A SunCam online continuing education course

Engineering after the Flood

by

Peter J. Tavino Jr., P.E.

Engineering after the Flood
A SunCam online continuing education course

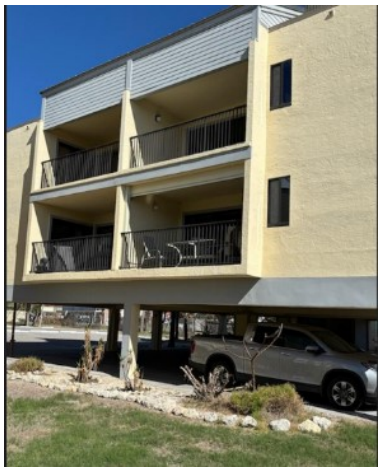
Introduction

Hurricanes have impacted several of the eastern United States in recent years. Areas previously not impacted did experience rare wind and flooding events. Many communities were not prepared for the forces applied to them. Sincere sympathy goes to those who lost their homes and businesses and to some who lost their lives, livelihoods or health. Seawater flooding remediation is the main topic of this course.

Critics have said "People place wind susceptible objects in the path of great winds and then wonder why these were blown over." Here is a 20 ft high sign that blew over because its small concrete foundation with minor anchor keys in the wrong direction was inadequate.

Shopping Center Sign failure

People also place buildings and infrastructure in low lying areas subject to flooding. Such facilities were built years ago before restrictions were enacted. New construction per building code must be above the designated flood level plus one foot of freeboard for extra safety. Only a Professional Engineer *or* Professional Surveyor and Mapper *or* Registered Architect may prepare an Elevation Certificate to assure the municipal government's building department that new construction is raised to safety. This course shows work to be performed by the Professional Engineer after a flood incident to assure that repaired or replaced items will be compliant. Sometimes building on stilts (Columns) is impractical although stilts do provide parking below as shown.



Parking stilts

Extreme single stilt column for a house - from public MLS listing.

Engineering after the Flood
A SunCam online continuing education course

Table of Contents

Roadway debris from a flood event

Elevation Certificate

An Elevation Certificate is the official documentation of the vertical level of a specific building component. It ensures that buildings and parts of buildings which are prone to flood water damage will be constructed above the predicted flood level waters. A municipality adopts an ordinance with a Flood Insurance Rate Map to comply with the National Flood Insurance Program. This map tells everyone what the anticipated 100-year flood levels will be for extreme weather events. Beyond insurance, an Elevation Certificate tells the Building Owner and the Building Department important information, especially the first-floor elevation that can be compared to the base flood level. Design replacement of important building elements after a flood that damages these items must show that new item will be set at an elevation above the base flood level plus one foot of freeboard safety per the applicable Building Code.

For example, consider an air conditioning condenser that was set on the ground at elevation 6 feet above mean sea level that preexists the adoption of a 10-foot predicted flood level. If it was submerged in salt water and was damaged and is inoperable, the Heating, Ventilating and Air Conditioning contractor may not simply install a new condenser unit at that same six-foot level. The building owner (sometimes through flood insurance) must pay to have an Elevation Certificate prepared that shows that the new condenser unit will be installed at 10 + 1 = 11 ft. above sea level.

Condensers and support pads are overturned and are inoperable after hurricane flood water and sand forces acted upon them.

Before a building permit can be issued for repairs after a flood, the Building Department will require an Elevation Certificate to be submitted with the seal of a Professional Engineer or Licensed Surveyor or Architect for that state. If floodwaters temporarily inundated floor beams that can be dried out, no building permit nor Elevation Certificate is required.

Removing wet sheetrock (or drywall) and replacing it if studs and floor joists are preserved will in most cases not require raising the existing floor above flood level and freeboard with an accompanying Elevation Certificate.

The bottom four feet of drywall are being removed by volunteer after the building was flooded.

Equipment above flood and freeboard level may be conventional. If areas below flood levels are to be made watertight, a separate floodproofing certificate must be prepared. This course covers the Elevation Certificate requirements only and not Floodproofing Certificate requirements.

These forms are available online usually from the local planning and zoning and engineering department's flood control website or from FEMA (Federal Emergency Management Agency) directly. FEMA is part of the United States Department of Homeland Security.

https://www.fema.gov/flood-insurance/find-form/underwriting

Adobe Acrobat easily fills in data prepared by the Professional Engineer.

Adobe Acrobat

Other pdf apps may not be able to open and complete the forms and digitally sign them. Free trials and Subscriptions are available. See some of the products available such as "Edit text" as shown below:

The Elevation Certificate Sections are as follows:

SECTION A – PROPERTY INFORMATION+
SECTION B – FLOOD INSURANCE RATE MAP (FIRM) INFORMATION
SECTION C – BUILDING ELEVATION INFORMATION (SURVEY REQUIRED)
SECTION D – SURVEYOR, ENGINEER, OR ARCHITECT CERTIFICATION
SECTION E – BUILDING MEASUREMENT INFORMATION (SURVEY NOT REQUIRED) FOR ZONE AO, ZONE AR/AO, AND ZONE A (WITHOUT BFE*)
SECTION F – PROPERTY OWNER (OR OWNER'S AUTHORIZED REPRESENTATIVE) CERTIFICATION
SECTION G – COMMUNITY INFORMATION (RECOMMENDED FOR COMMUNITY OFFICIAL COMPLETION)
SECTION H – BUILDING'S FIRST FLOOR HEIGHT INFORMATION FOR ALL ZONES (SURVEY NOT REQUIRED) (FOR INSURANCE PURPOSES ONLY)
SECTION I – PROPERTY OWNER (OR OWNER'S AUTHORIZED REPRESENTATIVE) CERTIFICATION

BFE means Base Flood Elevation*

These are images below of two sample pages that were filled in. The Professional Engineer completing the form should concentrate on Sections A, B, C & D as shown below for building permit purposes. The light blue shaded areas are for the Professional Engineer to input by typing. (That state's Licensed Surveyors or Architects may also perform and seal this work, but this course now refers to the Professional Engineer only). Please see the real form to read specifics. After the PE Seal is affixed and the form is signed, it cannot be changed again. It is recommended that drafts be saved until no more changes are required, including suggestions by the reviewing and approving governmental agency.

Form Instructions

U.S. DEPARTMENT OF HOMELAND SECURITY
Federal Emergency Management Agency
National Flood Insurance Program

OMB Control No. 1660-0008
Expiration Date: 06/30/2026

ELEVATION CERTIFICATE

IMPORTANT: MUST FOLLOW THE INSTRUCTIONS ON INSTRUCTION PAGES 1-11

Copy all pages of this Elevation Certificate and all attachments for (1) community official, (2) insurance agent/company, and (3) building owner.

