A — LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

(C) NC N/A — ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C NC (N/A) — MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C NC (N/A) — WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC (N/A) — SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

(C) NC N/A — GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)

(C) NC N/A — VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC (N/A) MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

C (NC) N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

(C) NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

(C) NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C (NC) N/A UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in the wall elements greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.11)

Lateral-Force-Resisting System

(C) NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C (NC) N/A SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 30 psi for clay units and 70 psi for concrete units for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.5.1)

Connections

C NC (N/A) WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)

(C) NC N/A WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)

C (NC) N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2 Sec. 4.6.2.1)

C NC (N/A) GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.15S Supplemental Structural Checklist for Building Type URM: Unreinforced Masonry Bearing Walls with Flexible Diaphragms

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral-Force-Resisting System

C (NC) N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than the following for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.2):

Top story of multi-story building	9
First story of multi-story building	15
All other conditions	13

C NC (N/A) MASONRY LAY-UP: Filled collar joints of multi-wythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)

Diaphragms

C (NC) N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC (N/A) OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC (N/A) OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

(C) NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C (NC) N/A SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing (Tier 2: Sec. 4.5.2.2)

C NC (N/A) UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC (N/A) NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

(C) NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)

Connections

C NC (N/A) STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)

(C) NC N/A BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters shall have independent secondary columns for support of vertical loads. (Tier 2: Sec. 4.6.4.5)

3.7.15 Basic Structural Checklist for Building Type URM: Unreinforced Masonry Bearing Walls with Flexible Diaphragms

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the Tier 2 Special Procedure for Unreinforced Masonry or the Tier 3 Evaluation Procedure.

C3.7.15 Basic Structural Checklist for Building Type URM

These buildings have bearing walls that consist of unreinforced (or lightly reinforced) brick, stone, or concrete block masonry. Wood floor and roof framing consists of wood joists, glulam beams, and wood posts or small steel columns. Steel floor and roof framing consists of steel beams or open web joists, steel girders, and steel columns. Lateral forces are resisted by the brick or concrete block masonry shear walls. Diaphragms consist of straight or diagonal lumber sheathing, structural wood panels, or untopped metal deck, and are flexible relative to the walls. Foundations consist of brick or concrete spread footings or deep foundations.

Building System

C (NC) N/A — LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

(C) NC N/A — ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C NC (N/A) — MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

(C) NC N/A — WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

(C) NC N/A — SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

(C) NC N/A — GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)

(C) NC N/A — VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

(C) NC N/A MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

C (NC) N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C (NC) N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C (NC) N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

(C) NC N/A UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in the wall elements greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.11)

Lateral-Force-Resisting System

(C) NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C (NC) N/A SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 30 psi for clay units and 70 psi for concrete units for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.5.1)

Connections

C (NC) N/A WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)

(C) NC N/A WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)

C (NC) N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2 Sec. 4.6.2.1)

(C) NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.15S Supplemental Structural Checklist for Building Type URM: Unreinforced Masonry Bearing Walls with Flexible Diaphragms

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral-Force-Resisting System

C (NC) N/A — PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than the following for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.2):

Top story of multi-story building	9
First story of multi-story building	15
All other conditions	13

C NC (N/A) — MASONRY LAY-UP: Filled collar joints of multi-wythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)

Diaphragms

(C) NC N/A — CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC (N/A) — OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC (N/A) — OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C NC (N/A) — PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC (N/A) — DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C (NC) N/A — STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

(C) NC N/A — SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing (Tier 2: Sec. 4.5.2.2)

C NC (N/A) — UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC (N/A) — NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

(C) NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)

Connections

C (NC) N/A STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)

(C) NC N/A BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters shall have independent secondary columns for support of vertical loads. (Tier 2: Sec. 4.6.4.5)

 CLASSROOM WING ADDITION

3.7.9A Basic Structural Checklist for Building Type C2A: Concrete Shear Walls with Flexible Diaphragms

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C3.7.9A Basic Structural Checklist for Building Type C2A

These buildings have floor and roof framing that consists of wood sheathing on wood framing and concrete beams. Floors are supported on concrete columns or bearing walls. Lateral forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of wood sheathing or have large aspect ratios and are flexible relative to the walls. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C (NC) N/A — LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

(C) NC N/A — ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C NC (N/A) — MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

(C) NC N/A — WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

(C) NC N/A — SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

(C) NC N/A — GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)

(C) NC N/A — VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC (N/A) MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

C (NC) N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

(C) NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC (N/A) POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

(C) NC N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

Lateral-Force-Resisting System

(C) NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

(C) NC N/A SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C NC (N/A) REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

Connections

C (NC) N/A WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)

C (NC) N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2 Sec. 4.6.2.1)

C NC (N/A) FOUNDATION DOWELS: Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

3.7.9AS Supplemental Structural Checklist for Building Type C2A: Concrete Shear Walls with Flexible Diaphragms

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral-Force-Resisting System

C NC (N/A) COUPLING BEAMS: The stirrups in coupling beams over means of egress shall be spaced at or less than $d/2$ and shall be anchored into the confined core of the beam with hooks of 135° or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC (N/A) OVERTURNING: All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C NC (N/A) CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than $8d_b$. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)

C NC (N/A) REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC (N/A) WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

Diaphragms

(C) NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C (NC) N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC (N/A) OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

(C) NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C (NC) N/A SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)

C NC (N/A) UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC (N/A) NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

(C) NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)

Connections

C NC (N/A) UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

 COVERED PLAY STRUCTURE

3.7.2 Basic Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C3.7.2 Basic Structural Checklist for Building Type W2

These buildings are commercial or industrial buildings with a floor area of 5,000 square feet or more. There are few, if any, interior walls. The floor and roof framing consists of wood or steel trusses, glulam or steel beams, and wood posts or steel columns. Lateral forces are resisted by wood diaphragms and exterior stud walls sheathed with plywood, oriented strand board, stucco, plaster, straight or diagonal wood sheathing, or braced with rod bracing. Wall openings for storefronts and garages, where present, are framed by post-and-beam framing.

Building System

C (NC) N/A — LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C NC (N/A) — MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C NC (N/A) — WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC (N/A) — SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC (N/A) — GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)

(C) NC N/A — VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC (N/A) — MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

C (NC) N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC (N/A) WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15 percent of inadequate fastening such as overdriven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.3.3.2)

Lateral-Force-Resisting System

(C) NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC (N/A) SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing	1,000 plf
Diagonal sheathing	700 plf
Straight sheathing	100 plf
All other conditions	100 plf

(C) NC N/A STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C NC (N/A) GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height with the exception of the uppermost level of a multi-story building. (Tier 2: Sec. 4.4.2.7.3)

C NC (N/A) NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Life Safety and 1.5-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of moderate and high seismicity. Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of low seismicity. (Tier 2: Sec. 4.4.2.7.4)

C NC (N/A) WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C NC (N/A) HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story due to a sloping site, all shear walls on the downhill slope shall have an aspect ratio less than 1-to-1 for Life Safety and 1-to-2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C NC (N/A) CRIPPLE WALLS: Cripple walls below first-floor-level shear walls shall be braced to the foundation with wood structural panels. (Tier 2: Sec. 4.4.2.7.7)

(C) NC N/A OPENINGS: Walls with openings greater than 80 percent of the length shall be braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or shall be supported by adjacent construction through positive ties capable of transferring the lateral forces. (Tier 2: Sec. 4.4.2.7.8)

Connections

(C) NC N/A WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C NC (N/A) WOOD SILLS: All wood sills shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

(C) NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.2S Supplemental Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral-Force-Resisting System

C NC (N/A) HOLD-DOWN ANCHORS: All shear walls shall have hold-down anchors constructed per acceptable construction practices, attached to the end studs. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.7.9)

Diaphragms

(C) NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

(C) NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

(C) NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

(C) NC N/A SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC (N/A) UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

(C) NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)

Connections

C NC (N/A) WOOD SILL BOLTS: Sill bolts shall be spaced at 6 feet or less for Life Safety and 4 feet or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

APPENDIX - C
BLRB Architects Facilities Assessment

ARCHITECTURAL

1.1 Overview

The intent of this Facility Assessment is provide an objective opinion of the school existing condition and make recommendation on how the school might be improved to meet current codes and be commensurate, contemporary learning environments in the State of Oregon. An exhaustive review or destructive testing of existing conditions was not included in the scope of the assessment. Capacity calculations are based upon methodologies used by school design professional and states that provide public funding for capital improvements.

Location:	410 N. Water Street	
Site Area:	Main Building site	2.73 Ac
	Play area across A Street	0.73 Ac
	Total	3.46 Ac
Building Area:	Main building	39, 324 square feet
	Modular buildings	3,020 square feet (3 modular buildings)
	Total	42,344 square feet

Building Summary:

Current enrollment:	Grades 1st-3rd	333 students
	Kindergarten	95 students
	Special Needs	25 students (self-contained classrooms)
	Total	454 students

over 65 students receive partial assistance (25+65 = 90 in special ed.)

Student Capacity:

Method One (calculated on the number of general classrooms)

Main Building	15 classrooms
Modular Buildings	3 classrooms + 1 music
Total	21 classrooms

Kindergarten students (20/clrm) = 100 students (5 clrms)
1st – 3rd grade students (25/clrm) = 375 students (15 clrms)
Special Needs students (9 to 16/clrm) = 25 students (2 clrms)
500 students

Method Two (calculated by Gross SF of building per student – typically between 85 to 100 SF/student for elementary schools)

Gross Area of School 42,344 SF

42,344 SF @100 SF/students = 423 students
42,344 SF @85 SF/student = 498 students

Current Plumbing Fixture count:
Boys – 8 w.c., 12 urinals, 9 sinks
Girls – 21w.c., 9 sinks
Staff – 1 w.c, 1 sink

1.2 Building Narrative and Evaluation

The building evaluations are a physical assessment of observable systems which encompasses the following components:

- Site Condition
- Exterior Building Condition
- Interior Building Condition
- Safety/Building Code
- Accessibility Provisions
- Mechanical System Condition
- Electrical System Condition
- Low Voltage System Condition
- Instructional Adequacy

The narrative provides general observations and comments for each of the components, as well as a brief narrative regarding instructional adequacy observations. The assessment was developed through an on-site facility visual review. No destructive demolition or intrusive investigation was performed for this assessment.

1.3 Summary of Findings

The original elementary school building is aging and well-worn and in need of substantial modernization and/or upgrades to address maintenance, code/building safety, and instructional adequacy issues. Maintenance issues are primarily a result of the aged components, as most of the doors; windows and fixed equipment are from the original building era.

The absence of a fire sprinkler system, insufficient fire alarm system and inadequate fire resistance capabilities are the primary concerns for building safety. Additionally, Classroom casework/cabinetry is nearing the end of its useful life and much of the classroom equipment is limited and worn, thus impacting instructional adequacy. Substantial modernization to the classrooms should be considered to accommodate 21st Century learning environments.

The site's small size and being bounded by public streets creates several less than desirable conditions. The mixing of buses, parent drop-off./pick-up and public street traffic is not a safe environment. The public street that is closed during school hours is a workable situation; but, not ideal. The school's close proximity to street noise and emissions at times of the year when windows are open most likely is an area of concern. The school building's close proximity to public streets as already generated an operational protocol for truck idling on adjacent streets.

1.4 Main Building

1.4.1 Building Type

- Original 1921 building – Type V B unreinforced masonry exterior walls & combustible roof framing
- Addition – Type V B cast-in-place concrete exterior walls & combustible roof framing

1.4.2 Site

- The school building site is significantly smaller than recommended for urban (5-8 Ac.) or suburban site (10 Ac.).
- Site access, bus drop-off/pick-up, and circulation is limited to public streets which places students in uncontrolled areas of vehicular traffic.
- Playground paving is showing sign of deterioration along assumed paths of vehicular travel and cold joints between old and newer paving.
- Other areas of asphalt paving are "alligatoring" and cracking of the wear surface.
- Site lighting is very limited and dependent upon adjacent street lighting.
- Surface inlets at the base of the building are easily clogged and susceptible to the growth of mold; especially where roof downspouts discharge at grade.

1.4.3 Exterior Building

- Original wood sash windows have been replaced with insulated vinyl units; however the wood jambs, sill and head were reused. Several wood window frames have deteriorated. Windows should be removed, sashes replaced and windows reinstalled or replaced.
- Gutters and downspouts are in fair to poor condition. The downspouts connect to underground drainage system or "day-lighted" at grade. In some instances, at grade drains have pipe extension to discharge water away from the foundation. The gutter of the roof that covers the ramp to the kitchen is in particularly poor condition. The school crawl space should be checked for water intrusion.

- The Wood fascia and mansard roofing is showing sign of deterioration and exposure to weather. The wood fascia and rake trim are showing rust streaking as a result of water contact with metal fasteners or other ferrous metals.
- Black and green mold has developed at base of walls where roof drainage is discharged on to hard pavement (i.e. playground).
- Exterior plaster stucco appears in good condition with few cracks or spawling.
- Evidence of chronic leaking at the main entry to the building is evident. The flat roof area and historic frieze/cornice above the fascia has been wrapped with a roofing membrane.
- The remainder of the roof has a low slope middle area with a pitched roof (6:12) at the perimeter. The low slope areas have been re-roofed with the same membrane roofing.
- Once water-damaged wood trim is replaced, the entire building should be repainted.
- The covered play area is adequately sized; however, a seismic analysis of the structure should be conducted.

1.4.4 Interior Building

- Classroom and corridor carpet is in good condition. Parents of students enrolled at this school who have severe nut allergies have concerns about conventional cleaning processes that are unable to remove all nut residue.
- Interior doors, frames, hinges and hardware are from the original era. See Accessibility
- Boys and Girls restrooms have original privacy screens and fixtures. Some sink bases and other 'off the shelf' cabinetry has been added to original sinks. See Accessibility
- Sinks in Boys and Girls restrooms are original; the porcelain enamel finish has worn off. These should be replaced.
- Most drinking fountains are from the original era and should be replaced. At least 1 has been replaced with an accessible unit. See Accessibility
- Cabinetry in classrooms and resources spaces is original, removed or added from 'off the shelf' residential units.
- The kitchen (prep only) in the lower level is outdated. Some equipment is new commercial grade equipment (dishwashing, broiler oven); however, other equipment (stove, cabinet freezer) is residential grade. The dry goods storage is a hallway. Floor and wall finishes most likely do not meet current health department regulation (impervious surface).

