Thornton Tomasetti
Building Solutions

Project

HUMBOLDT STATE UNIVERSITY
JENKINS HALL

SEISMIC EVALUATION

Prepared For

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1.0 Background

Humboldt State University (HSU) is planning a major renovation of Jenkins Hall, the former industrial arts building, on its Arcata, CA campus. The renovation extent may be significant enough to trigger "mandatory" seismic evaluation (and potential retrofit), as required by the 2016 California Existing Building Code (CEBC). In anticipation of this, HSU is interested in understanding what the scope of the retrofit (if any) will be.

2.0 Scope

Thornton Tomasetti (TT) has been retained by HSU to perform a seismic evaluation of Jenkins Hall, both as it currently exists, and also in consideration of the structural modifications currently proposed for the future renovation project. TT's scope of work for this assignment has been as follows:

- Review available "record" drawings.
- Perform a site visit to visually examine the general structural condition of the building, and to validate that existing construction is accurately reflected by the available record drawings.
- Perform a seismic evaluation of the lateral force resisting system, in general accordance with the requirements of Chapter 3 of the 2016 CEBC.
- Provide written evaluation report documenting the results of the seismic evaluation, and summarizing the recommendations for seismic retrofit and/or further study.

3.0 Seismic Evaluation Criteria

For CSU building renovations, Section 317.3 of the 2016 CEBC lists certain conditions that, when exceeded, trigger mandatory seismic evaluation in accordance with CEBC Section 317.4, and (if required by the evaluation) seismic retrofit in accordance with CEBC Section 317.6. The minimum seismic performance criteria for the evaluation and retrofit design are as stipulated in CEBC Section and Table 317.5, which require that two separate criteria be met. For Jenkins Hall, those criteria are as follows:

- Performance Criteria Level 1:
  - Earthquake Hazard Level BSE-R, which is an earthquake with a 20%/50-year probability of exceedance (225-year return period)
  - Structural Performance Level S-3, i.e. Life Safety
  - Non-structural Performance Level N-C, i.e. Life Safety
- Performance Criteria Level 2:
  - Earthquake Hazard Level BSE-C, which is an earthquake with a 5%/50-year probability of exceedance (975-year return period)
  - Structural Performance Level S-5, i.e. Collapse Prevention
  - Non-structural Performance Level N-D, i.e. Not Considered

The seismic design parameters associated with the Earthquake Hazard Levels BSE-R and BSE-C are as defined in the CSU Seismic Requirements Table 1. For the HSU campus, those parameters are as follows:

- For BSE-R:
  - $S_S = 0.90g$
  - $S_1 = 0.26g$
- For BSE-C:

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- S_S = 2.23g
- S_1 = 0.73g

Adjustments to these parameters for Site Class are made in accordance with Tables 2a and 2b of the CSU Seismic Requirements. For the Jenkins Hall evaluation, Site Class D has been assumed, consistent with the site class recommended by SHN Consulting Engineers & Geologists for the adjacent Library and Theater Arts buildings (in letters dated March 23, 2017).

CEBC Section 319 prescribes that evaluation and retrofit design be implemented in accordance with Method A (per CEBC Section 320) or Method B (per CEBC Section 321). Since all CSU projects have a SRB campus peer reviewer assigned, the evaluation/retrofit design qualifies for Method B, which allows some freedom in selection of the analysis procedure, subject to the agreement of the peer reviewer. In agreement with HSU, and expected concurrence from the SRB campus peer reviewer, TT has performed the seismic evaluation of the structural system in accordance with the Tier 3 procedure outlined in the standard "Seismic Evaluation and Retrofit of Existing Buildings" (ASCE 41-17), published by the American Society of Civil Engineers.

The Tier 3 "systematic evaluation" procedure consists of performing a structural analysis of the entire seismic force resisting system, and evaluating every critical component for adequacy relative to the prescribed seismic performance criteria. TT utilized the ASCE 41 Linear Static analysis procedure for this evaluation.

4.0 Basis of Evaluation

TT's seismic evaluation has been based primarily on the original record documents of the building made available by HSU. These documents include the following:

- Complete architectural, structural and MEP drawings for the original building construction, dated 1949.
- Partial set of steel shop drawings for the original building construction, dated 1949.
- Architectural and structural drawings for the Kiln Building addition, dated 1959
- Architectural and structural drawings for the Loading Dock addition, undated.

TT performed a site walk and investigation on January 16, 2018. The intent of the site visit was to visually examine the general structural condition of the building, and to validate that existing construction is accurately reflected by the available record drawings.

