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Bob Brown's

ARIZONA FOUNDATION SOLUTIONS

"Arizona's Certified Foundation Repair Specialist"

Arizona License # ROC 287865 KB-01

This Engineered Analysis was prepared especially for:

Sample Residence
123 Sample Street
Mesa, AZ 85202

Thank you for allowing us into your home.

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Table of Contents

EA Report Tracking Form (Office Use Only)	Page 1
Cover Page	Page 2
Table of Contents	Page 3
Engineered Analysis	Page 4
Satellite View	Page 5
Scope of Services	Page 6
Signs of Stress	Page 7
Floor Survey Results	Page 8
Manometer Data Points	Page 9
2D Topographical Map	Page 10
3D Topographical Map	Page 11
Observations	Page 12
Foundation Analysis	Page 13
Repair Recommendations	Page 14
Additional Recommendations	Page 15
Site Layout	Page 16
Repair Plan	Page 17
Drainage Plan	Page 18
Photo Examples of Damages	Page 19 & 20

(All photos available upon request)

Presented by: Thomas Cochran / Cell: 602-376-0354 / Thomas@azrm.net

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Engineered Analysis

April 5, 2019

Sample Residence
123 Sample StreetMesa, AZ 85040
E-mail: NoEmail@.NoEmail.com.org
Phone #: (000) 867-5309

Purpose of the Investigation:

Introduction:

Thank you for allowing Arizona Foundation Solutions to present this foundation survey and assessment for the proposed foundation repairs on your property.

The purpose of this report is to evaluate the foundation and the foundation conditions of this property, and to perform a manometer and foundation survey on the interior of the property.

Limitations:

We reserve the right to change our opinion as new information becomes available. This report is based on our observations and may not be indicative of all factors contributing to foundation and floor slab failure. Only a comprehensive geotechnical and structural engineering investigation by licensed engineers would be able to determine all of the factors contributing to the failure of a foundation. Only the areas of concern indicated by our customers, representatives, floor levels, and/or signs of stress are addressed in this report.

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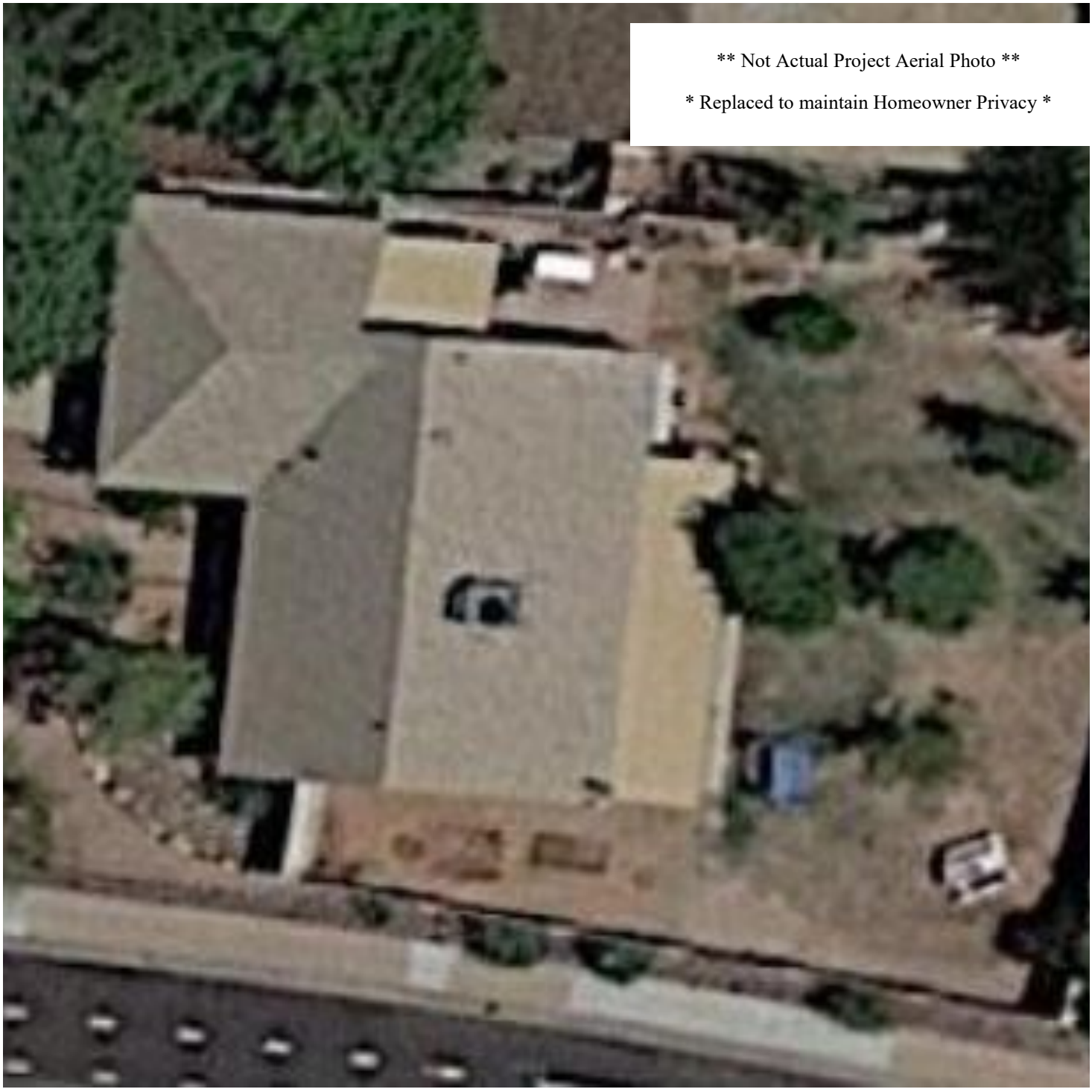
Satellite View



** Not Actual Project Aerial Photo **

* Replaced to maintain Homeowner Privacy *

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Scope of Services:

The extent and scope of this manometer and foundation survey and assessment is detailed as follows:

- Perform a manometer survey.
- Locate the areas of foundation and floor slab failure, if any.
- Visually inspect and record the interior and the exterior of the location.
- Determine the extent of the foundation failure, if any.
- Prepare a documented repair plan if needed.

