Creegan+D'Angelo
INFRASTRUCTURE ENGINEERS

Vine Street Water Treatment Plant

Seismic Assessment and Retrofit Strategy Report

Albany, Oregon

ENGINEERING YOUR SUCCESS

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1. EXECUTIVE SUMMARY

Creegan + D'Angelo Engineers is the prime consultant of a consultant team retained by the City of Albany to perform seismic assessment, develop seismic retrofit strategies, and to develop contract documents for the seismic retrofit of selected structures and nonstructural components at the Vine Street Water Treatment Plant (WTP) in Albany, Oregon. This seismic assessment and retrofit strategy report summarizes the seismic assessment of the structures under the selected seismic retrofit criteria, and presents proposed structural retrofits.

The seismic retrofit objective chosen by Creegan + D'Angelo is life-safety performance under earthquake shaking with a peak ground acceleration of 0.33g. This is generally that recommended by G&E Engineering Systems for the upgrade in their seismic performance evaluation of the City of Albany's water system, and the basis for the funding the City received for the project.

Creegan + D'Angelo evaluated the Control Building, Soda Ash Building, Old Filter Building, Raw Water Pumping Station building, High Pressure Pumping Plant building, Chemical Building, and the Large Filter Building, and has developed proposed seismic retrofits to meet the seismic retrofit objective where possible. In the cases of the Control Building, Raw Water Pumping Station and Old Filter Building, upgrade to meet the seismic retrofit objective is likely not possible. In these cases, retrofit recommendations are made with the aim of improving the building to a lower performance level.

A cost estimate of the proposed retrofit work is included in Appendix A, and suggested seismic retrofits are shown in Drawings 1 through 26 in Appendix B. The cost to retrofit the buildings is estimated to be $3.7 million. Given that the City's retrofit construction budget is approximately $1.3 million, some prioritization of retrofits based on building occupancy, water treatment and delivery redundancy at the other treatment plant, and building function will be required if no additional construction funding is available. The Creegan + D'Angelo consultant team expects to participate and provide guidance to the City to identify and develop the retrofit construction project.

2. INTRODUCTION AND BACKGROUND

2.1. SCOPE OF WORK

Creegan + D'Angelo Consulting Engineers is the prime consultant of a consultant team retained by the City of Albany to perform seismic assessment, develop seismic retrofit strategies, and to develop contract documents for the seismic retrofit of selected structures and nonstructural components at the Vine Street Water Treatment Plant (WTP) in Albany, Oregon. This seismic assessment and retrofit strategy report summarizes the seismic assessment of the structures under the selected seismic retrofit criteria, and presents proposed structural retrofits. The retrofits are intended to address deficiencies in the following seven buildings:

- Control Building

- Soda Ash Building
- Old Filter Building
- Raw Water Pump Station
- High Pressure Pumping Plant Building
- Chemical Building
- Large Filter Building

In addition, the scope of work includes upgrading three inlet/outlet pipes at the Maple Reservoir steel tank, and the addition of anchorage to selected nonstructural equipment identified in the G&E Engineering Systems report. Preliminary cost estimates to construct the recommended work are included at the end of the text of this report.

2.2. BACKGROUND

The following limited background information is our understanding of selected water treatment plant structures based on our discussions with City of Albany engineering staff, review of the "Vine Street Water Treatment Plant Seismic Evaluation" report prepared by CH2MHill, and the "Albany Water System" report prepared by G&E Engineering Systems. The background below pertains specifically to those structures that are part of the current evaluation, and is not intended to be an overview of the City's water treatment system or a detailed evaluation of all of the structures at this facility.

The Vine Street Water Treatment Plant is one of two treatment plants providing potable water to the City of Albany and its environs. The plant was originally constructed in the early 1900's, and consisted of two settling basins and six filter beds; reportedly, the Control Building was constructed around this time, and is a one-story unreinforced clay masonry (brick) structure with additions circa 1912 and 1927. More recently, a concrete masonry unit (CMU) conditioned space with its own ceiling/roof was added within the envelope of the Control Building. Other structures dating from around 1912 include the two-story, unreinforced brick Soda Ash Building, and the three-story unreinforced brick and reinforced concrete Old Filter Building. The Raw Water Pump Station is a one-story unreinforced masonry structure added circa 1948. Structures constructed circa 1960 include the High Pressure Pump Building (1960), a one-story reinforced CMU structure; the Chemical Building (1963), a two-story reinforced concrete structure; and the Large Filter Building (1965), consisting of reinforced concrete basins and a one-story, reinforced CMU building. Also addressed in this report are the connections to the Maple Reservoir, a two-million gallon steel tank dating to 1959. Four of the structures are considered "historic" and are "contributing resources" in the Monteith National Register Historic District. Table 2.1 below provides a summary of the structures addressed in this assessment.

Table 2.2-1 – Structures to be Seismically Retrofitted

Building	**Year Built**	**# of Stories**	**Walls**	**Diaphragm**	**Historic**
Control Building	~1900 to 1930's	1	URM	Wood deck on steel truss roof	Yes
Soda Ash Building	1912	2	URM	Concrete on steel beam floor and roof	Yes
Old Filter Building	1912	2	URM	Concrete floor Wood deck on steel truss roof	Yes
Raw Water Pumpstation	1948	1	URM	wood decking on wood truss roof	Yes
High Pressure Pumpstation	1960	1	CMU	wood deck on open-web joist roof	No
Chemical Building	1963	2	Concrete	concrete floor metal deck on steel joist roof	No
Large Filter Building	1965	1	CMU	wood deck on wood beam roof	No

2.3. SEISMIC RETROFIT OBJECTIVE

The seismic retrofit objective consists of the following two interrelated components: 1) the level of seismic force the structure is subjected to; and, 2) the desired performance objective of the structure. G&E Engineering Systems addressed both components in its 2006 evaluation of the Albany Water System; this report was the basis for the City's request for seismic retrofit grant funds. G&E recommended that the buildings be retrofit to levels "generally conforming to current code," which G&E defined as 1997 Uniform Building Code (UBC) Zone 3. Further, G&E recommended using a peak ground acceleration (PGA) of 0.30g, and in referring to the UBC recommended an importance factor of 1.0. The UBC's performance objective is life-safety performance, under a specific level of shaking; for Oregon, that level of shaking coincides with a PGA of 0.3g. The level of shaking used in the UBC is higher than that specified by the current Oregon Building Code.

Application of the 1997 UBC, or the 2006 International Building Code (IBC), which is the basis for the current building code for Oregon, is somewhat problematic because these codes were written for new buildings. As such, the seismic forces used in new design are predicated on structural detailing, levels of reinforcement, and other items that are not present in existing buildings designed and constructed to older codes.

Creegan + D'Angelo selected FEMA 356 (2000) "Prestandard and Commentary for the Seismic Rehabilitation of Buildings" as the design guideline for the retrofit of existing buildings for this project. Unlike the building code, these guidelines specifically address seismic retrofit of existing buildings. The FEMA 356 performance objective used for this project is life-safety performance, using a peak ground acceleration of 0.33g. The 0.3g recommended by G&E was increased slightly to conform to the UBC-level of shaking for a "Soil Profile C" site, which is predicated on the site soils. The linear static analysis procedure, which is similar to that used for most new buildings, was employed.

3. TYPICAL LATERAL LOAD DEFICIENCIES AND RETROFITS

3.1. GLOBAL FORCE RESISTING SYSTEM COMPONENT DEFICIENCY AND RETROFIT

Shaking-induced lateral forces in structures are resisted by components of the lateral force resisting system. These components, such as walls, for example, are often also part of the structure's gravity load resisting system. Global seismic performance is predicated upon the ability of the structure to transfer lateral loads from roof and floor diaphragms, through in-plane walls, to the foundation. The lateral systems for the buildings under consideration consist of flexible diaphragms (wood or light-gauge metal) or rigid concrete diaphragms and rigid walls. Common deficiencies observed and retrofit strategies for the types of buildings and building components at the Vine Street WTP are described below. The following discussion is not intended to provide a comprehensive list of every lateral force resisting component and/or failure mechanism for these buildings, or other types of buildings not evaluated here.

- Roof and floor diaphragms: transfer load from out-of-plane walls and diaphragm inertial forces to in-plane walls. Typical deficiencies are inadequate shear capacity within the field of the diaphragm, inadequate bending capacity (inadequate or missing chord element at perimeter), and inadequate connection to in-plane walls. Shear retrofit is typically achieved in wood roofs by the introduction of panel sheathing and nailing, and in concrete diaphragms by the addition of new concrete or fiber-reinforced polymer [FRP] (carbon- or glass-fiber fabric impregnated in resin, bonded to the diaphragm). Chord retrofit and connections to in-plane walls are often upgraded with the addition of new ledgers that provide a load path from diaphragm sheathing to the ledger, and through new anchor rods to the walls.

- In-plane walls and wall piers: transfer load from diaphragms to foundations. Typical deficiencies include inadequate shear or bending capacity. Typical retrofits include addition of in-plane steel frames to reduce load on walls, addition of shotcrete to increase shear and bending capacity, and addition of FRP.

- Connection of walls to foundation systems: transfer load to foundation, where it is resisted by friction and passive pressure of surrounding soil. Typical deficiencies include an inadequate connection to the foundation. Epoxy anchors and steel angles can be added to increase the connection capacity.

3.2. LOCALIZED STRUCTURAL COMPONENT DEFICIENCY AND RETROFIT

In addition to the components of the global lateral load path described above, other components resist localized seismic forces. These components are described below.

- Out-of-plane wall anchors: resist out-of-plane wall inertial forces at the diaphragm levels. Walls orthogonal to the direction of shaking are subject to inertial forces that tend to pull the walls away from the adjacent roof or floor diaphragms. This failure mechanism can result in instability of the wall, and/or failure of the in-plane shear-resisting connection between the diaphragm and wall for loading in the orthogonal direction. The typical retrofit for this condition is to attach the wall to the diaphragm with out-of-plane anchors that drag wall load into the diaphragm. For these buildings, anchor rod would be drilled and epoxied into the walls and connected to hardware attached to diaphragm framing members.

- Out-of-plane wall bending supports: out-of-plane inertial forces in the walls induce bending moment that can exceed the capacity, particularly for unreinforced masonry. This failure mechanism can lead to partial or complete collapse of masonry walls. Typical retrofits include adding supplemental vertical bracing attached intermittently to the walls and attached top and bottom to the diaphragms. Other retrofit methods include coring vertical holes in the walls from above and installing steel reinforcing in polymer.

- Parapet bracing: parapets are subjected to high inertial forces as they are located at the tops of buildings that could exceed the out-of-plane bending capacity at the base of the parapet. This failure mechanism can lead to partial or complete collapse of the parapet. Typical parapet retrofit is to brace the parapet back to the roof.

- Veneer anchorage: brick veneer is an architectural component that can constitute a falling hazard if not sufficiently anchored; it is included in this list because its behavior is dissimilar from other non-structural elements in a building such as mechanical, electrical, plumbing, and telephone/communications piping, conduit, wiring, and equipment. Retrofit can include additional anchoring, or removing and replacing the veneer.

3.3. RETROFIT PRIORITY

While each of the aforementioned components plays a role in overall structural performance, the importance of each retrofit type can be ranked according to the consequences of component failure, observation of the performance of components in past earthquakes, and inadequacy of the existing component with respect to the demand loading. Typically, higher priority retrofits are those that ameliorate an immediate life-safety hazard, or create a lateral force resisting load path where one does not currently exist. Lower priority retrofits may consist of upgrading the deficient existing lateral force resisting system to meet the anticipated loading. Ideally, all lateral force resisting components would be upgraded to withstand the anticipated lateral loading under the performance objective and shaking hazard. However, given limitations inherent in existing construction, and oftentimes, limited construction budget, ranking and prioritization of retrofit components is often required.

For the types of buildings evaluated at this site, the typical retrofit priority is as follows:

1. Parapet bracing
2. Out-of-plane wall anchors

3. Supplemental gravity framing for major gravity members supported by brick walls
4. Diaphragm shear transfer to in-plane walls
5. Collector and tie upgrade
6. Reduction of out-of-plane wall height/thickness ratio (out-of-plane wall bracing)
7. In-plane wall shear strengthening
8. Diaphragm shear strengthening
9. Diaphragm chord strengthening

The location of veneer anchorage in the priority list is variable depending upon the type and extent of veneer, and the relative deficiency of other components. At the seismic assessment and retrofit strategy phase of the project, recommendations for retrofit of all deficient components to the seismic retrofit objective are provided for those buildings where retrofit to the objective is possible. In those cases where the buildings cannot meet the objective, critical components have been selected for retrofit. As discussed in Section 7, the next step is to prioritize structures and functions so that a construction scope commensurate with the budget can be selected.

3.4. SHPO RETROFIT LIMITATIONS

The Oregon State Historic Preservation Office (SHPO) has some jurisdiction over the retrofit of the historic buildings at the Vine Street WTP. The interest of SHPO is to preserve the architectural fabric of historic buildings. It is our understanding that it will not be possible to change the exterior appearance of historic structures via the addition of anchor plates at the exterior of the building. Typically, out-of-plane, and in-plane attachment of roof and floor diaphragms to unreinforced brick masonry is achieved by drilling and epoxying threaded steel rod through the brick wall, terminating in an exterior steel plate approximately six inches square. We believe that this is not desired by SHPO. Alternatively, anchor rods can be installed by drilling and epoxying rods into the wall that terminate within the wall and do not penetrate the exterior face. This method typically results in lower anchor rod capacities. Anchor rod capacity will be particularly low in the case of the eight inch thick walls at the Raw Water Pumping Plant building. It is our understanding that through-bolting of anchor rods may be allowed at areas that are not visible to the public, such as at the south and west elevations.

Additionally, it is our understanding that SHPO may or may not allow the addition of interior retrofit framing that is visible through the windows of an historic structure. Thus the addition of in-plane braced frames, and out-of-plane wall bracing, may be subject to review by SHPO if these items are visible through windows.

4. BUILDING – SPECIFIC SEISMIC PERFORMANCE ASSESSMENT AND SUGGESTED RETROFITS

Analysis of the structures using the criteria defined above results in demand forces in various building lateral-system components that can be compared with allowable forces. This comparison can be expressed in terms of a demand/capacity ratio (DCR), which is the demand force divided by the force at the allowable capacity (as determined by the criteria). Structural components with a DCR greater than 1.0 are considered deficient, while those that are less than 1.0 are considered adequate. Performance of each of the buildings is explained below, along with selected DCRs for critical components.

To perform structural analysis, presumed material properties for brick, concrete masonry, concrete, steel, and wood were taken from FEMA 356 default values, as material properties were not identified on the structural drawings. In the case of the Control Building, structural drawings were not available. Because these material properties were not verified with testing in the field, capacities of structural components are reduced by 25 percent in accordance with FEMA guidelines.

4.1. CONTROL BUILDING

4.1.1. <u>Building Description</u>

The control building is a one-story, unreinforced clay masonry (brick) building, the main portion of which measures approximately 65 feet by 75 feet, with wings projecting from the west and north walls that are approximately 16 feet by 50 feet (west) and 32 feet by 18 feet (north). The only drawings available for this building are an architectural floor plan and section, and exterior wall elevations and an architectural roof plan. The west wing is used for storage, and the north wing overhangs the Calapooia River and supports two generators. The north wing has two, concrete beam and column-supported concrete structural slabs, one several feet below the main building slab-on-grade, and another approximately 18 feet below the main building slab-on-grade. The columns presumably bear on a foundation system that is beneath the surface of the river. The roof profile of the main portion of the building consists of a "double-gable," while the wings have low-slope roofs. The building was constructed in the early 1900's with subsequent addition/modification. Walls are in general approximately 13-inch thick brick, with the exception of the west wall of the west wing, which is wood-framed. The foundation system is unknown, and the floor of the main building and west wing consists of a concrete slab-on-grade. The east and north elevations of the structure are shown in Figures 4.1-1 and 4.1-2 below. Plans of this building are shown in Drawings 1 through 6 in Appendix B, along with proposed seismic retrofits.

Figure 4.1-1: Control Building east elevation (entrance)

Figure 4.1-2: Control Building north elevation (north wing)

It should be noted that many of the structural component dimensions were estimated, as they could not be reached for measurement. The roof at the double-gable consists of asphalt composition roofing over 1x nominal straight board sheathing supported by 2x8 flat boards spaced three feet on center. The 2x8's are in turn supported by steel channel purlins at approximately five feet on center that span between the walls and three, interior, steel double-gable trusses. The trusses are supported at the exterior by walls and in the interior by built-up steel columns.

At the west wing, roof framing consists of straight board sheathing over 2x6 rafters with intermediate beam support, and by 2x12 rafters, supporting straight board sheathing. At the north wing, rafters appear to consist of 2x8 boards intermingled with approximately 8-inch deep steel channels, supporting straight board sheathing. Roofing at the wings is membrane roofing over panel insulation.

Subsequent to the original construction, an interior, conditioned office space was constructed within the main portion of the building. The construction of the office consists of 6" and 8" nominal CMU block walls and wood stud walls supporting a ceiling/interior ceiling system constructed of either 2x wood joists spaced at 16 or 24 inches on center, or approximately 5-inch-wide wood beams at four feet on center supporting two-inch thick tongue and groove precast concrete panels or one inch panelized wood sheathing. There is also a wood and steel-rod-framed truss immediately above the conditioned office space ceiling framing, parallel to the 5-inch-wide beams, the purpose of which is not immediately apparent. The laboratory area within the office space has an eight-foot ceiling height, the southern portion of the office space has a nine-foot ceiling height, and the northern portion has an 11-foot ceiling height. Thus the ceiling is framed at two different elevations, with the laboratory having a false ceiling below the main ceiling. The ceiling supports unanchored HVAC equipment and ducts, various control wiring, cables, conduit, lighting and cable trays. Gypsum wallboard covers the wood framing. It is our understanding that control and/or operation of the treatment plant occurs from within this office space. A typical interior view of the conditioned office space is shown in Figure 4.1-3 below.

Figure 4.1-3: Interior of conditioned office space

4.1.2. Deficiencies

A field review of the structure indicated that it is likely missing the following lateral force resisting system components: out-of-plane wall anchors; in-plane shear connection between diaphragms and walls; diaphragm chords; parapet bracing; and conditioned office space ceiling diaphragm. Analysis indicates that the following lateral force resisting components are deficient: roof diaphragm in in-plane shear; brick walls in out-of-plane bending; brick walls in in-plane shear; conditioned office space walls in out-of-plane bending. Table 4.1.2-1 below indicates demand/capacity ratios for the primary components not mentioned above for the building.

Table 4.1.2-1

Component	**Detail**	**D/C Ratio**
Parapets	Out-of-plane bending	Exceed FEMA allowable
Roof diaphragm	Shear	18 (N-S); 26 (E-W)
	Bending	∞ (no chord)
	diaphragm/wall connection	∞ (no connection)
Out of plane wall anchors	at roof	∞ (no connection)
Out of plane wall capacity	ground to roof	Exceeds FEMA allowable
Brick walls	Shear	0.7 to 1.2
Conditioned office space “ceiling”	Shear, bending, wall connection	∞ (no connection)
Conditioned office space walls	Out-of-plane anchorage at “roof”	∞ (likely no connection)
Conditioned office space walls	Out-of-plane bending	6” walls (exceeds FEMA) 8” walls (exceeds FEMA)

In addition to the items listed above, there are two orthogonal walls, one at the north side of the west wing, and one at the east side of the north wing that abut the primary walls of the structure where the stiffness difference between the flexible roof diaphragm and the stiff walls will likely result in damage to the roof diaphragm in these areas as the diaphragm would tend to pull away from the adjacent wall.

The north wing of the structure overhangs the river below; the lateral system for this wing consists of shearwalls, and concrete beams and columns that may function as frames under low lateral loading but were likely not designed or detailed for such loading. Additionally, this portion of the building is supported by relatively flexible elements (frames), compared to the slab-on-grade and foundation system of the rest of the building. The difference in stiffness between the two support structures would tend to result in high torsional forces in the wing under east-west loading, and could tend to separate the wing from the rest of the building under north-south loading. Lateral forces in this wing could be high due to the large mass of the generators supported by the wing's structural slab.

There is a collector element that drags roof load from the north wing and main building in this vicinity into the north wall; this element is likely inadequately connected to the north wall.

As regards the interior conditioned office space, the ceiling of the office appears to be primarily architectural and does not constitute a horizontal diaphragm to transfer out-of-plane CMU wall loads or inertial loads generated by the ceiling itself. There is likely no shear transfer between the ceiling and the walls, as the ceiling framing extends over the tops of the walls.

4.1.3. <u>Proposed Retrofits to Main Building and West Wing</u>

Given the aforementioned deficiencies, the following retrofits are proposed to improve the seismic performance of the majority of the building to approximately the seismic retrofit objective. Retrofit of the north wing and the conditioned office space to the seismic retrofit objective may not be possible, as discussed below. Proposed retrofits for the structure include upgrading the following components:

1. Parapets: Add steel bracing above the roof to the tall parapet between the main building and west wing. Given the parapet height, supplemental roof framing may be required to accommodate bracing loads. Additionally, parapet bracing is likely required on the north and south walls of the main portion of the building.

2. Roof diaphragm shear: remove existing roofing, cricket framing, and 1X nominal board sheathing at the main building, and add wood sheathing panels, and reroof. At the wings, add panelized sheathing and reroof.

3. Diaphragm/Wall connection: add epoxy or grouted anchors and wood ledger at all sheathing/wall interfaces, main building and wings. Add framing anchors to blocking between rafters at the west wall of the west wing.

4. Out-of-plane wall anchors: At north and south walls of the main building add epoxy anchors with a custom coupler and holddown hardware to the existing 2x8

flat boards, and add blocking and strapping at the gable valleys and peaks to transfer load from one board to the next. At the gable ends, add epoxy anchors and fabricate a connection to the existing channel purlins; add nailers to purlins and upgrade all purlin/purlin connections at trusses. At gable ends, add additional framing and wall anchor between each purlin.

5. Out of plane wall bending: add vertical hollow structural sections (HSS), also referred to as "tube steel," at approximately six feet on center or adjacent to wall openings, attached intermittently to the walls, and to the floor slab and roof framing. These members would penetrate the conditioned space.

6. In-plane wall shear upgrade: Given that only one brick wall pier had a demand/capacity ratio greater than one, there would be limited benefit to upgrade brick walls for in-plane forces. No brick wall shear capacity upgrade is proposed.

7. Collector upgrade: upgrade connection between the steel beam adjacent the north wing, and the in-plane wall. Connection for the full demand load may not be possible due to limitations of anchor capacity in existing brick masonry.