5.0 Existing Building Description

Jenkins Hall is a two-story building, predominantly rectangular in plan, with overall dimensions of 130 feet (in east-west direction) by 70 feet (north-south direction). The building is situated on a significant site slope from northeast to southwest, such that the First Floor daylights at the west end of the building only, and the main entry along the north side of the building accesses a mid-level landing between the First and Second Floors.

The original building drawings show that the First Floor "rooms" along the north and east side of the building were to be unoccupied, and backfilled with dirt to near the underside of the Second Floor. However, in the actual present condition, these are in fact accessible rooms (although not "accessible" in the ADA sense). They occur at elevations well above the First Floor, consistent with the stepped footing

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elevations that occur around the building perimeter. It is not clear if these rooms were constructed as part of the original building construction, or at a later date.

The building is primarily of concrete construction, including concrete walls around the entire perimeter, and interior walls at select locations. The majority of the roof construction consists of 2x straight wood sheathing supported by structural steel trusses, which span from the south exterior concrete wall to an interior wall that parallels the north exterior. The roof between this interior wall and the north perimeter concrete wall is a one-way concrete slab and beam system. The Second Floor consists of a similar slab and beam system, supported by concrete walls and a row of interior concrete columns.

The building's lateral force resisting system consists of the wood sheathing and concrete diaphragms at the roof, the concrete diaphragm at the Second Floor, and interior and perimeter concrete shear walls.

The foundation consists of shallow pad and strip footings, and the First Floor construction is slab-on-grade.

6.0 Current State of Repair

Based on observation during TT's site visit, the existing building appears to be in generally good condition. There is no apparent deterioration of finishes, nor readily identifiable excessive cracking or signs of settlement that would indicate structural distress.

7.0 Seismic Evaluation Results

The structure was originally designed and detailed with a generally complete seismic force resisting system. However, due to changes in design force levels and detailing requirements since the time of the original building design, there are elements of the seismic force resisting system that do not meet the required performance criteria, either as determined per the ASCE 41 Tier 3 procedure, or as determined in TT's professional judgment. Those deficiencies, and recommendations for mitigation, are described below. In addition, refer to the plan mark-ups in Appendix A for specific locations.

- Wall-to-Roof Anchorage: During seismic events, heavy structural walls pull away from floor and roof diaphragms, and can be a potential collapse hazard if not adequately connected. This is a particular issue at flexible roof diaphragms (i.e. wood-framed or bare metal deck). For this building, the wall-to-roof anchorage connections are inadequate along the west and east building ends. Along the north and south sides of the building, the walls are well-anchored to the trusses, but the trusses are not adequately attached to the diaphragm. Both conditions should be should be prioritized for retrofit.

- Roof Diaphragm: Wood straight sheathing diaphragms have very low shear capacities, and are generally not used in modern seismic design; the diaphragm should be retrofitted by overlaying new plywood over the existing straight sheathing. Additionally, the wood and concrete diaphragms are not well tied together to transfer forces (primarily from the wood to concrete); new drag connections shall be provided.

- Shear Walls: The existing perimeter concrete walls have many large window openings, and corresponding narrow shear wall piers. This is of most concern at the First Floor, along the west perimeter wall, where the existing narrow wall piers support two stories of seismic shear (as

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compared with the north, south and east walls, where large portions of the First Floor walls are solid subgrade basement walls). While only marginally overstressed, this location is the weak link in the seismic force resisting system, and should be considered for retrofit. Retrofit may consist of infilling portions of windows to provide more shear wall length, and/or thickening of existing shear wall piers.

8.0 Considerations for Future Renovation Project

Based on the currently proposed renovation scheme, the CEBC provisions for mandatory evaluation/retrofit will not be triggered by the proposed structural modifications alone, as the existing lateral system would not be significantly weakened by the proposed demolition of certain portions of existing walls. However, it is still possible that mandatory evaluation/retrofit may be triggered by the construction cost of the proposed renovation (if greater than 25% of the building replacement cost). In either case, TT recommends the implementation of the seismic retrofit measures discussed in the previous section as a means to “modernize” the seismic force resisting system of the existing structure.

Additionally, TT notes HSU’s proposal to renovate the existing raised First Floor areas that were originally (per the original building drawings) intended to be unoccupied and backfilled with dirt. HSU’s concept renovation drawings note that these areas will require demolition and removal of “concrete steps, sections of slab and exposed concrete areas.” It should be noted that the majority of the exposed perimeter concrete steps are likely part of the perimeter building foundation, and cannot be demolished without significant shoring/underpinning operations, and reconstruction of the foundations at a lower elevation.

