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August 1, 2023

Adam Turner
Martha's Vineyard Commission
33 New York Avenue
Oak Bluffs, MA 02557

Ref: **Structural Assessment of Existing Residential Structure at 7 Arlington Avenue, Oak Bluffs, Massachusetts**

Overview:

On 5/31/2023, Souza Structural Engineering, LLC (herein referred to as SSE) conducted an inspection at the above-mentioned property. The purpose of the inspection was to gather information about the existing structure and its current condition. This information is used to assess the scope of structural repair work that SSE would recommend and what portions of the structure may be feasibly preserved or rehabilitated as part of a renovation of this structure. In his letter dated 7/21/22, Casey Decker, PE asserts that a renovation at this property would require extensive new floor, roof, and exterior wall framing. SSE agrees with that conclusion, though the observations and evaluation leading to that conclusion differs somewhat from Mr. Decker's assessment.

The format of this report is; 1) briefly summarize some of the observed structural conditions and provide recommendations regarding the scope of structural repairs and alterations that SSE would advise based on the observed conditions, 2) summarize the building code requirements for the proposed renovation to identify the required structural scope and determine what existing structural elements may be preserved in a renovation project for this structure, 3) summarize the findings. SK-1 and SK-2, attached, convey the existing structure along with notes documenting some of the observed conditions.

1) Existing Conditions:

Based on information provided in the Massachusetts Historical Commission Survey Form B for this property, the existing structure is understood to date to around 1917, when half of an existing 1875 structure was relocated to this property, renovated, and an addition (the current kitchen) was added to the west face of the original structure. It appears that at this time or some time before 1942, the footprint of the tower was increased to the south and west of the original tower. Also, it appears that the original structure maintained the 1st floor level below the tower as an exterior porch area with a lower floor level. Presumably a bearing wall extended from the current stair opening

across what is now the living room. SSE surmises that sometime after 1923 and before 1947, this portion of the porch was converted to interior space, building up the floor to match the interior level and removing the bearing wall separating the two spaces. Reportedly another small addition was added to the west face around 1950 (the current mudroom/laundry room). The entire structure is framed with 2x and 3x lumber in a balloon-framed construction style with large spacings between framing members. The foundation consists of a combination of brick piers and masonry walls with interior wood posts supported by brick footings. Some wood framing was not visible during the inspection, but most framing members were at least partly visible. Visible structural elements that were able to be observed during the inspection included roof framing (particularly at the overhangs), significant portions of the second-floor framing, most of the first-floor framing, and the above-grade foundation elements. As a result, SSE was able to accurately access the arrangement and condition of the structure.

Though much of the structure was found to be structurally sound, the structural elements supporting the tower structure have sustained significant damage and require repairs. SSE also recommends making structural alterations to change the current structural configuration supporting the tower structure by introducing new structural elements to adequately support the tower structure. The implications of these structural alterations, which will drastically modify the load paths, may necessitate justification of other existing structural elements such as the lateral load-carrying capacity of the existing wall framing. That in turn may necessitate reinforcing or replacing of additional structural elements. See SK-1 and SK-2, attached for drawings documenting the existing conditions.

a) Roof Framing

Much of the roof framing appeared to be in good condition and functioning satisfactorily. Exceptions included the porch roof rafters on two sides of the main house which were damaged or excessively sagging. On the south side of the structure, the rafter framing around the chimney was damaged and sagging (Figure 1 and Figure 2). Porch rafters below the dormer on the east side of the main house were also sagging excessively (Figure 3). The rafters below the second level dormer on the north side of the main house did not appear to be sagging excessively, however, given the added load imposed by the dormer, SSE would recommend examining the existing rafters below the dormer walls and reinforcing if necessary. The roof framing members over the master bedroom supporting the tower structure are also excessively sagging. See *e) Tower Structure* for documentation of that condition.