1.4.5 Safety/Building Codes

- The school does not have an automatic sprinkler system per Oregon Structural Specialty Code (OSSC) *903.2.3 Group E.*
- Per OSSC *717.4.3 Other groups. Exception: Draftstopping is not required in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1*

- The Stage curtain should be verified to current meet flame spread rating and resistance.
- All handrails are non-compliant with current code.
- The fire alarm system does not meet current code.
- The building exit signage is not illuminated and non-compliant with current code.

1.4.6 Accessibility

- All of the door hardware is non-compliant with current code
- All drinking fountains (except for 1) are non-compliant with current code.
- All sink hardware is non-compliant with current code.
- Most service counter and work surfaces are non-compliant with current code.
- Restroom fixtures, mounting heights, assistive devices and clearances are non-compliant with current codes.
- Replace ramp northwest end of school.
- Accessibility to the lower level requires the student to travel outside from the main parts of the building.

1.4.7 Mechanical

- The radiant heat system does not deliver uniform heating temperatures to classrooms.
- The school has no air circulation system; floor fans and open windows are utilized to induce fresh air movement.
- The school policy of opening windows to improve indoor air quality can cause extreme variation of temperatures in the classroom.
- Some classrooms are provided with recirculation ceilings fans which help to stratify the indoor air or mix outside air when windows are open.
- An exhaust fan in the lower level counseling space indicates that radon had been detected and a window exhaust fan was installed to exhaust the potentially harmful gas.
- Hot water piping for radiant heat has been replaced; however, asbestos pipe wrap still exists in the attic space.
- Exhaust hood over kitchen cooking equipment is exhaust only and maybe in violation of fire code.
- Minimum Plumbing Fixtures (Table 29-A):
  - Students
    - Boys (255 students) = 9 w.c. (1/30 students), 8 sinks (1/35)
    - Girls (255 students) = 10 w.c. (1/25 students), 8 sinks (1/35)
  - Staff
    - Female (max 35 teachers and staff) = 2 w.c.(2/ 35), 1 sink (1/40)
    - Male (max 35 teachers and staff) = 2 w.c. (2/35), 1 sink (1/40)

1.4.8 Electrical

- Numerous plug-molds, power poles, extension cords and exposed electrical cords illustrates that the school has insufficient power outlets to serve the classroom equipment currently being used by teachers.
- Locating the teacher work stations at front of classroom requires power cords to be laid across the floor and could cause a trip hazard.
- The electrical equipment in the basement is old; but, useable fuse equipment (large disconnect). Fuses can be replaced at a lower cost.
- The distribution system is old; but, connections should be inspected (IR scan). The labeling needs to be redone.
- Potential Electrical Code Violations
  - The routing of mechanical over the electrical equipment.
  - Service disconnects in excess of 6
  - Clearances in front of electrical equipment

1.4.9 Low Voltage System

- The fire alarm system is a non-addressable system that is no longer manufactured. The current system is typically acceptable to the fire marshal as an existing condition. Maintenance of this equipment is limited by the availability of replacement parts; repair of the existing system may not be possible and replacement will be required. Current code requires an addressable system.
- A wired data distribution system has been distributed throughout the building. The server is located in a closet in the library. The server's only venting is a through-wall louver into the library.
- The school is equipped with a surveillance camera system.
- Clock, bell and PA systems are out-of-date.

1.4.10 Instructional Adequacy

- The playground area is considerably smaller than most elementary schools. Use of the additional play area across A Street would increase the area; however, it's across a street.
- Students accessing the music program by walking outside to the portable classroom is not ideal.
- The location of a special needs resource room in the basement area with no window to the outside (window to covered ramp) is not a good learning environment. Research shows that kids learn better with natural light and fresh air.
- The resource room in the basement has access to natural light; however, the indoor air quality with the kitchen next door is not ideal. The open learning area is not conducive to differentiated learning.

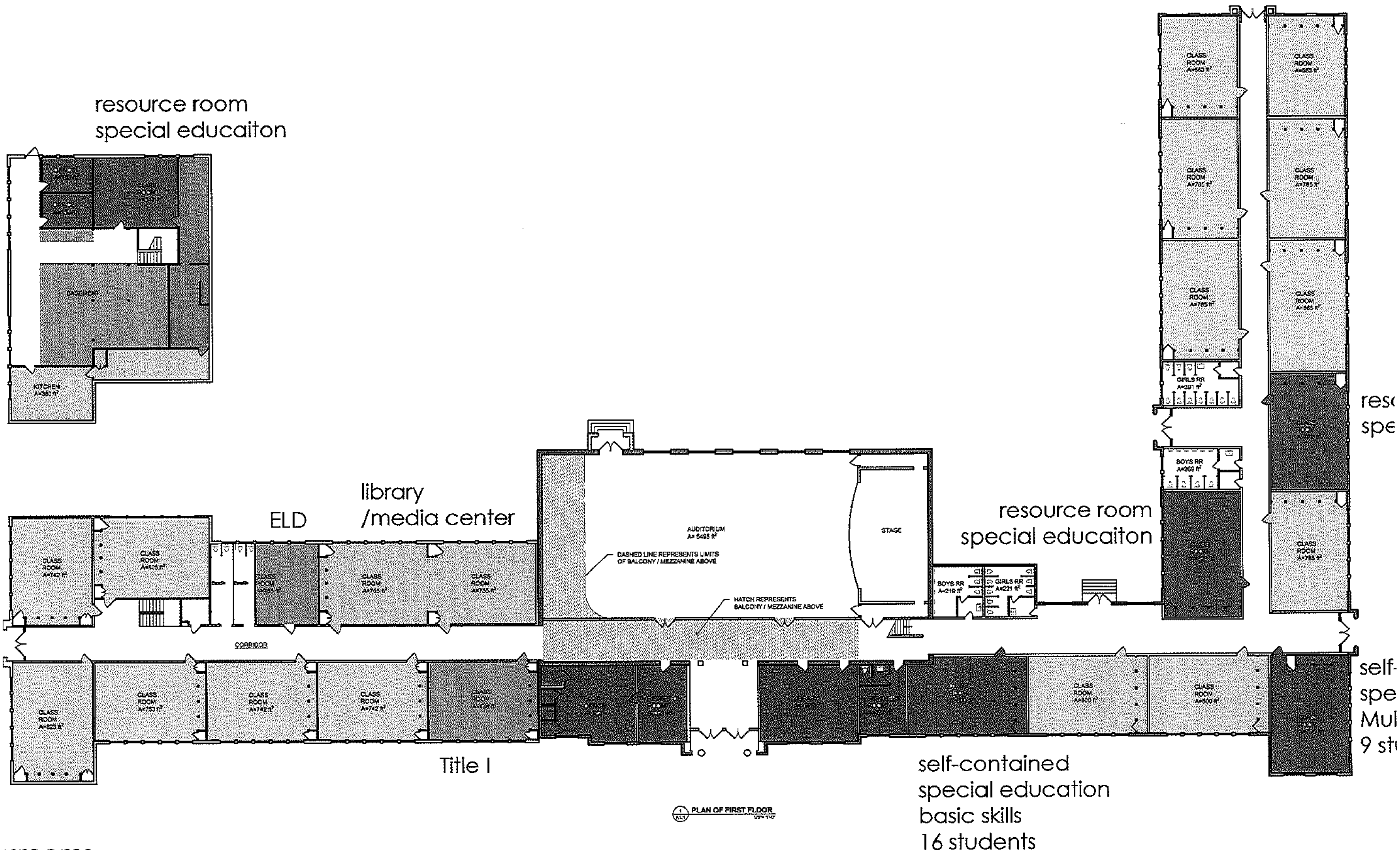
- The location of the kitchen separate from the gym/lunch area is a functional issue. Food service could as easily be prepared off-site as being prepared in the basement and being pushed up a ramp and across the playground.
- Bus loading, parent drop-off and pick-up is dependent upon surface streets around the school. Most schools have segregated bus and car areas to facilitate traffic flow and student safety.
- The balcony in the gymnasium is an under-utilized space due to the lack of safe exit or safety railing.
- State of Oregon requirements for providing physical education may be impacted by the dual use of the gymnasium as the cafeteria.
- Connectivity to information (Information Technology) is limited by access to power.
- The poor indoor air quality adversely impacts teaching and learning.
- Direct sunlight into the classroom's tall windows causes glare and legibility issues in the classroom. Provide day-light control interior, sunscreens.

1.4.11 Contemporary Learning Environments

Partnership for 21st Century Skills – 21st Century Learning Environments

- Contemporary schools "do more than meet academic needs; they function like miniature cities, providing food, facilities, health, security, transportation and recreation to their students."
- Schools are custom made buildings that meet of the community and today's multifaceted learning; they can inhibit or support and enhance learning.
- Effective learning environments align systems and synergies that:
  - Supports professional learning communities that share best practices, collaborate and integrates contemporary skills into the classroom
  - Create opportunities and spaces for project based learning or applied work skills.
  - Provides equitable access to quality tools, technologies and resources.
  - Provides spaces for group, team or individual learning.
- Contemporary learning spaces:
  - Must be flexible and adaptable to change. The agility to change to the class size or support the program they are delivering.
  - Convey friendliness, openness and accessibility.
  - Must have good indoor air quality, temperature control and adequate lighting
- Schools can support learning communities by:
  - Provide spaces available to the community to collaborate and share information.
  - Providing connection to the global community.
  - Providing performance and meeting spaces to the community
- The Library/Media Spaces could become the nerve center of the school where kids:
  - Get access to tools and infrastructure
  - Demonstrate Learning and create new knowledge

- Connects kids and adults to the wider world



ssrooms
cial Education
dent Resources
ary /Media Center
ool Office/Teacher space

Dec.

APPENDIX - D
Cost Budgeting Models

Major Renovation of Eugene Field

Issue	Budget
Interior Modernization (33.4K SF)	$1,699,000
Gym Replacement (5.9K SF)	$1,804,000
Re-roof Main Building	$670,000
Structural Upgrade	$961,000
Rework window sashs	$119,000
Replace inter. doors & hardware	$212,000
Replace restroom fixtures & piping	$540,000
Rework Kitchen Area	$287,000
Fire suppression system	$160,000
Replace Fire Alarm	$66,000
Add ventilation air system	$541,000
Electrical Upgrade	$392,000
Replace Clock, bell & PA sys	$51,000
Upgrade & repair playground	$133,000
Upgrade exit and emergency	$20,000
HazMat Abatement	$278,000
Construction Budget	**$7,933,000**
Inflation (2% per year)	$166,000
Development costs (35-40%)	$2,834,650
Project Budget	10,933,650
compared to cost of replacement	87%

BLRB architects

Replacement of Eugene Field

	Program Element	Total SF
5	Kindergarten CLRM	4,000
12	Grade 1-3 CLRM	9,600
1	Special Needs CLRM	1,000
1	School Office/Services	1,600
1	Library/Media Ctr	1,600
1	Gymnasium/Stage	6,000
1	Kitchen	1,200
2	Resource Room	2,400
	Programmed Space	27,400
	Net/Gross Factors (43.5%)	11,925
	TOTAL Building Ares (SF)	39,325
	Building ($217.00 per SF)	$8,533,525
	Site (3.6Ac)	$618,000
	Construction Budget	**$9,151,525**
	Inflation (2% per year)	$0
	Development costs (35-40%)	$3,203,034
	Project Budget	$12,354,559

BLRB architects

Contemporary Eugene Field

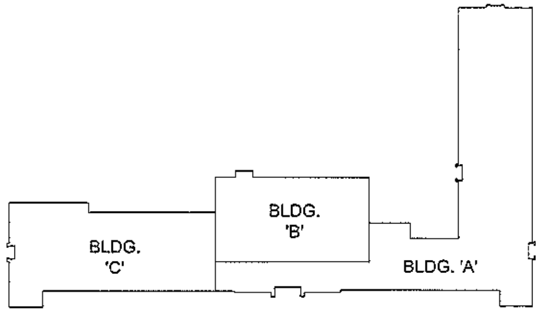
	Program Element	Total SF
5	Kindergarten CLRM	4,000
14	Grade 1-3 CLRM	11,200
1	Special Needs CLRM	1,000
3	Breakout space	2,400
1	School Office/Services	1,600
1	Library/Media Ctr	1,600
1	Gymnasium/Stage	6,000
1	Cafeteria	2,000
1	Kitchen	1,200
2	Resource Room	2,400
	Programmed Space	33,400
	Circulation	5,200
	Mechanical/Electrical	2,000
	Storage/Janitorial	1,500
	Restrooms	1,700
	Wall Thickness	2,600
	Net/Gross Factors (38.75%)	13,000
	TOTAL Building Ares (SF)	46,400
	Building ($217.00 per SF)	$10,079,000
	Site (3.6Ac)	$618,000
	Construction Budget	**$10,697,000**
	Inflation (2% per year)	$223,000
	Development costs (35-40%)	$3,822,000
	Project Budget	$14,742,000