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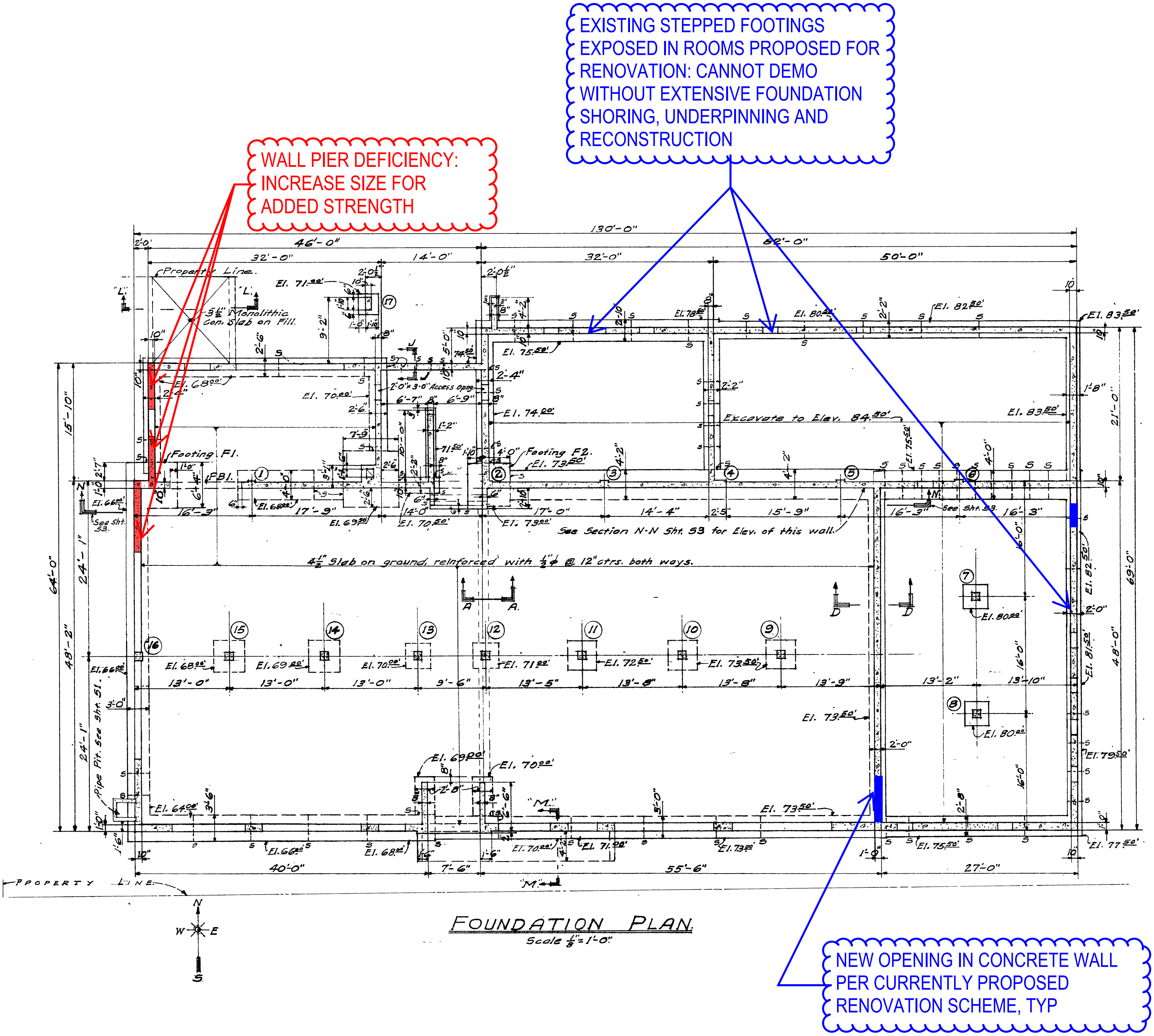