SECTION A – PROPERTY INFORMATION

FOR INSURANCE COMPANY USE

Policy Number:

Company NAIC Number:

A1. Building Owner's Name: ABC Condominium Community

A2. Building Street Address (including Apt., Unit, Suite, and/or Bldg. No.) or P.O. Route and Box No.:
2ABC Boulevard Building 6 Units 123 & 223

City: Venice State: FL ZIP Code: 12345

A3. Property Description (e.g., Lot and Block Numbers or Legal Description) and/or Tax Parcel Number:
PID 0000-00-0000 Building 6

A4. Building Use (e.g., Residential, Non-Residential, Addition, Accessory, etc.): Residential

A5. Latitude/Longitude: Lat. 20.0876400 Long. -80.4552304 Horiz. Datum: ☐ NAD 1927 ☒ NAD 1983 ☐ WGS 84

A6. Attach at least two and when possible four clear color photographs (one for each side) of the building (see Form pages 7 and 8).

A7. Building Diagram Number: 5

A8. For a building with a crawlspace or enclosure(s):

a) Square footage of crawlspace or enclosure(s): 1150 sq. ft.

b) Is there at least one permanent flood opening on two different sides of each enclosed area? ☒ Yes ☐ No ☐ N/A

c) Enter number of permanent flood openings in the crawlspace or enclosure(s) within 1.0 foot above adjacent grade:
Non-engineered flood openings: 4 Engineered flood openings: 0

d) Total net open area of non-engineered flood openings in A8.c: 33,264 sq. in.

e) Total rated area of engineered flood openings in A8.c (attach documentation – see Instructions): N/A sq. ft.

f) Sum of A8.d and A8.e rated area (if applicable – see Instructions): 231 sq. ft.

A9. For a building with an attached garage:

a) Square footage of attached garage: N/A sq. ft.

b) Is there at least one permanent flood opening on two different sides of the attached garage? ☐ Yes ☐ No ☒ N/A

c) Enter number of permanent flood openings in the attached garage within 1.0 foot above adjacent grade:
Non-engineered flood openings: N/A Engineered flood openings: N/A

d) Total net open area of non-engineered flood openings in A9.c: N/A sq. in.

e) Total rated area of engineered flood openings in A9.c (attach documentation – see Instructions): N/A sq. ft.

f) Sum of A9.d and A9.e rated area (if applicable – see Instructions): N/A sq. ft.

SECTION B – FLOOD INSURANCE RATE MAP (FIRM) INFORMATION

B1.a. NFIP Community Name: City of Sample (Florida) B1.b. NFIP Community Identification Number: 123456

B2. County Name: Sarasota B3. State: FL B4. Map/Panel No.: 123A123 B5. Suffix: G

B6. FIRM Index Date: 03/27/2024 B7. FIRM Panel Effective/Revised Date: 03/27/2024

B8. Flood Zone(s): AE B9. Base Flood Elevation(s) (BFE) (Zone AO, use Base Flood Depth): 8

B10. Indicate the source of the BFE data or Base Flood Depth entered in Item B9:
☐ FIS ☒ FIRM ☐ Community Determined ☐ Other: _____

B11. Indicate elevation datum used for BFE in Item B9: ☐ NGVD 1929 ☒ NAVD 1988 ☐ Other/Source: _____

B12. Is the building located in a Coastal Barrier Resources System (CBRS) area or Otherwise Protected Area (OPA)? ☐ Yes ☒ No
Designation Date: ☐ CBRS ☐ OPA

B13. Is the building located seaward of the Limit of Moderate Wave Action (LiMWA)? ☐ Yes ☒ No

Form Instructions

ELEVATION CERTIFICATE

IMPORTANT: MUST FOLLOW THE INSTRUCTIONS ON INSTRUCTION PAGES 1-11

Building Street Address (including Apt., Unit, Suite, and/or Bldg. No.) or P.O. Route and Box No.: 2ABC Boulevard Building 6 Units 123 & 223

City: [illegible] State: FL ZIP Code: 12345

FOR INSURANCE COMPANY USE

Policy Number:

Company NAIC Number:

SECTION C – BUILDING ELEVATION INFORMATION (SURVEY REQUIRED)

C1. Building elevations are based on: ☐ Construction Drawings* ☐ Building Under Construction* ☒ Finished Construction
*A new Elevation Certificate will be required when construction of the building is complete.

C2. Elevations – Zones A1–A30, AE, AH, AO, A (with BFE), VE, V1–V30, V (with BFE), AR, AR/A, AR/AE, AR/A1–A30, AR/AH, AR/AO, A99. Complete Items C2.a–h below according to the Building Diagram specified in Item A7. In Puerto Rico only, enter meters.
Benchmark Utilized: PID DM[illegible] Elev 13.09' Vertical Datum: NAVD 1988

Indicate elevation datum used for the elevations in items a) through h) below.
☐ NGVD 1929 ☒ NAVD 1988 ☐ Other:

Datum used for building elevations must be the same as that used for the BFE. Conversion factor used? ☐ Yes ☒ No
If Yes, describe the source of the conversion factor in the Section D Comments area.

		Check the measurement used:
a) Top of bottom floor (including basement, crawlspace, or enclosure floor):	10.7	☒ feet ☐ meters
b) Top of the next higher floor (see Instructions):	19.6	☒ feet ☐ meters
c) Bottom of the lowest horizontal structural member (see Instructions):	9.9	☒ feet ☐ meters
d) Attached garage (top of slab):	N/A	☐ feet ☐ meters
e) Lowest elevation of Machinery and Equipment (M&E) servicing the building (describe type of M&E and location in Section D Comments area):	9.5	☒ feet ☐ meters
f) Lowest Adjacent Grade (LAG) next to building: ☐ Natural ☒ Finished	6.0	☒ feet ☐ meters
g) Highest Adjacent Grade (HAG) next to building: ☐ Natural ☒ Finished	6.6	☒ feet ☐ meters
h) Finished LAG at lowest elevation of attached deck or stairs, including structural support:	6.3	☒ feet ☐ meters

SECTION D – SURVEYOR, ENGINEER, OR ARCHITECT CERTIFICATION

This certification is to be signed and sealed by a land surveyor, engineer, or architect authorized by state law to certify elevation information. *I certify that the information on this Certificate represents my best efforts to interpret the data available. I understand that any false statement may be punishable by fine or imprisonment under 18 U.S. Code, Section 1001.*

Were latitude and longitude in Section A provided by a licensed land surveyor? ☐ Yes ☒ No

☐ Check here if attachments and describe in the Comments area.

Certifier's Name: Peter J. Tavino Jr PE License Number: 1[illegible]

Title: President and Owner

Company Name: Peter[illegible]

Address: P[illegible]

City: [illegible] State: FL ZIP Code: [illegible]

Telephone: [illegible] Ext.: Email: Peter[illegible].com

PETER J TAVINO LICENSE FLORIDA PROFESSIONAL ENGINEER

Signature: Digitally signed by Peter J. Date: 2024.11.14 10:05:57 Date:

Place Seal Here

Copy all pages of this Elevation Certificate and all attachments for (1) community official, (2) insurance agent/company, and (3) building owner.

