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ANALYSIS OF HISTORIC STRUCTURES

AT

FROOM RANCH

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INTRODUCTION & METHODOLOGY

John and Susan Madonna wish to study the feasibility of preserving and/or renovating several existing structures of historic significance at the Froom Ranch property in San Luis Obispo.

The structures included in this analysis are the Main Residence, the Dairy Barn, the Old Barn, and the Creamery House. All structures consist of wood-framed walls and roofs, wood siding, and either a wood or concrete foundation. Construction of these buildings took place between the late 1800's and early 1900's.

As part of the preservation, it is necessary to assess both the gravity and lateral load resisting systems of the buildings in order to ensure life-safety of the occupants. For existing structures of historic significance, the structural analysis is to be per the 2016 California Historic Building Code (CHBC). In order to balance structural safety with historic preservation, this code allows for a 25% reduction in current building code design wind & seismic load levels. In addition, it also provides strength capacities for structural systems that would typically not be allowed for new structures. Where design gravity loads are not being increased, the CHBC also allows that the vertical load resisting system may be assumed adequate by having withstood the test of time, where no distress is evident, and a complete load path is present.

Guidelines for determining the feasibility of historic preservation is given in the City of San Luis Obispo Historic Preservation Ordinance, December 7, 2010. Feasibility is defined by this document as the ability of a building or other structure to "be repaired or rehabilitated so as to be safe and usable without significant loss of historic fabric," and that the structure has the "physical capacity...to withstand the repair and/or rehabilitation process without the danger of further damage."

Both the structural integrity and the feasibility of rehabilitation have been addressed in this report for the structures noted above. The study considers multiple building-use scenarios, including continued commercial use as well as the conversion to public space. For continued commercial use, the building code does not require any structural upgrades to be done. However, we have included in our recommendation the items that pose a significant risk to the structure, or to the life-safety of the occupants. Where the conversion to public space is considered, we have included all structural deficiencies, as well as potential increases to design live loads, and long-term performance improvements.

Our scope of work for this project involved the following tasks:

1. Review of the Froom Ranch/El Villagio Specific Plan Section 106 Prehistoric Report dated February 20, 2015.
2. Review of the Seismic Analysis Map provided by Geosolutions. The map shows the local fault zone, in which it is recommended that no structure with an occupancy of 2,000 cumulative man-hours per year may be within this zone.
3. Visually survey each building to verify the original construction, past alteration, and the current conditions.
4. Perform a structural analysis of each building for CHBC-level gravity, seismic and wind loads.
5. Prepare a report that includes an outline of the major structural deficiencies, as well as a general description of the proposed structural retrofit work.

MAIN RESIDENCE

The Main Residence [Figure 1] was constructed in 1915, and has been occupied continuously for use as both a residence and an office building. The approximately 1,600 SF one-story wood-framed structure appears to be in good condition, and has undergone several renovations and repairs throughout its history. The majority of the structural framing is original, however concrete foundations have been added at certain locations around the perimeter where excessive settlement has occurred. The lateral load-resisting system consists of wood siding over straight-sheathed exterior wood stud shear walls.

Roof Framing

The roof framing consists of consists of composite shingles over the original wood shakes over 1x6 skip sheathing supported by 2x4 roof joists at 30" spacing. The roof joists are braced mid-span with kickers down to interior stud walls below [Figure 2]. Although the existing roof framing appears to be in good condition, there is no recognized diaphragm system needed to resist lateral loads.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, the building code does not require any upgrades to the roof framing system. It is recommended, however that the next time the roof is replaced, the original wood shakes be removed, and a layer of plywood added over the existing 1x skip sheathing. The layer of plywood, if detailed and nailed properly, will act as a structural diaphragm. Additional wood blocking and metal framing clips will also be required to tie the roof diaphragm to the exterior walls below. It should also be noted that if a new roofing material is selected that is

heavier than the existing roofing material, strengthen of the roof rafters will be required.

For Use as Public Space – If the structure is to be used for public occupancy, the existing roofing shall be removed and the plywood, blocking and framing clips added as described above.

Exterior Walls

The exterior walls are constructed of horizontal 2"x4" wood studs at 24" spacing. The exterior is sheathed with 1x shiplap siding over 1x straight sheathing, which provides lateral stiffness for the structure in resisting wind and seismic loads. The wall framing and siding appear to be in good condition.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, the building code does not require any upgrades to the existing exterior walls. Although the walls are overstressed for CHBC-level design loads, one-story wood framed structures typically perform well in earthquakes, and no strengthening is recommended.