8. Orthogonal wall/roof connection: add connection, strapping, and blocking to drag loads into diaphragm.

9. West wing: the west wall of the west wing is a wood-framed stud wall. This wall should be sheathed with wood sheathing panels, and the roof rafter/wall connection be upgraded with the addition of Framing clips to existing blocking to transmit lateral load. Additionally, the connection between the rafters and the brick wall should be upgraded by adding blocking between the rafters, secured to the wall with epoxy anchors, to transmit lateral load. Ledgers should be added to the north and south walls of the wing to transmit in-plane roof diaphragm shear load to the brick walls.

4.1.4. <u>Proposed Retrofits to North Wing</u>

Upgrade of the north wing would consist of reducing the load to, or upgrading the capacity of, the concrete beams and columns that constitute the lateral force resisting system of the wing. Reduction of lateral loads to these elements is typically achieved via braced frames or the introduction of new shearwalls. Alternatively, the load-carrying capacity of concrete beams and columns can be upgraded by encasing them in reinforced concrete; numerous dowels to provide shear transfer between new and existing construction are typically required. Upgrade of existing beam and column capacity is difficult, and the upgraded elements would likely be too flexible in comparison to the adjacent building to perform as intended. Given the exposure of the retrofit system to the river below, the likely retrofit of choice is the addition of concrete shearwalls. Such walls could likely be added at the north and west sides of the wing; addition at the east side, if required, is complicated by the presence of a large diameter intake pipe. Required openings for pipes may preclude retrofit to the seismic retrofit objectives. The walls would have to be extended to the existing foundation system below the surface of the river; as such, upgrade of the foundation would likely be required. Connection of walls to the foundation and foundation upgrade would require cofferdam construction and dewatering. Performing construction in the river channel is likely to trigger an environmental permitting process and involve multiple state and/or federal agencies.

1. Proposed retrofits include:
2. Upgrade foundation system
3. Upgrade existing beam/column system with shearwalls.
4. Upgrade roofs

4.1.5. Proposed Retrofits to Conditioned Office Space

Given the various mixture of framing types and elevation differences across the conditioned office space “ceiling,” it is not possible to retrofit the ceiling to function as a diaphragm. As such, out-of-plane wall anchorage of existing CMU walls would not be achieved, nor would in-plane load transfer from the ceiling to the walls. The existing ceiling construction precludes lateral load transfer within the diaphragm.

There are likely two retrofit alternates for the office space. The first alternate is to demolish the entire space, and build a new conditioned space within the envelope of the brick control building. This space could be entirely wood framed, or constructed of CMU walls with a horizontal diaphragm of wood or concrete construction. This space would be structurally independent of the control building and would not transmit any load to it. Pricing for this option is incorporated into the total retrofit cost. A second alternative is to remove the existing office ceiling and replace it, and retrofit the walls; were this retrofit pursued, seismic isolation gaps between the CMU walls and adjacent brick walls should be constructed. It is likely that this would cost approximately the same as a complete replacement.

Proposed retrofit:

1. Remove existing office space and replace, or remove existing ceiling, upgrade existing walls, and rebuild ceiling.

A cost estimate for the Control Building retrofit scheme is included in Appendix A.

4.2. SODA ASH BUILDING

4.2.1. Building Description

The Soda Ash building is a two-story, rectangular structure measuring approximately 42 feet by 35 feet, with second story and roof diaphragms of concrete slab cast integrally with steel beams, unreinforced brick shearwalls, and concrete spread footings that are possibly unreinforced (available drawings do not indicate reinforcing). Steel beams are let in to the brick walls for support, and the perimeter of the concrete diaphragms are supported by corbelling at the second floor, and a wall setback at the roof. The elevation change between stories is approximately 20 feet. Significant modifications to the building compared to the configuration shown in the original construction drawings include the addition of a tall steel tank on legs, situated in the southeast corner of the building, extending through an opening added to the second floor of the building, and the addition of a large opening in the north wall to accommodate a roll-up door at the ground floor. A circular steel stairway extends through an opening in the second floor at the northeast corner of the building. Typical exterior and interior views of the Soda Ash building is shown in Figures 4.2 -1 and 4.2 -2. Plans illustrating the building and proposed seismic retrofits are shown in Appendix B, Drawings 6 through 8.

Figure 4.2 -1: Soda Ash building, north elevation

Figure 4.2 -2: Soda Ash first floor interior, looking west

4.2.2. Deficiencies

A review of the drawings indicates that the structure is missing the following lateral force resisting system components: out-of-plane wall anchors; in-plane shear connection between diaphragms and walls; parapet bracing; and diaphragm chords. A summary of component demand/capacity ratios is shown in Table 4.6.2-1 below for primary components.

Table 4.6.2-1

Component	**Detail**	**D/C Ratio**
Parapets		Exceed FEMA allowable
Roof diaphragm	Shear	2.0 (N-S)); 1.3 (E-W)
	Bending	∞ (no chord)
	diaphragm/wall connection	∞ (no connection)
2nd Floor diaphragm	Shear	1.4 (N-S); 0.8 (E-W)
	Bending	∞ (no chord)
	diaphragm/wall connection	∞ (no connection)
Out of plane wall anchors	at roof	∞ (no connection)
	at 2nd floor	∞ (no connection)
Out of plane wall capacity	2nd floor to roof	inadequate
	ground to 2nd floor	inadequate
Shearwalls – 2nd story	shear	1.1 to 3.0
Shearwalls – first story	shear	1.3 to 3.4

The demand/capacity ratios for the second floor north-south direction, and the roof east-west direction, were calculated neglecting the effects of openings. At the roof, in particular, are a series of large, circular openings oriented in the east-west direction; although the effect is difficult to quantify, it is likely that there are so many openings that shear capacity would be reduced. As indicated in the table above, both the roof and floor diaphragms are inadequate even with no openings. The first-story shearwalls were evaluated neglecting the opening associated with the north wall roll-up door. This wall is inadequate even with the effects of the opening neglected.

4.2.3. Proposed Seismic Retrofits

It is likely that upgrade to the seismic retrofit objective is difficult or not possible using the existing roof because retrofit to this objective is controlled in part by the connection between the roof diaphragm and wall to transmit in-plane shear forces. It is not possible to add this connection at the required force level to the existing structure because the three-inch thick concrete slab is too thin to attach with epoxy anchors for the force transfer required; additionally, the force level appears to be too high for alternate methods (such as fiber-wrap). Additionally, infilling the openings in a three-inch thick slab to carry the full shear load is not possible. To make this connection the existing roof will need to be replaced.

Proposed retrofits for the structure include upgrading the following components:

1. Parapet upgrade: add intermittent steel bracing from parapet to roof.

2. Roof diaphragm shear: replace existing roof system with concrete on steel beams.

3. In-plane roof diaphragm connection to wall: Drill and epoxy anchor rods to the inside faces of walls, above the roof; connect the rods to continuous steel angles that are then attached to the top of the diaphragm. Continuous steel angles act as a chord.

4. Roof out-of-plane anchors: the in-plane roof diaphragm connection described above will act as the out-of-plane diaphragm connection.

5. Second floor diaphragm shear: add carbon-fiber fabric to top of slab.

6. In-plane second floor diaphragm connection: attach continuous angles at the floor/wall interface by drilling and epoxying into the wall and floor. The angle will act as a chord

7. Second floor out-of-plane anchors: the in-plane second floor diaphragm connection described above will act as the out-of-plane diaphragm connection.

8. Out-of-plane wall bending: add vertical bracing members anchored to the 2nd floor and roof diaphragm, and 2nd floor and slab-on-grade, and to the walls via epoxy anchors.

9. Shearwall retrofit: shear load to existing walls can be reduced with the addition of frames or shotcrete at the interior of the building, or by the addition of fiberwrap. The use of fiberwrap is precluded because it is required on both the interior and exterior of the walls, and will not maintain the historic appearance of the building. Shotcrete is not recommended because the increased wall weight increases the diaphragm shear, shear transfer to walls, and out-of-plane wall anchor loads, which are already high. Steel braced frames are light and do not markedly increase the out-of-plane wall load and diaphragm load. Load is reduced on existing brick walls based upon the stiffness of the new frames. It will not be possible to install frames stiff enough to preclude damage; however, the frames will reduce damage and can likely be designed to limit the lateral drift to within 2006 IBC code limits (0.007 h_{sx}). New braced frames could also support additional, new roof framing and slab.

The existing tank limits the geometry of the new frames. It is likely that the placement of frame bracing will impact use of the north wall roll-up door. Alternate means of delivering chemicals, such as via hand pallet truck through the west wall double door, may be required.

A cost estimate for this retrofit scheme is included in Appendix A.

4.3. OLD FILTER BUILDING

4.3.1. <u>Building Description</u>

The Old Filter Building is a three-story reinforced concrete and brick structure with a basement constructed circa 1912. The basement and first stories (including the second floor structural slab) are of concrete construction, and are rectangular in plan. Above the second floor is a two-story "L-shaped" unreinforced brick structure, consisting of a two-story (above the concrete construction) central "core" and two, one-story wings. The concrete clearwell and ground story are approximately 55 feet by 65 feet, and the brick structure is approximately 45 feet by 55 feet.

The basement of the building functions as a clearwell and thus contains water; the structural slab above the basement at grade elevation is supported by concrete beams and columns; this slab supports filter galleries and water above. The second story structural slab is supported on concrete beams, columns, and perimeter and interior walls. At this elevation, concrete beams support the brick construction above. The central core of the brick structure contains two concrete slabs (mixing floor above, tank gallery floor below), five feet apart in elevation, that constitute the third story; at this elevation, the wings of the brick building have roofs of straight board sheathing supported by steel purlins and trusses. The central core extends one additional story to a roof above the upper of two concrete slabs. Typical exterior and interior views of the Old Filter Building are shown in Figures 4.3-1 and 4.3-2 below. Plans illustrating the building and proposed retrofits are included in Appendix B, Drawings 10 through 15.

Figure 4.3-1: Old Filter Building looking northwest; note projection of central core above wings. Soda Ash building in background

Figure 4.3-2: East wing interior looking east

4.3.2. Deficiencies

A review of the structural drawings indicates that the building is missing the following lateral force resisting system components: out-of-plane wall anchors; in-plane shear connection between diaphragms and walls; diaphragm chords; collector elements at reentrant corners; and parapet bracing. Table 4.3.2-1 below summarizes demand/capacity ratios calculated for some of the primary lateral force resisting system components.

Table 4.3.2-1

Component	**Detail**	**D/C Ratio**
Parapets		Exceed FEMA allowable
All wood roofs	Bending	∞ (no chord)
	diaphragm/wall connection	∞ (no connection)
	Out-of-plane wall anchors	∞ (few connections)
Collector elements	Tension/Compression	∞ (no connection)
Central core roof	Shear	19 (N-S); 50 (E-W)
Central core brick walls	Shear	1.8 to 10
South wing roof	Shear	10 (N-S); 18 (E-W)
East wing roof	Shear	22 (N-S); 16 (E-W)
Second story brick walls	Shear	1.2 to 38
Brick walls	Out-of-plane bending	Exceed FEMA allowable

In general, the building has a number of characteristics that tend to decrease seismic performance. These characteristics consist of a significant change in plan area from one story to the next, lack of connections between the central core concrete slabs and surrounding walls, lack of collector elements, beam- and column-supported brick shearwalls above the third floor of the central core, beam and column supported concrete shearwalls above the second floor (at grade), offsets of shearwalls between stories where horizontal transfer diaphragms are required to transmit load, significant changes in mass from one story to the next, and shearwalls with a large number of openings.

The mixing room floor and tank platform concrete slabs are connected to two walls, and one wall, respectively. These elements generate lateral load that is not easily transferred to brick shearwalls. The tank platform, in particular, is supported on one side by a brick wall and on three sides by beams and columns with low lateral-force-carrying capacity. Beams supporting shearwalls at the third story of the central core that could function as collector elements, were they upgraded, do not appear to be able to transfer third-story shearwall load into the walls of the wings. A viable lateral load path for these walls does not exist.

The probable lateral load path for this structure is for east-west trending loads generated in the upper, brick portion of the structure to be transferred horizontally across the second floor concrete diaphragm to perimeter concrete walls and then to the foundation. In the north-south direction, loads from the brick portion are transmitted to the second floor diaphragm and then to interior and exterior concrete walls; loads in the interior of the diaphragm would likely be transferred across the first-floor diaphragm to exterior walls.

4.3.3. Proposed Retrofits

It is the opinion of Creegan + D'Angelo that this building cannot be retrofitted to meet the 0.3 PGA, life-safety performance seismic retrofit objective. Beam elements that could possibly function as collectors for lateral load at the third-story diaphragm level cannot be connected to in-line brick shearwalls for the loads required as collector forces are too high. DCRs for the brick shearwalls are already high, and available methods for mitigating wall deficiencies are limited by the characteristics of the building. A large portion of the brick structure is supported by beams crossing the second floor diaphragm; this diaphragm is in turn ultimately beam-supported at the second or first stories. These supporting beams and columns were not designed for the high point loads generated by frames, and would likely require upgrading, or supplemental vertical elements, to function. Attachment of new frames to walls and beams to the supporting concrete structure below would be difficult, if not impossible, as the beams are not aligned with the walls and beams below. Shotcrete retrofit of walls adds additional mass and load to the entire structure. Diaphragm loads, out-of-plane wall loads, in-plane shear loads on unretrofitted elements, and collector loads all increase. It is possible that the entire lateral load path of the concrete portion of the structure would require upgrade; additionally, vertical loads from additional shotcrete above could trigger gravity load upgrade for concrete elements below. It is not possible to upgrade the central core wood roof for additional, shotcrete-induced loads; the entire roof structure would likely need to be replaced. Lastly, it is not possible to upgrade the collector elements to carry the demand load, which renders the shotcrete option infeasible.

Given the aforementioned, a limited retrofit that will not meet the seismic retrofit objective is recommended below. This retrofit addresses the performance of many of the critical building components, but not the in-plane shear capacity of existing walls:

1. All roof diaphragms: remove roofing, and at the central core, remove board sheathing. Add wood framing and panelized sheathing, and reroof.

2. Roof diaphragm/wall connection: add epoxy or grouted anchors and ledger. Add steel to act as chord member.

3. Out of plane wall anchors: add epoxy anchors and hardware, and connect to new wood framing.

4. Parapets: add steel bracing.

5. Out-of-plane wall bending: Add vertical wall bracing; at the filter galleries, add horizontal beams to provide load transfer across filter galleries.

6. Collectors: provide connection from beams supporting third-story shearwalls to existing brick walls.

It is possible that the veneer attachment at the ground floor is also inadequate, but retrofitting the veneer has not been addressed here. A cost estimate for this retrofit scheme is included in Appendix A.

4.4. RAW WATER PUMPING PLANT

4.4.1. Building Description

The Raw Water Pumping Plant building (RWPP) is a one-story, unreinforced clay masonry (brick) building that measures approximately 27 feet by 33 feet. Dates on drawings suggest that it may have been built circa 1948. The building has a gable roof with asphalt composition shingle roofing over 1x nominal straight board sheathing supported by 2x6 rafters at 24 inches on center supported by wood trusses. The building has a partial mezzanine level on three sides of the building, approximately eight feet wide. The floor at ground level consists of concrete slab-on-grade and structural slab over a partial basement. The basement floor is concrete slab-on-grade approximately 14 feet below ground level. The building shares a common wall with the control building. Typical exterior and interior views of the Raw Water Pumping Plant building are shown in Figures 4.4-1 and 4.4-2 below. Building plans and proposed retrofits are shown in Appendix B, Drawings 16 through 19.

Figure 4.4-1: Raw Water Pumping Station building, east elevation

Figure 4.4-2: Interior looking southeast

4.4.2. <u>Deficiencies</u>

Drawings of the structure are limited, and consist of a floor plan and several sections through the building.

A field review of the structure indicated that it is likely missing the following lateral force resisting system components: out-of-plane wall anchors; in-plane shear connection between diaphragms and walls; and diaphragm chords. Details of the connection of the roof trusses to the south wall are not shown and cannot be observed in the field and are presumed to be inadequate. Table 4.4.2-1 below indicates demand/capacity ratios for the primary lateral force resisting system components.

Table 4.4.2-1

Component	**Detail**	**D/C Ratio**
Roof diaphragm	Shear	8.5 (N-S); 8.0 (E-W)
	Bending	∞ (no chord)
	diaphragm/wall connection	∞ (no connection)
Out of plane wall anchors	at roof	∞ (no connection)
Brick walls	Out-of-plane loading	Exceeds FEMA allowable
Brick walls	Shear	0.7 to 1.5
Mezzanine floors	Shear connection to brick	Likely inadequate

4.4.3. Proposed Retrofits

The proposed retrofits will improve the seismic performance of the building, but will likely fall short of bringing the building up to approximately the seismic retrofit objective. The RWPP has eight inch thick walls; manufacturers provide design values for anchors epoxied in walls a minimum of 13 inches thick, and the International Existing Building Code provides design values for bolts with eight inches embedment. As such, the bolts should be through bolts, with anchor plates on the exterior, which would affect the appearance and will likely not be approved by SHPO. As such, the required capacity is unlikely to be achieved.

1. Roof diaphragm: Remove existing AC shingles and install new sheathing; it is likely possible to achieve the diaphragm capacity required by installing the panelized sheathing over the existing board sheathing; however, installation of a new ledger and cross-diaphragm ties (described below) may be best facilitated by removal of the board sheathing. Removal of board sheathing has been included in the cost estimate.

2. Diaphragm/wall shear connection: Add anchors and ledger to perimeter of roof diaphragm. At the north and south walls this could be installed along the wall between the trusses. At the east and west walls it will likely be necessary to remove board sheathing and replace the existing 2x joists. Epoxy anchors with reduced embedment will likely be required on the east wall that faces Vine Street; such anchors would likely not provide the required capacity. Through-bolts with exterior anchor plates will likely be used elsewhere if approved by SHPO.

3. Out of plane wall anchors: Epoxy anchors with holddown hardware can be added to the existing trusses and supplemental blocking, strapping, and anchors can be added in the north-south direction. For the east-west direction, existing 2x6 members can be anchored to exterior walls and connected together where they cross the trusses. It will likely not be possible to anchor the east wall for the full demand load because of the restriction on using through-bolts.

4. Out-of-plane wall bending support: Add HSS steel posts anchored to walls, roof framing, and slab-on-grade. Because of the restriction on using through bolts, the out-of-plane wall bracing on the east wall will likely not achieve the full demand load.

5. Supplemental gravity framing: Add HSS steel columns to provide additional gravity support to trusses where failure of old existing wall-mounted brackets or wall movement during shaking could compromise the vertical capacity of these elements. These columns will also act as out-of-plane wall braces.

6. Upgrade mezzanine diaphragm ledger and out-of-plane wall anchors at this level.

A portion of the east wall is deficient according to the FEMA criteria, with a DCR of 1.5 for a brick wall "pier" between the entrance door and adjacent window. Note that the other piers in this wall meet the life-safety criteria. Given the configuration of the building, retrofit of the front wall would be difficult. Installation of a braced frame to reduce pier load is not feasible because of the configuration of the door and the location of the basement. It may be possible to shotcrete portions of the wall, which would drive additional load into the roof diaphragm, and also into the common wall with the control building. However, achieving an adequate bond between the new shotcrete and existing brick walls would be questionable because of the limitation on installing anchors in this wall. The mezzanine would have to be removed from the front wall, and the new shotcrete would have to be connected to existing footings. It is estimated that shotcreting this wall and associated footing work could cost $15,000. Given that the deficiency is limited to one pier, and the difficulty inherent in applying a solution, retrofit of this wall for in-plane loading has not been pursued.

A cost estimate for this retrofit scheme is included in Appendix A.

4.5. HIGH PRESSURE PUMPING PLANT

This structure is a one-story, 24 feet by 60 foot in plan area, partially grouted, concrete masonry unit (CMU) shearwall structure with a flexible diaphragm consisting of 2x6 tongue and groove wood decking supported upon open web steel joists; it was constructed circa 1960. On the north and south walls are 3x ledgers on top of the walls; on the east and west walls it appears that the spaces between the trusses at the tops of the walls were infilled with shallow CMU blocks. The building has a membrane roof over rigid insulation. Masonry walls have a nominal thickness of eight inches on three sides and four inches at the south wall where there is an exterior brick veneer. The top of the wall is approximately nine feet above the slab. There is a perimeter concrete spread footing and a slab-on-grade floor. There are two concrete trenches approximately 4.5 feet deep covered with steel trench plates that extend the length of the building. Typical exterior and interior views of the High Pressure Pumping Plant building are shown in Figures 4.5-1 and 4.5-2 below. Drawings indicating building plans and suggested retrofits are included in Appendix B, Drawings 20 and 21.

Figure 4.5-1: High Pressure Pumping Plant, west elevation

Figure 4.5-2: Interior looking north

4.5.1. <u>Deficiencies</u>

The drawings do not clearly indicate the existing diaphragm nailing and connection to the walls. While the truss anchorage is indicated on the drawings as a masonry anchor, these anchors may not be present. Deficiencies in structural components are indicated in Table 4.5.1-1 below.

Table 4.5.1-1

Component	**Detail**	**D/C Ratio**
Roof diaphragm	Shear	1.6 (N-S); 5.7 (E-W)
	Bending – chord	0.1 (N-S); 1.0 (E-W)
	diaphragm/wall connection	unk. (N-S); 3.2 (E-W)
Out of plane wall anchors	at roof, E and W walls	unknown, likely no good
	at roof, N and S walls	unknown, likely no good
	N-S subdiaphragm	∞ (not present)
8” walls	out-of-plane loading	0.3
4” wall	out-of-plane loading	unknown
In-plane wall shear	shear	0.2 to 0.6

4.5.2. Proposed retrofits

The proposed retrofits will likely bring the building to approximately the seismic retrofit objective. Proposed retrofits for the structure include upgrading the following components

1. Roof diaphragm shear: remove and replace membrane roof and rigid insulation panels, add ½” APA-rated sheathing over existing board sheathing over entire roof.

2. Roof diaphragm connection: in the N-S direction, the sheathing/nailer and nailer/wall connections are unknown, but are likely inadequate; in the E-W direction, the sheathing/nailer connection is unknown, but the nailer/wall connection has a D/C ratio of 3.2. Retrofit this connection by adding a new 3x ledger inside the building and adding nailing from the board and panel sheathing to the nailer. The nailer would by attached to the grouted bond beam with epoxy anchors.