Foundation Footprint:

A drawing of the footprint of the first floor was created and is included in this report.

Exterior Inspection:

The exterior of the location was visually inspected. Items such as foundation cracks, exterior wall cracks, improper grading, type of structure, poor drainage, gutters or no gutters, bowed retaining walls, large trees close to the foundation and any type of obstructions that may or may not influence the repair process were noted and recorded.

Interior Inspection:

The interior of the location was visually inspected. Items such as floor cracks, wall cracks, ceiling cracks, sloping floors, uneven counter tops, doors and windows that are out of alignment, cracked window glass and bowed walls were noted and recorded.

Manometer Survey:

The manometer survey, also known as a floor survey, is a measurement of the differences of interior floor elevations. The flatness of the interior floor was measured using a highly accurate survey device known as a Manometer. The entire interior floor area was surveyed and the elevations were recorded. These data points were then entered into a computer program that provides a topographical map showing the high and low elevation contours of the floor surface. This topographical map shows where the foundation is out of level and shows where support and stabilization is needed. The floor survey also demonstrates whether any floor slab heave or settlement exists.

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Signs of Stress

Not to Scale

Highest Elevation 9.2"

Lowest Elevation 7.4"

Wall Crack	Slab Crack	Ceiling Crack	Pinched Door / Window	Grade Direction	Down Spout Pooling Area	Water Leak Site	Cracks that are 1/8" or Greater	
Vertical Stem Wall Crack X	Truss Crush	Horizontal Stem Wall Crack	Baseboard Cramming	Pooling of Water Area	Stem Wall Spalling			

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A manometer survey (floor level survey) was performed on the interior of the property.

9.0 inches was used as starting point for the manometer survey. (**M** marks the location of the manometer tripod on the manometer data points floor plan).

Measurements of the floor elevation were made in tenths of an inch.

The highest elevation was **9.2** inches located in Family Room as shown on page 7.

The lowest elevation was **7.4** inches located in the Master Suite as shown on page 7.

The overall difference in the floor readings was **1.8** inches.

"Manometer Instrument"

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Manometer Data Points

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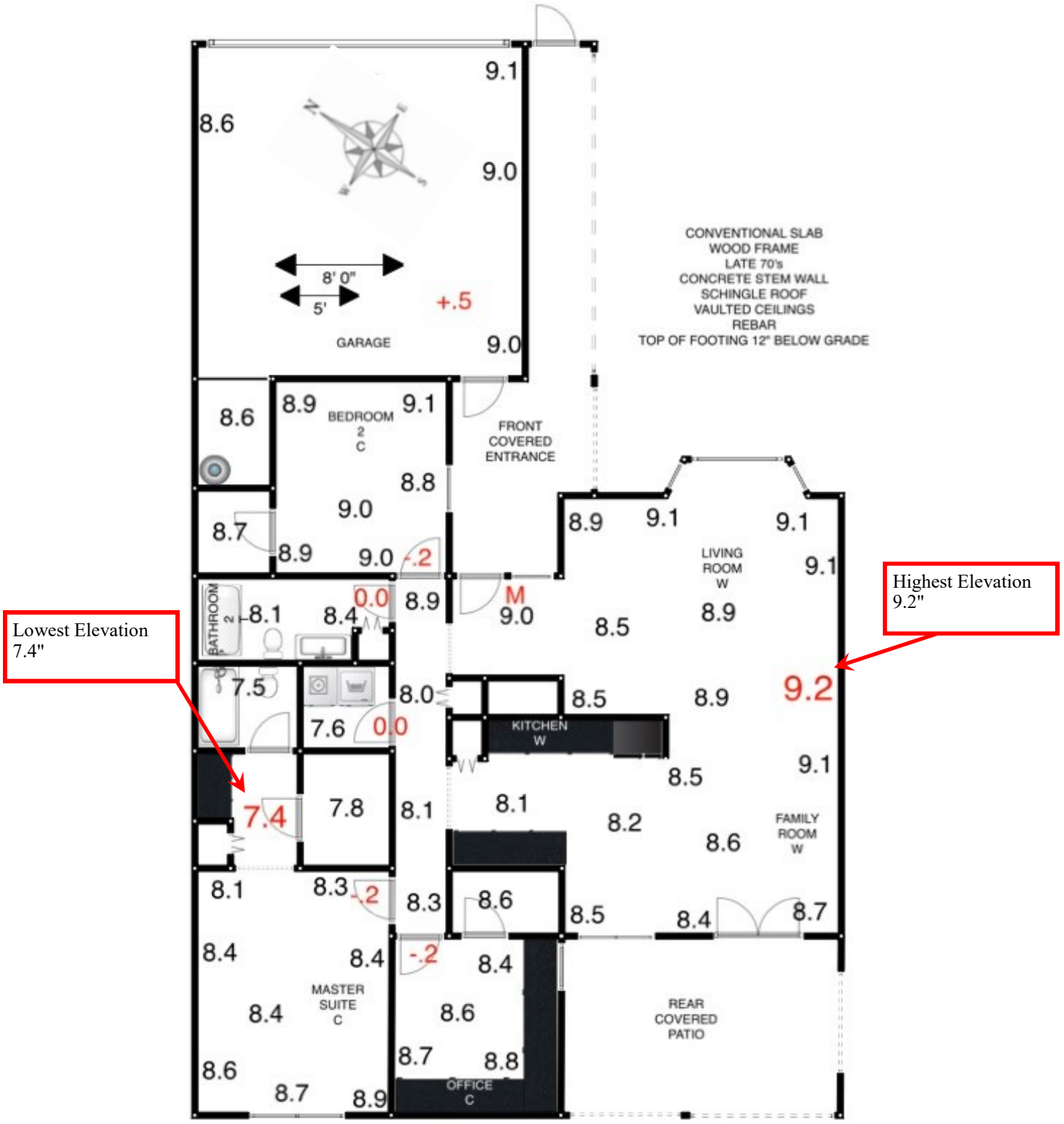