For Use as Public Space – If the structure is to be used for public occupancy, it is recommended that plywood shear walls be added. Plywood, when detailed and nailed properly provides significantly greater lateral strength and stiffness for wood shear walls than the existing 1x straight sheathing. For existing structures, the interior drywall in specific locations can be removed, plywood installed directly over the existing studs, and then the drywall reinstalled. Holdowns anchoring the shear wall boundaries to the foundation are also typically required.

First Floor

The first floor is constructed of wood flooring over 1x6 diagonal sheathing over 2"x5-1/2" wood floor joists spaced at 24". The wood floor joists span across unbraced wood cripple walls below spaced at approximately 7'-6" [Figure 3]. The 2x redwood sill of the cripple wall bears directly on grade. Releveling of the first floor has been performed several times throughout the life of the structure.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, the building code does not require any upgrades to the existing floor structure. The existing floor joists are adequate to resist code-level office live loads. It should be noted, however, that if future unevenness in

the floor surface is encountered, it could be an indication of excessive settlement in the foundation. See the foundation section below for potential strengthening recommendation.

For Use as Public Space – If the structure is to be used for public occupancy, strengthening of the floor joists may be required. The existing floor joists do not have the capacity to resist code-level design live loads when considering areas of assemblies. If space is to be made within the structure for meeting or conference areas, the floor joists below that area are required to be doubled up.

Foundation

The foundation consists of interior and exterior 2x wood stud cripple walls bearing on an existing wood sill placed directly on grade [Figure 3]. Where past excessive settlement has occurred, an undocumented concrete foundation was poured below the sill to provide a greater bearing surface and better long-term durability. The exterior cripple walls are lightly braced with occasional 1x diagonal boards, while the interior cripple walls are completely unbraced.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, as a minimum both the exterior and interior cripple wall systems should be strengthened. This can be done with either a system of properly detailed diagonal boards or a pattern of plywood sheathing. Where concrete foundations have been added in previous repairs, it should be verified that the wood sills are properly anchored to the concrete. Because the existing structure bears directly on top of the soil and proper concrete foundation embedded into the soil are not present, sliding of the structure during a large earthquake could occur. Although life-safety does not appear to be a significant risk assuming the cripple wall bracing is installed, non-structural damage to interior furnishings and equipment is likely. In addition, attention should be given if future unevenness in the floor surface is encountered. This could be an indication of excessive settlement in the foundation. For better long-term structural performance, see “For Use as Public Space” below.

For Use as Public Space – If the structure is to be used for public occupancy, a proper concrete foundation should be installed. To install the concrete foundation, the structure is jacked up, continuous trenches are dug below the exterior and interior cripple walls, and concrete footings are poured. The structure is then lowered and bolted to the concrete. In addition to the footings, all cripple walls require bracing as described above.

DAIRY BARN

The Dairy Barn [Figure 4] is an approximately 4,200 SF wood-framed farming facility built in 1913 to house livestock and hay. Weather and neglect has severely deteriorated many of the barn's key structural elements over the course of its history. In addition, a significant portion of the barn is located within the rupture zone setback of a potentially active trace fault. These items are discussed below and shall be addressed in the renovation along with the strengthening of the lateral load-resisting system.

Local Seismic Hazard Mitigation

Because the Dairy Barn is situated within the rupture zone setback of a potentially active trace fault, there is a high risk of significant damage to the structure due to ground rupture. If the barn is to be used in any way other than being fenced off and left in a state of arrested decay, significant alterations to the building footprint are required.

Required Remediation:

If left in its current location, it is recommended that the round-nosed portion of the barn be removed, in addition to the next three adjacent bays of framing, essentially cutting the structure in half. Also requiring demolition due to its proximity to the fault line is the northern masonry addition to the barn. Because the round-nosed portion of the building is unique and has historical significance, a portion of the demolished materials may be salvaged to rebuild the round-nosed portion at the eastern end of the structure. It is estimated that approximately 75% of the roof framing and 50% of the floor framing will be good for re-use. Nearly all the exterior siding is in such a state of decay that it will have no structural value. This remediation is required to ensure the safety of the occupants during a large seismic event. The rebuilt round-nosed portion will require a modern concrete foundation system to prevent the type of settling and deterioration that is currently present.