APPENDIX - E
Schematic Seismic Retrofit Drawings

SEISMIC REHABILITATION SCHEMATICS

SILVER FALLS SCHOOL DISTRICT

SILVERTON, OREGON



BUILDING KEY

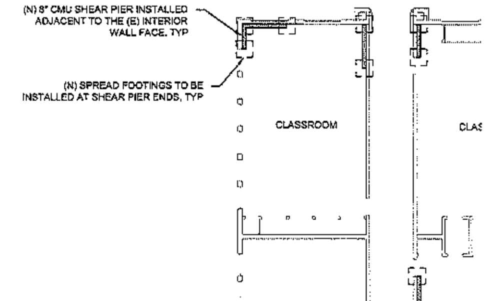
PROJECT NARRATIVE

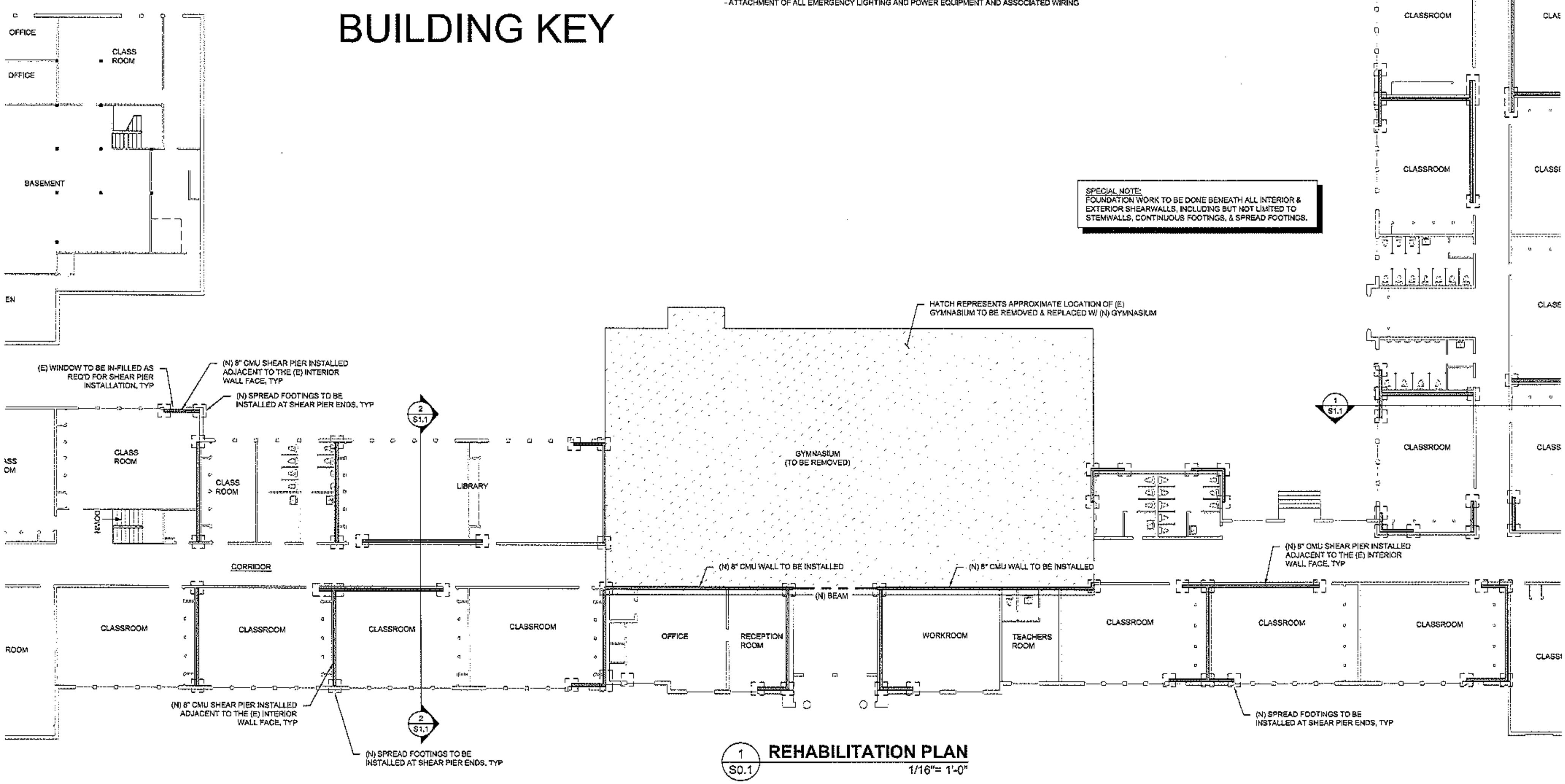
THE INTENT OF THESE DRAWINGS IS TO ILLUSTRATE THE LEVEL OF UNDERSTANDING THE APPLICANT HAS WITH REGARDS TO THE EFFORT THAT WILL BE REQUIRED TO SEISMICALLY REHABILITATE THE BUILDING. THESE SCHEMATIC DRAWINGS HAVE BEEN PREPARED USING THE CURRENT OREGON STRUCTURAL SPECIALTY CODE (OSSC) AND THE ASCE 41 (SEISMIC REHABILITATION OF EXISTING BUILDINGS) AS REFERENCES FOR PRESCRIBED LOADING AND BUILDING PERFORMANCE LEVEL RATINGS.

THE DRAWING ILLUSTRATES BOTH EXISTING CONDITIONS AND GENERAL STRUCTURAL REPAIRS THAT WOULD NEED TO BE ACCOMPLISHED TO REACH AN ACCEPTABLE LEVEL OF PERFORMANCE (LIFE SAFETY) ACCORDING TO CURRENT CODE.

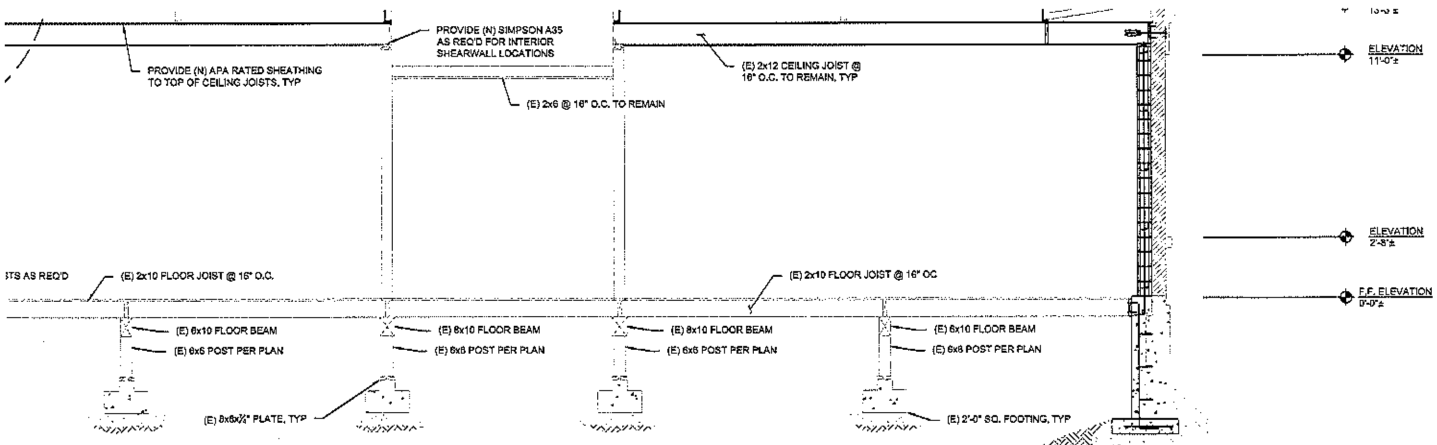
SEISMIC DEFICIENCIES
- CONNECTION OF ROOF FRAMING TO TOP OF WALL
- OUT OF PLANE BRACING AT TOP OF MASONRY WALLS
- POUNDING BETWEEN THE TALLER GYMNASIUM ROOF AND THE LOWER ADJACENT STRUCTURES
- CONTINUOUS CROSS TIES BETWEEN DIAPHRAGM CHORDS
- LATERAL FORCE RESISTANCE AT MASONRY WALLS
- ASPECT RATIO OF ROOF DIAPHRAGMS/CONDITION OF SHEATHING (STRAIGHT SHEATHING)
- NON-EXISTENT FOUNDATION BENEATH INTERIOR SHEARWALL LOCATIONS
- WOOD SHEARWALLS SUPPORTING EXTERIOR MASONRY WALLS

SEISMIC CONSIDERATIONS FOR NON-STRUCTURAL COMPONENTS:
- PROPER ATTACHMENT AND BRACING OF STORAGE RACKS/CABINETS/BOOK SHELVES OVER 4' OR 3:1 (HEIGHT:WIDTH) RATIO
- ATTACHMENT OF ALL EQUIPMENT OVER 20 LBS AND ABOVE 4', OR ALL EQUIPMENT OVER 100 LBS
- ATTACHMENT OF ALL EMERGENCY LIGHTING AND POWER EQUIPMENT AND ASSOCIATED WIRING

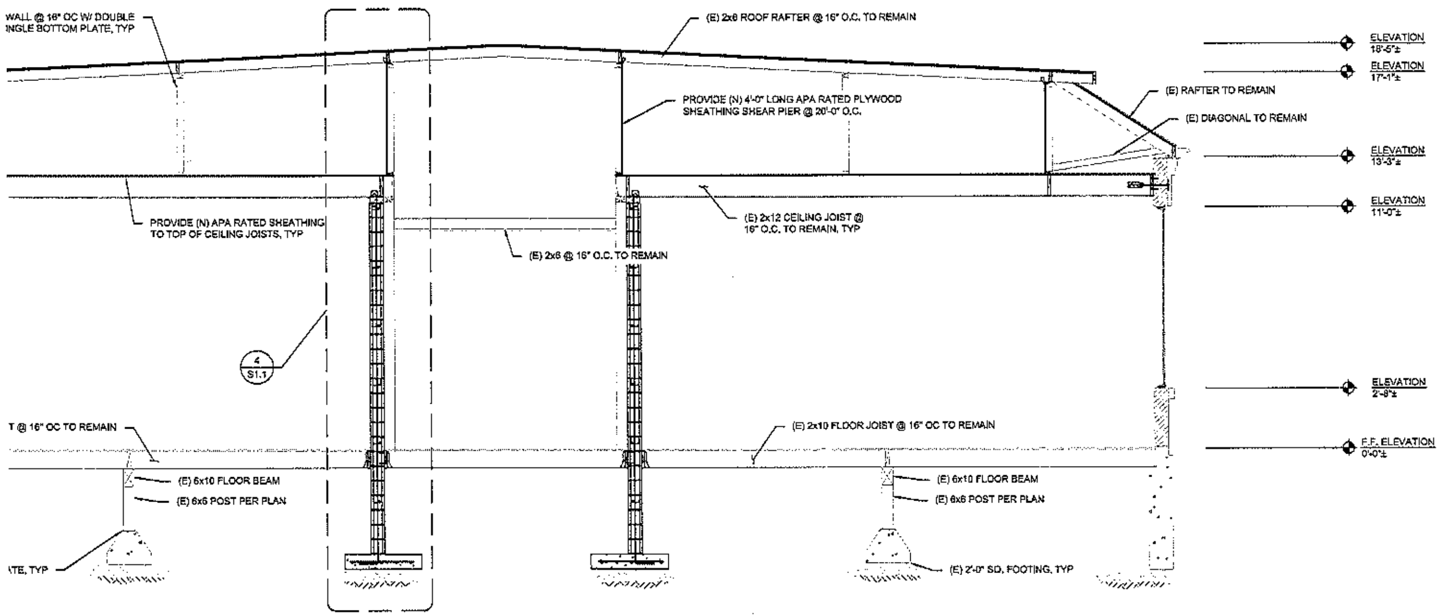




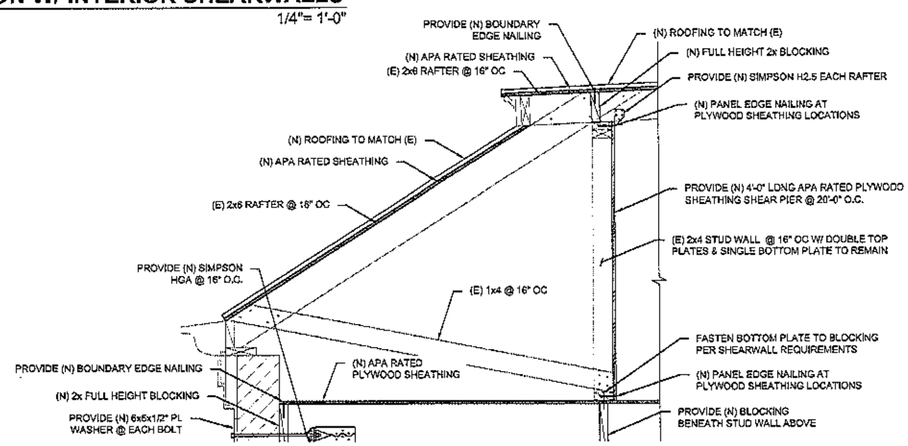
1 S0.1 **REHABILITATION PLAN**
1/16"= 1'-0"

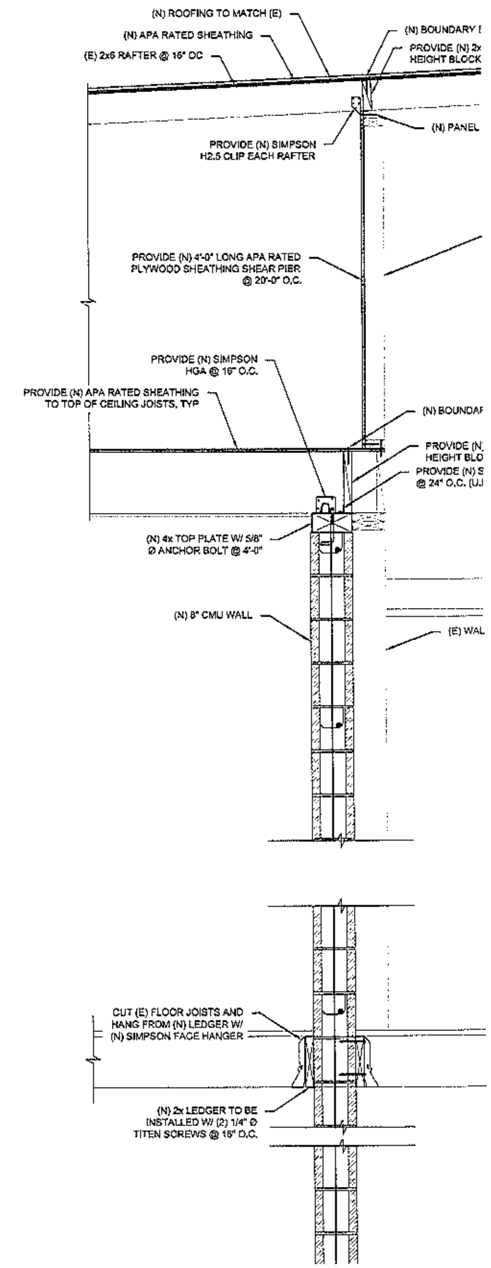


1 S1.1 **TRANVERSE SECTION W/ EXTERIOR SHEARWALLS**
1/4"= 1'-0"



2 S1.1 **TRANVERSE SECTION W/ INTERIOR SHEARWALLS**
1/4"= 1'-0"





SILVERTON CITY COUNCIL STAFF REPORT
TO THE HONORABLE MAYOR AND CITY COUNCILORS

	Agenda Item No.:	Topic:
	2.2	Discussion on Public Works Standards for Traffic Control Devices
	Agenda Type:	
	Discussion	
	Meeting Date:	
	February 26, 2018	
Prepared by:	**Reviewed by:**	**Approved by:**
Christian Saxe	Christy S. Wurster	Christy S. Wurster

Background:

The current adopted Public Works Standards do not include specific direction on the installation of traffic control signage. As such, the Department utilizes current industry standards and engineering practices in the assessment of any given traffic control situation and proposes, requires or installs traffic control devices to ensure safe vehicular and pedestrian mobility. An example of this occurred during the Steelhammer Road Improvement Project. The Public Works and Police Departments conducted a detailed review of the existing overall traffic conditions in comparison to the proposed final project improvements. The review included, but was not limited to: existing lane width vs. final design, introduction of bicycle and pedestrian facilities that were previously non-existent, road gradient, traffic counts (including average speeds) and traffic violation and accident history. Based on our joint review of this information, it was determined that a 3-way stop sign at the intersection of the new 42 lot subdivision (Jaysie Drive) and Steelhammer Road would be an appropriate measure to increase the overall safety conditions of this roadway segment.