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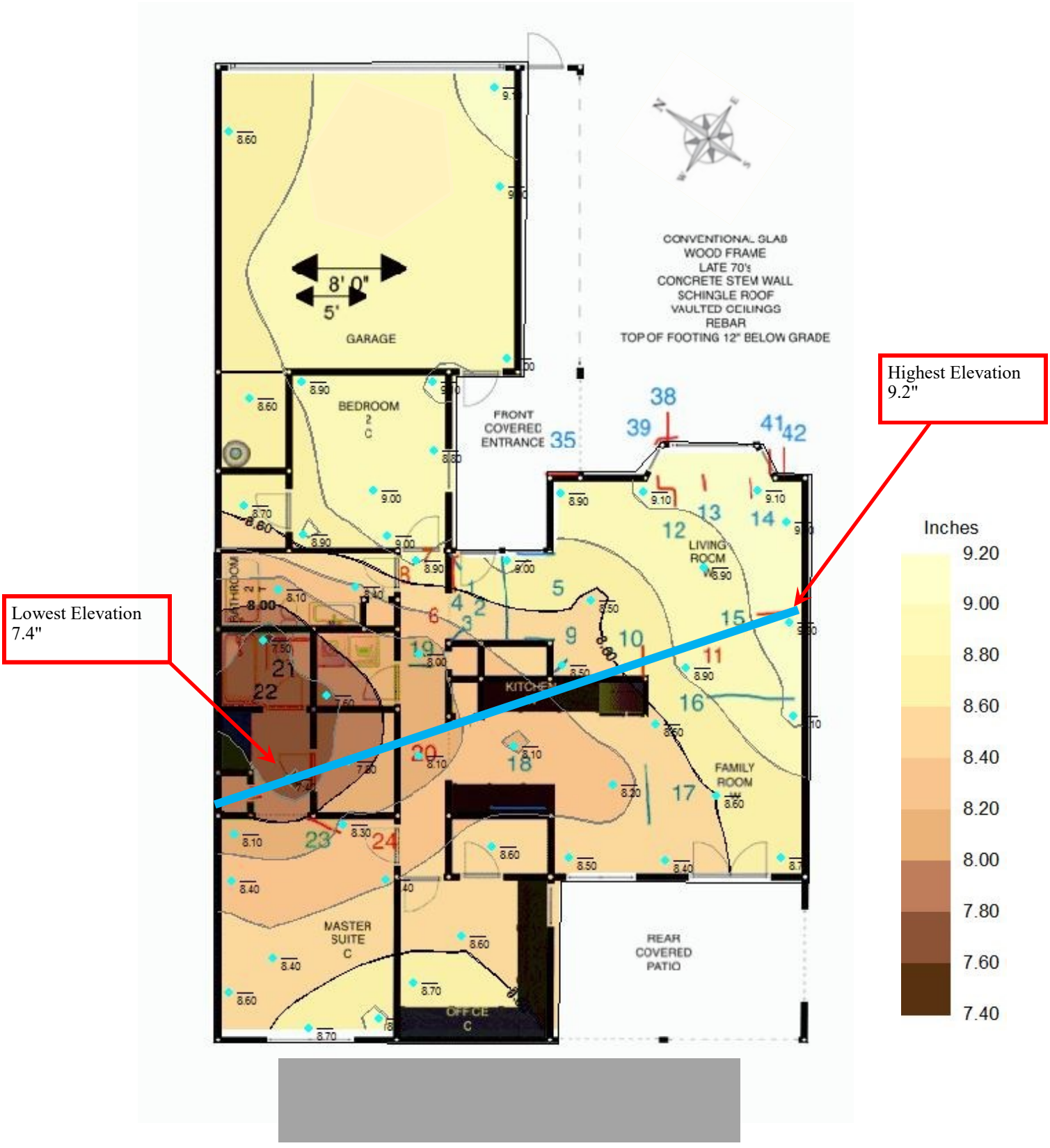
2D Topographical Map