Relocation Option:

Another option for the Dairy Barn is to demolish and rebuild the structure at another location. In order to preserve the historic aspect of the barn, the framing system should remain the same as the existing framing system, but with consideration of the strengthening requirements outlined in the sections below. It is also possible to re-use a portion of the lumber as noted above. Please refer to the schematic structural drawings provided for reference at the end of this document.

Roof Framing

The existing roof framing [Figure 5] consists of wood shingles over 1x6 skip sheathing supported by 2"x6" roof joists at 30" spacing. A collar tie system consisting of tension rods at 10'-0" spacing thru the double top plate at the two interior post lines is present to resist the horizontal thrust. The majority of the roof framing has the capacity to resist code-level dead and live loads. The existing skip sheathing provides minimal lateral stiffness lateral stiffness, and will not act as a proper roof diaphragm.

Required Strengthening:

Occupancy less than 2,000 cumulative man-hours per year (tours, exhibits, etc.) – Because the existing wood shingles are in a serious state of deterioration, much of the roof framing is exposed to weather. It is recommended that the existing roofing be removed and all framing be inspected for damage. It is estimated that approximately 10% of the roof framing will need replacing. It is possible that lumber salvaged from the seismic remediation described above may be reused for this purpose. Additionally, a layer of plywood will be required over the skip sheathing in order to create a roof diaphragm. The entire roof shall be re-roofed with a light weight standing seam or corrugated metal roof with better long-term performance.

Occupancy greater than 2,000 cumulative man-hours per year (public use, meeting space, etc.) – Same as above.

Exterior Walls

The exterior walls [Figure 6] are typically constructed with 1x12 vertical siding spanning from the double top plate to the wood sill, with an intermediate horizontal 2"x4" girt mid span. The double top plate and girt span horizontally to 4"x4" wood posts at 10'-0" spacing around the perimeter.

Required Strengthening:

Occupancy less than 2,000 cumulative man-hours per year (tours, exhibits, etc.) – The exterior vertical siding is required to be in good condition to allow for adequate nailing. Proper nailing is essential for shear wall performance. Because of years of neglect, it is estimated that up to 75% of the wood siding will need to be removed and replaced for the wood shear wall system. It is also estimated that approximately 10% of the wall framing will require replacement due to weather intrusion at the damaged siding. The entire exterior will require re-painting to help preserve the condition of the wood.

Occupancy greater than 2,000 man hours per year (public use, meeting space, etc.) – Same as above.

Wall Bracing

At the main western entrance to the Dairy Barn, not enough wall length existing to provide adequate lateral stiffness [Figure 7]. At this location, as well as at the two interior lines of posts [Figure 8], diagonal wood wall bracing will be required. All connections will be designed to be bolted and hidden. The bottom ends of the bracing will be required to be anchored to the existing foundation

Required Strengthening:

Occupancy less than 2,000 cumulative man-hours per year (tours, exhibits, etc.) – Install new 4x4 wall braces at the western wall and at the two interior lines of posts. Strengthen all brace connections and splices with steel plates and bolts. Anchor braced connections to new concrete pad foundation.

Occupancy greater than 2,000 cumulative man-hours per year (public use, meeting space, etc.) – Same as above.

Foundations

The majority of the perimeter foundation consists of a 24" high concrete stem or retaining wall [Figure 6] with an undetermined footing depth. The concrete foundation appears to be in good condition for the age of the structure. The majority of the foundation damage has occurred at the eastern downhill portion of the structure at the round-nosed area of the barn. The foundation system at the interior post line appears to be a redwood sill bearing directly on the soil, or else the wood posts are embedded directly into the soil [Figure 9]. The posts appear to have settled over time approximately 2".

Required Strengthening:

Occupancy less than 2,000 cumulative man-hours per year (tours, exhibits, etc.) – Provide a modern concrete foundation system to support the re-built round-nosed portion of the structure. This is included in the Seismic Remediation section above. Additionally, concrete pad footings will be required below the posts. These pad footings have been included in the Wall Bracing section above.

Occupancy greater than 2,000 cumulative man-hours per year (public use, meeting space, etc.) – Same as above.

OLD BARN

The old barn [Figure 10] is an approximately 1,300 SF wood structure with a corrugated metal roof, vertical wood siding, and a concrete slab-on-grade foundation. It is estimated that the barn is 125 year old, and has been moved from its original site. The barn appears to be in very good shape for its age due to the fact that it remains in use. However, its constant use has led to a number of undocumented alterations that have inadvertently compromised the historic fabric of the Old Barn significantly.