In reviewing the stop sign installation with third party consultants (DKS Consulting) and industry professionals (Dr. Mojie Takallou of the University of Portland) it was determined that the installation does not meet standard MUTCD warrants. However, because the roadway in question is a City road, the City has the right to install a traffic control measure should they feel it is in the best interest of public safety. This authority is granted under the Silverton Municipal Code (Section 10.04.040), which gives the City Manager the authority to direct or approve of the installation or removal of traffic control signage. Section 10.04.030 provides the Council with authority to require the removal of any sign or device installed under the previously mentioned Code Section.

Additional options often used for traffic calming include the installation of speed humps or permanent radar detection speed signs. Staff is opposed to the installation of speed humps as they adversely affect the ability to snow plow and pose a significant cost for street maintenance activities such as slurry sealing or pavement overlays.

City Council requested a work session to review and discuss current practices and standards.

Attachments:

1. Silverton Public Works Standards – Street Signs
2. Silverton Municipal Code – 10.04.030-.040

White and black reflectorized Type II barricades shall be used at the end of the sidewalk or pedestrian/bike path.

2.34 BIKEWAYS

a. Bikeway locations shall be determined by the City. Bikeway facilities shall meet the requirements of this document and the American Association of State Highway and Transportation Officials publication, Guide for Development of New Bicycle Facilities, as amended and adopted by the Oregon Department of Transportation.

b. A bikeway may be constructed adjacent to the curb within the pavement area.

c. Structural sections of bikeway facilities on streets shall conform to that of the street or be integral with the curb. Bikeways not within a street shall be constructed upon compacted subgrade that has been sterilized if an asphaltic concrete bikeway, to one of the following pavement section designs:

1) 4-inches of asphalt concrete over 2-inches of compacted baserock, or

2) 2½-inches of asphalt concrete over 4-inches of compacted baserock, or

3) 4-inches of Portland cement concrete over 2-inches of compacted baserock.

d. Design Standards regarding horizontal alignment, grade, sight distance, intersections, signing, marking, structures, drainage and lighting shall conform to the AASHTO Standards. When bikeways are integrated with a curb, all inlet grates shall be designed to protect the bicyclist from the grate or opening.

2.35 STREET SIGNS

a. Street signs shall be installed on all new or reconstructed public and private streets. Street names for all newly platted streets shall be approved by the City.

b. All street signs (material, color, wording, etc.) shall conform to OSSC (ODOT/APWA) Specifications, City Standards, and the Manual of Uniform Traffic Control Devices (MUTCD). Location and type of signs shall conform with MUTCD and City Standards.

c. Signs along County or State right-of-ways shall be approved by the County or ODOT as appropriate.

d. All signs shall be ordered, installed and paid for by the developer. Street names and sign types shall be approved by the City prior to placement of the sign order.

Silverton Municipal Code

10.04.030 Traffic controls designated by council.

A. After approval by the State Highway Commission, where such approval is required by the Motor Vehicle Laws of Oregon and for the best use of the streets in the public interest, the council shall designate by resolution the following traffic controls which shall become effective upon installation of appropriate traffic signs, signals, markings or devices:

1. Parking meter zones, denomination of coins for deposit in parking meters, the parking time permitted for the deposit of the coin, and the hours during which the coin is required;

2. Through streets;

3. One-way streets;

4. Truck routes;

5. Streets where trucks, machinery or any other large or heavy vehicles exceeding specified weights are prohibited, except for delivering or picking up materials or merchandise, but then only by entering such streets at the intersection nearest the destination of the vehicle and leaving by the shortest route.

B. Except when contrary to state law, if it appears that public safety or welfare does not require the installation or maintenance of a traffic sign, signal, marking or device, or will be better served by the removal or alteration thereof, the council may, by resolution, forbid the installation or order the removal or alteration of any traffic sign, signal, marking or device that is proposed or installed under SMC 10.04.040. Such traffic controls shall become inoperative only when removed or altered. (Ord. 860 § 3, 1987)

10.04.040 Local traffic regulations authorized when.

A. The city manager is authorized to provide appropriate and reasonable regulation of the classes of traffic signs, signals, markings and devices for the streets, sidewalks and other public property of the city as are found appropriate for public safety, convenience and welfare. Subject to approval by the State Highway Commission where such approval is required by the Motor Vehicle Laws of Oregon, the city manager shall base his or her determination only upon:

1. Traffic engineering principles and traffic investigations;

2. Standards, limitations and rules promulgated by the State Highway Commission; and

3. Other recognized traffic-control standards.

B. The city manager may establish, remove or alter the following classes of traffic controls:

1. Street areas and city-owned or city-leased land upon which parking may be entirely prohibited or prohibited during certain hours, and the angle of such parking;

2. Parking meters, with the zone provided for parking meters;

3. The location and the time of operation of traffic-control signals;

4. Bus stops, bus stands, taxicab stands and stands for other passenger common carrier vehicles;

5. The location of passenger loading zones for use in connection with a hotel, auditorium, theater, church, school or public building;

6. Loading zones for commercial purposes;

7. Intersections or areas where drivers of vehicles shall not make right, left or U-turns, and the time when the prohibition applies;

8. Crosswalks, safety zones, parking spaces, traffic lanes and other symbols;

9. Traffic-control signs;

10. All other signs, signals, markings and devices required to implement traffic and parking controls enacted by the council or required by state law or regulations.

C. The city manager may provide for experimental or emergency traffic regulation of a temporary nature that shall not remain in effect more than 30 days. No experimental or emergency regulation is effective until adequate traffic signs, signals, markings or devices are erected clearly indicating the regulation.

D. The city manager shall not remove or alter a traffic sign, signal, marking or device if that act would be contrary to state law or ordinance. If a traffic sign, signal, marking or device is installed under authority of a resolution of the council, the council shall first approve any change or alteration by the city manager. (Ord. 860 § 4, 1987)

From:	Jim Sears
To:	Lisa Figueroa
Cc:	Christy Wurster; Christian Saxe
Subject:	Council work session
Date:	Wednesday, February 21, 2018 11:41:17 AM
Attachments:	CONSIDERATIONS NEEDED WHEN DETERMINING STOP SIGN PLACEMENT.pdf ITE Traffic calming and speed control.pdf ITE Traffic calming booklet.PDF ITE Traffic Engineering Council 4-waystop.pdf City of Fort Collins why not install.pdf City of Worcester MA stop sign information.pdf Why and Where Are Stop Signs Needed.pdf

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Lisa,

As we discussed yesterday, attached is the information that I believe would be helpful in our discussion at Monday's Work Session on traffic calming/stop signs.

It consist of quite a few documents.

If possible I would like the first document in the packet I am providing to be the "considerations needed when determining stop sign placement". This is the brief I prepared for the discussion on stop sign placement as it relates to the MUTCD. The other documents are supporting information for my brief, as well as, information I believe will be helpful to the council as we discuss traffic calming options.

Thanks,

Jim

CONSIDERATIONS NEEDED WHEN DETERMINING STOP SIGN PLACEMENT

Need to have standards

I. Allow for consistent placement and responses to community requests.
II. Defensible should we have a law suit.
III. Insure roadway safety and efficiency.

Need to comply with established laws, practices and standards

I. State requires MUTCD to be used.

The Oregon transportation Commission, through the Oregon Administrative rules (OAR), which carries the same force and effect of state law, adopted the federally mandated MUTCD. The OAR requires that these adopted standards be used on all public roadways in the State. The list of roadways that are required to conform to the MUTCD includes all state highways and public roadways under the jurisdiction of cities and counties within the State of Oregon. This requirement is established by Oregon Revised Statute (ORS) (see ORS 810.200) and Oregon Administrative Rule (OAR) (see OAR 734-020-0005).

The MUTCD states "This Manual contains the basic principles that govern the design and use of traffic control devices for all streets…..It is important that these principles be given primary consideration in the selection and application of each device"

The MUTCD provides the basic principles through standards (shall), guidelines (should), options (may) and support (informational) for its implementation.

II. An Engineering study should be used to establish a multi-way stop control at an intersection (Section 2B.07) to assign right-of-way.

The study should consider the following criteria (warrants B-D):

A. Volume of traffic on the intersecting roads are approximately equal;
B. If there have been five or more reported crashes in a 12 month period;
C. Vehicular volume entering the intersection from the major street approaches averages at least 300 vehicles per hour for any 8 hours of an average day;
D. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches averages at least 200 units per hour for the same 8 hours, with and average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour.

Also to be considered, per Section 2B.04 is that stop signs should not be used for speed control nor on the higher volume roadway.

When an engineering study is conducted, per Section 1A.13, it includes a comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in the MUTCE and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. An engineering study shall be performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented.

III. City code requires following traffic engineering principles

10.04.040 Local traffic regulations authorized when.

The city manager is authorized to provide appropriate and reasonable regulation of the classes of traffic signs, signals, markings and devices for the streets, sidewalks and other public property of the city and are found appropriate for public safety, convenience and welfare. Subject to the approval by the state Highway Commission where such approval is required by the Motor Vehicle Laws of Oregon, the city manager shall base his or her determination only upon:

1. Traffic engineering principles and traffic investigations;
2. Standards, limitations and rules promulgated by the State Highway Commission; and
3. Other recognized traffic control standards.

The evaluation for placement of a multi-way stop should give consideration to the principles and guidelines outlined above from the MUTCD and required by city code. The use and adherence to the MUTCD provides such a structure and will allow the city to meet the stated needs for having standards.

Notes:

Guidance is a statement of recommended, but not mandatory, practice in typical situations, which deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate.

Standard—a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device. All Standard statements are labeled, and the text appears in bold type. The verb “shall” is typically used. The verbs “should” and “may” are not used in Standard statements. Standard statements are sometimes modified by Options.

A variances from standards need to be supported by engineering judgment or an engineering study as noted in MUTCD.

Engineering Judgement is defined (per Section 1A.13) as:

The evaluation of available pertinent information and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. Engineering judgment shall be exercised by an engineer or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgment is not required.

SPEED CONTROL IN RESIDENTIAL AREAS

FORWARD

This document is a revision of the "Speed Control in Residential Areas" booklet original written by the Residential Area Speed Control Ad-Hoc Committee. This revision represents the latest information and findings of the Institute of Transportation Engineers (ITE) Michigan Section's Technical Project Committee. The makeup of the Technical Project Committee is as follows:

Lori Swanson, Chair	Hubbell, Roth & Clark, Inc.
John Abraham	City of Troy
Matthew Smith	McNamee, Porter & Seeley, Inc.
Mshadoni Smith	Hubbell, Roth & Clark, Inc.
Eric Tripi	Barton-Aschman Associates, Inc. of Michigan

The information presented in this document represents the findings of the authors and does not necessarily reflect the views of the Michigan Office of Highway Safety Planning.

TABLE OF CONTENTS

I. INTRODUCTION

The perception of speeding on local streets is probably the most persistent problem facing residents and traffic officials, alike. Although local or residential streets carry the lowest traffic volumes and suffer the fewest traffic crashes, they are the single largest consumer of a traffic engineer's time and energy. Residents observe vehicles being driven at speeds they perceive are too fast and conclude that the speeds would decrease if stop signs were installed. Speeds considered excessive by residents are considered reasonable by these same persons when they are driving in another neighborhood. Every traffic engineer has been shaken by these same residents who announce "if something is not done about the traffic problem on my street, someone is going to be killed and it will be your fault." This is usually followed by a demand for various traffic control measures and often backed up with petitions from residents. Traffic officials then must focus their attention on responding to these pressures, often diverting resources that could be dedicated to solving major capacity and traffic crash problems on other streets.

Residents' complaints are usually accompanied by a proposed solution to the speeding problem... stop signs. Traffic officials respond that stop signs installed to control speeding: (a) don't work, (b) are frequently violated, (c) are detrimental to safety, (d) are not warranted in the Manual* and, (e) actually increase speeds between stop signs. When residents are told that stop signs are not the answer to the speeding problem, they feel they must fight city hall to get them installed. A confrontational relationship is established between residents and traffic officials and the stop sign becomes a "trophy" which is awarded to the winner of the confrontation. Solving the speeding problem becomes secondary to winning the "trophy". The end results of this process are: (1) unhappy citizens, (2) continued complaints and requests for more stop signs, (3) increased political pressure and, (4) often, approval of stop sign installations to bring the controversy, temporarily, to an end. However, experience shows the

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* The "Manual" refers to the *Michigan Manual of Uniform Traffic Control Devices* (MMUTCD that specifically states that stop signs should not be used for speed control).

speeding problem is usually not solved. Before and after studies show that stop signs usually increase mid-block speeds and create violators of the stop controls.

This booklet introduces traffic engineers, law enforcement officers, elected officials and community leaders to the concept of traffic calming which may help alleviate speeding in residential areas. Traffic calming is the combination of physical controls and community support to reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized users. Some objectives of traffic calming include: reducing speeds for motor vehicles, reducing crash frequency and severity, increasing safety, reducing the need for police enforcement, and reducing cut-through motor vehicle traffic.