Not to Scale



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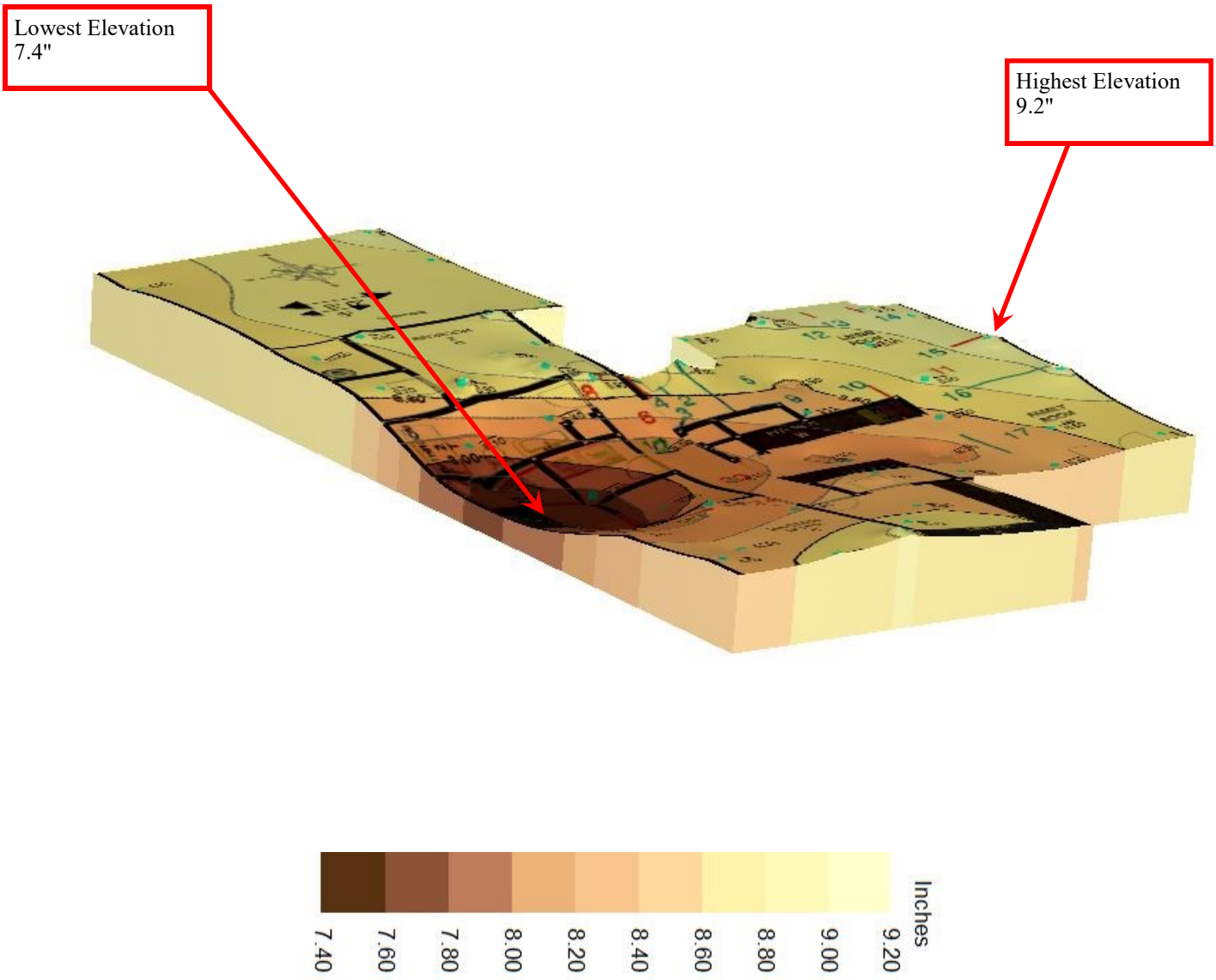
3D Topographical Map

Not to Scale



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Observations

After examining the home and performing the manometer survey, Arizona Foundation Solutions believes the home could be experiencing foundation settlement at the northwestern portion of the home as shown by the damage on page 7 (Signs of Stress) and lower readings on page 10 (Topographical Map). The drop off in floor elevations on the topographical map is consistent with a foundation settlement pattern. Settlement can be caused by one or any combination of many factors including sub-grade saturation of moisture due to poor drainage, years of storm runoff, plumbing leaks, improper compaction, the lack of a proper foundation system, and/or (in most cases) natural earth movement.

A heave pattern is observed in the eastern portion of the Living Room as indicated by the higher elevation readings on page 11 (3D Topographical Map). This phenomenon usually occurs in areas where structures are built on expansive clays. Moisture from one or any combination of the following: storm runoff, poor drainage around the foundation, plumbing leaks and/or underground moisture sources will allow the moisture/vapor to accumulate underneath the foundation. The moisture then interacts with the clayey soils, causing them to swell. The clay soils take the path of least resistance and expand upwards and lift the foundation.

The Foundation Performance Association (FPA) consensus standards and the accompanying spread sheet on page 13 is a general guide of observing movement. This guide helps in analyzing the tilt and deflection of the slab and should not be interpreted as being accurate in all situations. As shown on the following page, the foundation failed on overall deflection of L/218 from an allowable L/360 and passed on overall tilt with an actual percentage of 0.27% from an allowable 1.00%.

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Calculation Spreadsheet for FPA-SC-13-0 **www.foundationperformance.org**

Rev. 25 Jun 08

Guidelines for the Evaluation of Foundation Movement for Residential and Other Low-Rise Buildings

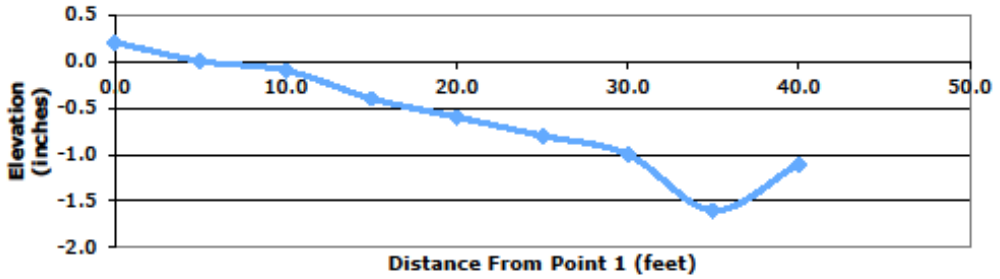
Instructions to Compute Deflection Limit, Tilt and k-factored Deflection Limit:

a) Input distances along profile into blue "L" cells from one edge of slab to the other.
(Spacing may be unequal, first L must be zero, each successive L greater than the previous)

b) Input elevations measured at each "L" into blue "Y" cells
(Start with Point 1; For less than 9 data sets, leave extra cells "empty", not zero)
* If Non-Principle Axis is used, enter Length and Width. Otherwise let Length=1, Width=0.01
** L/360 (Max. Allowable Deflection Limit) is used when L is along a principal axis. If Length L is not parallel to a principal axis, L is modified by the k-factor to adjust the Max. Allowable Deflection Limit to as much as L/255 for k-factors up to 1.414

PROFILE INPUT					*Length	1.0	*Width	0.0	(ft)
	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9
L (ft)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
Y (in)	0.2	0.0	-0.1	-0.4	-0.6	-0.8	-1.0	-1.6	-1.1

Profile Input Plot



OUTPUT	ACTUAL	ALLOWABLES	PASS/FAIL
Deflection=	L / 218	L / 360	FAIL
Tilt =	0.27 %	1.00 %	PASS

User input is in the blue cells only and echoed in the Input Plot. Output is in the yellow cells.