Repairs: Porch rafters at the south chimney and at the east dormer, roof framing over the master bedroom supporting the tower structure (see *e) Tower Structure*)
Alterations: Reinforcing or replacing the existing porch roof framing below the north dormer

Figure 1: Porch Ceiling Sagging Around South Chimney

Figure 2: Damaged Rafter Adjacent to South Chimney

Figure 3: Sagging Rafters Below East Dormer

b) *Floor Framing*

The floor framing was mostly visible except for the second-floor framing over the kitchen and the third-floor tower floor framing. The first-floor framing was observed to be generally in good condition and of adequate size and spacing. Some minor deterioration of the rim joist was noted below the kitchen entry door adjacent to the exterior stone landing. SSE would recommend replacing the deteriorated rim joist and sill plate portions as necessary to eliminate all rotted wood material. The floor framing at the northeast corner of the main house consisted of lower 2x6 joists spaced at 28" on-center with 3x4 sleeper joists at 2'-0" on-center shimmed and placed over the original floor deck (Figure 4 and 5). This condition results in misalignment of the joist framing layers. Significant deterioration of one joist was observed adjacent to the east foundation wall (Figure 6) resulting in a noticeable step in the floor at this location (Figure 7). Based on these observations, SSE would recommend replacing the first-floor framing in this area to replace the deteriorated framing and eliminate the joist misalignment. These joists represent the longest joist spans for this first-floor and should be replaced with new joists of adequate size and spacing. The other observed first-floor framing members appear to be structurally sound and provided that additional load is not added to them and/or their existing load-carrying capacity is not reduced, SSE believes that they are suitable for continued use.

The second-floor framing members are generally 3x members which span much longer distances than the first-floor framing members. The longest

second-floor joist span is approximately 14'-6" and occurs over the living room (Figure 8). SSE's evaluation of these joists differs significantly from the evaluation presented by Mr. Decker in his 7/21/22 letter. Mr. Decker presented these joists as 3x6s at 24" spacing spanning 14'-6". SSE believes these joists are 3x5s (2¾"x4¾") at 18" spacing, spanning 14'-6". Mr. Decker proposed a loading condition of 15 lb/ft² dead load and 40 lb/ft² live load, SSE proposes a loading condition of 10 lb/ft² dead load and 30 lb/ft² live load considering that the area above is used as a bedroom. Also, it appears that Mr. Decker assumes a lumber grade of No1/No2 SPF which has an allowable bending stress of 875 psi (determined by back-calculating from Mr Deckers overstress percentages). SSE found the existing lumber to be significantly defect-free and recommends assuming a grade of Select Structural SPF which has an allowable bending stress of 1,250 psi. SSE's analysis suggests that these joists are slightly overstressed in bending by 1.8% and exceed the deflection limits for floor framing members by 157%. In contrast the joists over the dining room were found to be within the allowable stress limits but exceed the deflection criteria by 66%. Although this analysis suggests that these joists could be undersized, SSE does not recommend reinforcing or replacing these joists unless they exhibit signs of failure, such as cracks or excessive deflection, or if they are to be subject to an increase in design load. SSE would recommend leaving any existing 2nd floor framing members in good condition, such as the joists over the dining room and office, in their current condition. One other exception to this recommendation would be if a new ceiling was to be installed on the underside of the existing floor framing. In locations where a ceiling is to be added below the floor joists, SSE would recommend reinforcing of those members, as a ceiling would be easily damaged by excess deflections. A significant portion of the second-floor framing over the living room was sagging excessively. This is largely due to the additional load imposed on those framing members by the tower structure above. Those elements are addressed in section *e) Tower Structure*.

Repairs: Replace the 1st floor rim joist and sill below the kitchen entry door, replace the 1st floor framing @ northeast corner where existing sleeper joists are present, Replace the 2nd floor framing below the tower footprint (see *e) Tower Structure*)
Alterations: Reinforce or replace 2nd floor framing if new ceilings are to be installed on the underside of the floor joists

Figure 4: 3x4 Shims over 2x6 Floor Joists @ NE Corner of Main Structure

Figure 5: Floor Shimming @ NE Corner of Main Structure

Figure 6: Deteriorated Floor Framing and Temporary Support Post

Figure 7: Step in First-Floor @ NE Corner of Main Structure

Figure 8: Second-Floor Framing Members over the Living Room

c) *Wall Framing*

The wall framing generally consists of 3x and 4x framing elements at corners and at window and door jambs with 1x plank sheathing between floor levels (Figure 9). Much of the wall framing appears to be in good condition, though some wall framing in the area below the tower structure showed signs of bowing and displacement (see *e) Tower Structure*). SSE believes that most of the existing wall framing elements are structurally sound and suitable for continued use provided they are not subject to an increase in load or a decrease in load-carrying capacity. Following SSE's recommendations provided in *e) Tower Structure*, may result in an increase in lateral load on some wall framing elements and therefore require justifying the lateral load-carrying capacity of those wall framing elements. SSE believes that the existing wall framing would need to be significantly modified or even replaced to comply with the braced wall requirements of the International Residential Code (IRC).