Traffic calming measures are typically installed as part of an area wide traffic management scheme rather than on a single street to avoid shifting the problem from one street to another. A successful traffic calming program must include enforcement, education, engineering and community involvement. Community support and participation is an integral part of a successful traffic calming program. This booklet will give guidance on how to set up a successful traffic calming program in your community.

This booklet provides alternatives that may help decrease speeds on residential streets. It discusses the advantages and disadvantages of each alternative. It points out that there is no single, simple solution to all speeding problems that satisfies residents, is effective, and meets good engineering practices and standards. It also stresses that there may not be a tool to reduce speeds. Regardless of the approach used, there are certain criteria that should be followed:

- All devices must meet Michigan Manual of Uniform Traffic Control Devices requirements.

- The integrity of streets classified as Major under the provisions of Public Act 51 must be preserved.

- Permanent traffic control devices should be used to the minimum extent required to achieve the objectives.

- Access to all properties must be accommodated.

- Access from the nearest arterial to the destination should be as direct as practical.

- Local access to neighborhood facilities must be accommodated.

- All permanently installed devices must be designed to allow emergency vehicle access.

- Consideration must be given to circulation, parking and needs of customers and business owners.

- Consideration should be given to the access needs of essential commercial services such as garbage pickup, snow plowing, student busing, etc.

- Changes must not unduly impact adjacent areas.

It states that residents and local officials must work together with a full understanding of each other's problems, limitations and concerns for the common goal of safety on residential streets. One of the best ways to accomplish this is to have citizens involved in standing or ad hoc community traffic safety committees.

This booklet is intended to be used as a traffic safety tool by traffic engineers, law enforcement officers, elected officials, and community leaders in their day-to-day traffic control responsibilities.

References : 40, 41, 42

II. COMMUNITY INVOLVEMENT

An important component of any traffic calming program is community involvement. If citizens are involved, the chance for problem resolution and a successful traffic calming program is greatly improved. Often the problem cited is one of perception and not fact, and the solution proposed could be ineffective or even counter-productive. One way to avoid the knee-jerk approach to traffic engineering is to develop a process that involves the community. While there are many ways to accomplish public involvement, this section will describe two that have been successful.

Approaches to Citizen Involvement

Standing Committee

Some communities have successfully employed a standing committee, normally referred to as the "Citizen Traffic Committee," to deal with traffic control issues. The makeup, function and authority of the committee are described below:

a. The committee is appointed by the mayor or council. It should consist of an odd number of members who serve staggered terms.

b. Non-voting staff experts (police and engineers) are available to prepare agendas, collect data, provide input and send recommendations to the city council.

c. Efforts should be undertaken to make committee members as knowledgeable as possible about traffic engineering and enforcement principles. This can be realized by providing technical materials and training for committee members.

d. The Committee reviews citizen requests for traffic control devices and staff analysis of those requests, and makes recommendations to the city council.

The Committee should hold monthly, evening meetings. The standing committee offers several advantages; acts as a buffer between the council and citizens; lessens the pressure to install unwarranted devices; may be perceived as more objective than staff; provides technical and citizen input to the council; and dampens the adversary relationship that often develops between citizens and staff. On the other hand, there are some drawbacks: the committee can become politically motivated; one strong member can have too much influence; it can slow the process; and it requires some staff time.

Ad hoc committee

In this approach, an *ad hoc* or advisory committee is formed when a community seeks help in dealing with a specific traffic control problem. While the governmental agency has the ultimate responsibility, it is highly desirable that the committee and agency work through the process and arrive at a consensus. This process works as follows:

a. A working committee of neighborhood residents should be selected to represent different parts of the neighborhood. If the neighborhood has an organized association it should be asked to assist with the appointments; otherwise, volunteers are sought.

b. Committee members should identify the problem brought to their attention.

c. Staff collects the appropriate data and presents it to the committee. The committee sets goals which are quantifiable, e.g., reduce the average speed by a certain percentage, etc.

d. Options should be identified and alternatives presented, listing the pros, cons, cost, etc. of each.

e. Committee and staff reach agreement on the alternative to be recommended.

f. Committee with staff support presents the plan to the larger community through a large meeting or several small meetings. One large meeting is enough if the plan is not controversial; the number of meetings should be directly related to the complexity of the plan. The purpose of the meetings is to obtain community support.

g. Once community support is achieved the plan is implemented. If possible, it is best to install temporary measures to determine the impact. This allows for adjustments and even removal if it is obvious that the measures will not produce the desired results.

The advantages of using advisory committees are that they will help develop neighborhood concerns and determine what, if anything, should be done; it builds a relationship between staff and residents to work through future problems; and the process creates a better understanding of traffic engineering and enforcement principles among lay people. Conversely, this process consumes considerable time and effort of staff. If consensus is not reached, the neighborhood can become divided. If not handled deftly by staff, the process can become unwieldy.

References: 19, 25, 28

III. PROBLEM IDENTIFICATION

The first step in a traffic calming program is to identify the problem. When a resident contacts their City, Village or County, a complaint is recorded. The resident will be directed to discuss their concerns with the other residents or an established traffic advisory committee. If an advisory committee has not been established, the public agency will give guidance on how to start one. Residents will assist the public agency in the identification of the problem.

These residents will also assist the public agency in the collection of data. Speed studies, traffic volume studies and license plate surveys, depending on need, will be performed at locations identified by the residents. The data collected will be analyzed to determine if there is a problem. If a problem is not identified, a letter with the supporting data will be sent to the residents explaining the findings and that no further action is required. If a problem is identified, then the public agency will move to the next steps of the program which include enforcement and education.

References: 42

IV. EDUCATION AND ENFORCEMENT

Once a speeding problem has been identified, the next steps in a traffic calming program is to initiate education and enforcement campaigns. Both of these steps should be conducted at the same time since many times a speeding problem can be reduced through effectively enforcing the traffic ordinances and educating the residents. From past enforcement activities, the City of Farmington Hills, Michigan found that most traffic violators within a residential area were the residents who live in the area. Therefore, it is critical to educate the residents of an area where a traffic problem is occurring.

Reference: 42

A. EDUCATION

1. Public Information And Education

An effective way to educate residents is through public information and education campaigns. Public information and education campaigns should be carried out through the mass media by law enforcement members of safety oriented groups. These campaigns "spread the word" about current enforcement emphasis and encourage voluntary compliance with the law. The perception that violators will be apprehended is essential to develop compliance with the law. Selecting the right media for your message is important. Clearly define the reason for the change; i.e., to reduce traffic crash casualties. The size of the audience and project will be a controlling factor in the media you select. An enforcement effort must be coordinated with the information and education campaign.

Reference: 5

2. Neighborhood Speed Watch Program

Another educational tool is the Neighborhood Speed Watch Program whereby residents can help control speeds with minimal police support.

A Neighborhood Speed Watch Program must involve law enforcement personnel and residents working as a team. Law enforcement's role is to provide the educational material and, if necessary traffic law enforcement. An effective tool used for education is speed radar trailers. The trailers are unmanned and equipped with radar equipment to detect the speed of vehicles. The trailer clocks the speed of an approaching vehicle and displays the speed on a display board that is visible to the motorist. This shows the motorist the actual speed at which they are traveling.

The neighbors must educate each other, establish their goals, and police themselves. Neighbors identify the speeders, the police make personal contact for the purpose of educating the speeder, and involve law enforcement as a last resort.

This program has the benefit of bonding the neighborhood together. The off-shoots of this are invaluable. The reduction of negative contacts with law enforcement enhances its image. The time involvement will depend on the individual's role and the size of neighborhood or community that is targeted. The media relationship involvement relates to the target area.

Neighborhood Speed Watch Programs rely on peer pressure and community spirit to increase awareness in a subdivision that may experience speeding traffic. It considers the fact that in a self-contained subdivision, the drivers involved are neighbors and friends of the people complaining of speeding. Neighborhood Speed Watch Programs have little or no effect on "through" traffic problems.

Typically, to be included in a Neighborhood Speed Watch Program, a street must (1) be a local street, (2) experience 85th percentile speeds in excess of 10 MPH greater than the posted speed, and (3) receive support from most of the households.

Once established, the following actions are taken:

a) A personal letter is sent to all households explaining the Program.

b) Neighborhood Speed Watch Program signs are posted.

c) Committee members call each household in the specific area to explain the program and appeal for cooperation.

d) Radar speed observations are made by local traffic personnel and personal letter are sent by the Chief of Police to drivers or owners of vehicles observed speeding.

e) Periodic speed studies are made to determine the Program's effectiveness.

f) Neighborhood organizations are involved as necessary.

Reference: 9, 42

8. ENFORCEMENT

1. <u>Surveillance/Enforcement</u>

Selective traffic law enforcement is the process of assigning police officers to a specific area at specific times to enforce traffic laws relating to a specific problem. The allocation of officers to the area is usually for a limited period.

When a police agency becomes aware of a particular traffic safety problem, officers can be assigned to the problem area to enforce related laws. Decisions must be made as to enforcement strategy, number of officers, time of day or any combination thereof, depending on the variables related to the location, type of violations, available officers, etc.

This type of activity tends to only solve the problem in the presence of the officer. The more officers assigned, the more effective this method. This is a costly process especially when it involves overtime or diverting officers from other assignments.

2. Automated Speed Enforcement Device

The newest tool in speed enforcement is the Automated Speed Enforcement Device, which is currently being tested at selected locations throughout the U.S. This device consists of a speed radar device and a 35 mm camera interfaced through a computer. It is located in an unmarked vehicle parked on the side of a road. As each vehicle comes within radar range its speed is determined. If that speed is over the preset threshold speed, the camera takes a photograph of the vehicle and its license plate.

The owner of the vehicle is then informed by either a warning letter or ticket of the date, time location, posted speed and travel speed of the vehicle. Currently, Michigan law does not permit the issuance of a ticket.

V. <u>ENGINEERING</u>

When the education and enforcement campaigns prove to be ineffective, the location qualifies for further analysis to determine what traffic engineering measure, if any at all, should be installed to effectively reduce speeds. In certain situations, vehicle speeds can only be effectively reduced by physical diversion of the traffic on the travelway. The application of traffic control devices, such as signs, alone normally are not effective in reducing vehicle speeds through residential neighborhoods. However, when used in conjunction with traffic calming devices, the proper use of traffic control signs can be an effective traffic management tool.

A. TRAFFIC CONTROL DEVICES

1. <u>Stop Signs</u>

The basic purpose of stop signs is to assign right-of-way to vehicles at intersections. There are Stop Sign Warrants outlined in the MMUTCD which must be satisfied before a stop sign can be installed. Stop signs are requested by residents more than any other traffic control *device* for the reduction of vehicle speeds and traffic *volumes.* Unfortunately, studies have shown that stop signs are largely ineffective in meeting the residents' requests for speed control.

a. <u>Two-Way Stop</u>

This is used to assign right-of-way to traffic on one of two intersecting streets by requiring traffic on one street to come to a complete stop. It is suitable where:

- one street is a major street;
- sight distances approaching the intersection are substandard, and traffic approaching under the general rules for uncontrolled intersections would run a strong risk of being involved in collisions;

- there is a history of a crash pattern that could be corrected by right-of-way controls, yet conditions do not require traffic on both streets to stop.

b. Four-Way Stop

This type of intersection control is intended primarily where two collector or major streets intersect and do not warrant a traffic signal. Its purpose is to assign right-of-way to traffic on both intersecting streets by requiring all approaching vehicles to come to a complete stop.

c. Effect on Traffic Volumes

When local streets offer significant savings in time over congested parallel major and collector routes, or allow avoidance of congestion points, traffic control devices, including stop signs, will do little to reduce traffic volumes. However, when the local streets offer only a slight savings in travel time over other routes, the time lost at stop signs may be enough to keep traffic off of local residential streets.

Stop signs may be installed at uncontrolled intersections in residential neighborhoods with a street network arranged in a grid pattern. Traffic would be stopped on every other block throughout the entire residential neighborhood. With no continuous "through" streets in the neighborhood, an even distribution of traffic would be encouraged.

d. Effect on Traffic Speed

Numerous studies have shown that stop signs are relatively ineffective as a speed control measure, except within 150 feet of the intersection. At the point of installation, speeds are reduced, but the effect on traffic approaching or leaving the stop-controlled intersection is negligible. In fact, some motorists actually increase their speed to make up for the "inconvenience" of stopping or disregard the stop signs. Studies show that more than 50% do not stop.

A study conducted in Boulder, Colorado, demonstrated that the 85th percentile speed and mean speeds on 25 mph and 35 mph roads were greater in areas that were controlled by stop signs.

Studies in various California cities showed a slight increase, or no change, in vehicle speeds after the installation of stop signs.

While the request tor stop sign installation leads all resident requests for speed control measures, it must be emphasized that studies have proven there is little or no effect on vehicle speeds in residential road networks after installation.

e. Warrants/Compliance

Warrants for stop sign installations are included in the Michigan Manual of Uniform Traffic Control Devices (MMUTCD). These warrants relate to right-of-way assignment and respond to site safety consideration.

A stop sign observance study of unwarranted four-way stops in Troy, Michigan, found that the percentage of "no" or "roll" stops to be significant after installation of unwarranted stop signs, while there was no significant change in 85th percentile speeds.

Many studies have been conducted to determine the degree to which stop signs are obeyed. When not required to stop by cross street traffic, only 5 to 20 percent of all drivers come to a complete stop; 40 to 60 percent will come to a "rolling" stop below 5 MPH, and 20 to 40 percent will pass through at higher speeds. High-volume, four way stop-controlled intersections have demonstrated the highest compliance levels, while three-way stop controlled intersections have shown the lowest.

In Star City, West Virginia, before and after studies showed an increase in "no-stops" from 14.1% to 25.1% when two-way stop intersections were converted every summer to four-way stops for pedestrian safety. Mean Speed was not significantly affected by the presence of the four-way stops. The recommendation of this particular study was to end the practice of using four-way stops for speed control.