Roof Framing

The existing roof framing [Figure 11] consists of corrugated metal roofing over existing wood shingles, over 1x6 skip sheathing, supported by 2"x4" roof joists at 32" spacing. A collar tie system consisting of 2x4 struts near the ridge is present to resist the horizontal thrust. This appears to have been added at a later date, most likely to combat a sagging ridge. The majority of the roof framing has the capacity to resist code-level dead and live loads. The existing skip sheathing provides minimal lateral stiffness lateral stiffness, and will not act as a proper roof diaphragm.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, the building code does not require any upgrades to the roof framing system. It is recommended, however that the next time the roof is replaced, the original wood shakes be removed, and a layer of plywood added over the existing 1x skip sheathing. The layer of plywood, if detailed and nailed properly, will act as a structural diaphragm. Additional wood blocking and metal framing clips will also be required to tie the roof diaphragm to the exterior walls below. It should also be noted that if a new roofing material is selected that is heavier than the existing roofing material, strengthen of the roof rafters may be required.

For Use as Public Space – If the structure is to be used for public occupancy, the existing roofing shall be removed and the plywood, blocking and framing clips added as described above.

Exterior Walls

At some point in the history of the barn, the exterior walls were reframed with a more modern system of 2x4 vertical studs spaced at 16" o.c. [Figure 12]. This system likely replaced a post-and-beam system with horizontal wall girts, similar to the Dairy Barn described above. Blocking between the vertical studs is used to support the 1x12 vertical siding.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, the building code does not require any upgrades to the existing exterior walls. However, because of the three large door openings at the north elevation of the structure, a wood bracing system is recommended along this line.

For Use as Public Space – Same as above. Additionally, the exterior vertical siding is required to be in good condition to allow for adequate nailing. Proper nailing is essential for shear wall performance. It is estimated that up to 50% of the wood siding will need to be removed and replaced for the wood shear wall system. It is also estimated that approximately 5% of the wall framing will require replacement due to weather intrusion at the damaged siding. The entire exterior will require re-painting to help preserve the condition of the wood

Wall Bracing

At each of the two interior lines of posts, a shear wall has been added [Figure 13]. It is unclear as to when and why the shear walls were added, however they do provide a significant amount of stiffness to the structure.

Required Strengthening:

Continued Private Commercial Use – If the structure will continue to be used for private commercial purposes, the building code does not require any upgrades to the existing exterior walls. However, if a plywood roof diaphragm is added at a later date, proper blocking and shear transfer detailing will be required.

For Use as Public Space – Same as above.

Foundations

The Old Barn bears on an undocumented concrete slab-on-grade foundation. The slab-on-grade appears to be in good shape, and no differential building settlement is noticeable.

Required Strengthening:

Continued Private Commercial Use – In order to resist the design lateral loads at the new bracing elements required at the north elevation, it is likely that several pad footings underpinning the existing slab-on-grade will be required.

For Use as Public Space – Same as above.

CREAMERY HOUSE

The Creamery House [Figure 14] is an existing wood-framed structure in a state of disrepair. Years of abandonment have made it unfeasible for renovation [Figures 15 through 18]. Among the issues are the following:

- All exterior siding requires replacement
- There are no wood studs in the majority of the walls. The siding, which has no bearing capacity, is currently supporting the majority of the roof loads.
- The roof framing is undersized and severely damaged.
- The floor framing is undersized and severely damaged.
- The wood post-and-beam foundation system is supported on rocks or soil and has failed.

Required Strengthening:

The Creamery House is an unsafe building in a state of disrepair, and the materials are unsalvageable for structure purposes. It is recommended that the structure be properly documented and demolished.

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Figure 1 – Main House



Figure 2 – Main House roof joists w/ mid-span bracing



Figure 3 – Unbraced wood cripple wall with redwood sill



Figure 4 – Dairy (Round-Nosed) Barn



Figure 5 – Dairy Barn roof framing



Figure 6 – Dairy Barn exterior wall framing



Figure 7 – Lack of wood bracing at main western entrance to the Dairy Barn



Figure 8 – Bracing at interior line of wood posts



Figure 9 – Interior Dairy Barn posts bearing on soil



Figure 10 – Old Barn



Figure 11 – Old Barn roof framing



Figure 12 – Old Barn exterior wall framing



Figure 13 – Full-height plywood shear wall (left & right of photo)



Figure 14 – Creamery House



Figure 15 – Deterioration of Creamery House



Figure 16 – Deterioration of Creamery House



Figure 17 – Creamery House foundation



Figure 18 – Deterioration of Creamery House