Repairs: Replace damaged or displaced wall framing elements in the area below the tower structure (see *e) Tower Structure*)
Alterations: Reinforce or replace wall framing elements subject to an increase in lateral design load

Figure 9: Northeast Corner Wall Framing

d) *Foundation Support*

The foundation elements generally appeared to be in good condition. No cracks or separation with adjacent elements were observed. SSE found some undermined brick supports (Figure 10) in the crawlspace below the main house as well as some dislodged support posts (Figure 11). In addition to these isolated conditions, SSE suspects that many of the existing foundation elements do not extend into the ground to frost depth. Although SSE did not excavate the foundation to verify its depth, it appears that in some locations, the perimeter masonry wall was not backfilled after construction (Figure 12). Based on these observations, SSE would recommend providing a new foundation for this structure.

Repairs: Repair or replace dislodged support posts and undermined brick foundation elements
Alterations: Provide a new foundation with proper frost protection

Figure 10: Undermined Brick Pier

Figure 11: Dislodged Support Column

Figure 12: Non-Backfilled Perimeter Masonry Wall

e) Tower Structure

The existing tower structure is not well supported by the existing structural elements and has resulted in significant damage to the roof framing, second-floor framing, and wall framing elements currently supporting it. As will be discussed in the *2) Building Code Application* section following, SSE believes that the building code would permit restoring this structure to its predamage condition, however, SSE would not recommend that primarily because the structural elements and configuration necessary to support this tower structure are simply not currently present.

SSE believes that the original tower structure had a smaller footprint and was better supported. It appears that the west and south walls – possibly the north wall as well – were supported down to the foundation with wall framing elements. The tower appears to have been expanded to the west – where it is currently supported by the header spanning the stair opening – and to the south – where it is currently supported by the roof framing over the master bedroom. As a result, significant deformations are currently present below both those walls. A deflection of approximately 2" was observed in the roof framing along the master bedroom closet wall (Figure 13). The load path for the tower structure continues down through the various wall and roof framing elements present between the master bedroom and master bathroom, all of which are offset from the location of the south tower wall above. The load is then carried by the second-floor framing members below which span over living room. The lowest elevation of the 2nd floor framing in this area

suggests that settlement on the order of 4" has occurred to date. As noted at the beginning of this section (*2) Existing Conditions*), SSE believes that a bearing wall was removed from what is now the living room at the northeast corner of the main house. The removal of this wall may have taken place anytime after 1923 up to the present day. SSE believes that the bearing wall was located where the large joist is currently visible over the living room (Figure 14). The removal of wall support for the tower coupled with the increased size of the tower has resulted in a substantial structural deficiency that cannot be easily remedied by reinforcing or even adding structural members. The settlement of this portion of the structure due to the tower appears to have resulted in bowing of the wall framing elements on the east wall of the house as well as bowing out of the porch support posts on the east end of the structure (Figure 15). Repairing or replacing these damaged elements is recommended. However, SSE believes that to adequately support this tower structure, a substantial change in the structural configuration is required at the second-floor roof, second-floor framing, and at the foundation levels. This would result in a substantial modification to the existing structure of the main house as well as effect the appearance and usage of the spaces. Furthermore, introducing a substantial change to the framing configuration in this area may necessitate justifying the lateral load-resisting elements for this portion of the structure and may prohibit preserving the existing wall framing in its current condition. The owner's design team would be responsible for designing and recommending a structural configuration to support the tower structure. The structural remedy that they propose would dictate the code requirements that need to be met for the surrounding structural elements directly effected by that work. SSE is not able to accurately predict the code implications of an unknown structural solution to this condition.