3. Out of plane loading at roof: East and west walls – attach a custom fabricated steel bracket to each truss, and epoxy it to the wall; north and south walls – remove board sheathing above existing trusses near the ends of the building and attach wood framing to the existing trusses, and attach them to each other with tension-compression hardware, and to the wall with epoxy anchors.

4. It may be beneficial to brace the south wall for out-of-plane loading, given the unknown reinforcing in this wall. The height/thickness ratio is approximately 29, vs. an allowable ratio of 13 for unreinforced masonry. The vertical reinforcing in the walls was not indicated in the drawings for three of the four exterior walls. The 8” walls meet the height/thickness ratio criteria contained in FEMA 356.

It is possible that the brick veneer at the south exterior is not adequately attached, but this component has not been evaluated in detail in this report. A cost estimate for the retrofits in the list above is included in Appendix A.

4.6. CHEMICAL BUILDING

The chemical building is a two-story rectangular concrete building measuring approximately 58 feet by 20 feet, constructed circa 1963. The roof consists of steel decking supported by open-web joists with rigid insulation and a membrane roof above. The second floor consists of a concrete slab on metal deck floor supported by steel beams that are let in to the walls. A portion of the building is one-story, and its roof is an extension of the second floor concrete slab on metal deck. Based on the drawings and observations in the field, the exterior walls appear to consist of precast panels connected together with vertical cast-in-place closure pours. The second story floor was constructed over and projects beyond the first story walls. It appears that the second story walls were then placed on top of the second story floor; the connection between the second story walls and the second floor, if present, is not indicated in the drawings. Typical exterior and interior views of the chemical building are shown in Figures 4.6-1 and 4.6-2 below. Appendix B, Drawings 22 through 24 depicts building plans and suggested retrofits.

Figure 4.6-1: Chemical building south elevation

Figure 4.6-2: Interior second floor looking north

4.6.1. Deficiencies

Some of the components and/or connections of the lateral force resisting system are not clearly depicted on the drawings, such as the roof connection to walls, the connection between the 2nd story walls and second floor, and first floor walls and foundation. Additionally, the metal deck roof diaphragm connection to open-web trusses is not indicated, nor is the metal deck sidelap and support connection. It is assumed that where connections are not shown, the lateral force resisting system load path is incomplete, and seismic retrofits will be designed. Deficiencies are summarized in Table 4.6.1-1below.

Table 4.6.1-1

Component	**Detail**	**D/C Ratio**
Roof diaphragm	Shear	unknown, likely inadequate
	Bending – chord	0.13 (N-S); 1.1 (E-W)
	diaphragm/wall connection	unknown, likely inadequate
Out of plane anchors, roof	E and W walls	unknown; may be OK
	N and S walls	unknown, likely inadequate
	N and S subdiaphragm	not present
Out of plane wall capacity	Second story	OK by inspection
2nd story shearwalls	shear and bending in-plane	(E and W) 0.3
		(S) 0.7
		(N) OK by inspection
	overturning	(S) 0.6
	shear transfer to 2nd floor	unknown; likely inadequate
	connection to 2nd floor	unknown; likely inadequate
Second floor diaphragm	Shear	OK by inspection
	Bending – chord	continuous chord not present
2nd Floor Diaphragm	Shear	0.5
	Bending – chord	0.3
	Diaphragm/wall connection	unknown; likely inadequate
Out of plane anchors, 2nd flr	E and W walls	unknown; likely inadequate
	N and S walls	unknown; likely inadequate
Out of plane wall capacity	First story	OK by inspection
First story shearwalls	Shear and bending in-plane	(E) 0.2; (W) 0.3
		(S) 0.9; interior 6” (0.4) 8” intermediate (0.9)
	Shear transfer to foundation	Unknown, likely inadequate
	Overturning	OK
	Wall/foundation connection	Unknown, likely inadequate

4.6.2. Proposed retrofits

The proposed retrofits will likely bring the building to approximately the seismic retrofit objective. Proposed retrofits for the structure include upgrading the following components:

1. Roof diaphragm shear: Remove built-up roofing and insulation; add stitch screws at sidelap connections and pneumatic fasteners at supports, or add welds; reroof with new insulation and membrane roofing.

2. Roof diaphragm connection to tops of walls for in-plane loading: add steel bent plate or angle at roof/wall interface attached to existing roofing with pneumatic fasteners (from above), and with epoxy anchors to concrete walls at interior of building. If the metal decking is replaced, puddle weld new decking to steel bent plate/angle.

3. Roof diaphragm out-of-plane anchors: fabricate steel connector to be attached to the trusses and then attached to walls with epoxy anchors. At north and south

walls, add additional angles attached to outriggers to extend depth of subdiaphragm.

4. Second story shearwall/second floor slab connection: add steel angle at interface with epoxy anchor rods connecting to floor and walls.

5. First story shearwall/second floor slab connection: add steel angle at interface with epoxy anchor rods connecting to floor and walls.

6. First story shearwall/foundation connection: given the amount of obstructions at the perimeter of the building, particularly on the west side, excavating adjacent to the building and exposing the footing will be problematic. The purpose of this connection would be to improve sliding resistance. An alternative to attaching to the footing would be to attach to the floor slab and mobilize the sliding resistance of the slab. This option has been included in the cost estimate.

A cost estimate for this retrofit scheme is included in Appendix A,.

4.7. LARGE FILTER BUILDING

4.7.1. Description of Building

The large filter building is a one-story CMU shearwall building constructed circa 1965 and expanded circa 1991. This building sits atop a steel-beam supported concrete slab on metal deck, which is approximately 14 feet above the ground and is supported by concrete walls at the perimeter and interior. In essence, the structural slab floor of the CMU building is the second story floor of the structure, with the concrete slab “floors” of the filter galleries at the ground floor. The roof system of the CMU building consists of 2x or 3x tongue and groove decking supported by open web joists (original construction) or a glulam beam (expansion). The roof decking of the original structure (proprietary insulated panels) was removed during the expansion and replaced with decking as part of the expansion. The structure has a membrane roof over rigid panel insulation.

Construction drawings suggest that the original CMU walls are 6” nominal block that contain vertical reinforcing and grout only adjacent to openings. The new CMU walls are 8” nominal block and appear to be fully grouted, with vertical reinforcing steel at an unknown spacing. Typical exterior and interior views of the large filter building are shown in Figures 4.7-1 and 4.7-2 below. Building plans and recommended retrofits are shown in Appendix B, Drawings 25 and 26.

Figure 4.7-1: Large filter building, south elevation

Figure 4.7-2: Interior looking south

4.7.2. Deficiencies

Deficiencies are summarized in Table 4.7.2-1below.

Table 4.7.2-1

Component	**Detail**	**D/C Ratio**
Roof diaphragm	Shear	1.4 (N-S); 1.8 (E-W)
	Bending – chord	<0.1 (N-S) & (E-W)
	diaphragm/wall connection nailing	0.1 (N-S) unknown (E-W)
	diaphragm/wall connection anchor bolts	at new bldg 0.16 (N-S); 0.22 (E-W) at exist. bldg possibly 0.13 (E-W) unknown in (N-S)
Out of plane wall anchors	at roof, E and W walls	unknown, possibly OK
	at roof, N and S walls	∞ (no connection)
	N-S subdiaphragm	∞ (not present)
	cross-chord ties	(N-S) not continuous
Out of plane wall capacity	1965 walls	possibly inadequate
	1991 walls	OK by inspection
Shearwalls	shear and/or bending	0.1 to 0.2
	bed-joint sliding	0.5

4.7.3. Proposed Retrofits

The proposed retrofits will likely bring the building to approximately the seismic retrofit objective. Proposed retrofits for the structure include upgrading the following components:

1. Roof diaphragm shear: remove existing membrane roofing and panel insulation, add panelized wood sheathing, and reroof.

2. Connection of diaphragm to walls: add interior ledger at the top of the walls with new wood framing and epoxy anchors to existing bond beams.

3. Out of plane wall anchors: at the original structure, add fabricated anchors to attach existing open-web trusses to the walls; add supplemental framing in the orthoganol direction. At the addition, add framing and hardware, and upgrade existing glulam/wall connections.

4. Vertical reinforcing in the original 6" CMU walls is indicated on the drawings at each side of all openings; the height/thickness ratio for these walls is approximately 17, which exceeds the FEMA 356 limit of 13 for unreinforced walls. However, given that three of the four original walls are mostly open, the wall between the original building and the expansion is the only wall that is largely unreinforced. Out-of-plane wall support for this wall has been included in the retrofit cost estimate for this building.

A cost estimate for this retrofit scheme is included in Appendix A.

5. MAPLE RESERVOIR (STEEL TANK) CONNECTION UPGRADE

The seismic engineering study prepared by G&E Engineering Systems recommended that several pipes attached to the Maple Reservoir steel tank be retrofitted to accommodate four to 12 inches of vertical movement at the attachment. There is one above-ground connection of a 24-inch diameter steel pipe, one below-ground attachment of a 24-inch diameter steel pipe, and one below-ground attachment of a 10-inch diameter steel overflow pipe. Retrofitting of the below-ground pipes will involve expanding existing concrete vaults, removing sections of pipe, and installing double ball-joint expansion joints. Vault-covers would likely need to be traffic-rated as the vaults appear to lie within an area used for vehicle access and parking. Given the configuration of the above-ground 24-inch diameter pipe, it will be necessary to reroute a portion of the pipe adjacent the tank prior to installing the expansion joint. Adding three expansion joints, rerouting pipe, and expanding concrete vaults is estimated to cost approximately $150,000.

6. EQUIPMENT ANCHORAGE

Selected equipment identified in the G&E study is to be anchored. The equipment consists of the following:

6.1.1. <u>Control Building</u>

- Unanchored equipment racks with control equipment/computers
- Several unanchored/unrestrained electrical/measuring cabinets

6.1.2. <u>Raw Water Pump Station</u>

- Floor-standing control cabinet housing pump controls (three total)

6.1.3. <u>Old Filter Building</u>

- Two of three floor-standing motor control centers

6.1.4. <u>Large Filter Building</u>

- Two plastic chemical tanks
- Floor-standing motor control cabinet

6.1.5. <u>Chemical Building</u>

- Anchor limited number of tanks

7. IMPLEMENTATION OF RECOMMENDATIONS

The cost estimate of $3.7 million for the implementation of retrofits to meet the seismic retrofit objective, or in the cases of the Soda Ash, Old Filter, and Raw Water Pumping Plant buildings, improve the buildings to an objective less than life-safety, exceeds the project construction budget. At this time, the City will need to prioritize buildings and/or building functions in order that the existing construction budget can be allocated to buildings/components with the highest priority, or seek additional funding to perform a greater percentage of the retrofit than can be accommodated with the existing budget. As indicated above, there is a hierarchy of recommended retrofits, with some retrofits providing more benefit per construction dollar than others. Creegan + D'Angelo can provide guidance to the City during prioritization process to effectively allocate available construction funds.

8. LIMITATIONS

As with all seismic retrofits, adherence to a seismic retrofit objective in the design of a seismic retrofit is not a guarantee of structure performance during a seismic event. Due to uncertainties inherent in seismic retrofit, which include uncertainties in material properties, existing construction and detailing, and anticipated ground motion, it is likely that not all structures and/or structural components retrofitted to the seismic retrofit objective will meet the performance objective.

The configuration of existing buildings not detailed for seismic loading (including plan irregularities such as changes in floor area from one story to the next, reentrant corners, and story irregularities, such as changes in stiffness, strength, or mass from one story to the next) will have a detrimental affect on building performance. It should be noted, however, that even new buildings designed to the current building code may not behave entirely as expected or predicted by analysis, or conform to the performance objectives implicit in the current code. Retrofit of each of the structures within the scope of work to meet the seismic retrofit objective may not be possible due to limitations inherent in the existing construction, including material properties, as-built detailing, building geometry and architectural layout, construction budget, and/or limitations imposed by the Oregon State Historic Preservation Office.

The basis of the retrofit recommendations contained herein consists of the engineering drawings provided by the owner, limited site observation, the application of the retrofit guidelines cited above, and engineering judgment. It is possible that the as-built construction does not conform to the drawings, either in strength (where specified) or type of materials employed, or in the actual construction of connections and components in accordance with the geometry or detailing shown on the drawings. Assumptions regarding material properties, such as yield stress and elastic modulus of concrete, steel, and masonry elements were made in accordance with established engineering principles and FEMA guidelines, as testing was not performed. Additionally, in some cases engineering drawings do not exist. Retrofit recommendations in such cases are based upon limited visual site inspection. As no destructive evaluation was performed, some structural connections, elements, and detailing could not be observed. Deviations between construction drawings and the as-built condition, and the true nature of concealed construction, may contribute to differences between the target seismic retrofit objective and actual building performance during a seismic event.

Cost estimates are based on Creegan + D'Angelo's experience with other, similar projects. Construction costs are highly variable, and can be affected by the number of contractors bidding on a job, the price and availability of materials, the strength of the local economy and the number of local construction projects under construction, the size of the project, unique aspects of the job and project complexity, project schedule, site access, project location with respect to large metropolitan areas, local or regional contractor experience with similar projects, and client/owner requirements. In particular, limited interest from contractors, reflected in a small number of bidders on the project, could significantly increase the construction cost, from 50% to possibly 100% or more. Additionally, price escalation could be significant. As such, the project cost developed at this stage of the retrofit project should be viewed as a rough approximation of what the actual costs will be when the project is bid.

The scope of this seismic assessment as applies to buildings is limited to the seven buildings listed above. Evaluation of building contents, utilities, piping, wiring, ductwork, and other, nonstructural components including mechanical, HVAC, laboratory, and electrical equipment and control units, is limited to those items identified in the G&E Engineering Systems report (listed above in Sections 5 and 6), which formed the basis for the City of Albany's grant application for retrofit construction.

9. APPENDIX A: COST ESTIMATES

9.1. SUMMARY TABLE

Vine Street WTP Voluntary Seismic Retrofit Seismic Assessment and Retrofit Strategy Phase Engineer's Cost Estimate		
Structure/Component		**Retrofit Cost**
Control Building		$ 1,200,605
Soda Ash Building		$ 528,680
Old Filter Building		$ 258,892
Raw Water Pumping Plant		$ 69,560
High Pressure Pumping Plant		$ 63,302
Chemical Building		$ 72,820
Large Filter Building		$ 17,560
Maple Reservoir		$ 150,000
Equipment Anchorage		$ 20,000
Subtotal		**$ 2,381,419**
Contractor Overhead	13%	$ 309,584
Contractor Profit	10%	$ 238,142
Bond	2%	$ 47,628
Contingency on Schematic Design	25%	$ 595,355
Escalation	5%	$ 119,071
Subtotal		**$ 1,309,780**
Total		**$ 3,690,000**

9.2. CONTROL BUILDING

Building:	Control Building		MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	*Main Portion of Building*				
2	Remove ac shingles and board sheathing	SF	5040	$2	$ 10,080
3	Add sheathing	SF	5040	$5	$ 25,200
4	Add blocking	SF	5040	$5	$ 25,200
5	Add ledger	LF	284	$50	$ 14,200
6	North and south wall out-of-plane roof anchor	EA	42	$250	$ 10,500
7	North-South cross-diaphragm tie straps	EA	63	$75	$ 4,725
8	East and west wall out-of-plane roof anchor	EA	60	$250	$ 15,000
9	Purlin nailers	EA	60	$350	$ 21,000
10	Drag members between purlins	EA	32	$200	$ 6,400
11	Purlin connections at frames	EA	45	$250	$ 11,250
12	Orthogonal wall ties	EA	2	$2,000	$ 4,000
13	Out-of-plane wall bracing	EA	35	$1,200	$ 42,000
14	Parapet bracing west	EA	12	$1,200	$ 14,400
15	Parapet bracing N & S	EA	30	$350	$ 10,500
16	Reroof	SF	5040	$30	$ 151,200
17	Supplemental gravity framing at perimeter walls	EA	3	$1,000	$ 3,000
18	Collector connection at north wing, nailer	EA	1	$2,000	$ 2,000
19					$ -
20	*Wings*				$ -
21	Remove membrane roofing & insulation at wings	SF	1300	$1	$ 1,300
22	Add 1/2" sheathing at wings	SF	1300	$5	$ 6,500
23	Add ledger	LF	142	$50	$ 7,100
24	Out-of-plane wall anchors	EA	36	$150	$ 5,400
25	Out-of-plane wall anchors framing	LS	1	$3,500	$ 3,500
26	Out-of-plane wall bracing	EA	9	$1,000	$ 9,000
27	Add wood sheathing, west wall of west wing	SF	630	$5	$ 3,150
28	Reroof	SF	1300	$30	$ 39,000
29	Drag members at out-of-plane wing walls	EA	2	$2,000	$ 4,000
30	North wing footing/shearwall at base	EA	1	$75,000	$ 75,000
31	North wing lower slab shearwall	EA	2	$10,000	$ 20,000
32					$ -
35	*Conditioned space*				$ -
36	Replace	SF	3,280	$200	$ 656,000
	Total				$ 1,200,605

9.3. SODA ASH BUILDING

Building: Soda Ash			MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	Remove roofing; wood framing; insulation	SF	1200	$4	$ 4,800
2	Remove existing roof slab and framing	SF	1200	$15	$ 18,000
3	Replace existing roof slab and framing	SF	1200	$75	$ 90,000
4	Attachment of roof to walls	LF	150	$200	$ 30,000
5	Upgrade wall/2nd floor diaphragm connection	LF	150	$200	$ 30,000
6	Upgrade slab shear capacity with FRP	SF	1,200	$40	$ 48,000
7	Add out-of-plane wall bracing, 1st and 2nd floors	EA	44	$1,200	$ 52,800
8	Infill and relocate roll-up door	SF	240	$35	$ 8,400
9	Parapet bracing	EA	400	$30	$ 12,000
10	Reroof	SF	1,200	$25	$ 30,000
11	Baseplates	EA	4	$2,000	$ 8,000
12	Gussets	EA	24	$750	$ 18,000
13	Beams	EA	8	$3,500	$ 28,000
14	Columns	EA	8	$3,500	$ 28,000
15	Column Splices	EA	4	$1,500	$ 6,000
16	Braces	EA	16	$2,500	$ 40,000
17	Connection to diaphragms	LF	120	$100	$ 12,000
18	Slab demolition	EA	360	$3	$ 1,080
19	Footing demolition	EA	4	$750	$ 3,000
20	Drilled pier/pier cap	EA	4	$3,500	$ 14,000
21	Grade beam	LF	120	$150	$ 18,000
22	Slab-on-grade repair	SF	360	$10	$ 3,600
23	Second floor slab repair	LS	1	$5,000	$ 5,000
24	Equipment Relocation	LS	1	$20,000	$ 20,000
25					$ -
26					$ -
27					$ -
28					$ -
29					$ -
30					$ -
	Total				$ 528,680

9.4. OLD FILTER PLANT BUILDING

Building: Old Filter			MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	remove roofing	SF	2716	$2	$ 5,432
2	Add ledger and chord element	LF	250	$170	$ 42,500
3	Additional roof framing at central core	SF	420	$25	$ 10,500
4	Out-of-plane anchors S & E wings	EA	22	$300	$ 6,600
5	Out-of-plane drag framing S & E wings	LF	300	$15	$ 4,500
6	Out-of-plane anchors central core	EA	46	$300	$ 13,800
7	Out-of-plane drag framing central core	LF	400	$15	$ 6,000
8	Out-of-plane wall supports	EA	41	$1,000	$ 41,000
9	Supplemental gravity framing	EA	4	$1,500	$ 6,000
10	Collector connections at reentrant corner	EA	3	$2,500	$ 7,500
11	Install panelized sheathing	SF	1,680	$5	$ 8,400
12	Parapet Bracing	EA	58	$200	$ 11,600
13	Reroof	SF	2,716	$35	$ 95,060
14					$ -
15					$ -
16					$ -
17					$ -
18					$ -
19					$ -
20					$ -
21					$ -
22					$ -
23					$ -
24					$ -
25					$ -
26					$ -
27					$ -
28					$ -
29					$ -
30					$ -
	Total				$ 258,892

9.5. RAW WATER PUMPING PLANT BUILDING

Building: Raw Water Pumping Plant			MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	Remove AC shingles and board sheathing	SF	890	$2	$ 1,780
2	Demolish (E) mezzanine ceiling, wall	LS	1	$4,000	$ 4,000
3	Install Roof ledger A.B. and ledger	LF	120	$20	$ 2,400
4	Install out of plane wall anchors (N wall)	EA	16	$250	$ 4,000
5	Install out of plane wall anchors (S wall)	EA	16	$500	$ 8,000
6	Install out of plane wall anchors (E and W walls)	EA	32	$250	$ 8,000
7	Install E-W tie connection to 2x rafters	EA	48	$35	$ 1,680
8	Install cross diaphragm blocking, strapping (N-S)	LF	216	$30	$ 6,480
9	Supplemental N-S framing at ledger	EA	32	$30	$ 960
10	Interior wall out-of-plane bracing	EA	13	$1,000	$ 13,000
11	Install 1/2-inch panelized sheathing	SF	890	$5	$ 4,450
11	Upgrade mezzanine ledger	LF	87	$30	$ 2,610
13	Add out-of-plane anchors to mezzanine	EA	22	$150	$ 3,300
14	Reroof with AC shingles	SF	890	$10	$ 8,900
15					$ -
16					$ -
17					$ -
18					$ -
19					$ -
20					$ -
21					$ -
22					$ -
23					$ -
24					$ -
25					$ -
26					$ -
27					$ -
28					$ -
29					$ -
30					$ -
	Total				$ 69,560

9.6. HIGH PRESSURE PUMPING PLANT BUILDING

Building: High Pressure Pumping Plant			MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	Remove roofing and insulation	SF	1792	$1	$ 1,792
2	Add panel sheathing and nailing	SF	1792	$4	$ 7,168
3	Add epoxy anchors for new ledger	EA	126	$50	$ 6,300
4	Out of plane anchors on trusses (E&W)	EA	28	$500	$ 14,000
5	Remove and replace board sheathing at ends	LS	1	$1,000	$ 1,000
6	Add hangers and framing (N&S walls)	EA	30	$400	$ 12,000
7	Add ledger boards	EA	25	$38	$ 950
8	Add nailing to (E) joists	LF	336	$2	$ 672
9	South wall bracing	EA	3	$500	$ 1,500
10	New insulation and roofing	SF	1,792	$10	$ 17,920
11					$ -
12					$ -
13					$ -
14					$ -
15					$ -
16					$ -
17					$ -
18					$ -
19					$ -
20					$ -
21					$ -
22					$ -
23					$ -
24					$ -
25					$ -
26					$ -
27					$ -
28					$ -
29					$ -
30					$ -
	Total				$ 63,302