Deflection between points 1 and 3: Deflection = Y2-[Y1+(L12/L)(Y3-Y1)]
Points 1 & 3 are end points of any intermediate span chosen by spreadsheet;

Point 2 is any point chosen by spreadsheet that falls in between 1 & 3

Edge-to-edge Tilt: Tilt = (100%) |Yb-Ya| / Lab

k-factor: k = SQRT(Length^2 + Width^2) / Length

This spreadsheet was used by the Foundation Performance Association to determine the appropriate deflection threshold, and is provided to FPA members as a courtesy and with no guarantee of its accuracy. Section 6 of FPA-SC-13-0 provides definitions and further information on the calculations performed.

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Repair Recommendations

Arizona Foundation Solutions believes that the proper way to permanently stop the perimeter foundation settlement is to underpin the areas that are experiencing movement. Underpinning is the process of installing deep foundation elements called piles. Piles are engineered foundation supports that are driven down past the unstable soils and are then locked up into load bearing strata, which can support the loads that are transferred to them. Once the piles have been installed, they can be used to lift the perimeter foundation up to it's **Highest Practical Maximum**. The piles should be spaced approximately six to eight feet on center and should start and stop near the hinge points of movement (exact spacing to be determined after load bearing calculations). In this case, the piles would be located at the northwestern portion of the home. The slab can then be treated by injecting a light weight expansive polyurethane to fill existing voids and lift the floor slab. This is done by drilling small 5/8" holes in the slab after which polyurethane grout is injected directly under the slab to raise it up to it's Highest Practical Maximum. Using the expansive materials will help prevent additional slab settlement by compacting the upper layer of soil as it expands.

Arizona Foundation Solutions believes that the proper way to deal with foundation heave is by lowering and managing the moisture content of expansive clays that cause heaving. It is our recommendation to manage the moisture underneath the foundation through active soil depressurization. This process will remove existing moisture from the soil as well as new moisture from the expansive clays and will help bring the moisture content down to an optimal level using both convection and evaporation. This will mitigate future heaving of the clay soil and possibly allow existing heaving to subside. This process can take six months to several years to reach equilibrium.

The Moisture Level® System is designed to control the moisture of expansive clays that cause heaving under the home. If optimal results are not achieved with the Moisture Level® System including additional measures described below, more aggressive measures may be required. The manometer and foundation survey will act as a baseline to measure performance over time.

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Additional Recommendations

Not to Scale

Since storm runoff is responsible for the majority of the moisture that pools next to the foundation, gutters need to be installed to prevent the storm runoff from increasing the amount of foundation movement. A proper gutter system should be installed to discharge the storm runoff a minimum of 10 feet, preferably 20 feet away from the foundation. We do not recommend installing gutters that discharge next to the foundation as this will only increase the probability of a foundation problem.

It is also beneficial to manage the moisture around your home using conventional means as outlined below:

- Hire a reputable plumbing leak detector and repair service to check both pressure and sewer lines, this is usually done for less than $500. If repairs are needed, they are usually not expensive. We recommend **Ken Stolworthy at American Leak Detection at 602–242-8573**

- Make sure the grading of the terrain is sloped downwards at 5% slope from the home at all areas of the perimeter.

- Stop irrigating plants that are near the foundation and make sure there is nothing trapping the moisture from flowing away from the home.

When permanently stabilizing, lifting and/or mitigating a foundation movement problem, AZFS recommends waiting AT LEAST 6 months before investing in cosmetic repairs.

Saguaro Landscaping
480-782-0395

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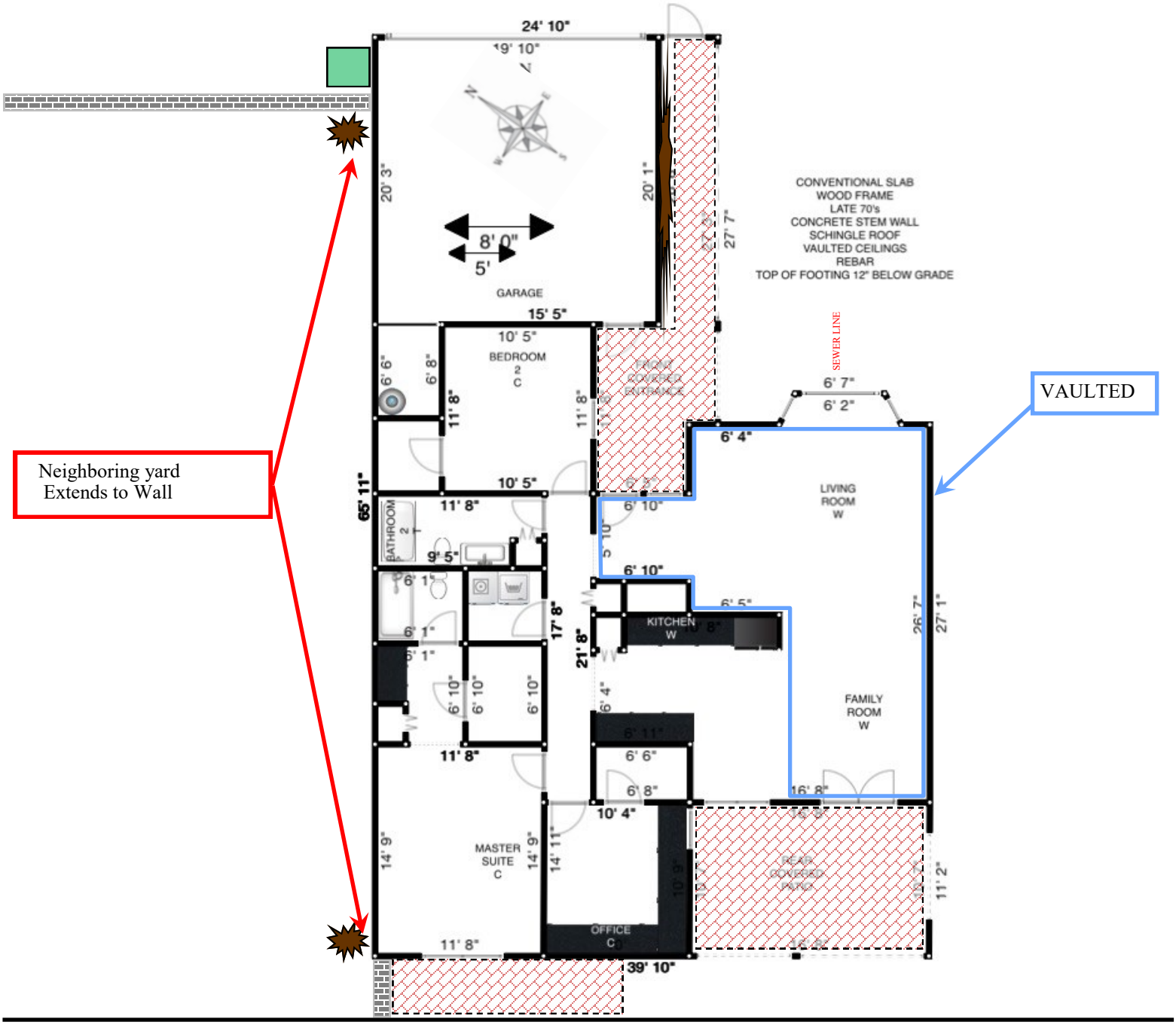
Site Layout