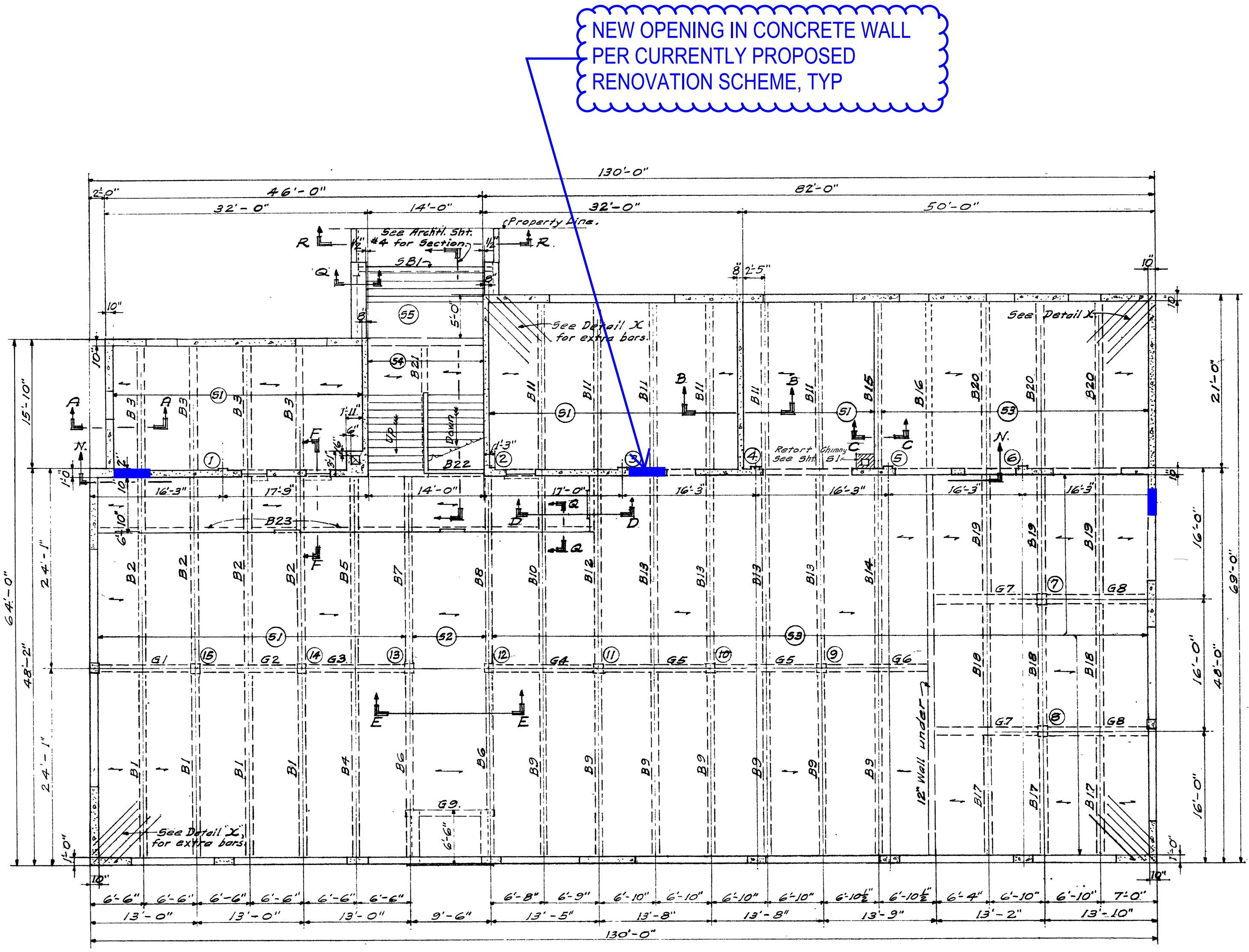
APPENDIX A