Comments (including source of conversion factor in C2; type of equipment and location per C2.e; and description of any attachments):
AC units replacement - all on south side of the building.
The elevation of the lowest unit is 9.5'.
The building was pre-existing in 1976 before replacement of AC units only.
Re A8. f) Flood opening area is shown as 33,264 sq inches non-engineered and 0 engineered openings.
33,264 sq inches divided by 144 = 231 sq ft sum total pre-existing from 1976.

FEMA Form FF-206-FY-22-152 (formerly 086-0-33) (8/23) Form Page 3 of 8

Brief instructions on how to prepare an Elevation Certificate may be included with the form download, but they are not all inclusive. From FEMA, a more detailed set of 11 pages of instructions is available here:

https://www.fema.gov/pdf/library/elvcert.pdf

Here is the first page to the right:

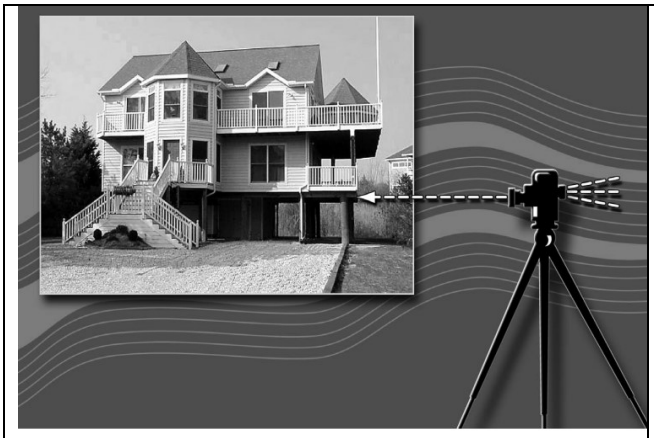
FEDERAL EMERGENCY MANAGEMENT AGENCY

NATIONAL FLOOD INSURANCE PROGRAM

ELEVATION CERTIFICATE

AND

INSTRUCTIONS



Floodplain Management Bulletin

Elevation Certificate

May 2004

Another FEMA resource is here:

https://www.fema.gov/sites/default/files/2020-07/fema467-6-10-04.pdf

One of the most important items in the Instruction Packet concerns the applicable Building Diagram. Building Diagrams are defined here on pages 9 & 10 of 11. They must be input to the Elevation Certificate form Section A7. Download the actual instructions to observe and select the appropriate Building Diagram carefully.

BUILDING DIAGRAMS

The following eight diagrams illustrate various types of buildings. Compare the features of the building being certified with the features shown in the diagrams and select the diagram most applicable. Enter the diagram number in Item C2. and the elevations in Items C3.a-C3.g.

In A zones, the floor elevation is taken at the top finished surface of the floor indicated; in V zones, the floor elevation is taken at the bottom of the lowest horizontal structural member (see drawing in instructions for Section C).

DIAGRAM 1

All slab-on-grade single- and multiple-floor buildings (other than split-level) and high-rise buildings, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor is at or above ground level (grade) on at least one side. *

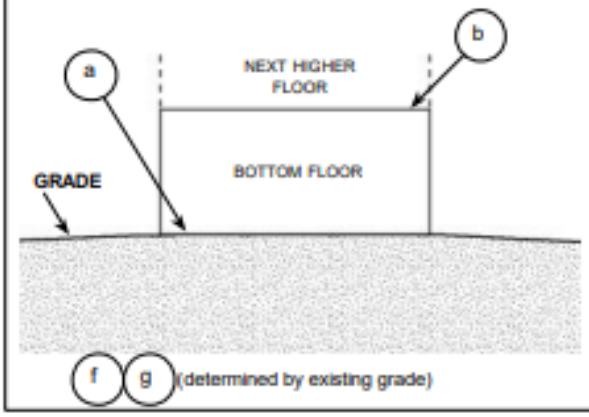


DIAGRAM 2

All single- and multiple-floor buildings with basement (other than split-level) and high-rise buildings with basement, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (basement or underground garage) is below ground level (grade) on all sides. Buildings constructed above crawl spaces that are below grade on all sides should also use this diagram.*

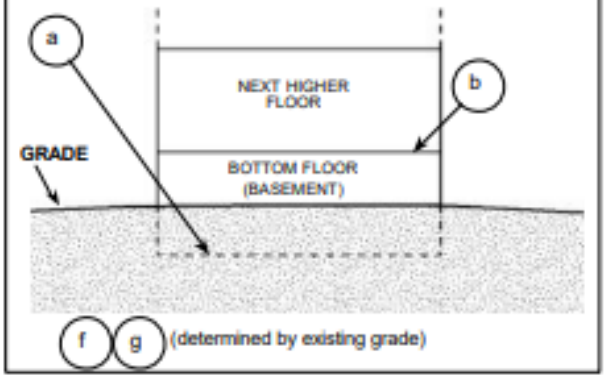


DIAGRAM 3

All split-level buildings that are slab-on-grade, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (excluding garage) is at or above ground level (grade) on at least one side.*

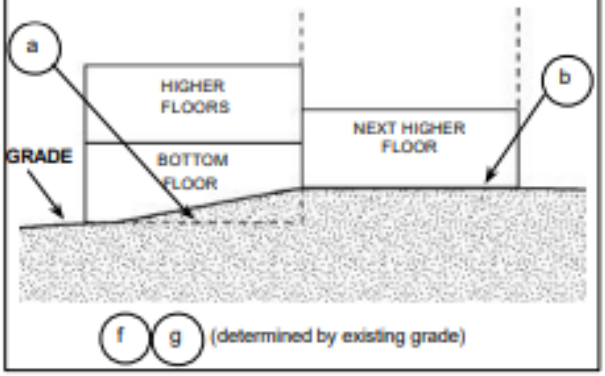
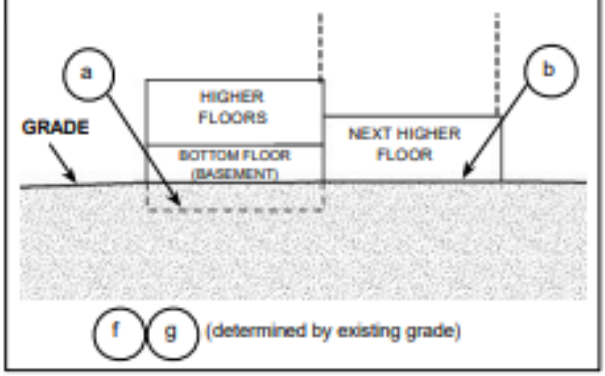