Not to Scale



Meter | AC Drip | Tight Access (less than 4 ft) | Block Wall | AC Unit | Cool Deck, Decretive Pavers | Concrete Slabs

SHED | Planter Box | Pool (within 10ft of home) | Pool Filter | Large Tree | Shrubs, Bushes, Tree Stumps

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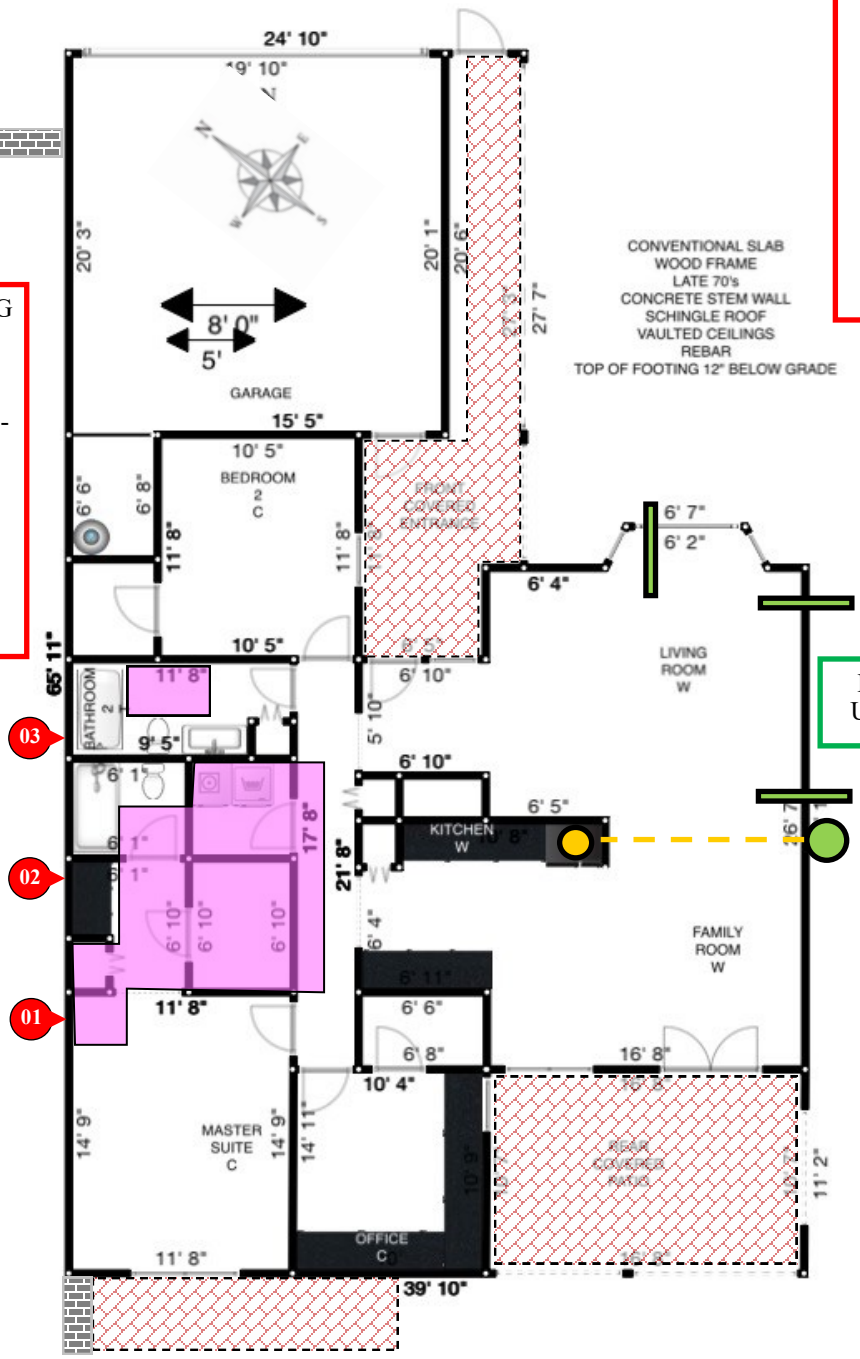
Repair Plan

Not to Scale

Product location is approximate and may vary due to field conditions.