The deficiency of this existing structure with respect to supporting the tower structure is the primary reason that SSE would not recommend pursuing a straightforward restoration of this building by simply restoring the structure to its predamage condition. It is SSE's opinion that this condition should be addressed and that addressing it would necessitate significant modification of the gravity and lateral load carrying elements of the main portion of this structure.

Repairs: Repair or replace second-floor roof framing elements below the existing tower structure, replace existing sagging second-floor framing elements below the tower structure, repair or replace bowed wall and post framing elements in the vicinity of the tower structure
Alterations: Provide new gravity and lateral framing elements to support the tower structure including foundation elements

Figure 13: Second-Floor Roof Sagging along the Master Bedroom Closet Wall

Figure 14: Second-Floor Framing Below Tower Structure

Figure 15: Bowed Framing Along East Side of Existing Structure

2) Building Code Application:

It is SSE's understanding that the building code generally permits existing structures and their individual structural elements – which have not failed – to remain in use unaltered as long as the structure remains legally occupied. Furthermore, modifications to a structure are permitted to be justified on the basis that the modifications do not increase the load (gravity or lateral) on a structural element and the modifications do not decrease the load-carrying capacity of any structural element. Modifications that violate either of these principles, require that any structural elements subject to an increase in load and/or a decrease in load-carrying capacity be justified by analysis or otherwise modified as needed to meet the requirements of the International Building Code (IBC) for new structures. With this understanding, SSE first seeks to identify any existing conditions which would be considered 'failure' and which therefore require repairs. This is work that is required by the building code regardless of any other desired alterations or structural modifications. SSE considers failures to include structural members which have sustained substantial inelastic deformations. In addition to identifying the repairs, SSE also seeks to identify structural alterations that would be recommended to improve the performance of certain structural elements. The alterations identified are more elective in nature and may be omitted either by tailoring the renovation work to avoid the need for the alteration or at the discretion of the design team and client.

The International Existing Building Code (IEBC) – permits the legal occupancy of any building to continue without change when new codes are adopted by any municipality (IEBC 101.4.2). This shields existing structures from the need to reevaluate the structure whenever changes are adopted into the governing building code. When

repairs are required (as recommended herein), or changes are being made to the structure, the IEBC provides guidance for how that work is to be conducted. When dealing with an existing structure, the work is classified as; *repairs*, *alterations*, *changes of occupancy*, *additions*, or *relocation* of an existing building. In this instance, at the very least, *repairs* are required for existing damage (which is documented herein), and the owner is proposing both *alterations* and *additions* to the structure. SSE assumes that the structure is not to undergo a *change of occupancy* or *relocation*. The IEBC outlines three methods of compliance when making these *repairs*, *alterations*, *changes of occupancy*, *additions*, or *relocating* an existing structure. They are the; *Prescriptive*, *Work Area*, and *Performance* compliance methods. For this evaluation, SSE follows the *Prescriptive* compliance method (Chapter 4).

a) *Repairs:*

The code requires that "dangerous conditions shall be eliminated" (IEBC 401.3). The definition of "dangerous" in this case is having some level of collapse or loss of ground support or there exists a significant risk of collapse. Where damage has occurred, the requirement for *repairs* depends on whether the damage meets the definition of *substantial structural damage*. *Substantial structural damage* applies to:

1) damages to the vertical elements of the lateral force-resisting system (SSE interprets this to be primarily damages to the exterior walls and foundations) wherein the lateral load-carrying capacity of any story in any horizontal direction has been reduced by more than 1/3 from its predamage condition and/or

2) the capacity of any vertical component, or group of components, carrying gravity load (roof framing, wall framing, columns, and foundation walls) that supports more than 30% of the total area of the structure's floor(s) and roof(s) and has been reduced by more than 20% from its predamage condition…

In this case, SSE contends that neither criteria is met. With regard to the first criteria; although some foundation repairs are warranted, the observed conditions have not reduced the lateral load carrying capacity of the foundation by more than 1/3. With regard to the second criteria; the totality of the damaged roof framing, wall framing and support columns do not account for more than 30% of the total area of the structure's floors and roofs.