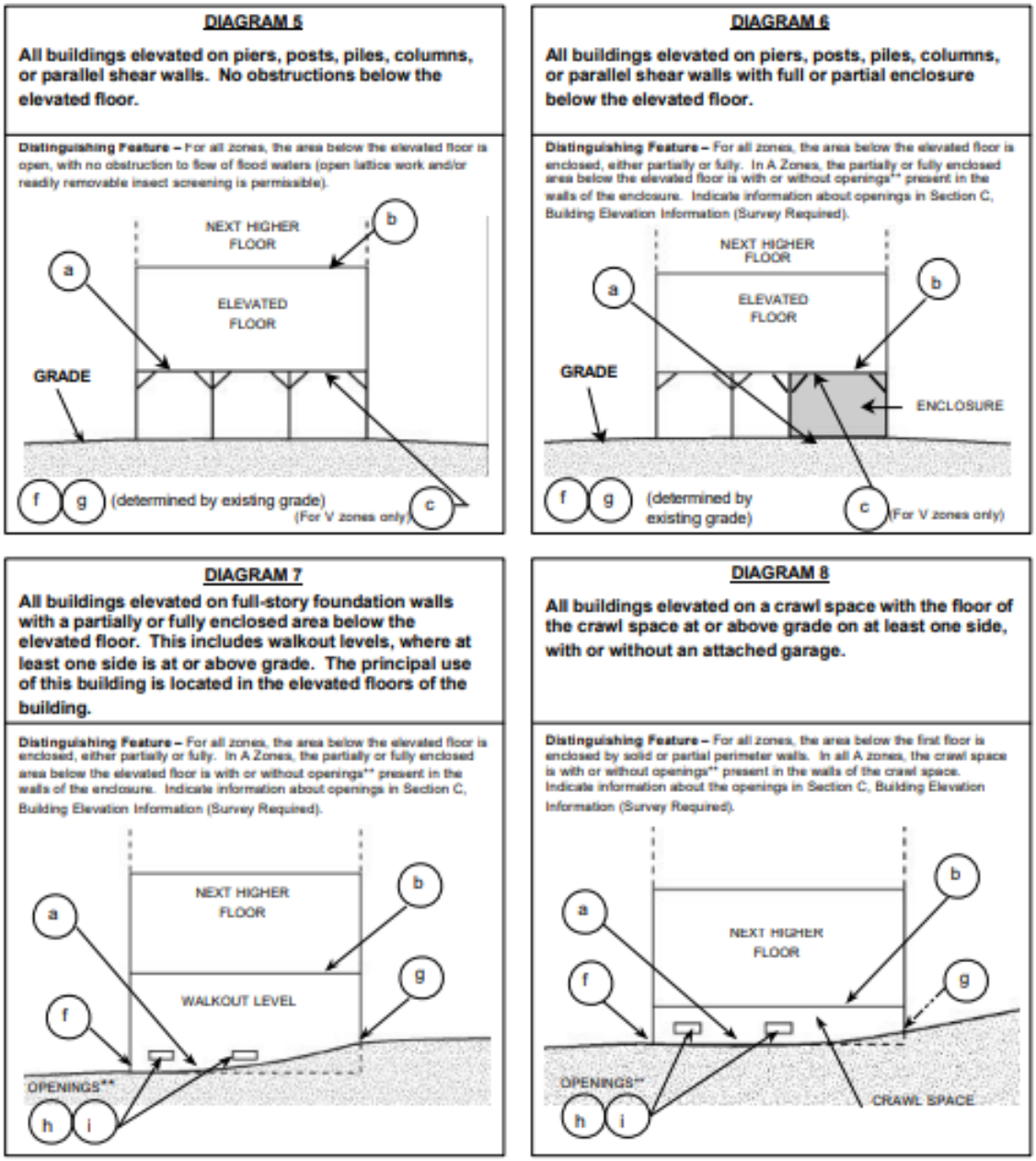
DIAGRAM 4

All split-level buildings (other than slab-on-grade), either detached or row type (e.g., townhouses); with or without attached garage.

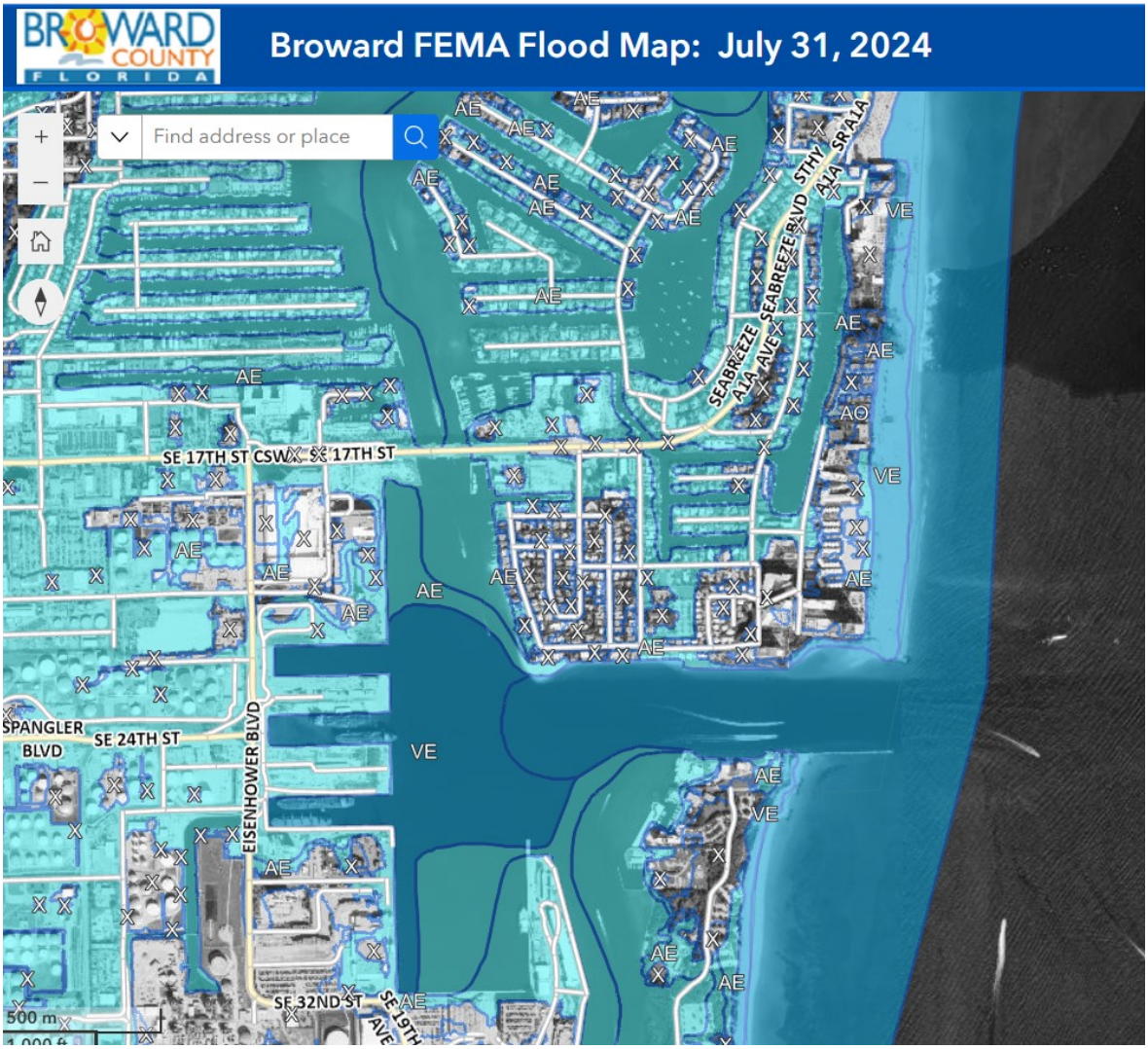
Distinguishing Feature – The bottom floor (basement or underground garage) is below ground level (grade) on all sides. Buildings constructed above crawl spaces that are below grade on all sides should also use this diagram. *



* A floor that is below ground level (grade) on all sides is considered a basement even if the floor is used for living purposes, or as an office, garage, workshop, etc.