SEISMIC DEFICIENCIES


EXISTING STEPPED FOOTINGS EXPOSED IN ROOMS PROPOSED FOR RENOVATION: CANNOT DEMO WITHOUT EXTENSIVE FOUNDATION SHORING, UNDERPINNING AND RECONSTRUCTION
WALL PIER DEFICIENCY: INCREASE SIZE FOR ADDED STRENGTH
NEW OPENING IN CONCRETE WALL PER CURRENTLY PROPOSED RENOVATION SCHEME, TYP
FOUNDATION PLAN
Scale 1/8"=1'-0"
4½" Slab on ground, reinforced with ¼"φ @ 12" ctrs. both ways.
See Section N-N Sht. 53 for Elev. of this wall.
Excavate to Elev. 84.50'
130'-0"
PROPERTY LINE

FIRST FLOOR



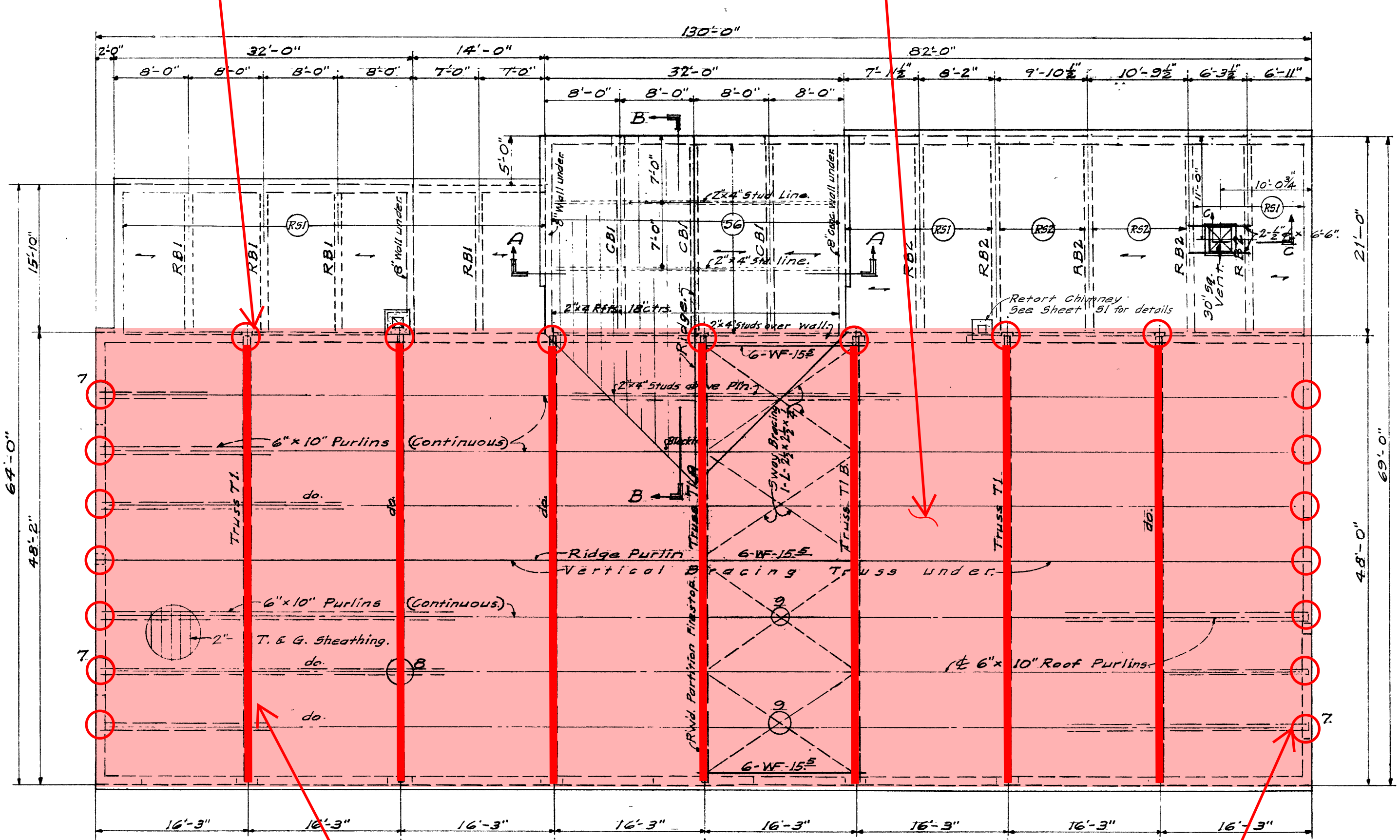
FLOOR FRAMING PLAN.
Scale 1/8"=1'-0"

SECOND FLOOR

NO RETROFIT SCOPE AT THIS LEVEL

DIAPHRAGM TIE DEFICIENCY:
PROVIDE NEW CONNECTIONS BETWEEN WOOD AND CONCRETE DIAPHRAGMS, TYP AT EACH TRUSS LOCATION

DIAPHRAGM DEFICIENCY:
STRENGTHEN DIAPHRAGM BY PROVIDING NEW PLYWOOD SHEATHING OVER EXISITNG 2x STRAIGHT SHEATHING



ROOF FRAMING PLAN.
Scale. 1/8"=1'-0".

WALL ANCHORAGE DEFICIENCY:
STRENGTHEN CONNECTION OF WALL TO PURLIN, TYP AT EAST AND WEST WALLS

WALL ANCHORAGE DEFICIENCY:
PROVIDE NEW BLOCKING TO CONNECT DIAPHRAGM TO TRUSS, TYP AT EACH TRUSS

ROOF