Studies have shown that when a driver does not believe that a stop sign appropriately reflects the actual traffic conditions, the driver often disregards it. The use of unwarranted stop signs not only decreases the compliance levels of motorists, but has the unintended effect of decreasing compliance at intersections where stop signs have been installed for warranted operation and collision reduction.

f. Effect on Traffic Safety

While no study has proven the effectiveness of stop signs as traffic safety measures, general engineering belief is that the unwarranted use of stop signs increases the safety hazard at the intersection. This is shown in the studies of the compliance rates at stop-controlled intersections. In addition, motorists disregard for unwarranted stop signs presents a significant hazard to crossing pedestrians.

Effects of unwarranted stop signs on driver behavior and safety at stop signs throughout a community are difficult to substantiate. Evidence to date on the safety effects of individual stop signs placed for volume and speed reduction purposes is mixed. At some intersections where a degradation in safety was measured, placement of the signs in poor visibility positions and lack of supplementary markings may account for the crash experience. Cases where safety experience was reportedly improved may include instances where traditional warrants for stop sign installation were actually met, or were close to being met.

g. Environmental Effects

Stop signs affect the environment around the intersection, and the use of unwarranted stops signs could unnecessarily add to this problem. Stopping and idling at intersections increases the amount of automobile exhaust in the area. In addition, tire noise and engine noise increase with the braking and acceleration associated with stop signs. Automobile fuel consumption is increased with the stopping, accelerating, and idling of vehicles at stop-controlled intersections.

h. Community Reaction

Residents often see stop signs as a solution to "near miss", as well as actual crashes. They are also viewed as being effective at controlling vehicle speeds. Suggestions that unwarranted stop signs have very poor compliance and that they might be detrimental to safety are generally discounted by residents. Residents also dismiss concerns over a community's exposure to tort liability for unwarranted use of traffic control devices. By disregarding the warrants presented in the MUTCD, this presents potential liability concerns for the responsible jurisdiction. If a stop sign installation could be considered irresponsible or in clear contradiction to accepted standards, liability suits could result.

Objections to stop signs come mainly from residents at the intersections who are subjected to additional noise and pollution which come from decelerating and accelerating vehicles, and from motorists who think they are being stopped needlessly.

It should be the goal of the traffic engineer and local policy makers to explain to the public why unwarranted stop signs are ineffective at controlling vehicle speeds. Special attention should be given to explaining the adverse effects on the environment, motorist safety, and pedestrian safety.

A community's policy of installing 4-way stops at school crossings should be reviewed in light of the above items. Stops at these locations are only useful about 2% of the time. Therefore, 98% of the time, they can be serious traffic safety hazards.

References: 1, 2, 3, 4, 36, 37, 38, 39, 40

2. Speed Limit Signs

a. Speed Limit Signs/Speed Zoning

The speed limit sign is a regulatory device that informs drivers of the speed limit imposed by the governing agency. Some signs merely remind drivers of the limits applicable to the type of highway and area. Where the speed limit is not applicable to specific sites because of special hazards, a deviation from that limit is shown by posting advisory speed signs. A new speed limit is determined by an engineering and traffic study of the street section involved. Special attention is given to the character of the street (sidewalks, driveways, and sight obstructions), horizontal and vertical alignment, pedestrian activities, and hazards which may not be easily detected by drivers. If no unusual safety problems are detected, the 85th percentile speed of traffic on a street is usually taken as an indication of the speed limit which could be implemented.

Studies that tested the effect of speed limit signs on speeds have been largely confined to major streets and expressways. Performance on these highways is not considered relevant to the local street situation. Studies have shown that speed limit signs have very little impact on drivers' speeds on major streets. Motorists Drive at speeds that they consider reasonable, comfortable, convenient and safe under existing conditions. Drivers appear not to operate their vehicles by the speedometer, but by roadway conditions.

Speed limit signs, other than the standard 5 MPH increment (i.e., 28 MPH), are not standard and may be illegal. The desired effect of posting a non-standard speed limit sign is to gain compliance by capturing the driver's attention with a unique number. If drivers are consciously aware of the speed limit, they are more likely to comply with it. While the signs are inexpensive, they do not conform to the MMUTCD. Initially, the signs would be noticed and make drivers aware of their speed. Once drivers became used to the signs, they have no further effect on drivers' speeds.

If posted speed limits are significantly lower than prevailing traffic speed, residents normally place some hope in them or in subsequent enforcement. However, if the posted limits are within a few miles per hour of the previously prevailing traffic speed, they are not addressing the residents' problem.

b. Speed Limit Signs With Other Devices

Speed limit signs with flashing beacons have been shown to have a minor effect in reducing vehicular speeds. Such signs have been shown to be most effective in school zones. Other traffic activated signs with variable messages and warnings may also have minor effectiveness in reducing speeds.

One such device is a trailer-mounted *variable* message sign with a radar speed gun which displays the posted speed limit and the approaching driver's speed. The intent is to increase the motorists' awareness of both posted speed limit and their own travel speed.

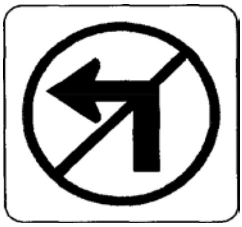
Observations show that most motorists reduce their speed when they see the device. In addition to reducing motorists' speeds, other advantages of the equipment include the creation of positive public relations, better acceptance of speeding tickets, and its ability to act as a teaching device. The disadvantages include potential vandalism to the equipment if left unattended, and it may encourage speeding by those who wish to "test" it. Its speed reduction effectiveness is isolated to the immediate area and time of its use, and this likely will diminish over time. However, effectiveness can be improved with the use of visible speed enforcement.

References: 5, 6, 7

3. Turn Prohibitions

Turn prohibitions will reduce traffic volumes, noise, and, in some cases, speeds on streets where they are applied. They may also improve traffic safety on streets to which they are applied.

However, volumes, noise and speeds will increase on alternate routes. They are difficult to enforce, and reduce access for residents. In some cases, speeds may increase, and traffic safety may decrease, when motorists are forced to take alternate routes.



Turn prohibitions can be used to reduce traffic volumes on local streets by installing them on major/collector streets to prevent traffic from entering local streets. Such controls are usually in effect during peak traffic volume hours, when motorists are seeking less congested, alternate routes.

Although turn prohibitions have been in use for some time, very little quantitative research was found, and it was related to the number of violations. Violations in the range of 10% to 15% of the original turning volume can be expected.

Reference: 8

4. One-Way Streets

The use of one-way streets has mixed results. They are not useful in reducing speeds on local streets. In fact, the use of one-way signs may increase speeds in the permitted direction, and may increase the amount of cut-through traffic on other residential streets.

One-way streets can be used to make travel through a neighborhood difficult by creating a maze effect in the internal street pattern, which may discourage through traffic. However, the amount of traffic on other residential streets may be increased.

Reference: 8

5. Commercial Vehicle Prohibitions

It is a common practice in communities to prohibit commercial vehicles from most, if not all, local streets in residential areas. This is done to protect the pavements and eliminate nuisances. However, commercial vehicles are normally allowed to travel on any street when engaged in pickup and delivery. Such regulations are unlikely to affect vehicle speeds, but they will reduce truck traffic volume and noise.

Reference: 8

6. Special Warning Signs

Special warning signs such as "Children at Play", "Watch for Children", or others that warn of normal conditions are not effective in reducing speeds in residential areas. It is also likely that such signs encourage parents to believe that there is an added degree of protection, which is not the case. These signs suggest that it is acceptable for children to play in the street. The Michigan Vehicle Code prohibits the use of signs not deemed standard by the MMUTCD.

The MMUTCD provides standards for signs warning drivers that they are approaching recreational facilities such as parks and playgrounds. However, there is not enough evidence to determine the effect of these warning signs on vehicle speeds.

Reference: 40

7. Portable Signs

One growing trend in many communities is the use of portable stop signs placed in the street between crosswalks, to protect pedestrians. This has actually turned out to be a very controversial issue in many areas.

Municipalities feel that these signs are very effective in forcing traffic to stop for pedestrians in crosswalks. However, some state departments of transportation have banned the use of these portable signs, citing reports that the signs, when hit by vehicles, have caused injuries to nearby pedestrians. The MMUTCD states "As noted herein or for emergency purposes, portable or part-time STOP signs shall not be used". The exceptions refer to hand-held STOP signs used by construction flaggers and school crossing guards.

B. TRAFFIC CALMING DEVICES

1. Speed Humps and Bumps

The speed hump is generally 3 to 4 inches high, rounded section of pavement, approximately 12 feet in length. A speed bump is approximately 12" to 18" long, causing a more severe "bump" to be felt by the driver.

The speed hump was developed in the Transportation Road Research Laboratories (TRRL) in Great Britain and has been tested in closed test areas and on public roads. Tests in the United States and in various countries around the world, have shown speed humps to be effective in controlling vehicle speeds and in reducing traffic volumes in the immediate area of the hump or bump.

Studies in Australia, the United Kingdom, and the United States have shown reductions in 85th percentile speeds ranging from 3 MPH to 14 MPH between speed humps and from 6 MPH to 27 MPH at the speed hump location. Recent experience in a Michigan community indicated a 5 mph reduction in the 85th percentile speed. Volumes were found to be reduced from 1 to 55 percent.

Anothe type of speed hump is the flat top hump or speed table. These humps are typically 22 inches long with a 10 foot flat section and can be used on collector roads with more than 12,000 vehicles per day. This type of speed hump can serve as pedestrian crossings. Studies have shown these humps not only greatly reduce the 85^{th} percentile speed of mainstream traffic but also have shown that, unlike speed humps, the speed between the humps and at the humps are essentially the same as before hump or bump installation.

Some of the negative effects of speed humps are an increase in noise level from individual vehicles near the humps caused by braking and acceleration, but not due to the sound of vehicles striking the humps. Studies have shown that speed humps have a more severe impact on longer wheel base vehicles and should not be used on neighborhood collectors, major fire and ambulance routes, or on routes frequently used by large trucks or buses. They are a major hindrance to snowplowing efforts.

Often the implementation of such traffic calming measures bring up liability issues. A recent survey of a number of communities using different traffic calming devices found that most had no legal problems at all while the remainder had mostly experienced threats and no action. As more and more traffic calming devices are installed, the question of the legality of these measures are becoming irrelevant.

The reports on speed humps have shown that both the design and location/spacing of speed humps are critical. For typical residential streets the most widely used design is the circular, parabolic speed hump. A series of speed humps is more effective than a single installation. The spacing of speed humps ranges from 200 feet to 750 feet, depending upon the desired 85^{th} percentile speed between speed humps. Formulas have been developed to determine the optimal spacing of humps, depending on the use of either a 3 inch or a 4 inch high hump. Adequate pavement markings and traffic signs are important to warn drivers of speed humps. Speed humps can be installed on roadways carrying 3,000-8,000 vehicles per day. The cross-section design of humps or bumps is critical to their effectiveness.

The speed hump should not be confused with the speed bump that is 3 to 5 inches in height and 1 to 1 ½ feet in length. Because speed bumps are abrupt, they are considered to be potentially hazardous for motor vehicles. The main use of the speed bump has been in private parking lots and on private roads. They are generally considered to be inappropriate by traffic engineers because they are not included in design guides.

As of September 10, 1997, The Institute of Transportation Engineers (ITE) plans to publish the recommended practices for Guidelines for the Design and Application of Speed Humps.

References: 10, 11, 12, 13, 14, 15, 16, 32, 33

2. Rumble Strips

Rumble strips are a series of either bumps or depressions in the pavement. They are intended to alert drivers of a special situation, such as a speed reduction or stop ahead condition. They are typically ½ to 1 ½ inches high or deep, 3 to 4 inches wide and placed 90° to traffic flow.

Rumble strips produce both an audible rumble and a vibration that creates an awareness of a condition for which a driver must react. They are used most frequently on shoulders of high-speed roadways to alert drivers that they are not driving in the travel lanes of a road. They are also commonly used to alert drivers in rural or high speed areas of an unexpected stop-ahead condition.

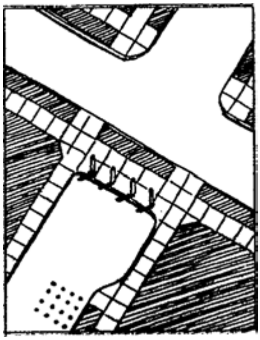
Many states now use 'portable' rumble strips, which are basically high density rubber sheets with a series of undulations. Though these are popularly used near construction zones, these may be used as a temporary measure in residential areas before installing permanent rumble strips.

Little research has been performed in residential areas for their use as a speed control device. A study in the City of Rochester Hills showed speed reductions of up to 2 MPH, whereas another study showed reductions of up to 15 MPH. Rumble strips can produce an annoying noise, cause vibration in nearby homes and be snow removal obstructions. One study suggests they should not be used where there is significant bus or truck activity or where traffic volumes exceed 2,500 vehicles per day. Due to the adverse effects, their installation must be carefully considered.

References: 4, 17, 18

3. Street Closures

The primary effect of street closures is to eliminate through traffic rather than to reduce speed. There may be some speed reduction because higher speed through traffic is discouraged from using the neighborhood streets. This is true particularly where a pattern of closures is carefully designed to accomplish this end. Street closures can be constructed at an intersection or at midblock. The midblock application can be effectively used where it is desired to restrict traffic in a residential section while allowing access to a high traffic generator adjacent to the residential area. Generally, whenever a street closure is used, a cul-de-sacs should be constructed so as not to "trap" a vehicle. Cul-de-sacs often require the purchase of right-of-way and often are constructed in a resident's front yard.



Among the disadvantages of street closures are:

- Restricted access to the neighborhood by service and emergency vehicles.
- Problems with vandalism and maintenance.
- Traffic is often transferred to neighboring streets, generating new problems and complaints.

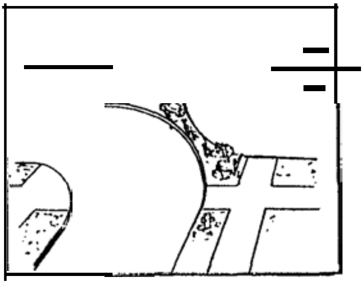
Street closures are difficult to apply to existing roadways and are better suited for newly developing subdivisions.

When cul-de-sacs are used, adequate turnaround areas must be provided at the end of the street. Proper signs must be installed to warn drivers of the end of the street.