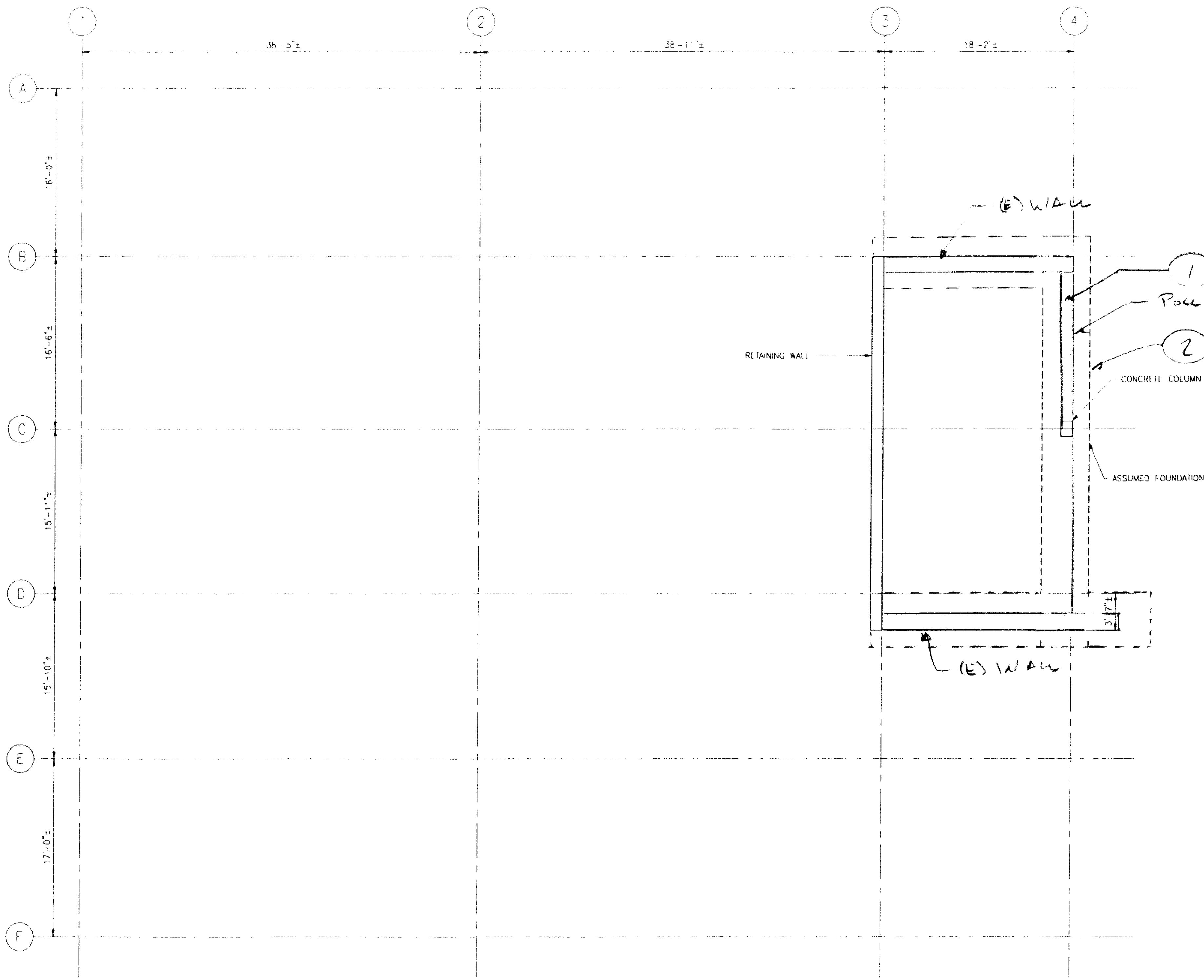
9.7. CHEMICAL BUILDING

Building: Chemical Building			MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	Remove roofing and insulation	SF	800	$1	$ 800
2	Add connections at steel deck	SF	800	$10	$ 8,000
3	Add steel angle at wall/roof interface	EA	16	$200	$ 3,200
4	E & W wall out-of-plane anchor connection at wall	EA	14	$500	$ 7,000
5	N & S wall out-of-plane anchor connection at wall	EA	4	$500	$ 2,000
6	N & S subdiaphragm ties	EA	8	$350	$ 2,800
7	2nd story wall/2nd story floor attachment	LF	120	$65	$ 7,800
8	2nd story wall/1st story wall attachment	LF	188	$65	$ 12,220
9	1st story wall/slab-on-grade attachment	LF	194	$100	$ 19,400
10	Install roofing and insulation	SF	800	$12	$ 9,600
11					$ -
12					$ -
13					$ -
14					$ -
15					$ -
16					$ -
17					$ -
18					$ -
19					$ -
20					$ -
21					$ -
22					$ -
23					$ -
24					$ -
25					$ -
26					$ -
27					$ -
28					$ -
29					$ -
30					$ -
	Total				$ 72,820

9.8. LARGE FILTER BUILDING

Building: Large Filter Building			MATERIAL & LABOR COST		
LINE NO.	ITEM	UNIT OF MEASURE	QUANTITY	UNIT	TOTAL
1	Remove roofing and insulation	SF	488	$3	$ 1,220
2	Anchor existing trusses	EA	0	$500	$ -
3	Anchor (E) GLB	EA	2	$500	$ 1,000
4	Add cross diaphragm framing (old portion)	EA	6	$300	$ 1,800
5	Add cross diaphragm framing (new portion)	EA	6	$300	$ 1,800
6	Add epoxy anchors for new ledger	EA	31	$50	$ 1,550
7	Add ledger	LF	124	$5	$ 620
8	Interior wall out-of-plane bracing	EA	3	$750	$ 2,250
9	Install roofing and insulation	SF	488	$15	$ 7,320
10					$ -
11					$ -
12					$ -
13					$ -
14					$ -
15					$ -
16					$ -
17					$ -
18					$ -
19					$ -
20					$ -
21					$ -
22					$ -
23					$ -
24					$ -
25					$ -
26					$ -
27					$ -
28					$ -
29					$ -
30					$ -
	Total				$ 17,560

10. DRAWINGS



CONTROL BUILDING
NORTH WING FOUNDATION PLAN
3/16"=1'-0"

NORTH

LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

KEY NOTES

1. (N) CONCRETE INFILL SHEARWALL (1)
2. FOOTING UPGRADE (1)

DESIGNED BY: CD
DRAWN BY: ML
CHECKED BY: CD
DATE: 4/4/08
SCALE: AS NOTED

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CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
CONTROL BUILDING
NORTH WING FOUNDATION PLAN

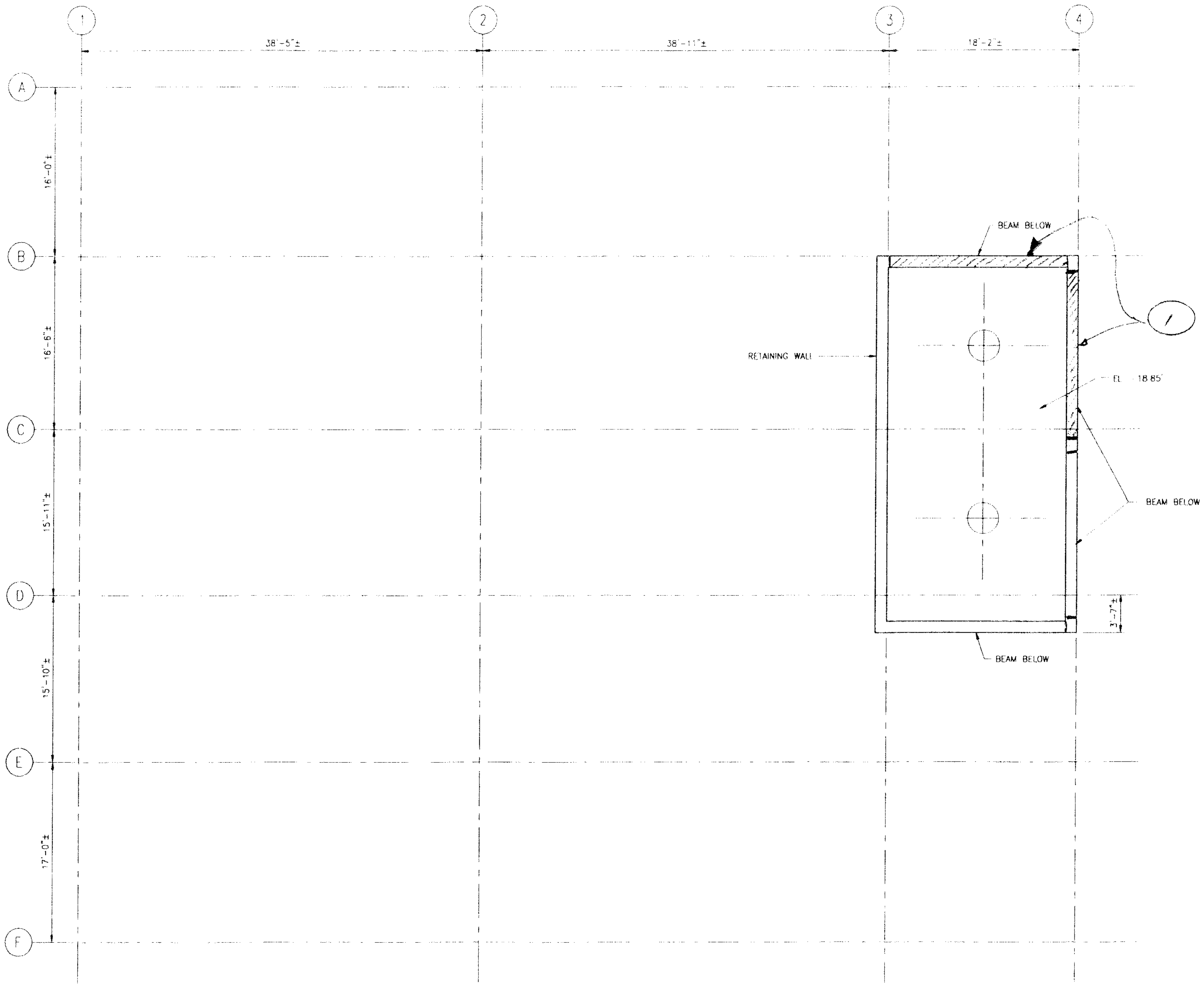
SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
CON1
OF x SHEETS

DRAWING NO.
207025

DRAWING 1



CONTROL BUILDING
NORTH WING LOWER SLAB
3/16"=1'-0"
EL124-64

LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

INDICATES NEW SHEARWALL ABOVE

KEY NOTES

1 (N) CONCRETE INFILL SHEARWALL (2)

DESIGNED BY CD
DRAWN BY ML
CHECKED BY CD
DATE 4/4/08
SCALE AS NOTED

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CONTROL BUILDING
NORTH WING LOWER SLAB

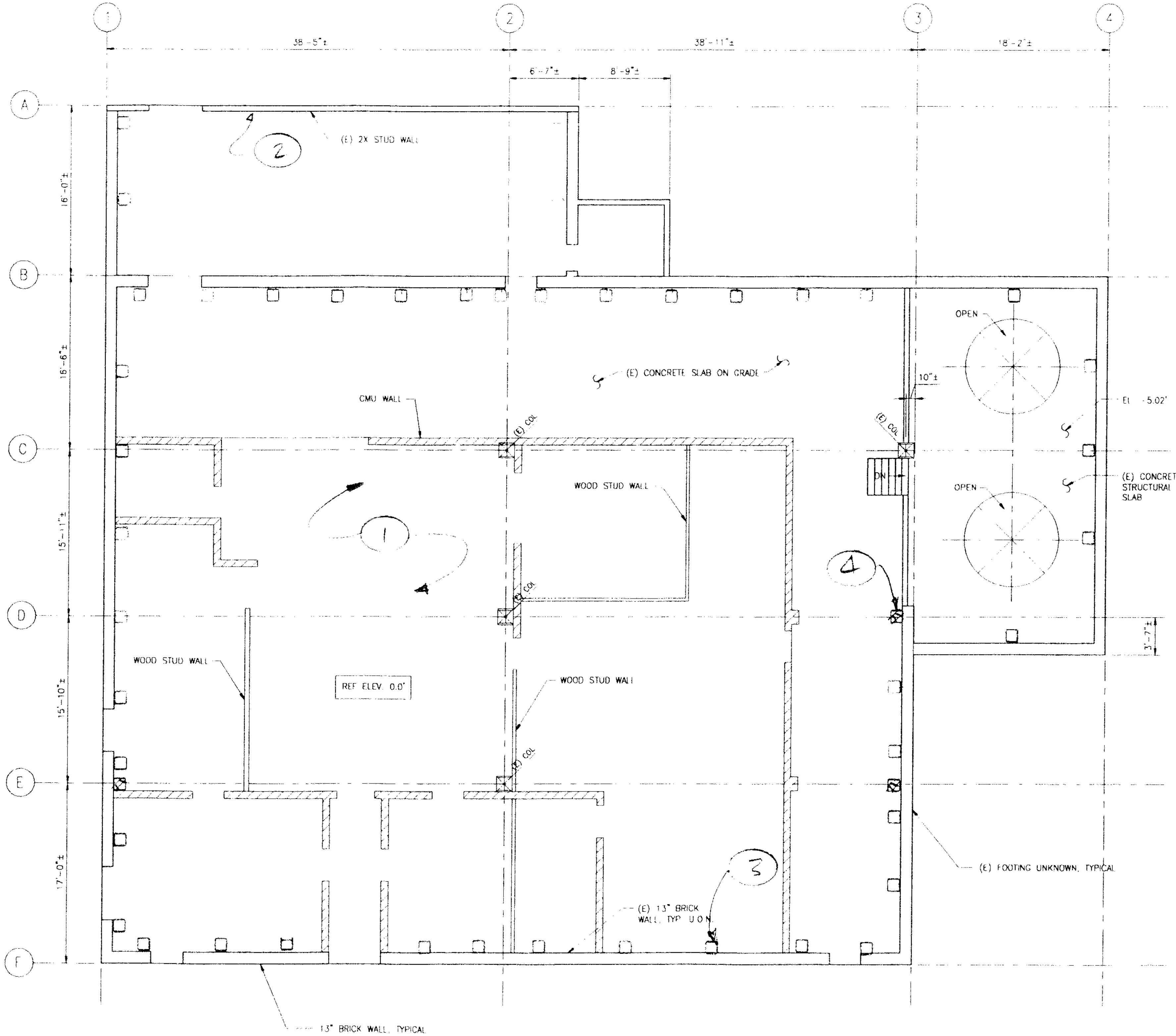
SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
CON2
OF x SHEETS

DRAWING NO.
207025

DRAWING 2



CONTROL BUILDING FOUNDATION PLAN
3/16"=1'-0"
FOUNDATION64

LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

INDICATES CMU WALL ABOVE

KEY NOTES

1. DEMOLISH [illegible] SPACE WALLS
2. ADD SHEATHING TO (E) 2X STUDWALL (630 SF)
3. OUT-OF-PLANE WALL BRACING (44)
4. SUPPLEMENTAL GRAVITY FRAMING (3)

DESIGNED BY:	CD
DRAWN BY:	ML
CHECKED BY:	CD
DATE:	4/4/08
SCALE:	AS NOTED

REV. | DATE | DESCRIPTION | APPR'D | SCH | DATE | DESCRIPTION

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VOLUNTARY SEISMIC RETROFIT
CONTROL BUILDING
FOUNDATION PLAN

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
CON3
OF x SHEETS

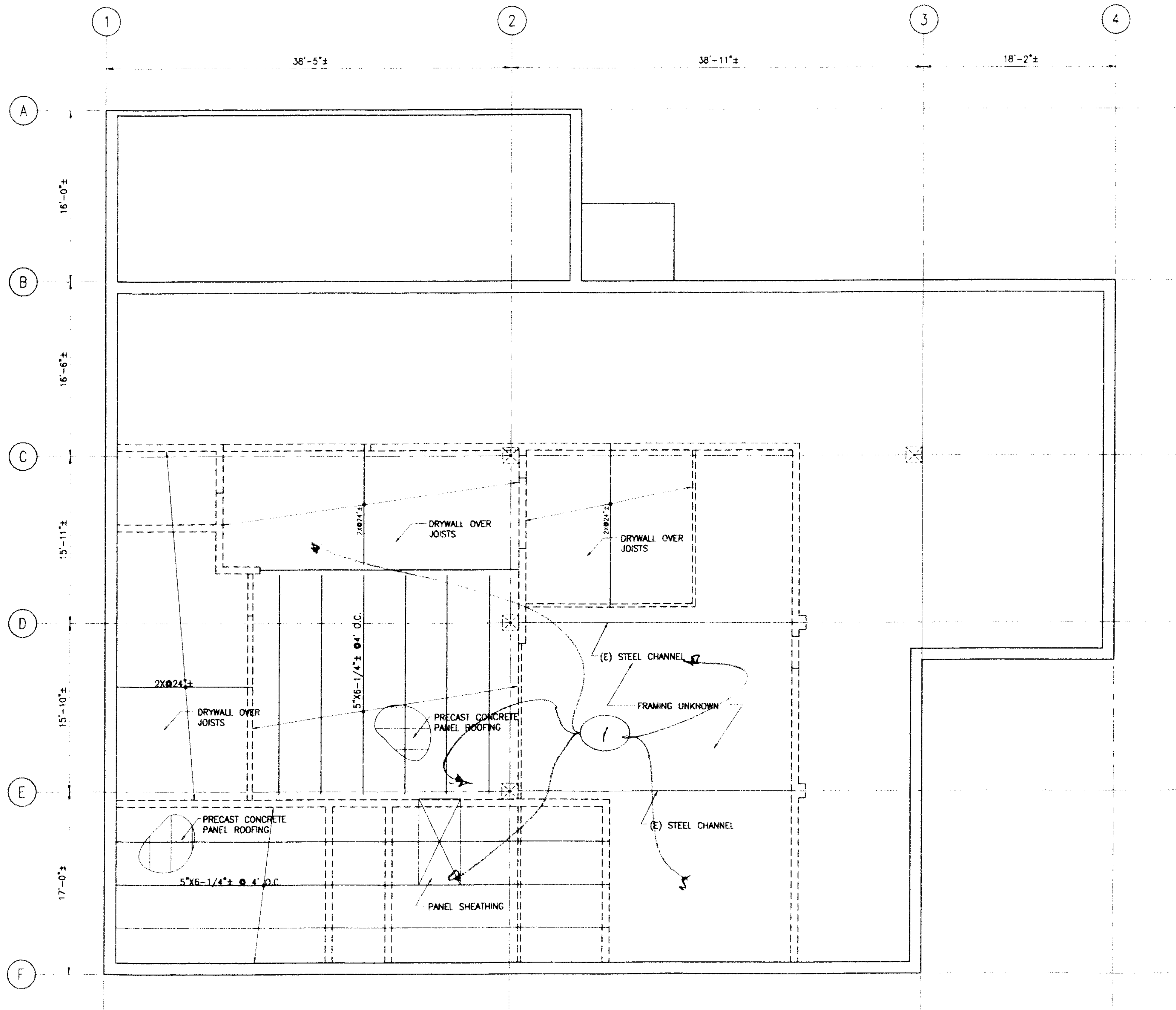
DRAWING NO.
207025

DRAWING 3

LEGEND

INDICATES WALL BELOW

INDICATES WALL ABOVE



CONTROL BUILDING
CONDITIONED SPACE ROOF FRAMING PLAN
3/16"=1'-0"
CONTROL_CONDITIONED_ROOF

NORTH

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DATE 4/4/08
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VOLUNTARY SEISMIC RETROFIT
CONTROL BUILDING
CONDITIONED SPACE ROOF FRAMING PLAN

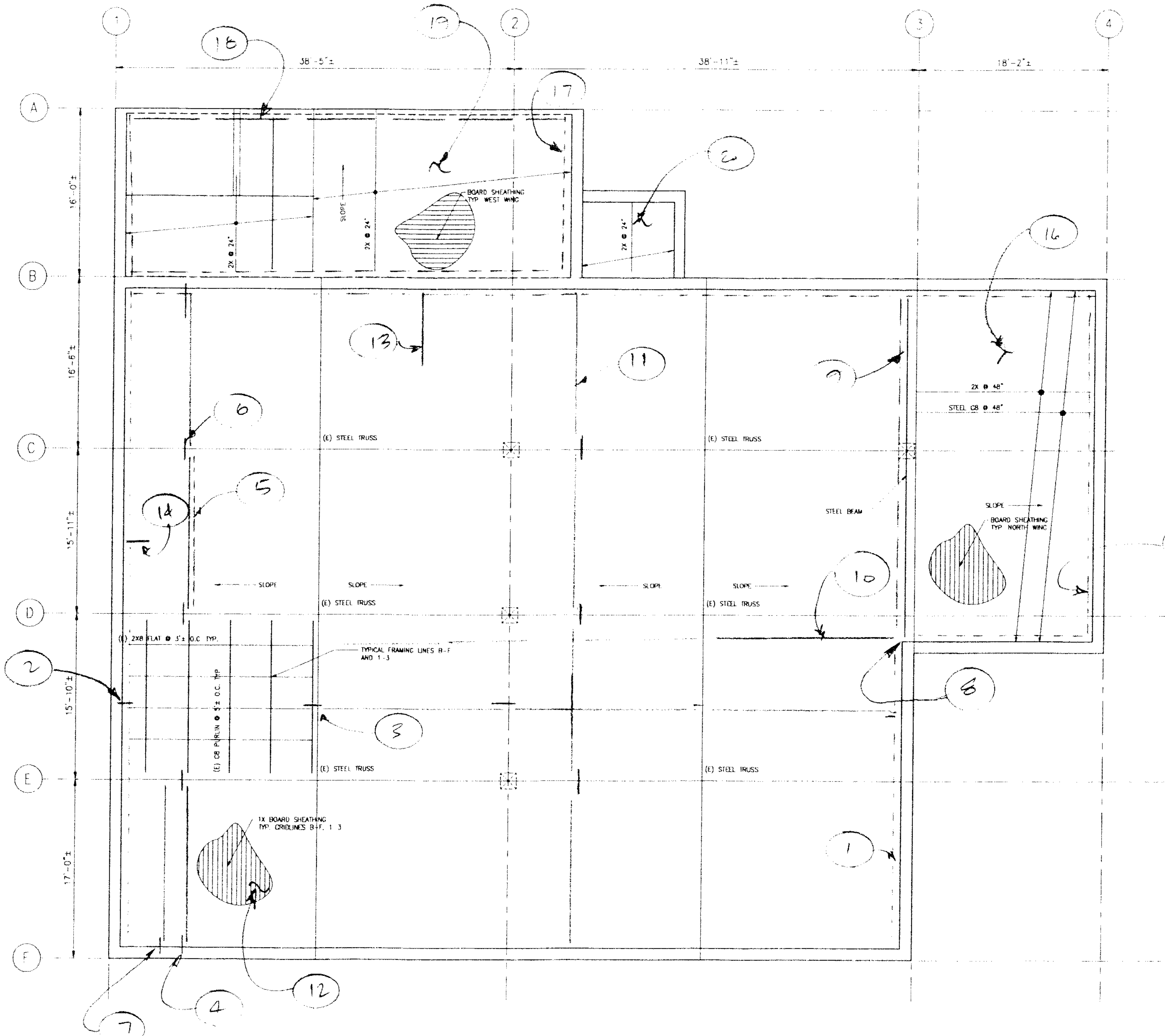
SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
CON4
OF x SHEETS