The advantage when repairs amount to less than *substantial structural damage* is that the repairs are then permitted to restore the structural elements to their predamage condition (IEBC 404.4), while ensuring that new structural members be required to comply with the code requirements for new structures. When *substantial structural damage* is found to have occurred per criteria 1, the IEBC calls for an evaluation of the structure with regard to lateral (wind) loading (IEBC 404.2.1) and if that evaluation determines that the predamage building does not comply with the current lateral load requirements for new buildings, then rehabilitation and repairs are called for, but even then the wind loading considered for the repairs is permitted to be the wind loads required by the building code in effect at the time of original

construction, so long as the damages were not caused by wind (IEBC 404.2.3). In this instance all the damages observed appear to be caused by gravity loads (dead, live, and snow). When *substantial structural damage* is found to have occurred per criteria 2, the damaged structural members are required to be rehabilitated in accordance with the applicable gravity loads of the IBC including snow loads if the damage was caused by snow. Furthermore, any existing elements supporting any of the rehabilitated components must also be rehabilitated as necessary to comply with the applicable gravity loads of the IBC (IEBC 404.3).
In this case, SSE does not believe that damage observed for this structure meet the definition of *substantial structural damage* – particularly with its emphasis on "vertical" components – and therefore within the requirements of the code would be permitted to be restored to its predamage condition. However, for this structure, SSE would not recommend restoring this structure to the predamage condition due to the fact that the current structural configuration supporting the tower structure is not structurally sound and significant structural alterations would be recommended to support the tower in its current form and eliminate the structural instability presently observed.

b) Alterations:

Alterations refer to work done other than *repairs* and are more elective in nature. Any new structural elements introduced as part of an alteration must meet the current building code requirements for new structures (IEBC 403.1). Additionally, any existing structural elements which see a gravity load increase of more than 5% are also required to show compliance with the current building code requirements for new structures (IEBC 403.3). With respect to the lateral load resisting system for a structure, so long as the alteration does not increase the design lateral load or decrease the capacity of an existing lateral load-carrying structural element, the lateral framing of the existing structure does not need to be shown to comply with the lateral load requirements of the building code for new structures (IEBC 403.4). In order to not increase the design lateral load on the wall framing or decrease the lateral load-carrying capacity of the existing wall framing, any renovation work would need to avoid increasing the profile of the structure (eg including enlarging the tower) and would also need to avoid modifying the openings in the perimeter walls. In SSE's judgement, the proposed renovation – as conveyed in the 3/6/23 Sullivan Associates elevation drawings – is not compatible with keeping the existing wall framing of the main house. To make the type and level of changes to the structure being proposed, SSE believes the existing structure would need to be shown to comply with the lateral load requirements of the building code for new structures and additional work would likely be required such as rebuilding the walls to comply with the IRC braced wall requirements, adding shearwalls, and/or adding moment frames.

c) *Additions:*

Additions should be configured to be structurally independent of the existing structure to avoid imposing additional lateral load on the existing structure (IEBC 402.4). The renovation proposed in the 3/6/23 Sullivan Associates elevation drawings includes a significant *addition* to replace the existing western portion of the structure. It does not appear that this *addition* can be made structurally independent from the existing structure, and therefore the addition would impose additional lateral loads on the existing lateral load-carrying structural elements. In that case the lateral load carrying elements that are subject to an increased design lateral load (in this case SSE believes that all lateral load resisting walls of the main house would be affected) would be required to comply with the lateral load requirements of the building code for new structures.

d) *Flood Hazard Areas:*

Regarding flood hazard areas, the building code does require for projects undergoing *substantial improvement* to comply with the flood provisions of the code. The threshold used to determine what constitutes *substantial improvement* is 50% of market value of the structure. The compliance required is limited to the flood design requirements for repairs (IEBC 404.5), alterations (IEBC 403.2), and additions (IEBC 402.2). In this case, SSE does not believe that this structure is currently located in a designated flood hazard area.

e) *Historic Buildings:*

The building code affords special consideration for existing structures which are *historic buildings*. *Historic buildings* are permitted to consider the code required improvements to not be mandatory in comparison to maintaining the existing condition (IEBC 408.1). SSE is not aware if this structure meets the definition of a *historic building* in accordance with the code. If designated as historic under an applicable state or local law, then this code exception could be applied as a means of limiting the modifications required for this structure.