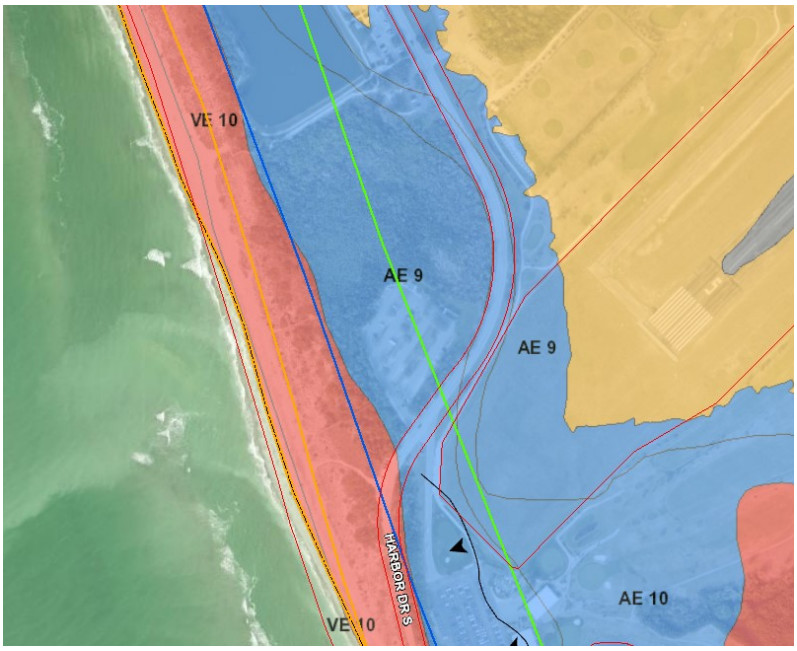


Before going out to the field, the first task is to locate the subject property on the adopted floodplain map. The designations mapped are: Zone AO, Zone AE, Zone AH, Zone VE Zone X-Shaded *(0.2 PCT Annual Chance Flood Hazard & 0.2 PCT Annual Chance Flood Hazard)* and Zone X. Most zones are based on the 100-year flood with a 1 % chance of occurrence each year. The X Zone may vary from 100 years to 500 years occurrence. See a sample map shown here. Sometimes a coastal zone might include LiMWA (Limit of Moderate Wave Action). Also Coastal A Zone with waves of 1.5 to 3 ft high.



Map shows flood zones, but not their corresponding flood elevation.

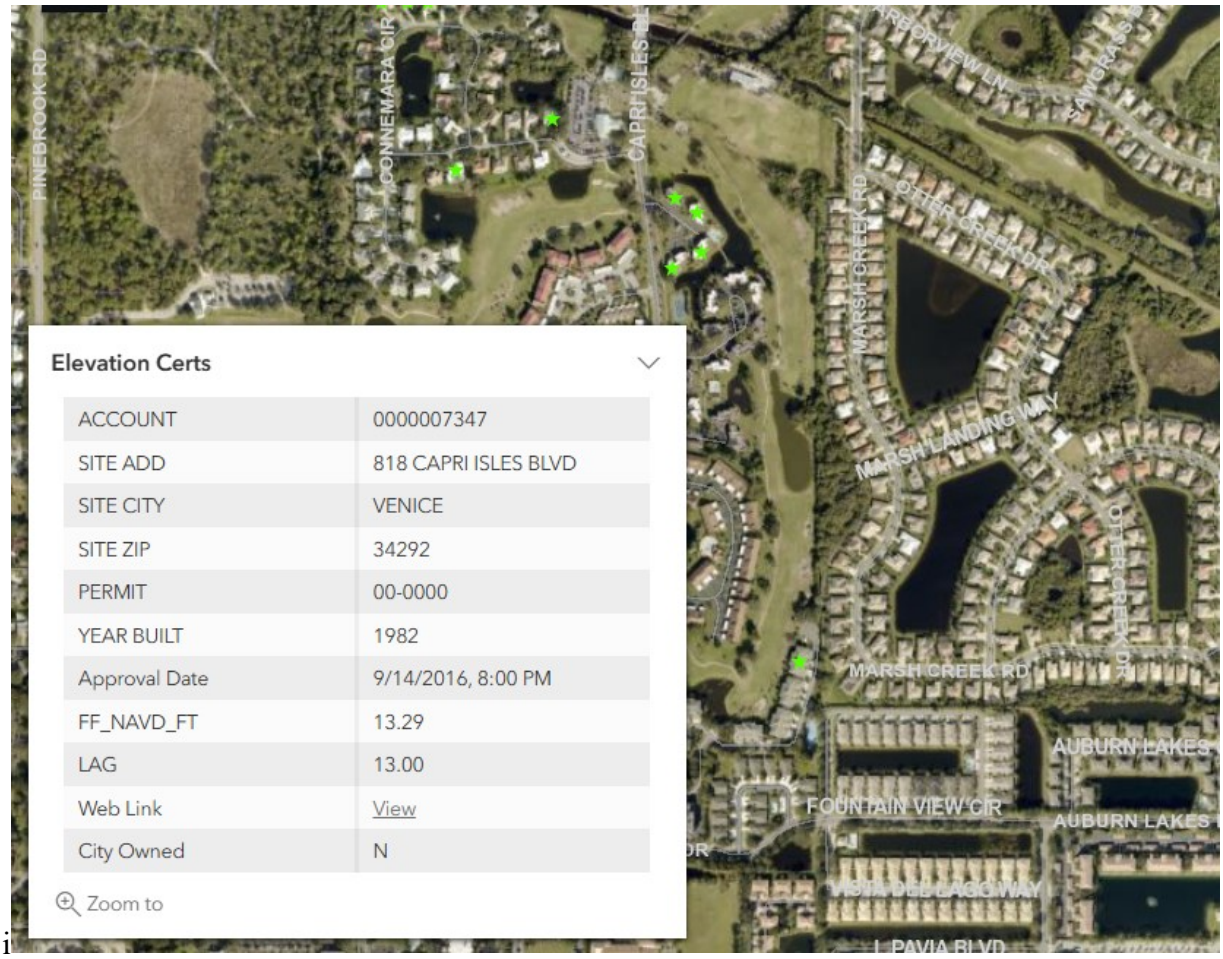
The next on-line Flood Zone map example does indicate the elevation without lookup.