DRAWING NO.
207025

DRAWING 4



CONTROL BUILDING
ROOF RAMING PLAN
3/16"=1'-0"
CONTROL ROOF

LEGEND

INDICATES WALL BELOW

INDICATES ... ABOVE

KEY NOTES

1. UPGRADE MAIN BUILDING LEDGER (284 LF)
2. N&S WALLS OUT-OF-PLANE ANCHOR @ 3' O.C. (42)
3. 2X8 FLAT DRAG STRAP @ 3' O.C. (63)
4. E&W OUT-OF-PLANE ANCHOR TO (E) C8 PURLIN @ 5' O.C. (28)
5. ADD NAILER TO (E) PURLIN (60)
6. PURLIN CONNECTION UPGRADE AT TRUSS (45)
7. E&W ANCHOR TO SUPPLEMENTAL FRAMING @ 5' O.C. (32)
8. COLLECTOR CONNECTION UPGRADE (1)
9. COLLECTOR NAILER ADDITION (1)
10. OTHOGONAL WALL DRAG (1)
11. ORTHOGONAL WALL DRAG (1)
12. REMOVE AND REPLACE ROOFING, SHEATHING (5040 SF)
13. WEST WALL PARAPET BRACE (12)
14. NORTH AND SOUTH WALL PARAPET BRACE (4)
15. NORTH WING LEDGER UPGRADE (68 LF)
16. NORTH WING REMOVE ADD SHEATHING, REPLACE ROOFING (580 SF)
17. WEST WING LEDGER UPGRADE (74 LF)
18. WEST WALL STUDWALL/RAFTER BLOCKING UPGRADE (45 LF)
19. WEST WING REMOVE ADD SHEATHING, REPLACE ROOFING (740 SF)
20. UPGRADE STORAGE ROOM SHEATHING (64 SF)

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
CONTROL BUILDING
ROOF FRAMING PLAN

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CHECKED BY CD
DATE 4/4/08
SCALE AS NOTED

SHEET NUMBER
CON5
OF x SHEETS
DRAWING NO
207025

DRAWING 5

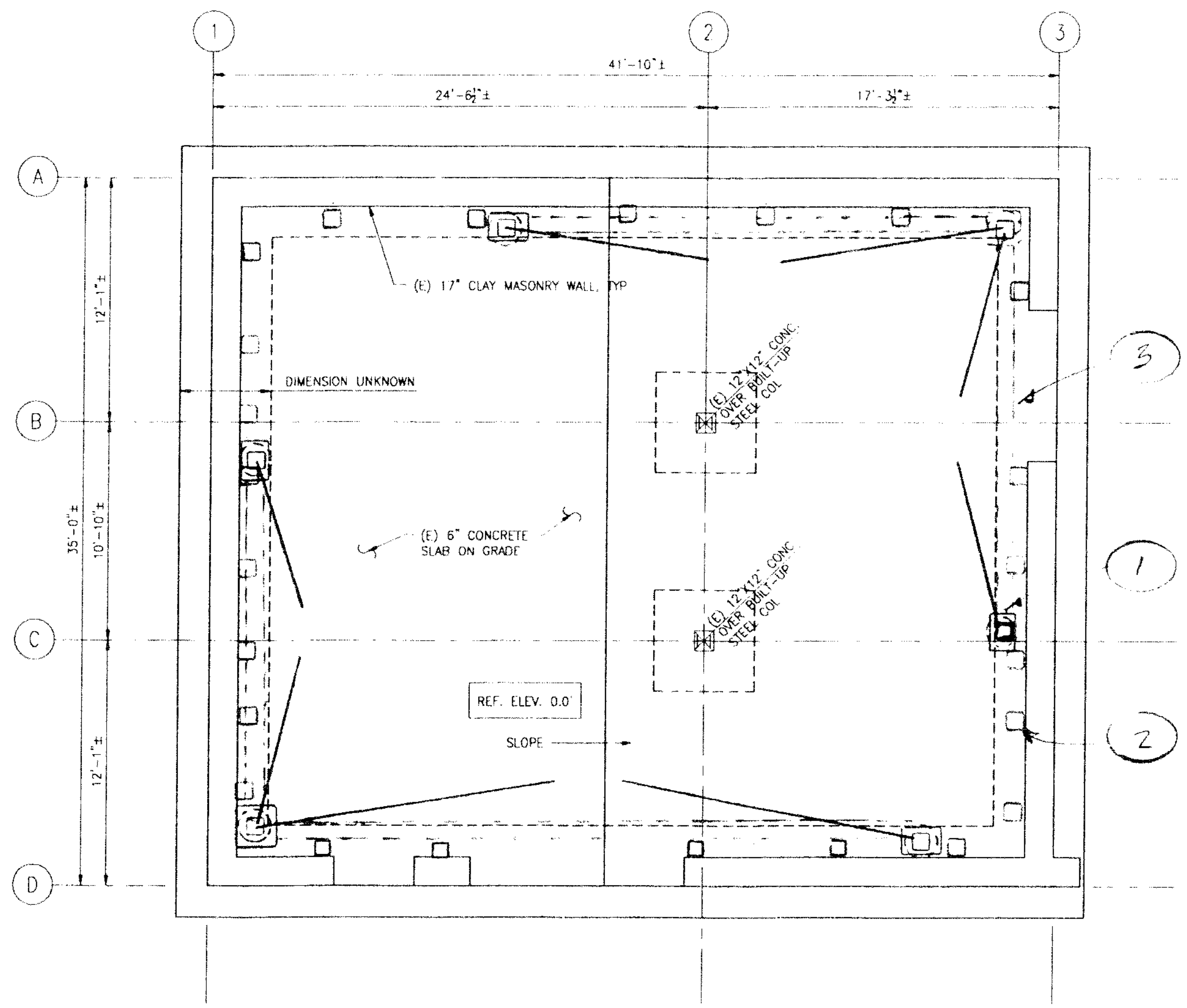
LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

KEY NOTES

1. PIER, PIERCAP, BRACED FRAME (4)
2. OUT-OF-PLANE WALL BRACING (22)
3. CONCRETE GRADEBEAM (4)



SODA ASH BUILDING
FOUNDATION PLAN
1/4"=1'-0"
FOUNDATION
NORTH

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SCALE AS NOTED

CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
SODA ASH BUILDING
FOUNDATION PLAN

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
SA1
OF x SHEETS
DRAWING NO.
207025

DRAWING 6

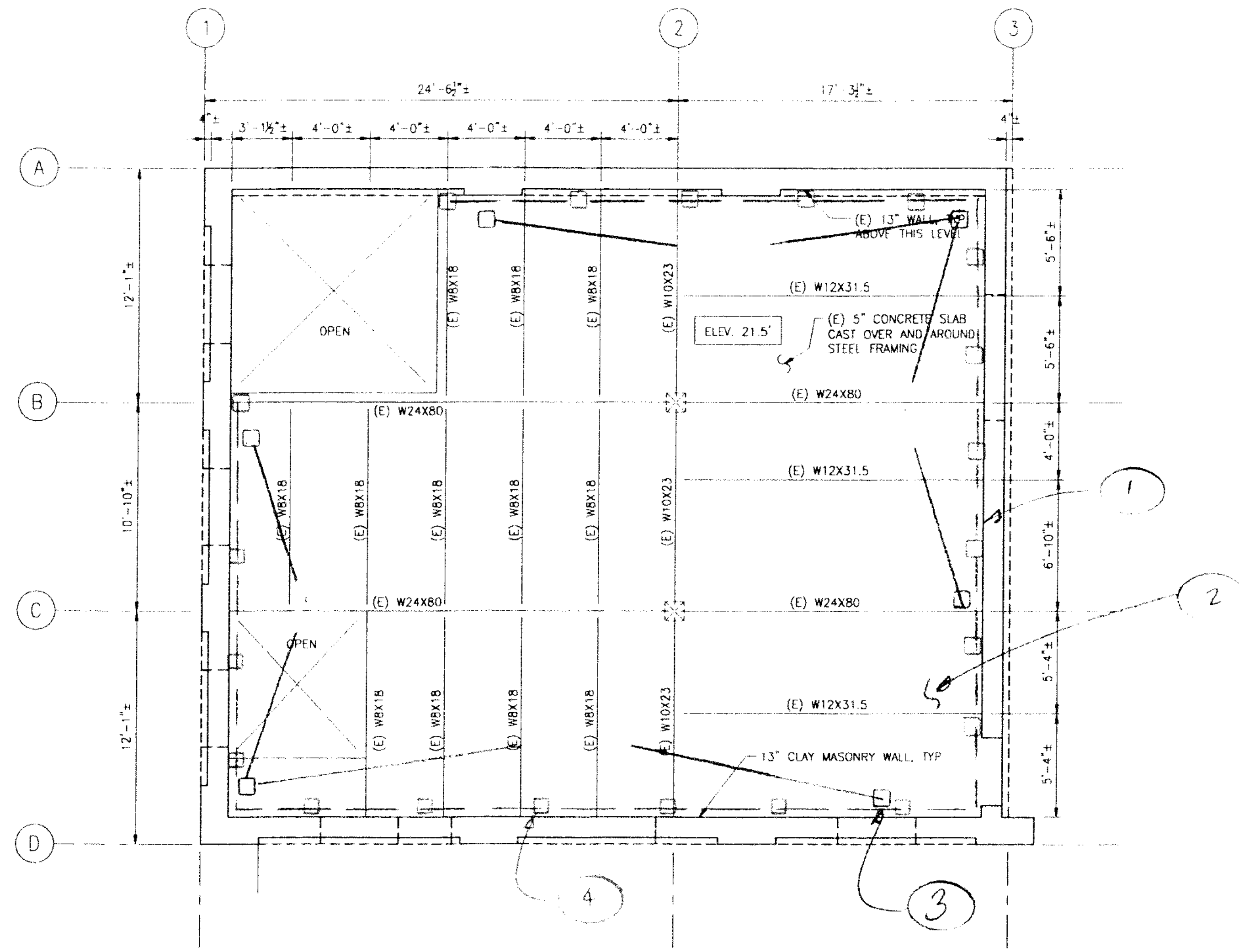
LEGEND

INDICATES WALL BELOW

INDICATES PARAPET ABOVE

KEY NOTES

1 DIAPHRAGM/WALL SHEAR CONNECTION (150 LF)
2 CARBON FIBER FABRIC UPGRADE (1200 SF)
3 BRACED FRAME ([illegible])
4 [illegible] (21)



SODA ASH BUILDING
SECOND FLOOR FRAMING PLAN
1/4"=1'-0"
SECOND

NORTH

DESIGNED BY CD
DRAWN BY ML
CHECKED BY CD
DATE 4/4/08
SCALE AS NOTED

REV. | DATE | DESCRIPTION | APPR'D

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CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
SODA ASH BUILDING
SECOND FLOOR FRAMING PLAN

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
SA2
OF x SHEETS
DRAWING NO.
207025

DRAWING 7

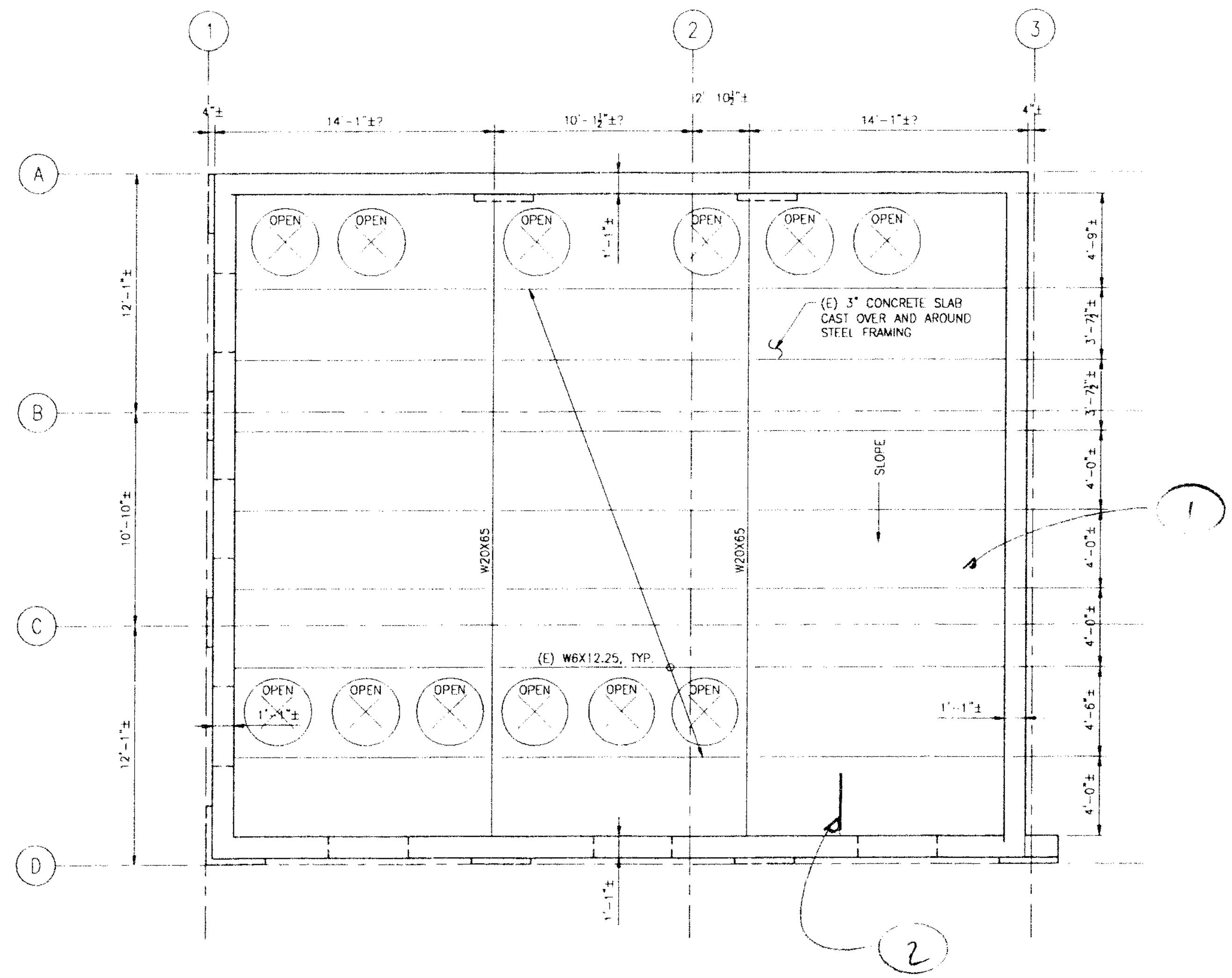
LEGEND

INDICATES WALL BELOW

INDICATES PARAPET ABOVE

KEY NOTES

1. REPLACE EXISTING ROOF DIAPHRAGM (1200 SF)
2. PARAPET BRACING (30')



SODA ASH BUILDING ROOF FRAMING PLAN
1/4"=1'-0"
ROOF

NORTH

DESIGNED BY: CD
DRAWN BY: ML
CHECKED BY: CD
DATE: 4/4/08
SCALE: AS NOTED

REV. | DATE | DESCRIPTION | APPR'D

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CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
SODA ASH BUILDING
ROOF FRAMING PLAN

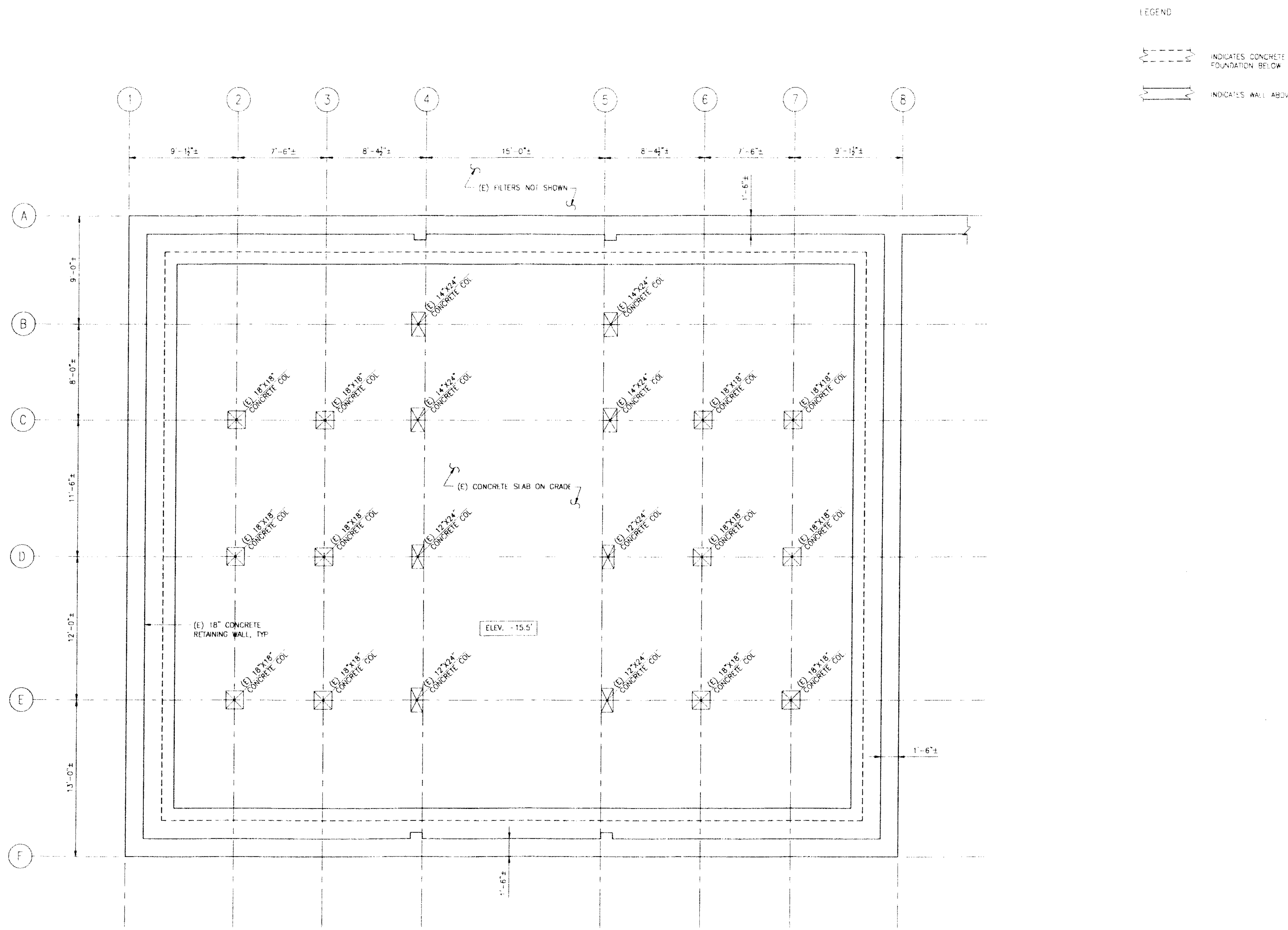
SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
SA3
OF x SHEETS

DRAWING NO.
207025

DRAWING 8



OLD FILTER BUILDING
BASEMENT - CLEARWELL FOUNDATION
1/4"=1'-0"

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
CLEARWELL FOUNDATION PLAN

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DESIGNED BY: CD
DRAWN BY: ML
CHECKED BY: CD
DATE: 4/4/08
SCALE: AS NOTED

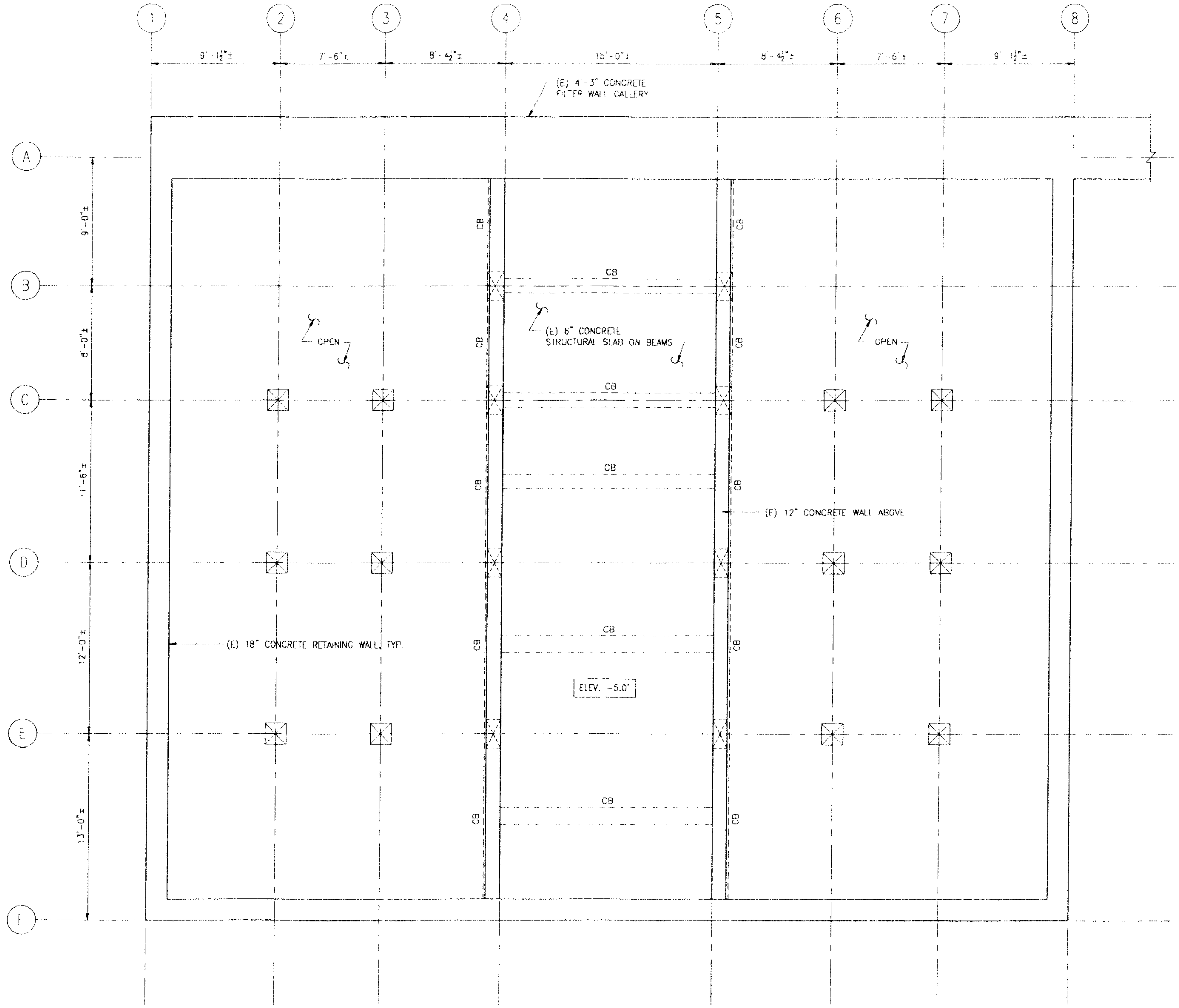
SHEET NUMBER
OFB1
OF x SHEETS
DRAWING NO.
207025