3) Summary:

- SSE is recommending both *repairs* and *alterations* to the existing structure.
- The *repairs* are required to repair damages and eliminate unsafe conditions and include: 1) porch rafters at the south chimney and east dormer 2) sagging roof framing members below the tower structure 3) deteriorated floor framing @ kitchen entry door 4) 1st floor framing at recessed floor section in the northeast corner 5) 2nd floor framing with excessive deflections below the tower structure 6) displaced and bowed wall and post support elements below

the tower structure and 7) dislodged and undermined interior post supports below the main house.

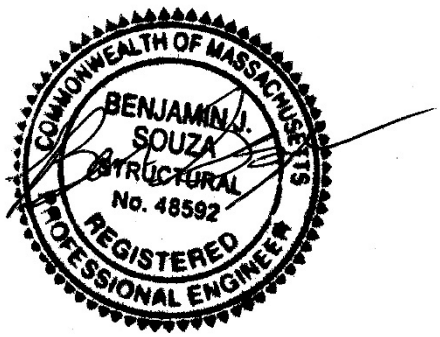
- The *alterations* are more elective in nature. In this case SSE is making recommendations for *alterations* to 1) reinforce the structural elements supporting the north dormer 2) reinforce the second-floor framing elements where ceilings are to be introduced 3) modify or replace wall framing where an increase in lateral load or decrease in lateral load-carrying capacity is expected 4) provide a new foundation structure that affords frost protection and 5) provide a new structural framing configuration and elements to support the tower structure including at the foundation level.
- Addressing the structural deficiency associated with the support of the tower will likely require a new structural configuration below that tower structure. That new structural configuration will dictate code requirements for the surrounding structural elements directly effected by this new work and may not permit preservation of the existing wall framing in this area.

Regarding the ultimate question that the commission seeks to answer: "whether the structure may feasibly be preserved, renovated, or rehabilitated as an alternative to demo and new construction", SSE believes that if the owner were to pursue the code required minimum repairs to this structure, then it would be feasible to rehabilitate this structure and largely restore it to its predamage condition. However, as noted in the conclusion to section (2, a) above, SSE believes that restoring this structure to its predamage condition would retain the structural instabilities surrounding the stair tower and SSE would not recommend doing that. SSE would recommend that additional, more involved, alterations be made to the structure to better support the stair tower. Although SSE is not directing specifically how the alterations be done, they would address both lateral and gravity load considerations for the stair tower. It may be possible to undertake alterations that would provide new gravity and lateral load support to the stair tower, while not impacting the existing lateral framing of the structure, however this would most likely require the introduction of structural elements within the existing usable spaces at the master bedroom and living room and would significantly alter those spaces and reduce their usability. SSE believes that conducting the alterations to address the stair tower gravity and lateral load support while minimizing the impact on the existing usable space would likely result in making significant modifications to the plank walls around the stair and living room. In doing so, it would then require these lateral elements to be evaluated and ultimately brought into compliance with the building code for new structures. This would effectively require the lateral force resisting system of the existing main house to be redone in a way that complies with the requirements for new structures. In short, if the owner were to do the alterations that SSE would recommend for this structure – particularly with regards to the stair tower – it would be difficult to do so without also requiring major changes to the exterior walls (or 'shell') of the adjacent structure. In so doing, the portion of the existing structure that can be preserved is considerably reduced and the new construction required is considerably increased. If the owner wanted to preserve this structure and was willing to forego some recommended structural performance alterations to do so that could be done. If the owner wanted to undertake the recommended structural performance alterations while preserving as much