ANY WORK NEEDING TO BE DONE AT THE NORTHWESTERN PORTION OF THE HOME, THE PRODUCTION CREWS WILL HAVE TO ACCESS THROUGH THE NEIGHBOR'S YARD

MLM Pit to go Under the Fridge



Stem Wall Repair | Stem Wall Patch | 0 Smart Jacks | Under Excavation | Concrete Slabs | Cool Deck, Decretive Pavers

0 Piles | Polylevel Area | LMG Area | Composite Interlock | MoistureLevel® System + Intakes

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Drainage Plan

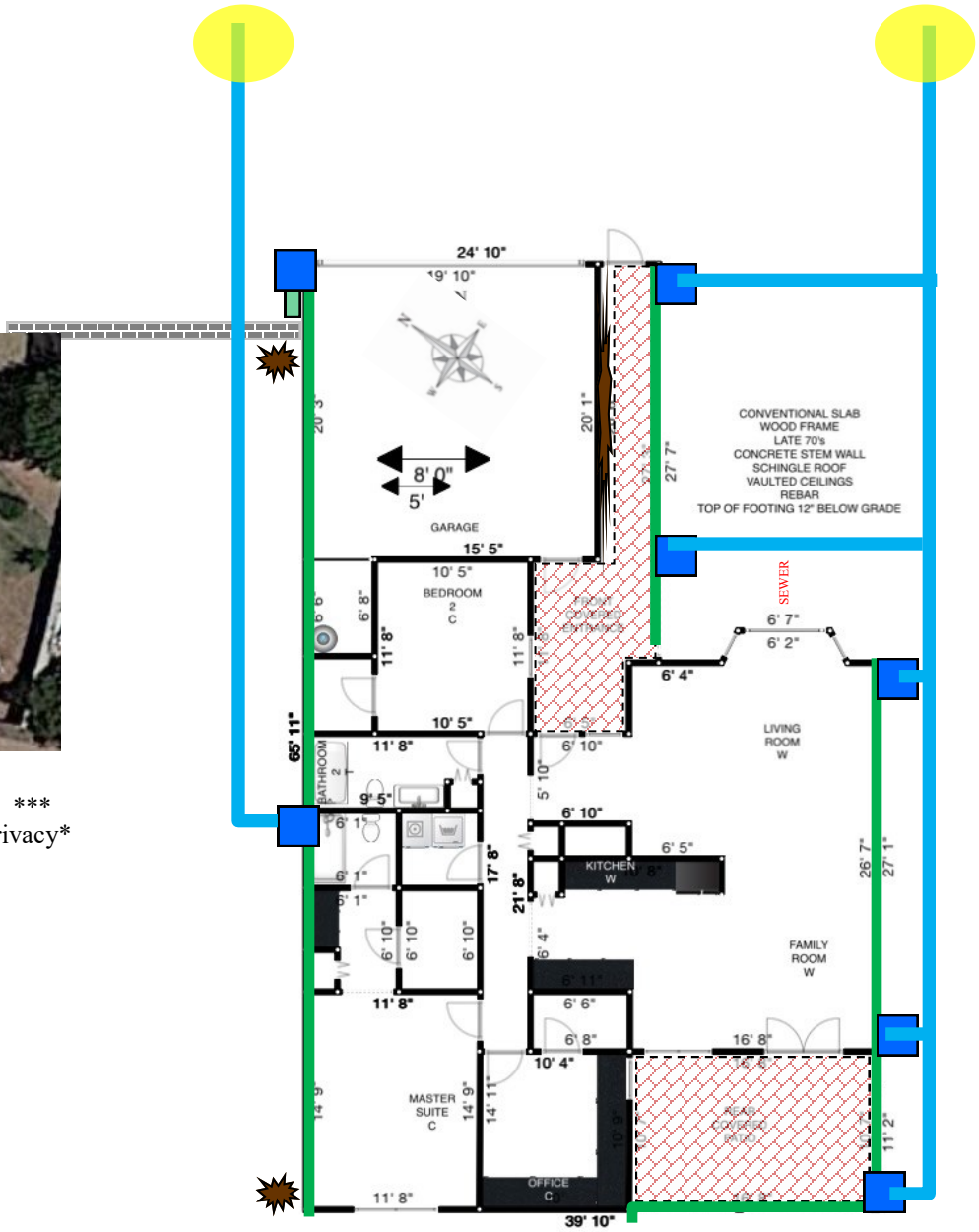
Not to Scale

Retentions need to be a minimum of 20 ft. away from home.

Gutters measure about 157'

A site visit is required to design an accurate gutter and or drainage plan

*** Not Actual Project Aerial Photo ***
Replaced to maintain Homeowner Privacy



5" Gutter

6" Gutter

Existing Gutter

Downspout 3 x 4

Existing Scupper

Existing Downspout

Grade Direction

3'PVC Drain Line

4'PVC Drain Line

Mini Retention

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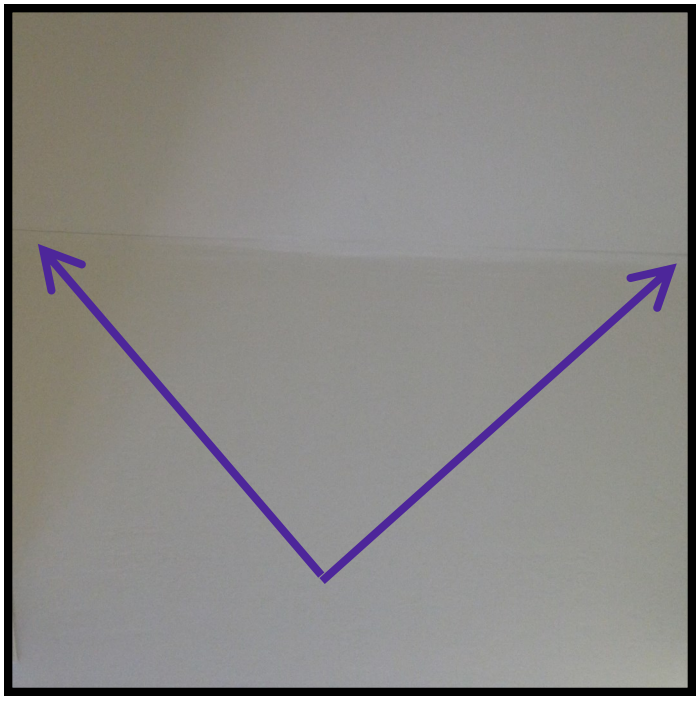
Photo Examples of Damages