VE 10 in pink and AE 9 in blue show 10 foot and 9 foot flood levels expected.

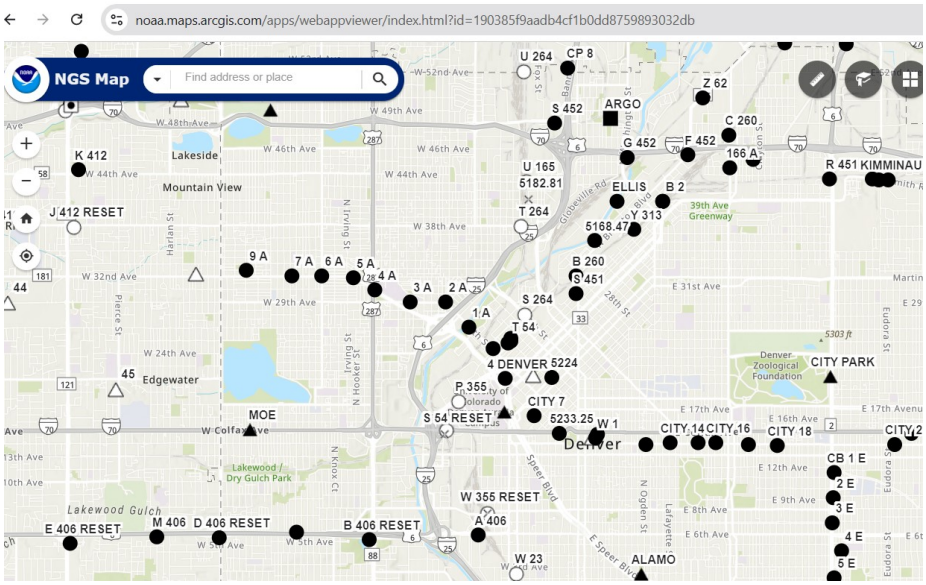
If the building subject to an Elevation Certificate is in the blue area with no part of the building touching the pink area, enter "AE" in box B8 = Flood Zone. Enter "9" in box B9 = Base Flood Elevation. Begin considering that this building's required permit work will be conducted at or above 9 + 1 = 10 feet above sea level.

The Elevation Certificate determines the elevation of the first floor and other facilities such as exterior air conditioning condensers. Once emailed to and reviewed and approved by the floodplain manager (and/or its consultants) a building repair construction permit may be issued. Elevation Certificates are also used for FEMA compliance and for insurance purposes. All facilities in special flood hazard areas must comply. In instances when an existing floodplain Elevation Certificate exists, it might need recertification. View existing elevation certificates on line with popup windows showing elevation data. For form Sections B10, B12 and B13, check the FIRM (Flood Insurance Rate Map) information on line and check with the flood manager for Community Mapping information, Coastal Barrier Resources System and Limit of Moderate Wave Action certainty.



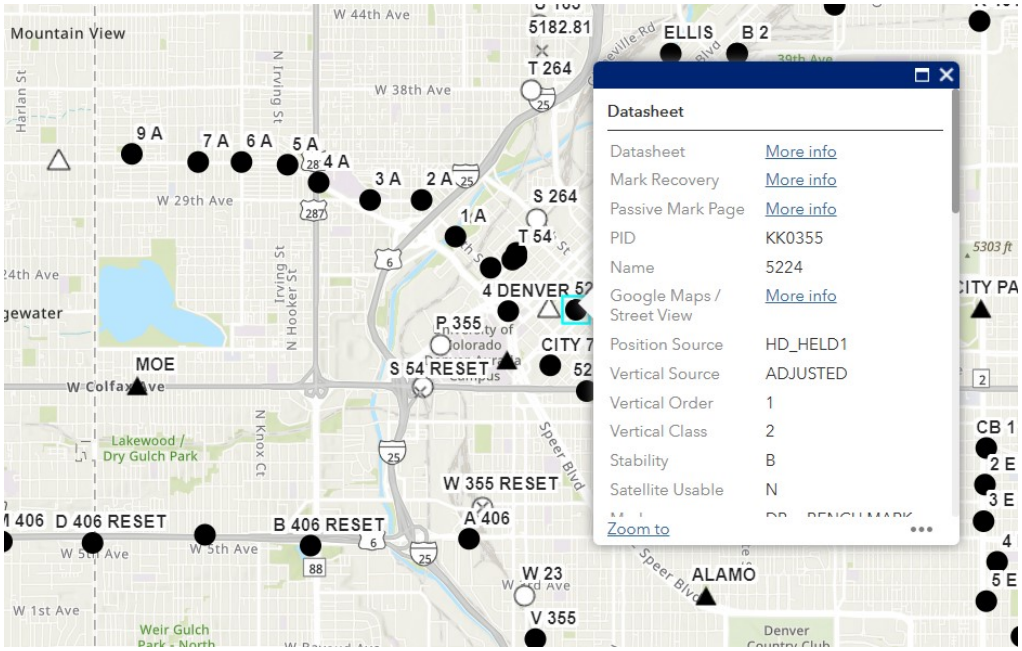
By clicking on a green star, a popup shows the existing approved Elevation Certificate data.

Outdated Elevation Certificates might require updating by the same or another Professional Engineer, especially if based on NVGD (National Geodetic Vertical Datum) of the year 1929. Conversion to NAVD (North American Vertical Datum) of 1988 is required. Online conversion tools may not be precise enough. The floodplain manager might require a new Elevation Certificate based on a nearby NAVD benchmark. The Professional Engineer must therefore locate a nearby benchmark and transfer the elevation across highways and such to the site being certified. The Professional Engineer may not recertify an existing Elevation Certificate and must take his or her own measurements. Start with an approved benchmark map that can be studied. The NOAA (National Oceanic and Atmospheric Administration) maps show approved benchmarks.
https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=190385f9aadb4cf1b0dd8759893032db



The NOAA Maps Arc Gis benchmark map opens to Denver, Colorado.

From this Colorado beginning, pan across the United States to the neighborhood showing the subject building to be measured against a nearby benchmark. Once there, click on a suitable benchmark black circle that is as close as possible to the subject building to see it's unique PID (Permanent Identifier) data.