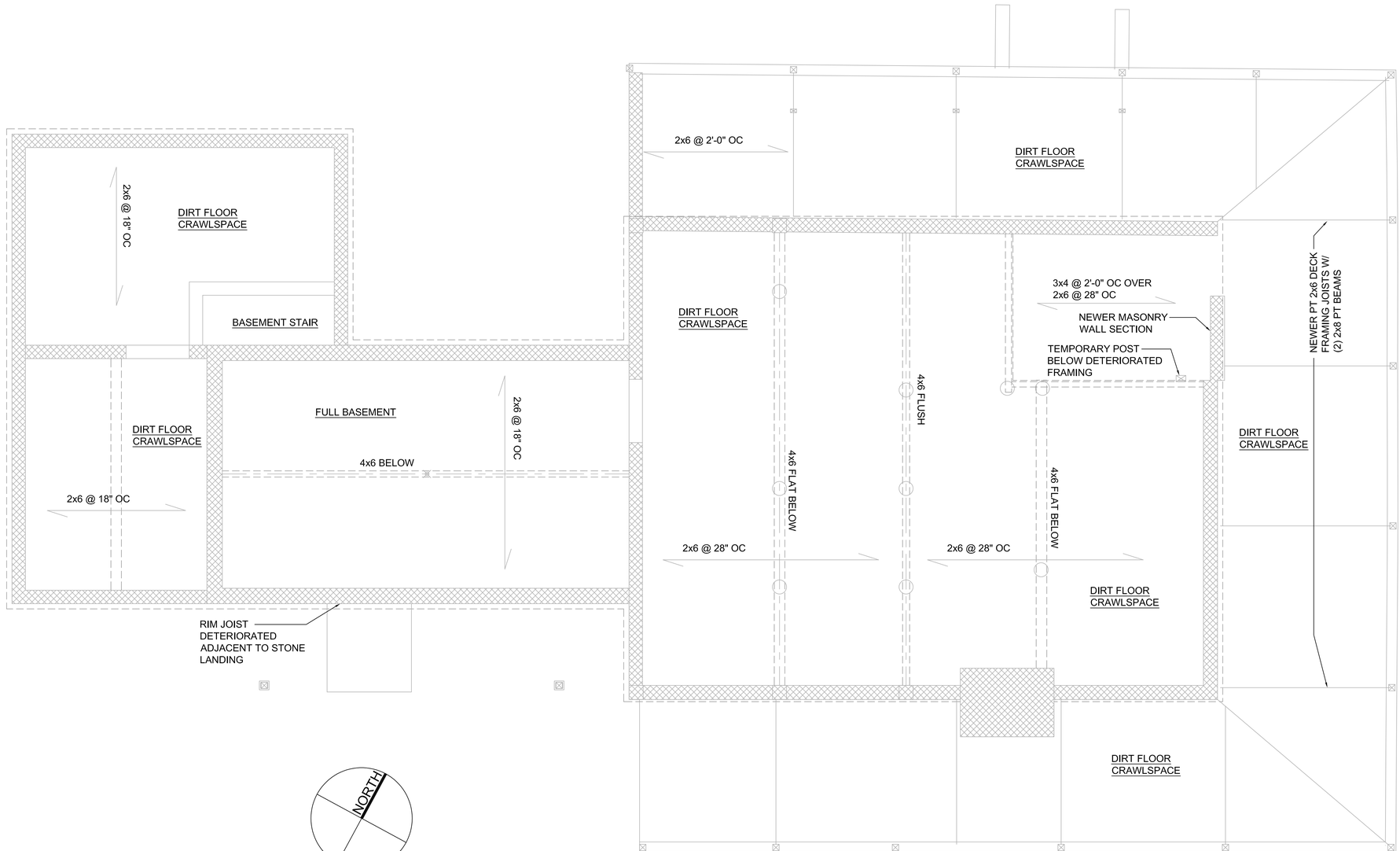
of the existing structure as possible, SSE believes that they would need to accept significant modifications to the existing usable spaces below the stair tower. Finally, if the owner wanted to undertake the recommended structural performance alterations while minimizing the impact on the usable space, SSE believes they would be required to make substantial changes to the shell of the structure thereby minimizing the portions of the structure that could be preserved.

The recommendations included herein are based on limited site observations. Any observance of structural conditions, especially existing damage, that vary from what is reflected in this report should be brought to the attention of SSE. If you have any questions regarding this report, please do not hesitate to contact me.