DRAWING 9

LEGEND

CB INDICATES CONCRETE BEAM BELOW

INDICATES WALL ABOVE



OLD FILTER BUILDING
ELEVATION 41.5' - PIPE GALLERY
1/4"=1'-0"
EL41.5

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
PIPE GALLERY FRAMING PLAN

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DATE: 4/4/08
SCALE: AS NOTED

SHEET NUMBER
OFB2
OF x SHEETS
DRAWING NO.
207025

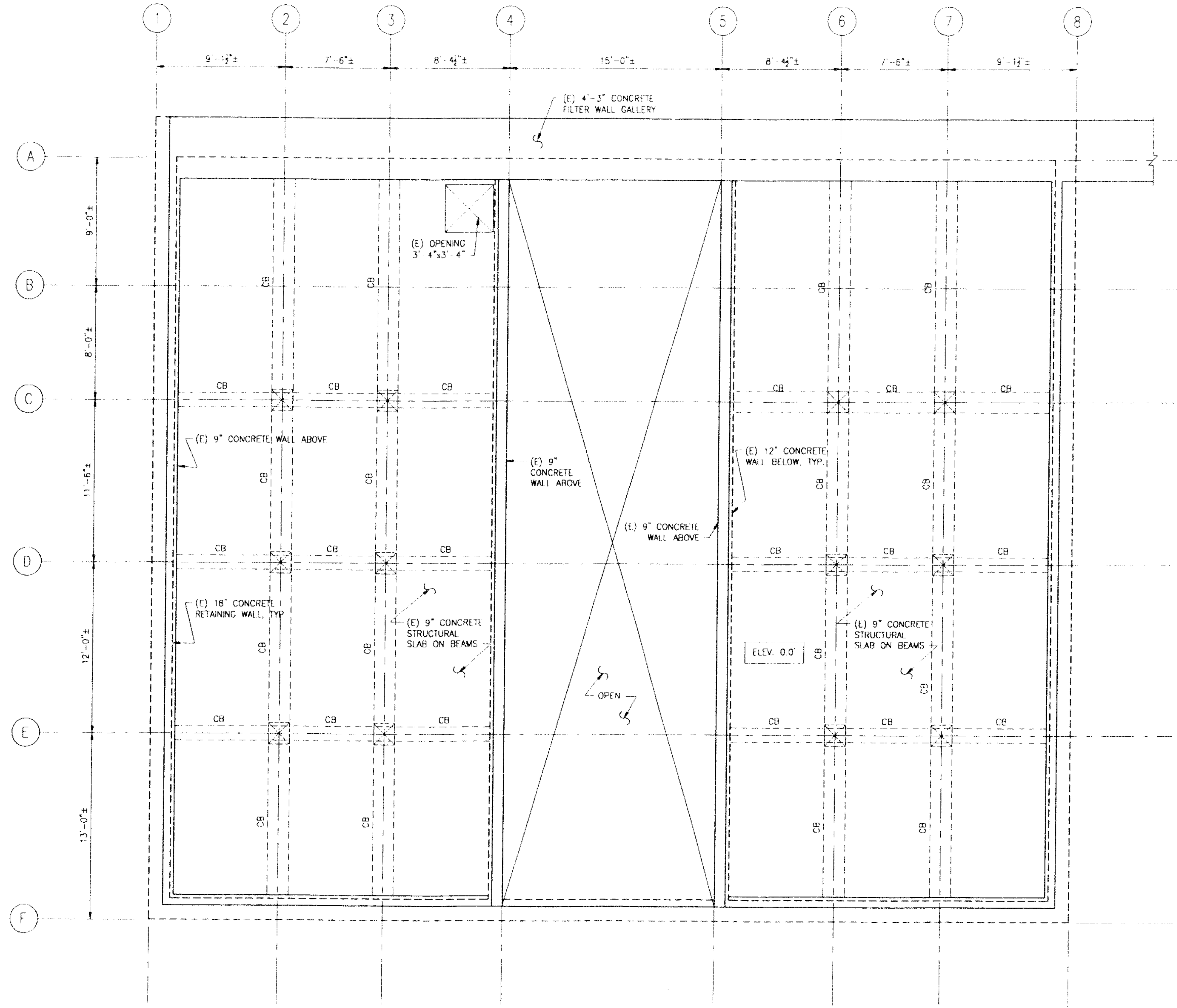
DRAWING 10

LEGEND

INDICATES CONCRETE WALL BELOW

CB INDICATES CONCRETE BEAM BELOW

INDICATES WALL ABOVE



OLD FILTER BUILDING
ELEVATION 46.5 - FILTER GALLERY
1/4"=1'-0"
EL46.5

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
FILTER GALLERY SLAB FRAMING PLAN

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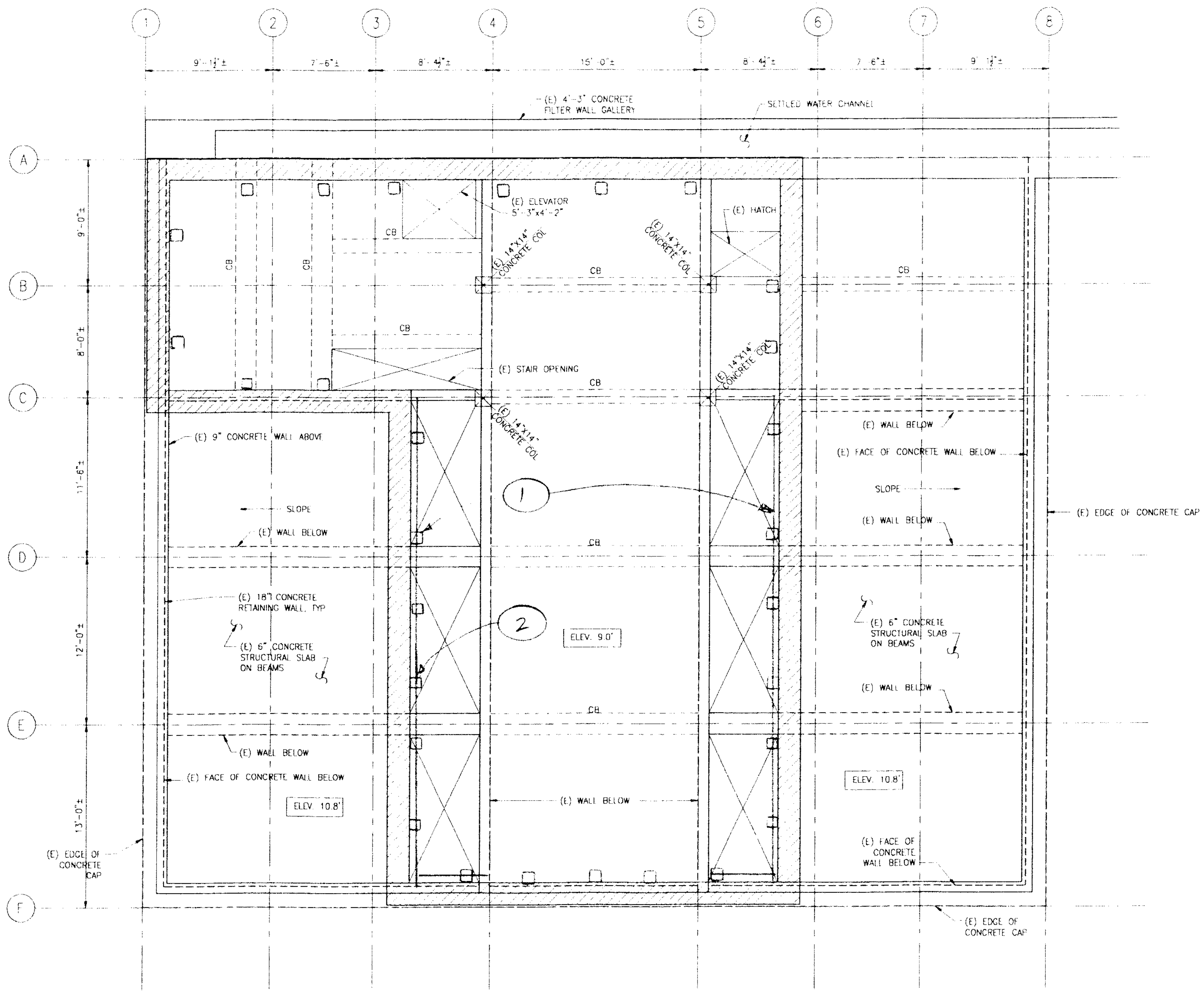
SCALE: AS NOTED

REV. DATE DESCRIPTION

SHEET NUMBER
OFB3
OF x SHEETS

DRAWING NO.
207025

DRAWING 11



OLD FILTER BUILDING
ELEVATION 56.5 - OPERATING FLOOR
1/4"=1'-0"
EL 56.5

LEGEND

INDICATES CONCRETE WALL BELOW

CB INDICATES CONCRETE BEAM BELOW

INDICATES WALL ABOVE

INDICATES BEAM SUPPORTING BRICK STRUCTURE ABOVE

KEY NOTES

1. ADD SUPPLEMENTAL STEEL FRAMING (2)
2. OUT-OF-PLANE WALL BRACING (29)

REV.	DATE	DESCRIPTION	APPR'D	SCH.	DATE	DESCRIPTION

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CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
OPERATIONS FLOOR SLAB FRAMING PLAN

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
OFB4
OF x SHEETS
DRAWING NO.
207025

DRAWING 12

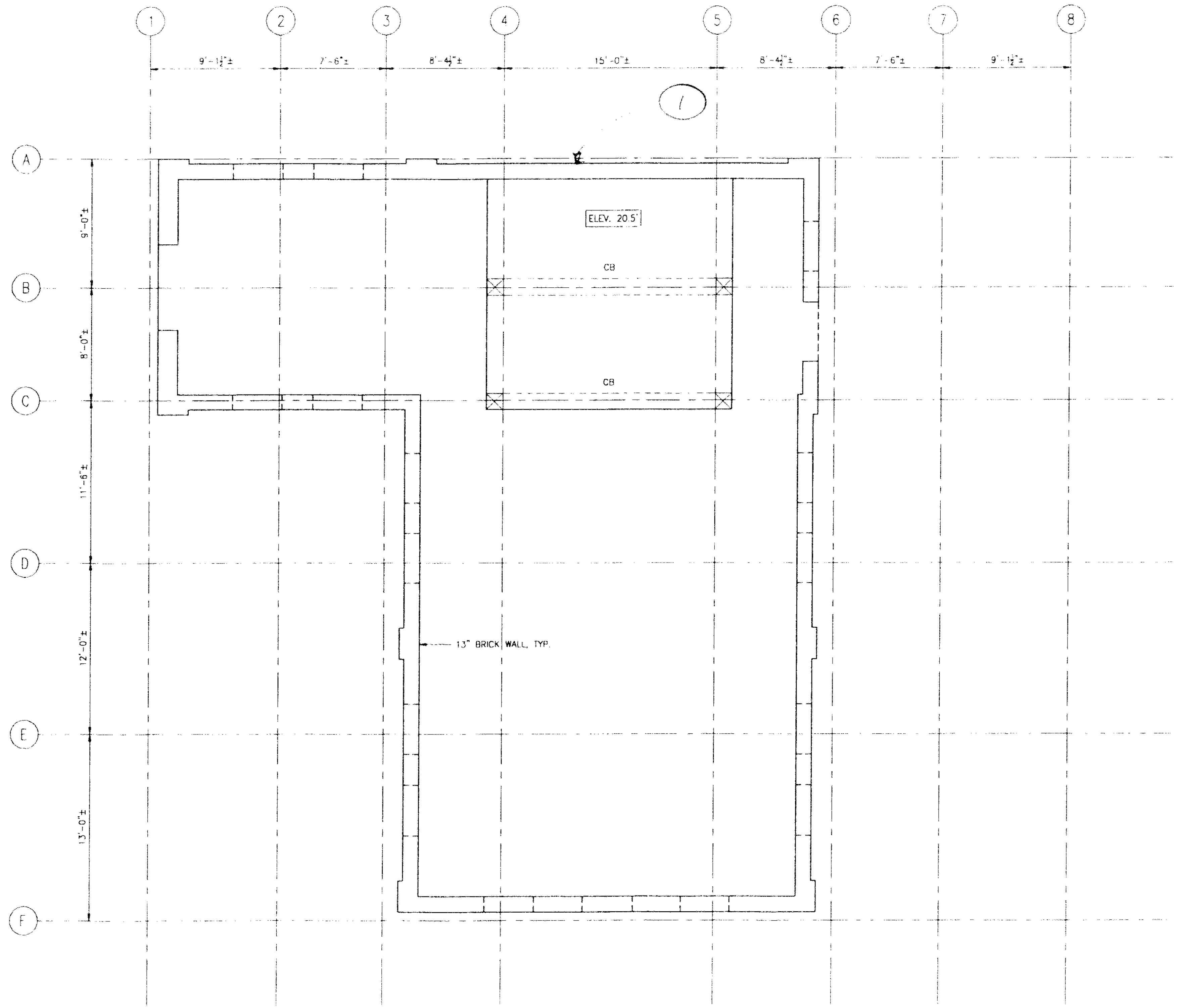
LEGEND

CB — INDICATES CONCRETE BEAM BELOW

INDICATES BRICK WALL ABOVE

KEY NOTES

1. ADD OUT-OF-PLANE WALL ANCHORS (4)



OLD FILTER BUILDING
ELEVATION 67' - TANK GALLERY FLOOR
1/4"=1'-0"
EL667

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
TANK GALLERY SLAB FRAMING PLAN

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REV. | DATE | DESCRIPTION | SCH. | APPR'D

SHEET NUMBER
OFB5
OF x SHEETS
DRAWING NO.
207025

DRAWING 13

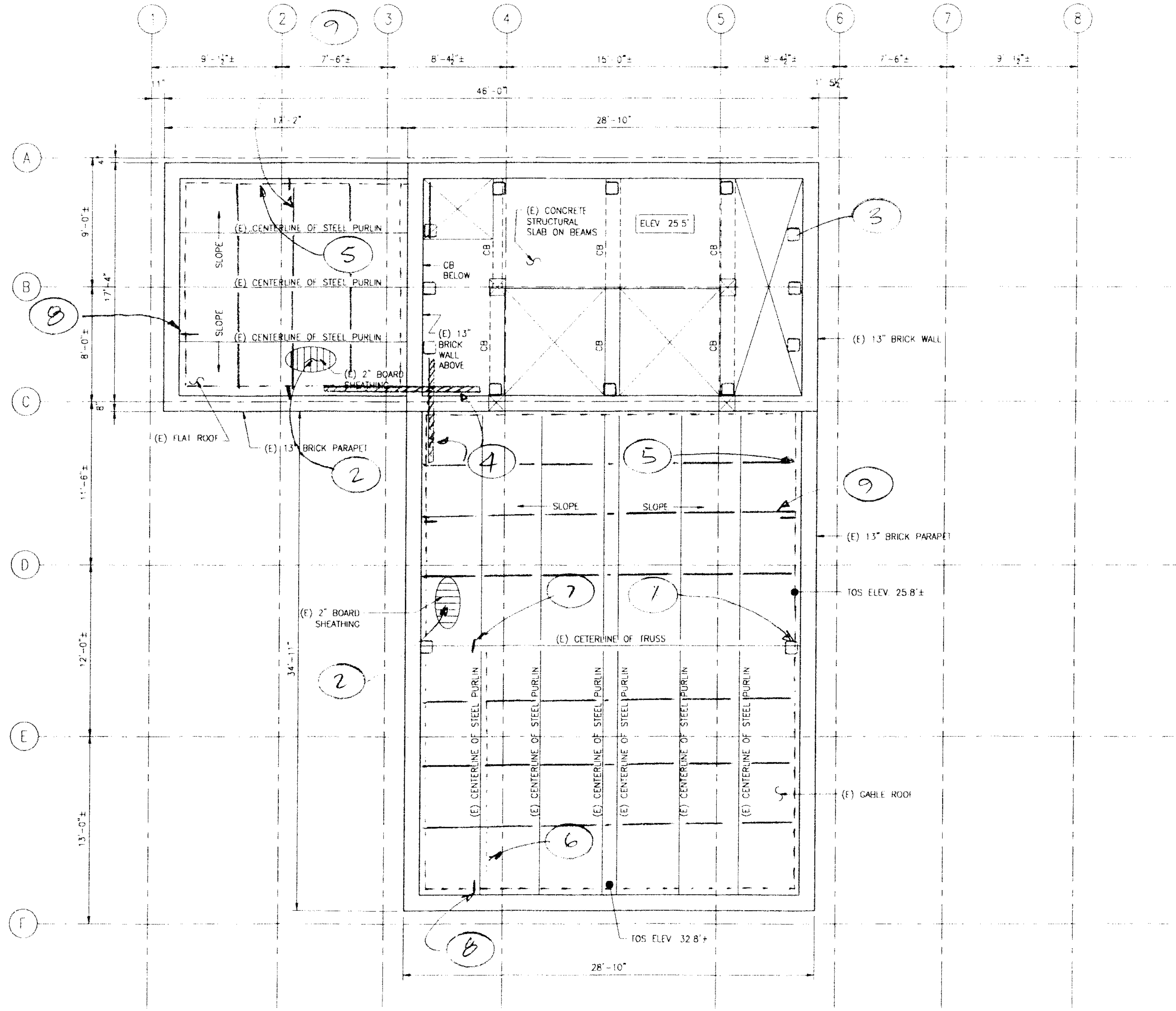
LEGEND

CB — INDICATES CONCRETE BEAM BELOW

INDICATES WALL ABOVE

KEY NOTES

1. ADD SUPPLEMENTAL GRAVITY FRAMING (2)
2. REMOVE ROOFING; ADD PANEL SHEATHING; REROOF (420 SF)
3. OUT-OF-PLANE WALL BRACING (12)
4. COLLECTOR UPGRADE (2)
5. ADD LEDGER (50 LF)
6. ADD NAILERS TO ALL PURLINS (12)
7. UPGRADE PURLIN CONNECTION (6)
8. ADD OUT-OF-PLANE ANCHORS (18)
9. ADD NEW CROSS CHORD TIES (9)



OLD FILTER BUILDING
ELEVATION 72 - SECOND FLOOR AND LOWER ROOF
1/4"=1'-0"
FL72

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
SECOND FLOOR FRAMING PLAN

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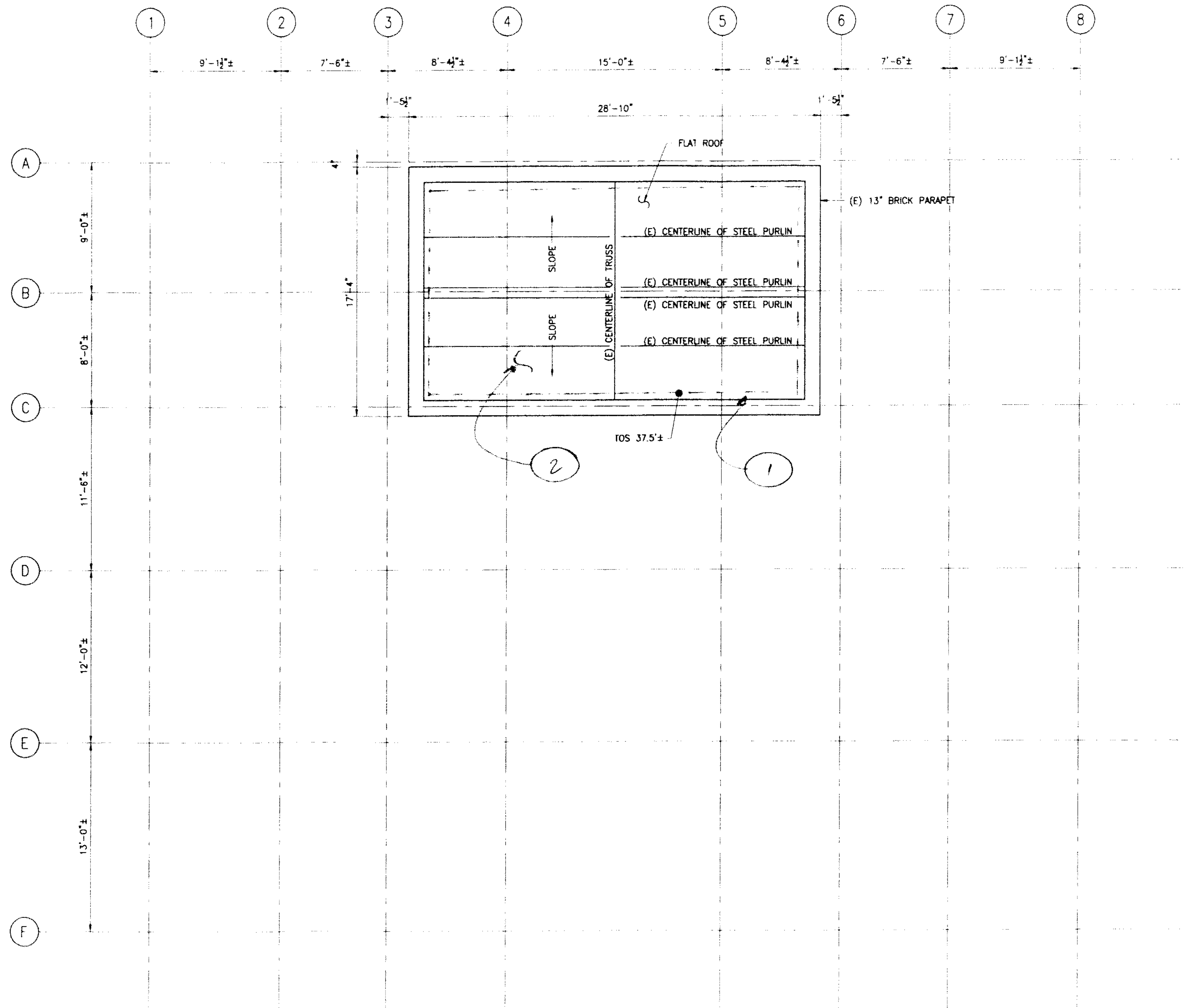
SCALE AS NOTED