Datasheet popup

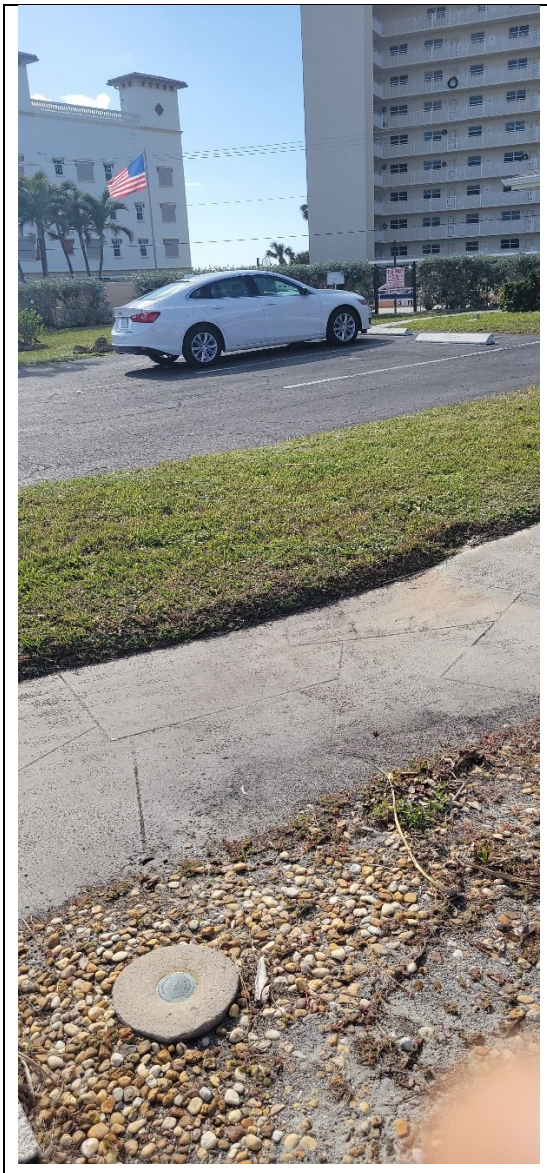
Complete data sheet is below.