Issued by:
SOUZA STRUCTURAL ENGINEERING, LLC



Benjamin J. Souza, PE
Principal



1 / SK-1 EX FOUNDATION PLAN
SCALE: NOT TO SCALE

project name

EXISTING STRUCTURE

7 ARLINGTON AVENUE
OAK BLUFFS, MA

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340 Boothby Rd
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NO.	M/D/Y	ISSUED FOR

date:
8/1/23

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WHEN PRINTED ON 24x36
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project #:
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drawing:
PLAN

SK-1

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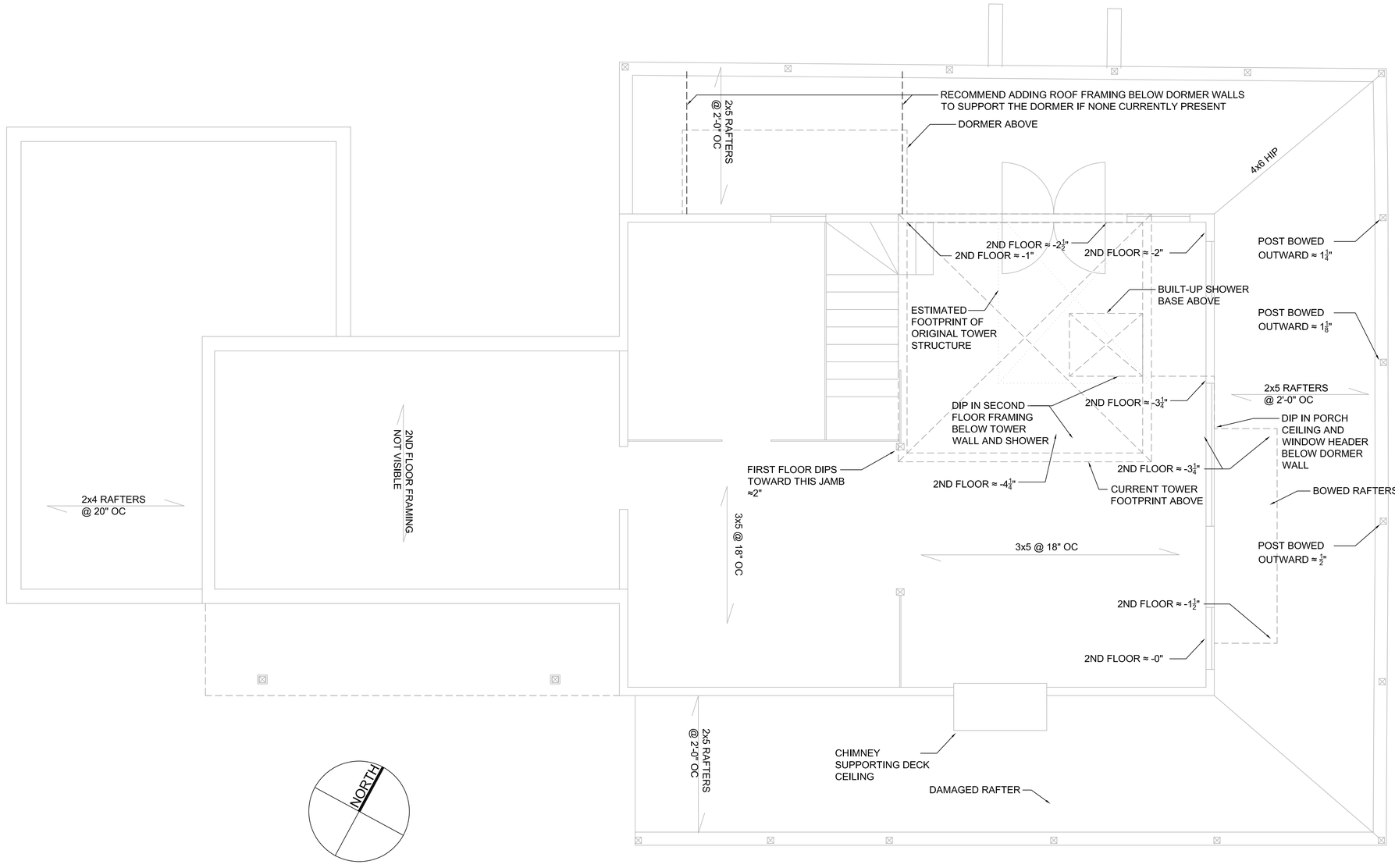

2
SK-2
EX MAIN LEVEL PLAN
SCALE: NOT TO SCALE

project name

EXISTING STRUCTURE

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8/1/23

scale:
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WHEN PRINTED ON 24x36

project #:
23-027

drawing:
PLAN

NOT FOR CONSTRUCTION

SK-2