SHEET NUMBER OFB6
OF x SHEETS
DRAWING NO. 207025

DRAWING 14

LEGEND

INDICATES PARAPET ABOVE



KEY NOTES

1. ADD LEDGER (85 LF)
2. REMOVE AND REPLACE ROOF AND FRAMING
ADD OUT-OF-PLANE ANCHORS (400 SF)

OLD FILTER BUILDING
CENTRAL CORE ROOF FRAMING PLAN
1/4"=1'-0"
EL83.8
NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
OLD FILTER BUILDING
CENTRAL CORE ROOF FRAMING PLAN

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SHEET NUMBER
OFB7
OF x SHEETS

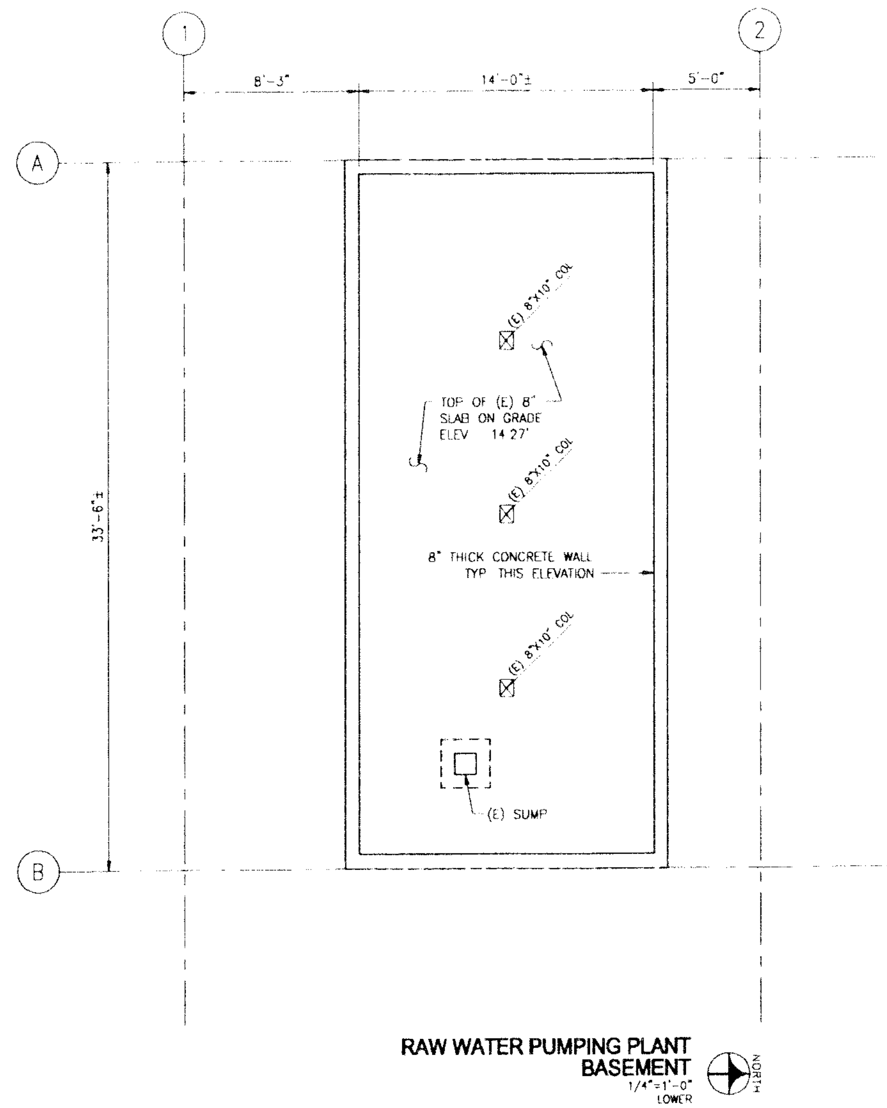
DRAWING NO.
207025

DRAWING 15

LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE



RAW WATER PUMPING PLANT BASEMENT
1/4"=1'-0"
LOWER

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
RAW WATER PUMPING PLANT
BASEMENT FOUNDATION PLAN

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SCALE:	AS NOTED

REV. | DATE | DESCRIPTION | APPR'D | DATE

SHEET NUMBER
RWPP1
OF x SHEETS
DRAWING NO.
207025

DRAWING 16

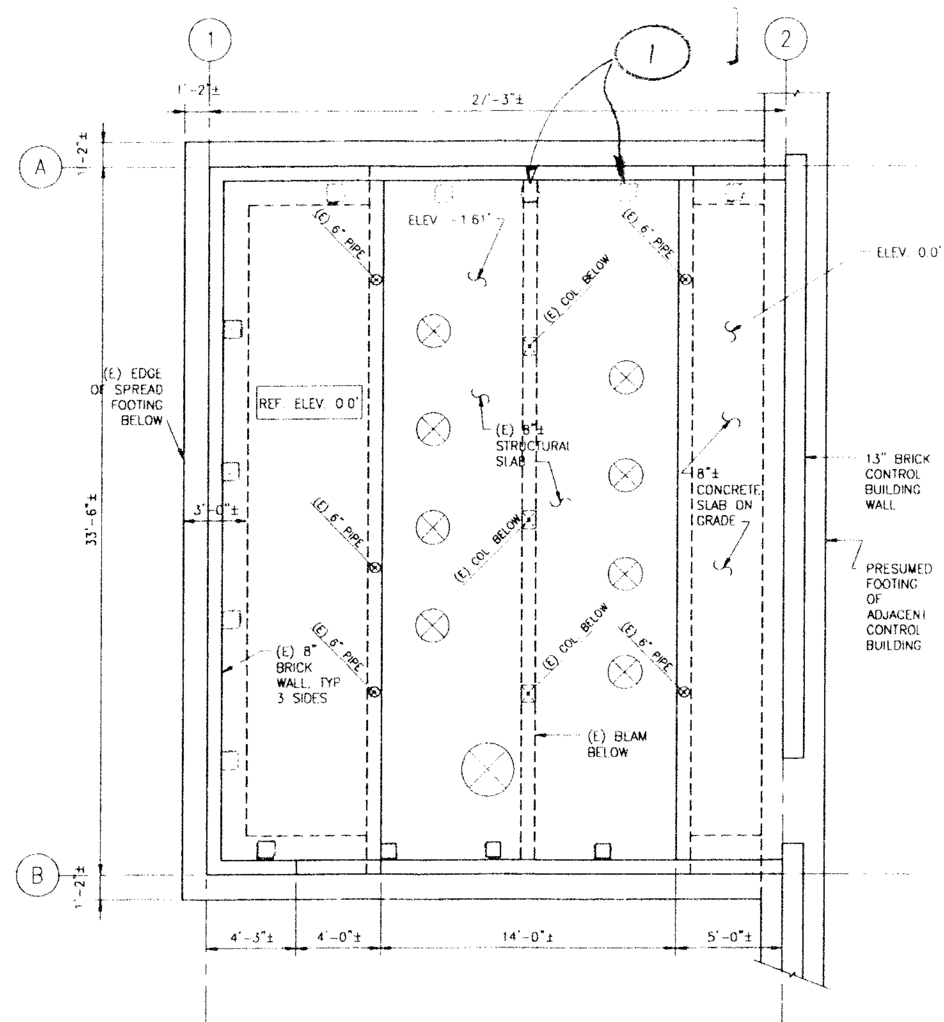
LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

KEY NOTES

1. OUT OF PLANE WALL BRACES (13)



RAW WATER PUMPING PLANT
FOUNDATION PLAN
1/4"=1'-0"
FOUNDATION

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
RAW WATER PUMPING PLANT
AT-GRADE FOUNDATION PLAN

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REV | DATE | DESCRIPTION | APP'D

SHEET NUMBER
RWPP2
OF x SHEETS
DRAWING NO
207025

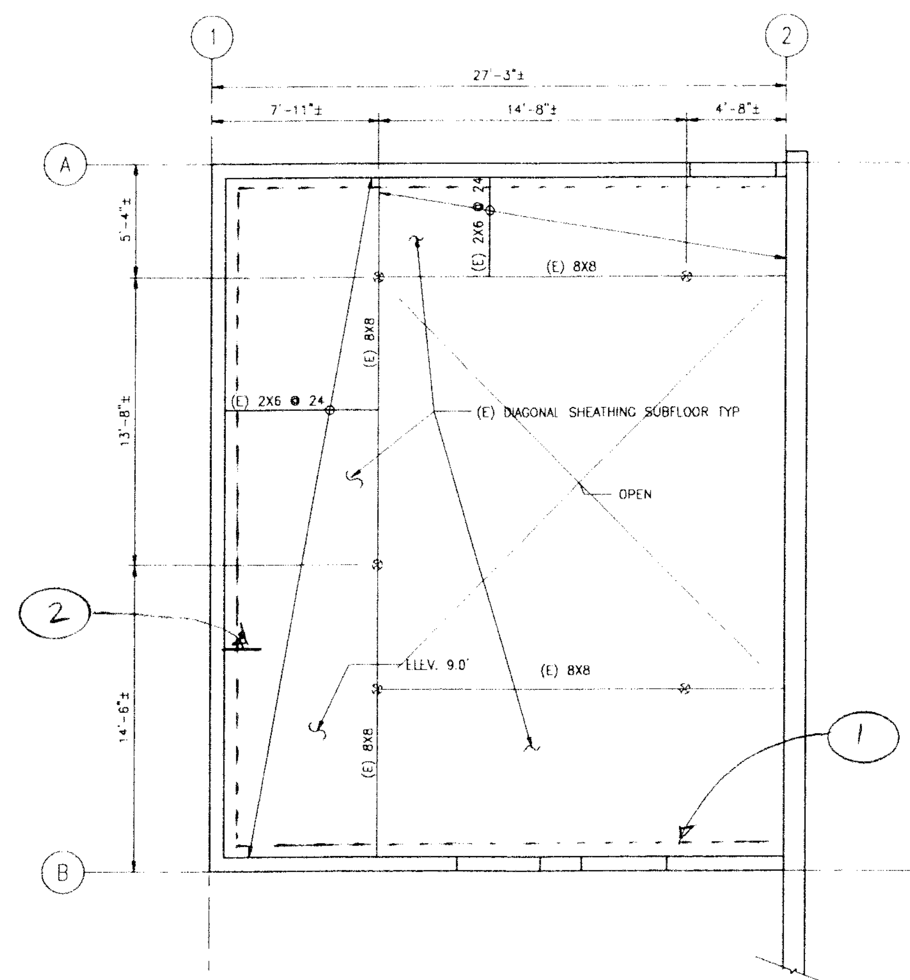
DRAWING 17

LEGEND

INDICATES WALL ABOVE

SHEET NOTES

1. MEZZANINE LEDGER UPGRADE (85 LF)
2. MEZZANINE OUT-OF-PLANE WALL ANCHORS (27)



RAW WATER PUMPING PLANT
MEZZANINE FRAMING PLAN
1/4"=1'-0"
MEZ

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
RAW WATER PUMPING PLANT
MEZZANINE FRAMING PLAN

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SHEET NUMBER
RWPP3
OF x SHEETS
DRAWING NO
207025

DRAWING 18

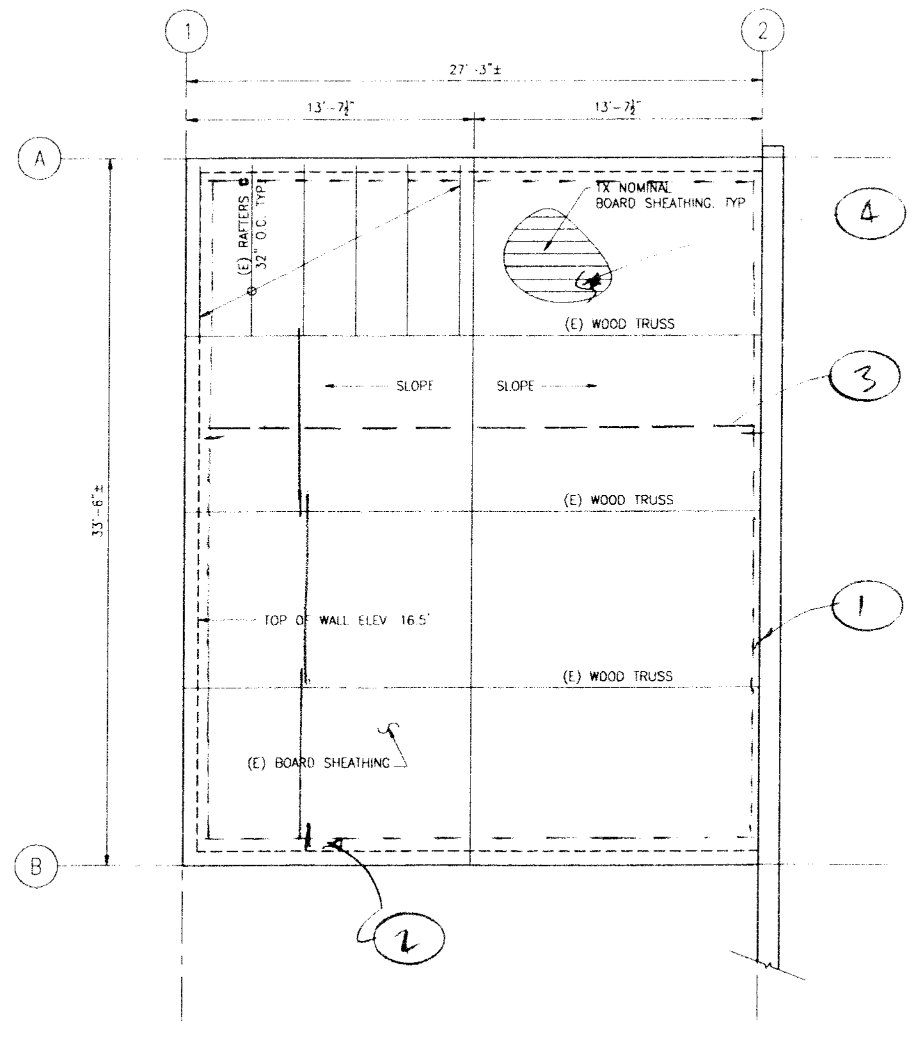
LEGEND

INDICATES WALL BELOW

INDICATES WALL ABOVE

KEY NOTES

1. LEDGER UPGRADE (120 LF)
2. OUT-OF-PLANE WALL ANCHOR AND PURLIN TIES (32)
3. OUT-OF-PLANE WALL ANCHOR, BLOCKING, AND STRAPPING (32)
4. ADD PANELIZED SHEATHING (890 SF)



RAW WATER PUMPING PLANT
ROOF FRAMING LAN
1/4"=1'-0"
OFB ROOF

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
RAW WATER PUMPING PLANT
ROOF FRAMING PLAN

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SHEET NUMBER
RWPP4
OF x SHEETS

DRAWING NO.
207025

DRAWING 19

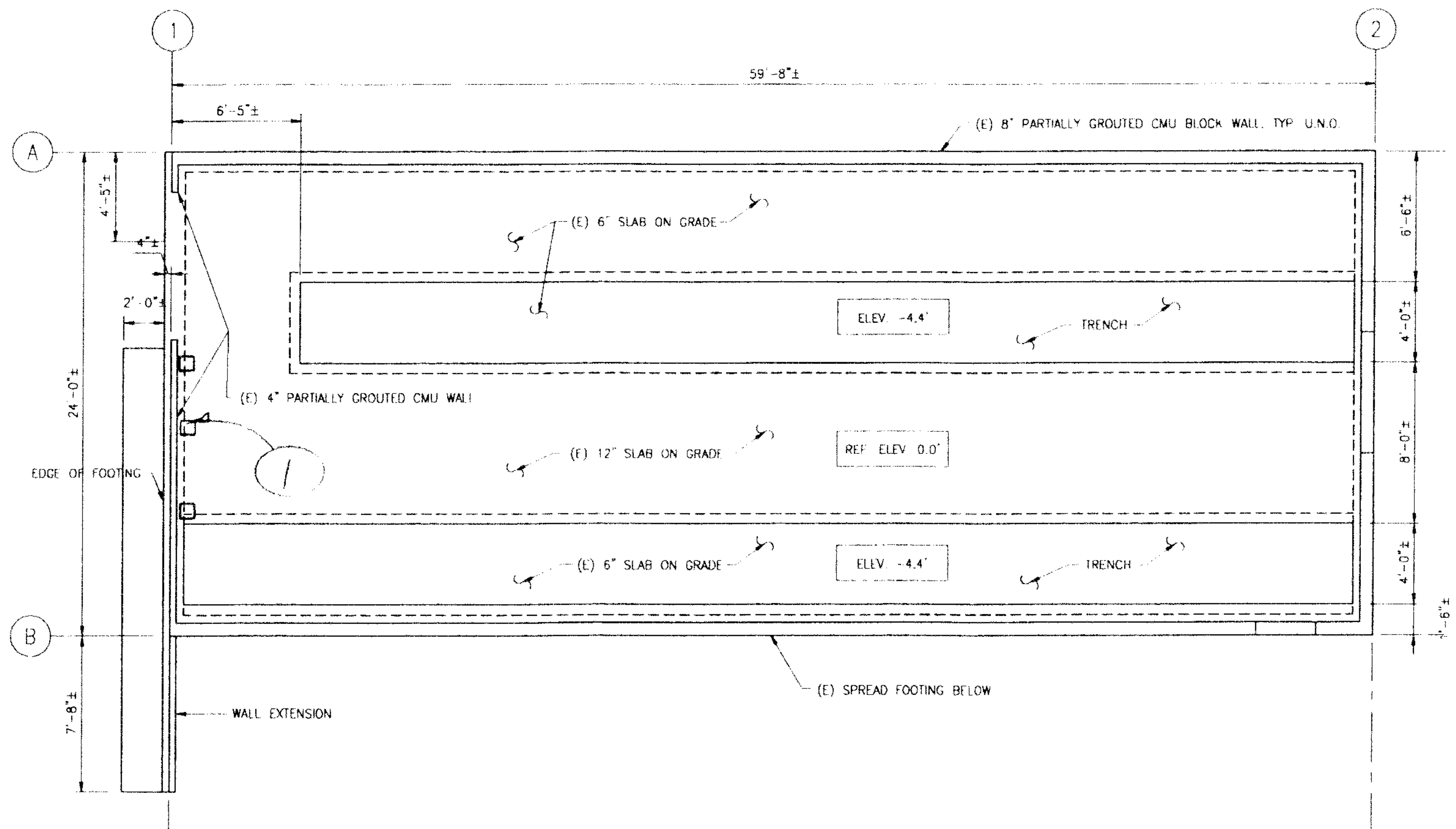
LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

KEY NOTES

1. OUT OF PLANE WALL BRACES (3)



HIGH PRESSURE PUMPING PLANT FOUNDATION PLAN
1/4"=1'-0"
FOUNDATION

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
HIGH PRESSURE PUMPING PLANT
FOUNDATION PLAN

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DATE 4/4/08
SCALE AS NOTED

SHEET NUMBER HPPP1
OF x SHEETS
DRAWING NO. 207025

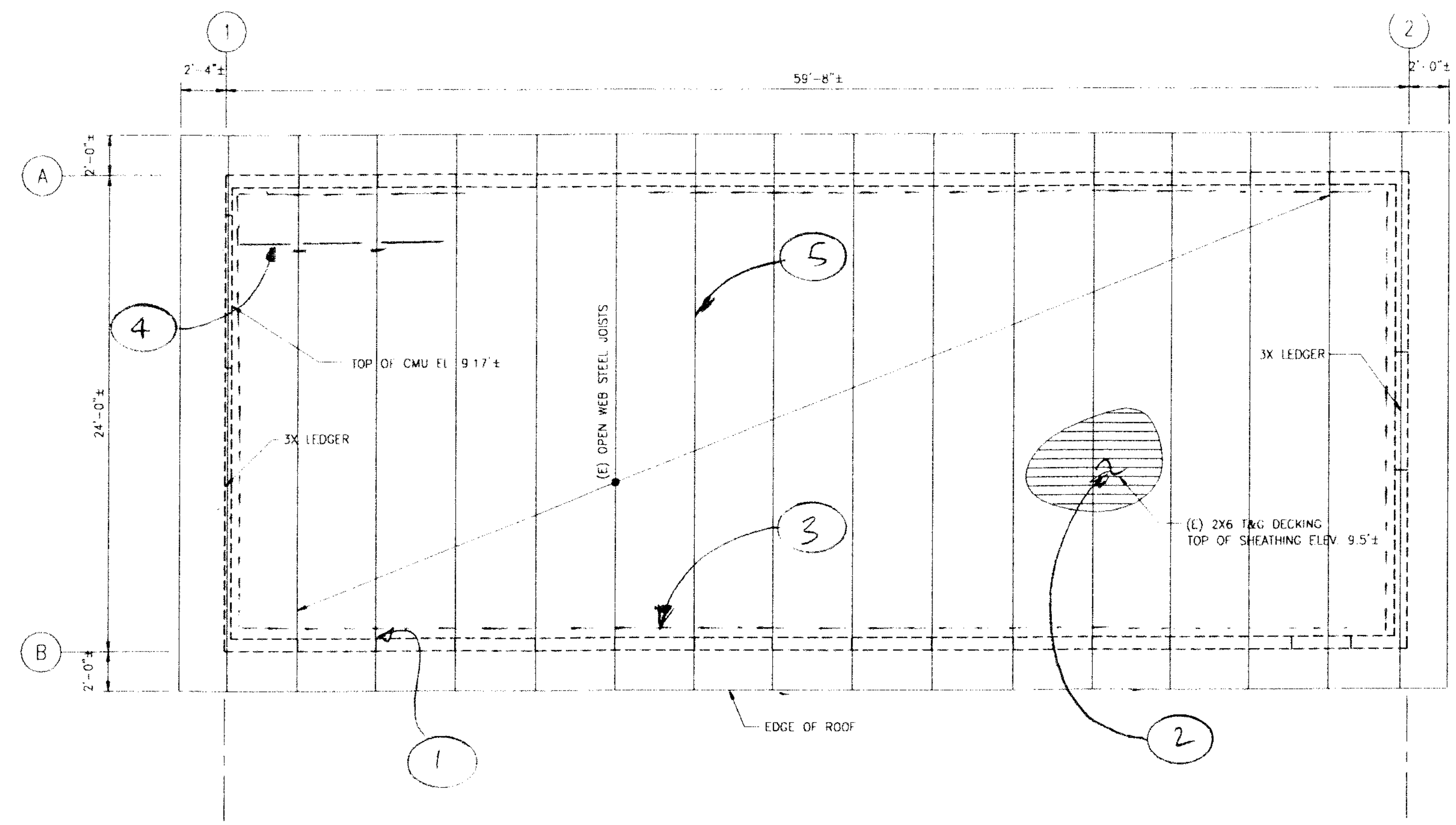
DRAWING 20

LEGEND

INDICATES WALL BELOW

KEY NOTES

1. OUT OF PLANE WALL ANCHORS (26)
2. REMOVE ROOFING; ADD PANEL SHEATHING; REROOF (1792 SF)
3. ADD LEDGER (168 LF)
4. SUBDIAPHRAGM TIES (30)
5. ADD SCREWS FROM DECKING TO JOISTS (336 LF)