Reference : 8, 28

4. **Traffic Diverters**

a. Diagonal Diverters



Diagonal diverters are barriers

section. This converts a normal four-legged intersection into two separate roadways, each with a 90° turn. The purpose is to discourage "through" traffic by requiring it to take a circuitous route through the neighborhood.

Speeds of vehicles are only affected in the immediate vicinity of the diverter because drivers must make a 90° turn. Diverters may discourage drivers from using the street as a short-cut route. However, some drivers will simply move to another residential street, thus moving the problem. Since they create formidable barriers in the intersection, they must be marked similar to one-way streets and have appropriate lights so they can be seen at night.

References: 8, 9, 19

b. Semi-Diverters

A semi-diverter is a barrier placed transverse to traffic at the beginning of a block. It prohibits traffic from entering the block, but allows two-way traffic within the block. Since they create formidable barriers in the intersection, they must be marked similar to one-way streets and have appropriate lights so they can be seen at night.

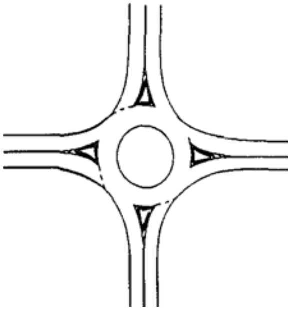
Semi-diverters have no effect on speeds other than in the immediate vicinity of the barrier. They can reduce traffic volumes, but only at the end of the block at which they are placed. The violation incidence can be quite high.

Reference: 8, 19

5. **Traffic Islands**

a. Traffic Roundabout

Modern roundabouts are different from traditional traffic circles, in that all approaching traffic yields right of way to circulating traffic. This is reinforced through the use of yield signs on the approaches. Other characteristics of roundabouts include deflection and flared approaches. Use of deflection helps slow entering vehicles, leading to safer merges with the circulating traffic stream. The use of splitter islands helps drivers perceive a change in the roadway geometry and enter the roundabout safely. Benefits of roundabouts realized in the states of California, Florida, Maryland and others include slowing of traffic, reducing delay and emissions when compared to stop/signal controlled intersections, improving safety and aesthetics.



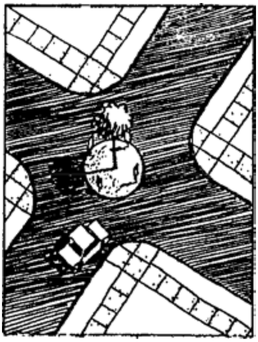
Its primary use is to reduce crash frequency at residential intersections. These roundabouts also have an effect on traffic volume and speeds.

At ten study locations, average speeds were reduced 4 MPH (from 27.5 MPH to 23.3 MPH) downstream from the circles, but only for short distances. Speed reductions can be even more significant near the circle, similar to speeds near stop signs.

One study shows a significant 77% decrease in crashes. Traffic volumes on the higher volume street at twenty study locations decreased an insignificant 2%. The construction cost of a roundabout is quite high ($10,000 - $30,000).

References: 4, 8, 19, 20, 30

b. Traffic Islands



A traffic island is a defined area, painted or raised, included in highway design for the primary purposes of controlling and directing traffic movements. They also provide refuge for pedestrians, reduce excessive pavement areas, and can be used to indicate proper use of an intersection or to locate traffic control devices.

Painted/striped islands do not affect speeds significantly; raised islands reduce vehicle speeds in some instances, mostly in combination with narrow lanes, which can create hazards.

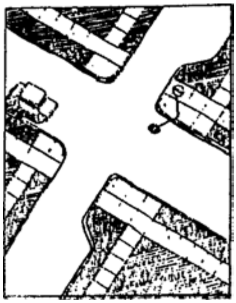
Improper islands make roadways unsafe. If an island is not large enough to command attention, motorists will drive over it. Curbed islands are sometimes difficult to see at night due to oncoming headlights or other light sources, thus causing crashes.

Islands do not reduce traffic volume by any significant amount, but can be an effective treatment for traffic movement and safety. If a traffic island is used, it might be beneficial to plan an island initially, then observe the effect and change the layout arrangement accordingly. The same process can be repeated until an optimum arrangement is established and a permanent raised island can be installed.

6. Chokers and Road Narrowing

Chokers are narrowed roadway widths using landscaped areas between the sidewalk and street. The pavement width between chokers can be constructed for one or two lanes of traffic. The choker can be constructed parallel to the traveled way or twisted to the direction of travel.

Road narrowing is a method used mostly in residential areas to control vehicle speeds and reduce traffic volume to improve safety. Another road narrowing technique can be found by the use of medians. In one community in Maryland, medians 20 to 50 feet or more in length have been constructed in advance of intersections. It was found to effectively reduce speeds though, it was necessary to construct bulb-outs to force drivers to shift over inconveniently. Once implemented, the 85th percentile speeds were reduced by 2-5 mph.



Chokers and road narrowing can control the speeds of vehicles efficiently and can increase safety and reduce traffic flow if properly installed. However, they should not be used on high volume streets, and sudden road narrowing should always be avoided. Curbside parking may have to be sacrificed to implement these methods. Proper signs should be installed to warn drivers of the chokers.

Reference: 4, 32

7. On-Street Parking

On-street parking is parking that is allowed on a street in the curb lane and is commonly permitted in residential areas.

Drivers of through vehicles generally reduce their speed in anticipation of conflict situations with parked vehicles or pedestrians. A study was done in Dallas where parking was removed in four central business districts. A 60-day study showed an increase of 26.7% in vehicle speed. In another study, only peak period prohibitions were reported which increased average speeds by 27%.

A clear relationship exists between crashes and vehicles parked on-street. One study in a community of 65,000 people found that 43% of all local and collector-street crashes involved on-street parking.

The angle of on-street parking has an affect on safety. Although angle parking allows for more parking spaces per unit of curb length than parallel parking, it requires more space for maneuvering, increases the amount of time a car is exposed to oncoming traffic, and can create a visibility problem for drivers when backing out into traffic. Therefore, angle parking has a substantially higher crash rate than parallel parking. Many studies have found that eliminating angle parking and replacing it with parallel parking reduces crashes 19 to 63 percent. A study in Maine found that parallel parking had a crash rate 12 percent lower than angle parking. A study in Nebraska concluded that parking should be of parallel rather than angle type to improve safety by reducing traffic crashes.

Several studies have been conducted that show the safety concerns of on-street parking. Primary hazards are:

1. Parked vehicles make the road width narrower and significantly restrict the flow of traffic. Parked vehicles can easily increase rear-end or side-swipe crashes due to hazardous maneuvers by drivers avoiding parked vehicles or drivers entering or leaving parking stalls.

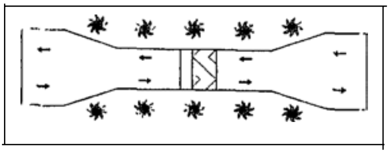
2. Drivers or rear-seat passengers getting out of parked vehicles on the side street present an added obstacle in the roadway. This produces both rear-end and side-swipe collisions.

3. Reduced sight distances involving pedestrians, especially children, attempting to cross the street from between parked vehicles or at intersections.

It is advisable to avoid on-street parking especially on residential streets because of the crash hazard, traffic volume/capacity/flow reduction, etc. It does, however, reduce speeds by restricting sight distances.

References; 21, 22, 23, 24, 34, 35

8. Combination of Physical Control Measures



Various combinations of traffic control and traffic calming measures can be used to enhance effectiveness. The combinations are governed by the major objectives or purpose for which the installation is planned. For example, the objective of reducing speeds and cut through traffic may be achieved by using a combination of a speed hump and street narrowing. The illustration presents such a combination. This combines the installation of a speed hump as well as street narrowing within the vicinity of the speed hump. The street narrowing helps to reduce speeds over a longer distance than a conventional speed hump.

References: 31

C. ROADWAY MARKINGS

1. Transverse Markings

Transverse pavement markings consist of a series of painted lines placed across the road. The spacing between the lines gradually decreases as the hazard is approached. The paint pattern is intended to give the illusion of high speed and causes drivers to reduce their speeds. In Maine, transverse pavement markings used in conjunction with standard speed limit signs, when entering a small town, increased the number of vehicles traveling below the speed limit by 10 percent. In Scotland, similar success occurred when yellow transverse markings were applied in advance of a traffic circle. Initial results showed a 30 percent reduction in 85th percentile speeds. which were later reduced to 16 percent after one year. Crashes were reduced at the Scotland site from 14 crashes in the year prior to the installation to only 2 crashes in the 16 months following the installation.

A study in Great Britain showed that speeds were influenced by the existence or non-existence of a hazard following the transverse markings. If no hazard exists at the first location with transverse markings, the driver would not slow down at the second location even if a hazard existed.

It appears from the various studies that if transverse markings are used at locations in advance of potentially hazardous locations or in addition to normal speed limit signing when entering small towns, that speed reductions will occur at both types of locations and crashes will be reduced at the hazardous locations. However, it does not appear from the literature reviewed that reductions in speeds should be anticipated by applying transverse pavement markings in the middle of a typical residential area.

Reference: 27

2. <u>Longitudinal Markings</u>

Longitudinal pavement markings for speed control is intended to give drivers the impression of a narrow lane through which the vehicle must be guided. One study involved the striping of two residential streets to nine foot wide lanes. It was found that speeds changed in a range of a decrease of 1.4 MPH to an increase of 3.2 MPH. It was theorized that the narrowing by striping was ineffective because it actually made the drivers task of tracking the roadway easier.

3. <u>Crosswalks</u>

The use of painted crosswalks is to provide improved pedestrian safety by guiding them across the street and to notify drivers of the possibility of the presence of pedestrians. When painted crosswalks are used, sidewalks on both sides of the road should also be provided. There is no indication in the literature that crosswalks result in lower vehicular speeds.

Reference: 16

D. PLANNING-RELATED ALTERNATIVES

1. Adequate Arterial Capacity

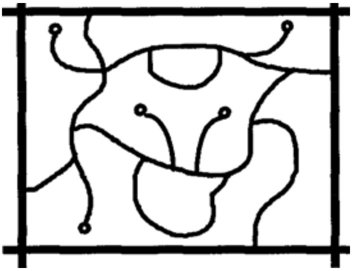
By providing adequate capacity on the surrounding major street network, the amount of through traffic using residential streets can be reduced. Although not specifically a speed regulating method, reducing the traffic volume can decrease the number of speed complaints on residential streets and can improve safety.

Though this is a costly means of reducing residential speeding complaints, improved traffic flow and crash reduction can be realized on residential streets.

Reference: 26

2. Subdivision Planning

Residential street design can influence the speed of vehicles through a neighborhood. Designs that feature curvilinear alignment, a narrow cross-section, short block length, reduced building setback and roadside tree planting can create a feeling of restriction and result in a speed reduction and may increase traffic crashes. Conversely, local streets built to high standards, in an attempt to improve safety, create an environment that allows increased vehicle speeds.



New subdivision streets can be designed to discourage cut-through traffic, which will reduce speeding complaints.

Care must be taken in the design process to ensure adequate sight distances along the roadway and at intersections, to provide the highest level of safety possible.

Reference: 26, 29

VI. CONCLUSIONS

An effective traffic calming program can be implemented by following the guidelines in this booklet. The key to a successful program is **community involvement.** Local officials and residents must work together for the common goal of improving safety on residential streets. This booklet provides alternatives that may help decrease speeds and/or reduce through traffic on residential streets. It also gives direction for developing a traffic calming program in those communities that currently use only traffic law enforcement to control speeds.

Whenever traffic calming devices are used, special care must be taken to advise drivers of the device by installing adequate warning signs and/or permanent markings.

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#OHSP 701 (2/98)

ite
Traffic Information Program Series

The Institute of Transportation Engineers
Traffic Engineering Council
presents TIPS on

Four-Way Stop Signs

Why can't we have an all-way stop to reduce accidents?

Many people believe that installing STOP signs on all approaches to an intersection will result in fewer accidents. Effects of unwarranted stop signs on driver behavior and safety are difficult to substantiate. Also, there is no real evidence to indicate that STOP signs decrease the overall speed of traffic. Impatient drivers view the additional delay caused by unwarranted STOP signs as "lost time" to be made up by driving at higher speeds between STOP signs. Unwarranted STOP signs breed disrespect by motorists who tend to ignore them or only slow down without stopping. This can sometimes lead to tragic consequences.

Generally, every State requires the installation of all traffic control devices, including STOP signs, to meet state standards of the Department of Transportation. The state standards are based on the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD is published by the U.S. Department of Transportation, is the national standard for traffic control devices. The MUTCD prescribes standards for the design, location, use and operation of traffic control devices.

The installation of multi-way stop control must first meet the warrants as set forth in the MUTCD. Any of the following conditions may warrant an all-way STOP sign installation:

1. Where a traffic signal is warranted, multi-way stop control is an interim measure that can be implemented

quickly to control traffic until the signal is designed and installed.

2. The occurrence within a twelve-month period of five or more reported accidents of a type susceptible to correction by multi-way stop control. Such accident types include turn collisions, as well as right-angle collisions.

3. Total vehicular volume entering the intersection from all approaches must average 500 vehicles per hour for any eight hours of an average day and the combined vehicular and pedestrian volume from the minor street or highway must average at least 200 units per hour for the same eight hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the maximum hour. However, when the 85th percentile speed of traffic approaching on the major street exceeds 40 miles per hour, the above minimum volumes are reduced to 70 percent.

STOP signs should not be viewed as a cure-all for solving safety problems but, when properly located, can be useful traffic control devices to enhance safety for all roadway users.

Question/Request: WHY DON'T THEY PUT IN MORE STOP SIGNS?

A stop sign is one of our most valuable and effective control devices when used at the right place and under the right conditions. It is intended to help drivers and pedestrians at an intersection decide who has the right-of-way.

One common misuse of stop signs is to arbitrarily interrupt through traffic, either by causing it to stop, or by causing such an inconvenience as to force the traffic to use other routes. Where stop signs are installed as "nuisances" or "speed breakers", there is a high incidence of intentional violation. In those locations where vehicles do stop, the speed reduction is effective only in the immediate vicinity of the stop sign, and frequently speeds are actually higher between intersections. For these reasons, it should not be used as a speed control device.