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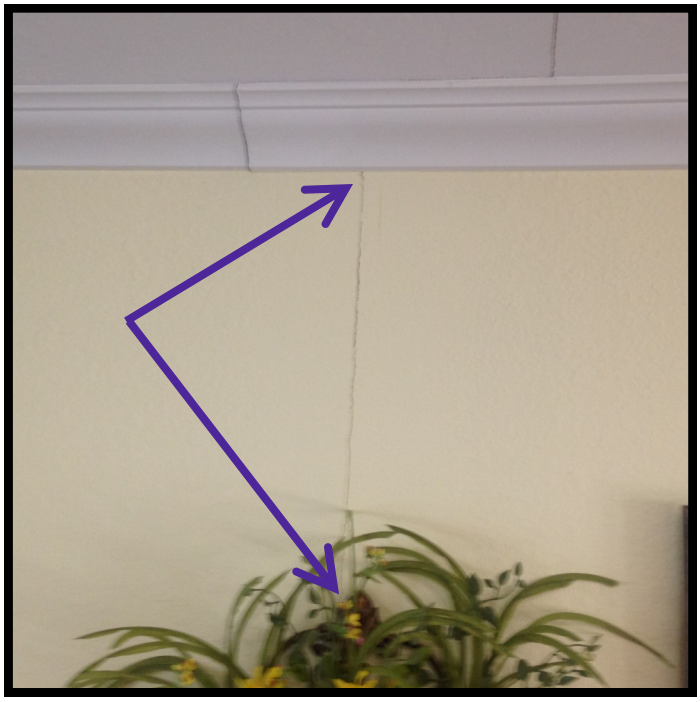
P11



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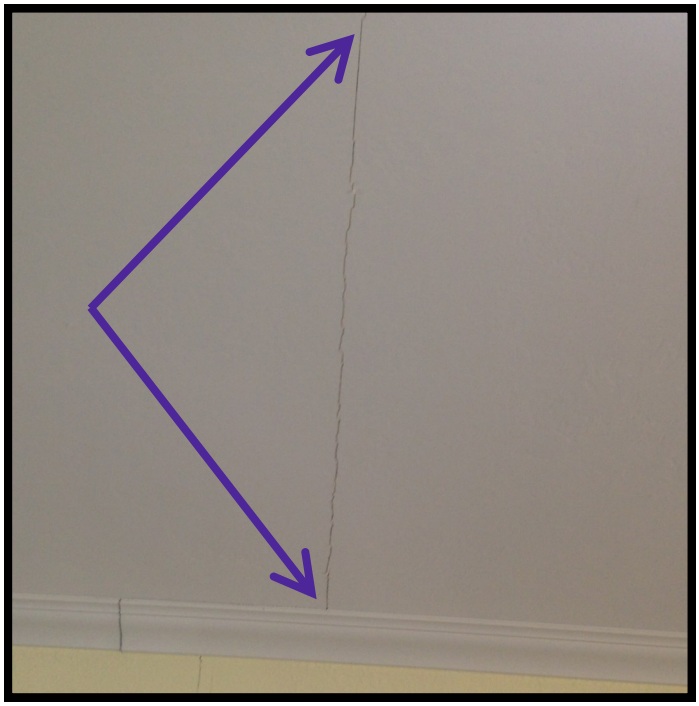

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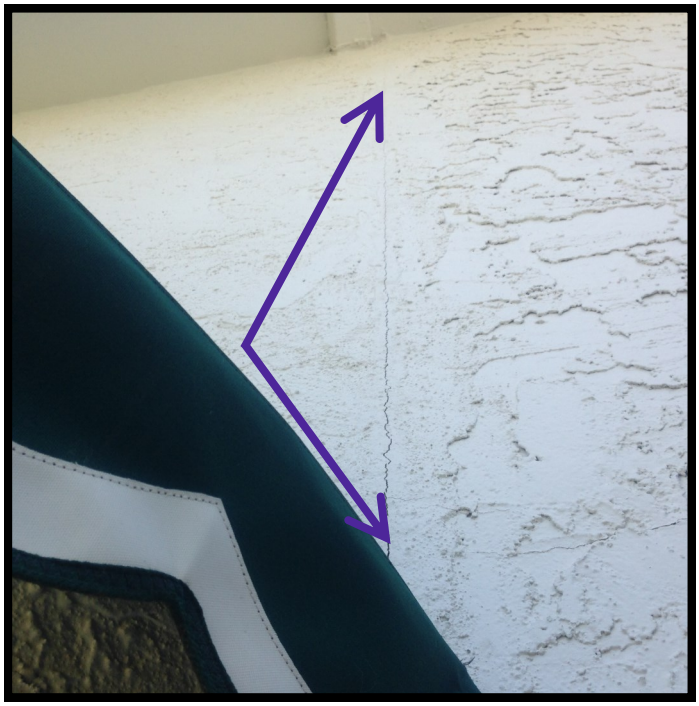
Photo Examples of Damages

P20

P22

P35



P38

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Engineering Certification

Arizona Foundation Solutions certify that the proper investigation has been conducted under the direction of a current licensed engineer, following a "Level B" investigation as defined by the Foundation Performance Association and/or Texas ASCE. The conclusions and recommendations for the repair of your foundation by us are supported by the professional licensed engineer for that investigation.

Company Name Arizona Foundation Solutions