HIGH PRESSURE PUMPING PLANT
ROOF FRAMING PLAN
1/4"=1'-0"
ROOF

NORTH

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CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
HIGH PRESSURE PUMPING PLANT
ROOF FRAMING PLAN

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
HPPP2
OF x SHEETS
DRAWING NO.
207025

DRAWING 21

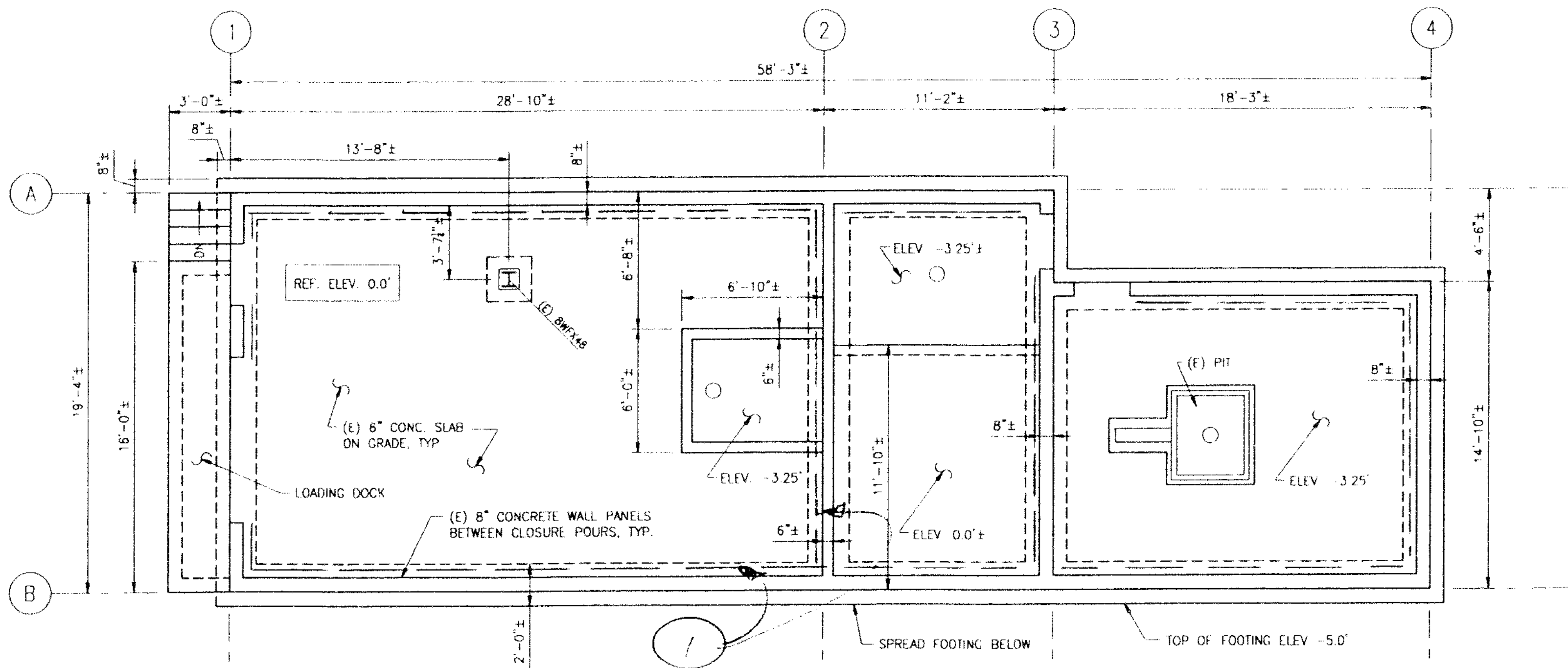
LEGEND

INDICATES CONCRETE FOUNDATION BELOW

INDICATES WALL ABOVE

KEY NOTES

1. ADD WALL/SLAB CONNECTION (194 LF)



CHEMICAL BUILDING FOUNDATION PLAN
1/4"=1'-0"
FOUNDATION

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
CHEMICAL BUILDING
FOUNDATION PLAN

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SCALE: AS NOTED

SHEET NUMBER
CB1
OF x SHEETS

DRAWING NO.
207025

DRAWING 22

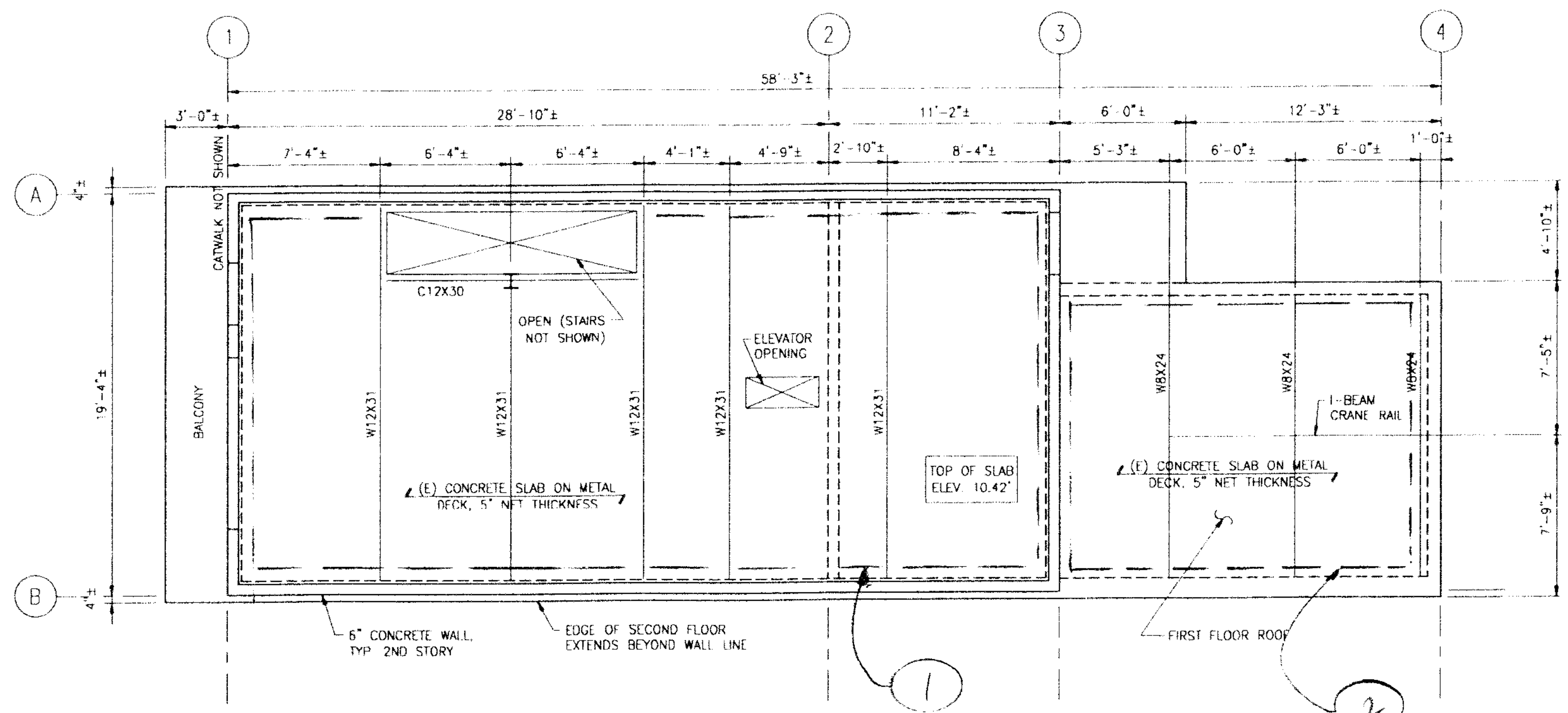
LEGEND

INDICATES WALL ABOVE

KEY NOTES

1. ADD SECOND STORY WALL/SECOND FLOOR CONNECTION; ADD SECOND STORY/ FIRST STORY WALL CONNECTION BELOW (120 LF EACH)

2. ADD FIRST STORY ROOF/ FIRST STORY WALL CONNECTION BELOW (63 LF)



CHEMICAL BUILDING
SECOND FLOOR FRAMING PLAN
1/4"=1'-0"
SECOND

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
CHEMICAL BUILDING
SECOND FLOOR FRAMING PLAN

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NO. | DATE | DESCRIPTION | APPR'D | SCH | DATE | DESCRIPTION

SHEET NUMBER CB2
OF x SHEETS
DRAWING NO 207025

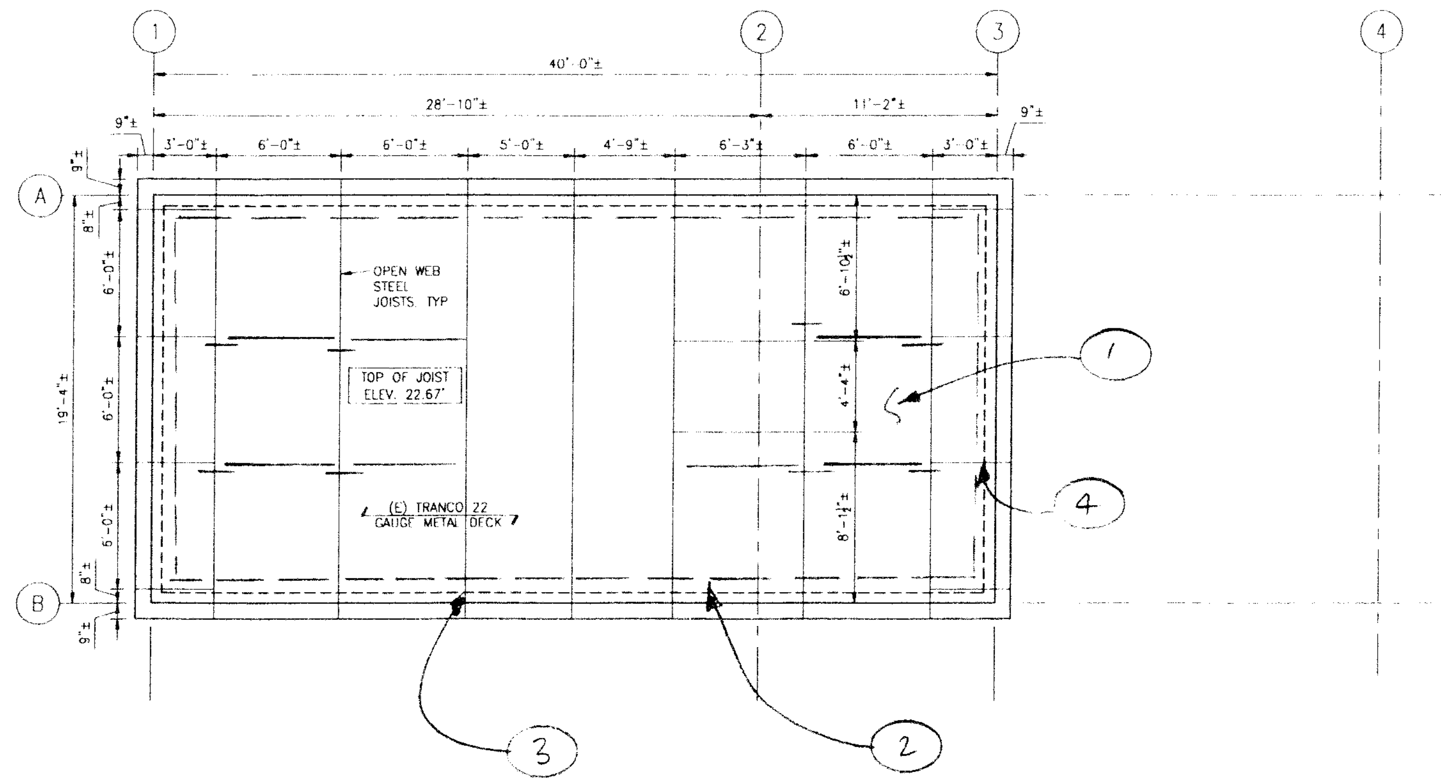
DRAWING 23

LEGEND

INDICATES WALL BELOW

KEY NOTES

1. UPGRADE METAL DECK CONNECTIONS (800 SF)
2. ADD WALL/DECK DIAPHRAGM CONNECTION (120 LF)
3. OUT-OF-PLANE WALL ANCHORS ON (E) TRUSSES (14)
4. OUT-OF-PLANE WALL ANCHORS AND NEW DRAG MEMBERS (12)



CHEMICAL BUILDING
ROOF FRAMING PLAN
1/4"=1'-0"
ROOF

NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY - VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
CHEMICAL BUILDING
ROOF FRAMING PLAN

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SHEET NUMBER
CB3
OF x SHEETS
DRAWING NO
207025

DRAWING 24

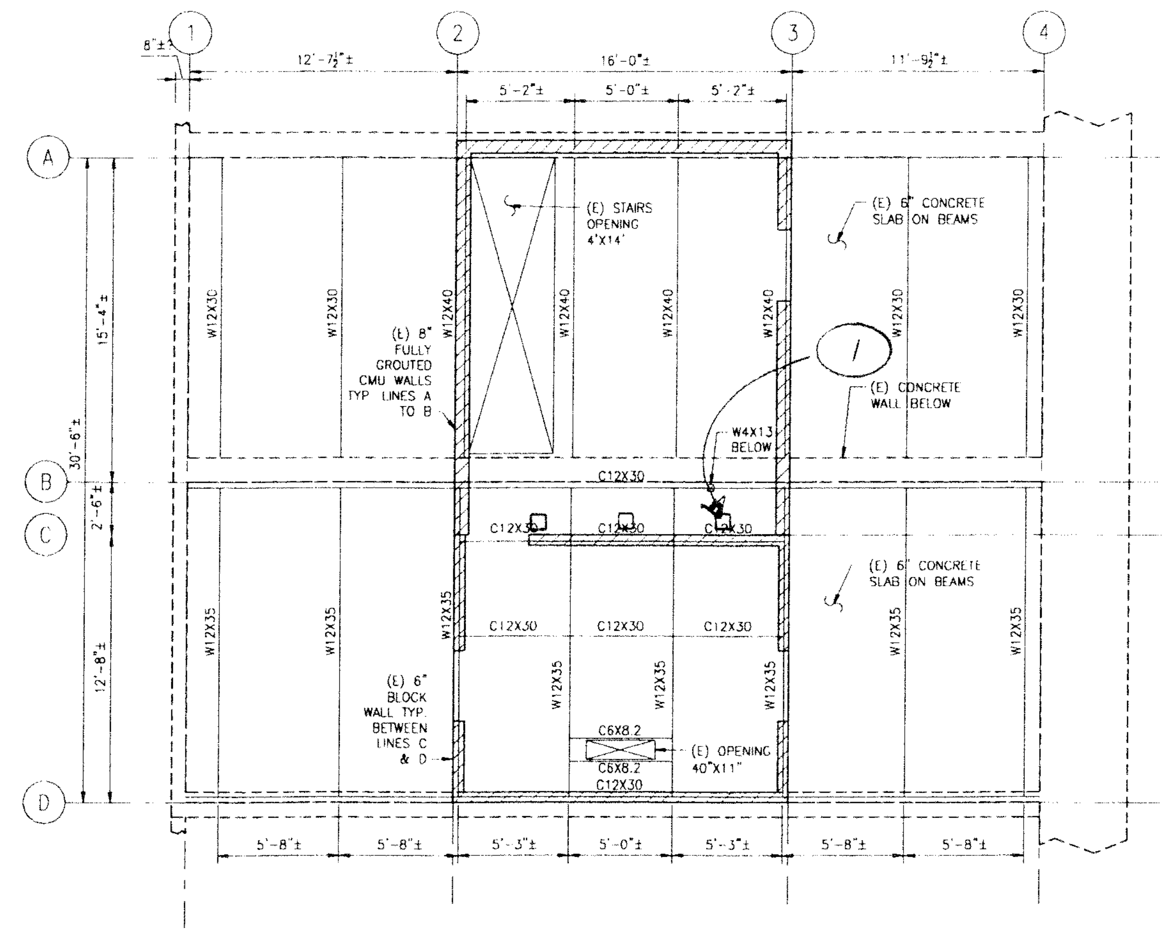
LEGEND

INDICATES CONCRETE WALL BELOW

INDICATES CMU WALL ABOVE

KEY NOTES

1. OUT OF PLANE WALL BRACING (3)



LARGE FILTER PLANT
SECOND FLOOR FRAMING LAN
1/4"=1'-0"
FOUNDATION
NORTH

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CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
LARGE FILTER BUILDING
SECOND FLOOR FRAMING PLAN

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

SHEET NUMBER
LFP1
OF x SHEETS
DRAWING NO.
207025

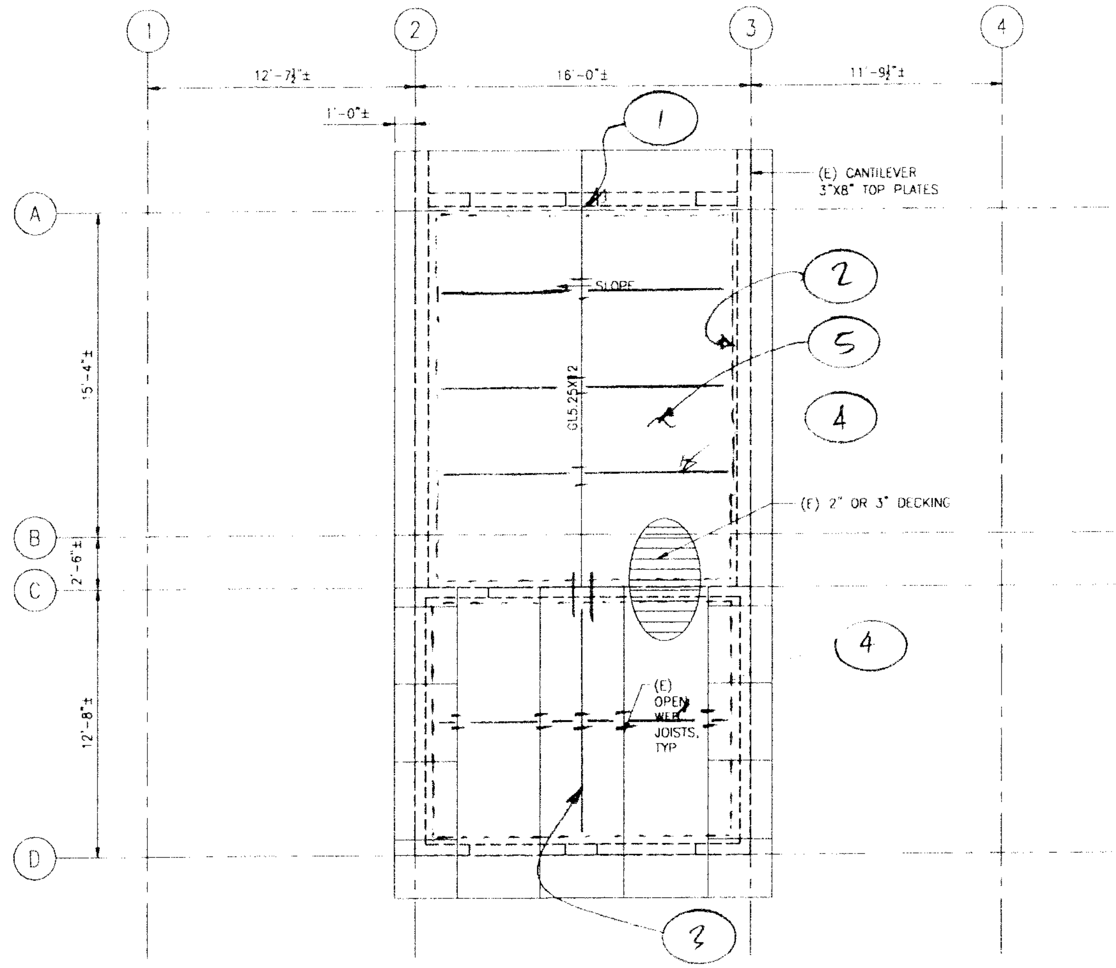
DRAWING 25

LEGEND

INDICATES WALL BELOW

KEY NOTES

1. NEW GLB ANCHORS (2)
2. LEDGER UPGRADE (108 LF)
3. CROSS CHORD TIE (6)
4. CROSS CHORD TIES (6)
5. REMOVE (E) ROOFING; ADD PANEL SHEATHING; REROOF (800 SF)



LARGE FILTER PLANT ROOF FRAMING LAN
1/4"=1'-0"
ROOF
NORTH

SEISMIC ASSESSMENT AND RETROFIT STRATEGY

NOT FOR CONSTRUCTION

CITY OF ALBANY – VINE STREET WTP
VOLUNTARY SEISMIC RETROFIT
LARGE FILTER BUILDING
ROOF FRAMING PLAN

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OF x SHEETS
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207025

DRAWING 26