Well-developed, national and state recognized guidelines help to indicate when such controls become necessary. These guidelines take into consideration, among other things, the probability of vehicles arriving at an intersection at the same time, the length of time traffic must wait to enter, traffic delays, and the availability of safe crossing opportunities.

Speed
An unwarranted STOP sign installation reduces speed only immediately adjacent to the sign. In most cases, drivers accelerate as soon as possible, to a speed faster than they drove before STOP signs were installed. They do this apparently to make up for time lost at the STOP sign. **STOP signs are not effective for speed control.**

Through-Traffic Volumes
In almost all cases, through-traffic volumes stay the same after the installation of unwarranted STOP signs. Occasionally the street experiences a slight volume decrease. However, after a few months, the volume of through-traffic at the test sites where an initial decrease did occur was back to original levels or in some cases it was even higher. STOP signs do not necessarily reduce volume.

Local Neighborhood Traffic Volumes
Local neighborhood traffic generally finds the path of least resistance. If there are alternative routes to get from Point A to Point B and if these alternate routes have fewer traffic controls, local drivers will take them. In many cases, this significantly increases the traffic volume on other local streets - thus relocating the problem. In the very few cases where they have, the problem merely shifted to another location - often times from a collector to a purely local street. STOP signs generally do not reduce volumes on a street. Information collected by the Institute of Transportation Engineers

Compliance
Drivers tend to ignore unwarranted traffic controls or obstacles that, in their view, are unnecessary. If they are frequently required to stop for STOP signs and rarely see any traffic on the opposing street, they may become impatient and tend to disregard STOP signs that have no obvious need.

Accidents
Unwarranted STOP signs do not reduce accidents and may increase the potential for accidents. There is not enough documentation to determine if there is an actual increase in accidents on local low volume streets, but experience of some cities shows that where unwarranted signs used to stop a high volume street for a local street, cause the accidents to increase drastically.

Vehicle Operating Costs
Unwarranted STOP signs increase vehicle fuel consumption. The unwarranted STOP signs require additional stop/start maneuvers costing the motorists a substantial amount of money, wear and tear, and causing excessive gasoline consumption. This is especially noteworthy in light of the present fuel situation. Wear and tear on vehicles also increases. It should be noted that no detailed mechanical evaluations have been made but obviously increased stopping and starting would increase wear on tires, brakes, transmission, and engine.

Environmental
Although not specifically documented, it is logical to assume that unwarranted STOP signs increase stop/start actions and therefore increase exhaust fumes and associated hydrocarbons.

Noise
Noise pollution increases due to stops and acceleration and the associated engine noises and brakes. Noise tests at the STOP signs and at mid-block locations showed that the stop/start and acceleration resulting from the four-way STOP installations increased the noise levels over the "before" conditions.

Effectiveness
Even the minimal initial compliance and through-traffic diversion wear off over time because the unwarranted signs are not associated with a perceived need by the motorist. Most drivers are reasonable and prudent with no intention of maliciously violating traffic regulations; however, when an unreasonable restriction is imposed, it results in flagrant violations. In such cases, the stop sign can create a false sense of security in a pedestrian and an attitude of contempt in a motorist. These two attitudes can and often do conflict with tragic results.

City of Worcester MA

Stop Signs and Traffic Signals Q & A

***Related Pages*:** Public Works & Parks » Engineering » Parking & Traffic

Stop signs and traffic signals are placed at strategic locations to provide safe and efficient movement of the travelling public, including pedestrians. The placement of stop signs and traffic signals are governed by a Federal Government publication: The Manual on Uniform Traffic Control Devices (MUTCD). Worcester follows the Commonwealth of Massachusetts in complying with the MUTCD.

The following are frequently asked questions and the DPW&P response.

Q:
Why can't we have stop signs to reduce speeding along my street?

A:
One of the most frequent complaints that people have in residential areas is that vehicles constantly speed by the front of their house. They are concerned about the safety of their children. These residents frequently request the erection of additional stop signs. The addition of a stop sign, however, usually does not solve the problem.

A stop sign is an inconvenience to motorists. Because of this, stop signs should only be placed if they meet a Manual on Uniform Traffic Control Devices (MUTCD) warrant. Stop signs are frequently violated if unwarranted. In certain cases, the use of less restrictive measure or no control at all will accommodate traffic demands safely and effectively.

Warrants for a Stop Sign:
Because a stop sign is an inconvenience to through traffic, it should be used only where needed. A stop sign may be warranted at an intersection where one or more of the following conditions exist:

- intersection of a less important road with a main road where application of the regular right-of-way rule is hazardous;
- street entering a through highway or street;
- unsignalized intersection in a signalized area;
- other intersections where a combination of high speed*, restricted view and serious accident record indicates a need for control by the stop sign.

Existing sign installations should be reviewed to determine whether the use of a less restrictive control or no control at all could accommodate the existing and projected traffic flow safely and more effectively.
**Speed, in this warrant is directly related to sight distance and its relationship to vehicles/drivers approaching an intersection.*

Q:
Can stop signs control speed?

A:
Many studies have shown that stop signs are not an effective measure for controlling or reducing midblock speeds. In fact, the overuse of stop signs may cause drivers to carelessly stop at the stop signs that are installed. In stop sign observance studies approximately half of all motorists came to a rolling stop and 25 percent did not stop at all. Stop signs can give pedestrians a false sense of safety if it is assumed that all vehicles will come to a complete stop at the proper location. Engineering studies also show that placing stop signs along a street may actually increase the peak speed of vehicles, because motorists tend to increase their speed between stop signs to regain the time spent at the stop signs.

Q:
What is the harm in placing stop signs in our neighborhood to reduce speed?

A:
Installing stop signs can do more harm than good. Too many stop signs may also actually discourage good driving habits. Studies have shown that if stop signs are overused or are located where they don't seem to be necessary, some drivers become careless about stopping at them. This can be especially dangerous for pedestrians and bicyclists who may have a false sense of safety from the existence of a stop sign.

Additionally, unwarranted stop sign locations can increase the number of motor vehicle accidents. Studies have shown that stop signs placed where drivers do not expect them can increase the number of 'rear-end' accidents because the average driver does not expect, or anticipate, the need to stop.

Q:
Why can't we have a four-way stop to reduce accidents?

A:
Four-way stop signs are not always the answer to reducing intersection crashes. Crash analysis is very complicated and usually identifies multiple causes. Stop signs delay drivers, and many times the drivers become impatient. Impatient drivers may cause crashes. Not all four-way stop intersections are dangerous, but they must be warranted.

Q:
What is required for the installation of four-way stop control?

A:
The addition of four-way stop control is an inconvenience to all the drivers using the intersection. For this reason, three warrants have been developed and are listed in the Manual on Uniform Traffic Control Devices (MUTCD). A multiway stop control installation may be warranted at an intersection if any of the following conditions exist:

1. Traffic signals are warranted and urgently needed, and the multiway stop signs are an interim measure that can be installed quickly to control traffic while arrangements are being made for the signal installation.

2. A crash problem, as indicated by five or more reported accidents of a type susceptible to correction by a multiway stop installation in a 12-month period. Such accidents include right- and left-turn collisions as well as right-angle collisions.
3. Minimum traffic volumes. (a) The total vehicular volume entering the intersection from all approaches must average at least 500 vehicles per hour for any eight hours of an average day; and (b) the combined vehicular and pedestrian volume from the minor street or highway must average at least 200 units per hour for the same eight hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the maximum hour; but (c) when the 85-percentile approach speed of the major street traffic exceeds 40 miles per hour, the minimum vehicular volume warrant is 70 percent of the above requirements.

A four-way stop installation should only be used when traffic volumes on the intersecting roadways are approximately equal. However, if volumes are particularly large a traffic signal may be more appropriate. Investigating the warrants listed above will require an extensive traffic engineering study. This study may indicate whether or not a multiway stop control installation is appropriate.

Q:
Won't crashes be reduced if a stop sign is installed?

A:
One of the multiway stop control warrants is crash related. If an intersection meets this requirement and it has approximately equal approach volumes, a multiway stop control installation may be warranted for safety purposes. However, the overall results of the traffic engineering study and the professional judgment of the engineer should also be considered. In fact, research has shown that under certain conditions other traffic control measures may be more effective and safer than the addition of a multiway stop sign. A study conducted by the City of Irvine, California, indicated that simply improving intersection visibility can sometimes be a successful approach to crash reduction at intersections.

Q:
Can we get a traffic signal at our intersection?

A:
Justification of signal installation requires considerable data collection and analysis.

The MUTCD lists 11 warrants for the placement of traffic signals. These warrants are summarized below (please refer to the MUTCD for the engineering details). If none of these warrants are met, a traffic signal should not be placed. In addition, the fulfillment of a warrant or warrants also does not in itself justify the installation of a signal.

1. Minimum vehicular volume. The volume of intersecting traffic must be above a certain value.
2. Interruption of continuous traffic. The traffic volume on a major street is so significant that the traffic on the minor street cannot safely merge, enter or cross the major street.
3. Minimum pedestrian volume. The volume of pedestrians crossing a major street exceeds a certain value.

4. School crossing. At an established school crossing, a signal can be placed if it is shown that there are not enough gaps in the traffic for the children to safely cross.
5. Progressive movement. To maintain the proper grouping of vehicles and to effectively regulate the group speed.
6. Accident experience. When less restrictive remedies and enforcement has failed to decrease the accident rate below levels expected with signalization.
7. Systems warrant. A common intersection that serves a principle network for through traffic flow.
8. Combination of warrants. If warrants 1 and 2 are each satisfied by 80 percent of the stated values, a signal placement could be justified.
9. Four-hour vehicular volume. The traffic volumes on the major and minor streets exceed a certain value for each of any four hours on an average day.
10. Peak hour delay. The minor street traffic suffers major delay in entering or crossing the major street for only one hour of an average weekday.
11. Peak hour vehicular volume. The traffic volumes on the major and minor streets exceed a certain value for only one hour of the day.

Installing a traffic signal at a low-volume intersection can significantly increase crashes and delays.

Again, the increase in delay and stops then translates into higher fuel consumption, increased travel times and higher point source pollution. The length of delay is directly related to a number of factors. Cycle length is one factor, for example, that is influenced by traffic volumes and the need to safely accommodate pedestrians. The pedestrian crossing time constraints could significantly increase the necessary cycle lengths.

Although traffic signals can reduce the total number of collisions at an intersection, research has shown that certain types of crashes (e.g., rear-end collisions) may actually increase after a signal is installed. For this reason, the type and number of crashes at an intersection should be considered before the installation of a signal.

Traffic signals can represent a positive public investment when justified, but they are costly. A modern signal can cost $150,000 to $200,000 to install. In addition, there is the cost of the electrical power consumed in operating a signalized intersection 24 hours a day and general maintenance.

Why and Where Are Stop Signs Needed?

Each year, Cities receive requests for stop signs as a way to reduce speeding, minimize driver delay and curtail traffic accidents. Stop signs are needed to assign right-of-way at an intersection, not to control speeding. Right-angle accidents can also be reduced by the installation of stop signs when warranted, but additional stops may also increase the frequency of rear-end accidents. The need for stop signs involves a trade-off between safety and delay. Because drivers have preconceived opinions on traffic control, public opinion can often justify the use of these devices when they are not needed.

Traffic Law

Not every intersection must have an official traffic control device controlling traffic movement through the intersection. *If a vehicle approaches or enters an intersection that does not have an official traffic-control device and another vehicle approaches or enters from a different highway at approximately the same time, the driver of the vehicle on the left shall yield the right of way to the vehicle on the right. If the intersection is T-shaped and does not have an official traffic-control device, the driver of the vehicle on the terminating street or highway shall yield to the vehicle on the continuing street or highway.* There are many intersections that do not have stop signs, yield signs or traffic signals, particularly in residential areas.

What Harm Can Arise From Unnecessary Stops?

Stop signs should be installed at an intersection ***only*** when a careful evaluation of existing conditions indicates that their installation is warranted and appropriate. But what harm can arise from unnecessary stops when unwarranted stop signs are installed?

1. Overuse of stop signs reduces their effectiveness because drivers tend to speed up between stop sign controlled intersections rather than slow down. In fact, studies have shown that at residential speeds, drivers accelerate to their original speed prior to the stop sign in less than 200 feet (that's less than 3 house lots from the intersection). Driver acceleration and deceleration only adds to noise levels that can turn a quiet neighborhood into a race track.
2. Stop compliance is poor at unwarranted stop signs. Studies have determined that drivers see little reason to stop and yield the right-of-way when there is no traffic on the minor street. Unwarranted stop signs foster disrespect and disregard of the law.
3. Studies have found that pedestrian safety, particularly small children, is decreased at unwarranted stop sign locations. Pedestrians expect vehicles to stop at the stop signs but many vehicles "run" the unnecessary stop sign.
4. The cost of installing stop signs is relatively low, but enforcement costs are not. In addition, enforcement cannot be provided "24/7" and at best, can only have limited effectiveness.
5. Finally, according to some State Codes, placement of stop signs not warranted by engineering studies may violate State law.

When are Stop Signs Warranted?

Installation Policies and Warrants

The Federal MUTCD (Manual on Uniform Traffic Control Devices) dictates the size, shape and color of all traffic control devices. The City is required by State law to comply with the guidelines of the MUTCD when warranting stop signs. If stop signs are installed when they are not warranted, traffic safety is not improved and may actually be impaired. Unnecessary stops may cause rear-end accidents while increasing fuel consumption and adding to environmental concerns.

***** Stop signs must only be installed when an engineering study provides justification for their installation at the subject location. *****

The MUTCD provides the following warrants for the use of stop signs: *STOP signs should be used if engineering judgment indicates that one or more of the following conditions exist:*

- *Intersection of a less important road with a main road where application of the normal right-of-way rule would not be expected to provide reasonable compliance with the law;*
- *Street entering a through highway or street;*
- *Unsignalized intersection in a signalized area; and/or*
- *High speeds, restricted view, or crash records indicate a need for control by the STOP*

Most T-intersections in residential neighborhoods are not signed because when sight distance is adequate, these signs contribute little to traffic safety. The MUTCD warrants for ALL-WAY stops (4-way and 3-way at T-intersections) are typically not met in residential areas because traffic volumes must be roughly equal on both streets and exceed 500 vehicles per hour for at least eight hours of the day. These conditions are typically only found where two major streets intersect and a traffic signal is not warranted.