See file dsdata.pdf for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.12.5.19
Starting Datasheet Retrieval...
1    National Geodetic Survey, Retrieval Date = JANUARY  6, 2025 11:50:52 EST
 DP9185 ***********************************************************************
 DP9185  DESIGNATION -  C 794
 DP9185  PID         -  DP9185
 DP9185  STATE/COUNTY-  FL/CHARLOTTE
 DP9185  COUNTRY     -  US
 DP9185  USGS QUAD   -  EL JOBEAN (2018)
 DP9185
 DP9185                        *CURRENT SURVEY CONTROL
 DP9185 ______________________________________________________________________
 DP9185* NAD 83(1986) POSITION- 26 54 37.53   (N) 082 11 34.10   (W)   HD_HELD1
 DP9185* NAVD 88 ORTHO HEIGHT -     8.732 (meters)        2.48  (feet) ADJUSTED
 DP9185 ______________________________________________________________________
 DP9185  GEOID HEIGHT    -        -23.858 (meters)                     GEOID18
 DP9185  DYNAMIC HEIGHT  -          8.731 (meters)        2.48  (feet) COMP
 DP9185  MODELED GRAVITY -    979,118.4   (mgal)                       NAVD 88
 DP9185
 DP9185  VERT ORDER      -  SECOND    CLASS I
 DP9185
 DP9185.The horizontal coordinates were determined by differentially corrected
 DP9185.hand held GPS observations or other comparable positioning techniques
 DP9185.and have an estimated accuracy of +/- 3 meters.
 DP9185
 DP9185.The orthometric height was determined by differential leveling and
 DP9185.adjusted by the NATIONAL GEODETIC SURVEY
 DP9185.in November 2015.
 DP9185
 DP9185.Significant digits in the geoid height do not necessarily reflect accuracy
 DP9185.GEOID18 height accuracy estimate available here.
 DP9185
 DP9185.Click photographs - Photos may exist for this station.
 DP9185
 DP9185.The dynamic height is computed by dividing the NAVD 88
 DP9185.geopotential number by the normal gravity value computed on the
 DP9185.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 DP9185.degrees latitude (g = 980.6199 gals.).
 DP9185
 DP9185.The modeled gravity was interpolated from observed gravity values.
 DP9185
 DP9185;                  North         East     Units  Estimated Accuracy
 DP9185;SPC FL W     -   285,494.1     180,849.1     MT  (+/- 3 meters HH1 GPS)
 DP9185
 DP9185_U.S. NATIONAL GRID SPATIAL ADDRESS: 17RLK8155677072(NAD 83)
 DP9185
 DP9185                           SUPERSEDED SURVEY CONTROL
 DP9185
 DP9185.No superseded survey control is available for this station.
 DP9185
 DP9185_MARKER: F = FLANGE-ENCASED ROD
 DP9185_SETTING: 49 = STAINLESS STEEL ROD W/O SLEEVE (10 FT.+)
 DP9185_STAMPING: C 794 2015
 DP9185_MARK LOGO: NONE
 DP9185_PROJECTION: RECESSED 15 CENTIMETERS
 DP9185_MAGNETIC: O = OTHER; SEE DESCRIPTION
 DP9185_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 DP9185_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
 DP9185+SATELLITE: SATELLITE OBSERVATIONS - April 21, 2015
 DP9185_ROD/PIPE-DEPTH: 10.6 meters
 DP9185
 DP9185  HISTORY     - Date     Condition        Report By
 DP9185  HISTORY     - 20150421 MONUMENTED       CARDNO
 DP9185
 DP9185                           STATION DESCRIPTION
 DP9185
 DP9185'DESCRIBED BY CARDNO INC 2015 (SU)
 DP9185'THE STATION IS LOCATED APPROXIMATELY 7.6 MI (12.2 KM) SOUTHWEST OF
 DP9185'MURDOCK, 10.5 MI (16.9 KM) SOUTHEAST OF ENGLEWOOD.
 DP9185'
 DP9185'THE STATION IS WITHIN THE RIGHT-OF-WAY OF CHARLOTTE COUNTY ROADS.
 DP9185'CHARLOTTE COUNTY, FLORIDA.
 DP9185'
 DP9185'TO REACH THE STATION FROM THE NORTH END OF THE BRIDGE OVER THE MYAKKA
 DP9185'RIVER IN THE SOUTH EDGE OF EL JOBEAN GO SOUTHWEST ON STATE ROAD 776
 DP9185'(SOUTH MCCALL ROAD) FOR 2.25 MI (3.6 KM) TO THE JUNCTION OF COUNTY
 DP9185'ROAD 771 (GASPARILLA ROAD) ON THE LEFT, GO SOUTHWEST ALONG COUNTY ROAD
 DP9185'771 (GASPARILLA ROAD) FOR 1.5 MI (2.4 KM) TO THE JUNCTION WITH SAN
 DP9185'DOMINGO BOULEVARD ON THE LEFT, GO SOUTHEAST ALONG SAN DOMINGO
 DP9185'BOULEVARD FOR 1.5 MI (2.4 KM) TO THE INTERSECTION OF SAN DOMINGO
 DP9185'BOULEVARD AND CALUMET BOULEVARD, GO NORTHEAST ALONG CALUMET BOULEVARD
 DP9185'0.9 MI (1.4 KM) TO THE JUNCTION OF CALUMET BOULEVARD AND SAINT PAUL
 DP9185'DRIVE.  GO SOUTHEAST ALONG SAINT PAUL DRIVE APPROXIMATELY 100 FT (30.5
 DP9185'M) TO THE MARK ON THE LEFT.
 DP9185'
 DP9185'IT IS 187 FT (57.0 M) NORTH OF A FIRE HYDRANT, 60.5 FT (18.4 M) SOUTH
 DP9185'OF THE CENTER OF A TELEPHONE BOX, 57 FT (17.4 M) EAST OF THE
 DP9185'CENTERLINE OF SAINT PAUL DRIVE AND 28 FT (8.5 M) WEST OF THE TOP OF
 DP9185'BANK OF A WATERWAY AND 2.0 FT (0.6 M) WEST OF A CARSONITE WITNESS
 DP9185'POST.  NOTE, ACCESS TO THE DATUM POINT IS THRDUGH A 5 INCH (13 CM)
 DP9185'LOGO CAP.
```


Do not confuse elevations in meters above sea level with feet above sea level. If units are not shown, verify if benchmark elevation “4.115” is really 13.5 feet above sea level. On the Elevation Certificate at section C2, enter the unique PID number and the benchmark elevation of the plaque of choice in units of feet.

Next the Professional Engineer or crew goes out to the field and finds the benchmark datum plaque with verified vertical elevation at its center.



Benchmark plaque suitable for placing a measuring rod to determine height of instrument.

Self-leveling rotary laser level instrument kit with measuring rod.

The Professional Engineer understands accuracy required to determine a proper elevation when transferred over long distances, such as a mile or so. For Professional Engineers without sophisticated instruments available, here is the procedure:

Set up the leveling instrument about 200 feet in line of sight from the benchmark and find the height of the instrument above the benchmark plaque.

If the benchmark is at 13.50 feet and the rod reads 4‘- 6 ¼” , note that the H.I. (Height of Instrument) is 18.02’. Use spray paint to mark pavement elevation locations a few hundred feet toward the subject building. Determine that paint elevation and leapfrog the instrument a few hundred feet again. Record the new H.I. Repeat until reaching the building where you establish your new elevation reference point.

Leapfrogging the instrument to transfer established benchmark elevation to determine building elevation.

Author sets rod on white spray paint

Set a new personal benchmark somewhere on the building grounds. It need not be recorded on the Elevation Certificate. That elevation reference point can be used to measure required first floor and ground elevations. The form requires accuracy to the nearest 0.1 foot, so measure carefully en route.

Once at the building, easily determine the latitude and longitude off a maps app on your cell phone. Enter both in section A5. That Horizontal Datum should be NAD (North American Datum) 1983.

Complete the remaining items after establishing the important first floor elevation without needing the leveling instrument anymore. Be sure to record proper first floor elevation as either the top of the plywood or bottom of floor joists per instructions. Second floor elevations can be measured with plumb measuring rod. Take at least two representative photographs of the side elevations. Use average and not small digital pixel size.

Measure LAG (Lowest Adjacent Grade) and HAG (Highest Adjacent Grade) by reasonably touring the building and measuring plumb with a rod relative to the level first floor. For buildings with Crawl Space, identify opening areas versus engineered (Vent like) opening areas. Be careful with square feet versus square inches reporting units in Section A8.

Item C2 e) is especially important: M&E (Machinery and Equipment) must be shown to be raised above flood mapped level plus freeboard. Consider the example where a broken condenser at 6 ft is in an 8 ft flood level zone. Item C2 e) should propose the new elevation to be 9.2’ or so to allow the HVAC technician to conform even if off slightly. At the bottom of Section D, provide comments about what kind of building permit/ M&E work is proposed.

Always fill in N/A (Not Applicable) to cells instead of leaving them blank. Anticipate that the Flood Plain Manager and possibly their engineering consultants will need time to review submitted Elevation Certificates. This is especially true after a flooding event. By having an unsigned draft of your Elevation Certificate saved besides the digitally signed version that cannot be revised, form revision completion time can be saved. Sometimes the Owner’s digital signature might not be required, so keep communication lines open with the Flood Plain Manager by clear emails. Do not fill out the parts of the form to be filled out by the municipality, i.e.. Section G.

Once an Elevation Certificate is approved for publishing and Building Permit purposes, an approval form like the one below will be sent to the Professional Engineer. Later, check the online database to be sure that your Elevation Certificate is properly linked and accurate. Keep your benchmark elevation records for possible future clients in the same neighborhood.

		EC Type:	FINISHED CONSTRUCTION
Building Permit #		Building Use:	RESIDENTIAL
PID:	00[redacted]3	Year Built:	19[redacted]3
Address:	[redacted]1	CRS Audit Year:	2024
Lot #:		Vertcon Conversion:	0.338 -1.11
Flood Zone:	VE/AE	Floodproofing Certificate	n/a
Building Diagram:	5	Area of Crawl/Enc. (BD #2A,2B,3,4,6,7,8 & 9 only):	3750.00
Attached Garage (FC)		Total Net Area of flood openings:	27072.00
Engineered Openings:	N	Total Number of Flood Openings	4

Elevation Checks	Input NGVD	Input NAVD	NAVD Conv.	Calcs		Status
BFE/B9		10.0	10.0	BFE +1' Freeboard		
FFE/ C2.a)		10.7	10.7	FFE -(BFE + 1.0)≥ 0	-0.3	Approved
Top of Next Higher Floor/C2.b)		19.6	19.6	C2b-C2a>5	8.9	Approved
Bottom of lowest member /C2.c)		9.9	9.9	Bott. of lowest mbr -(BFE + 1.0)≥ 0	-1.1	
Attached Garage/C2.d)		n/a	n/a	FFE -(BFE + 1.0)≥ 0		
M&E/C2.e)		11.5	11.5	M&E-(BFE+1)≥ 0	0.5	Approved
LAG/ C2.f)		6.8	6.8	HAG>LAG	0.5	Approved
HAG/ C2.g)		7.3	7.3	FFE>HAG	3.4	Approved
Finished LAG		7.0	7.0	Finished LAG	7.0	
Crown of Road		n/a	n/a	FFE - CR ≥ 1.25		
Design FFE		n/a	n/a	FFE - DFF ≥ 0		
Review Status:	Approved					

Flood Manager Approval Form

End of Elevation Certificate Section

FEMA 50% Rule:

After a flood, the owner of a non-conforming building cannot just rebuild at great expense by keeping damaged items below the flood level where they could be damaged again by a future flood. Non-conforming structures were built before present day flood level requirements and are thus susceptible to flood damage. A small portion can be done in this manner, but not more than half of the value of the property. FEMA (the Federal Emergency Management Agency) therefore has a fifty percent rule. By following this rule, which can be audited and verified by FEMA, local municipalities may enjoy the benefits of NFIP (the National Flood Insurance Program).

The cost of repair, replacement alterations and additions, etc., must be reported to the municipality. This is checked against the appraised market value of the building. It does not include the value of the land, landscaping, swimming pool, etc. The taxing authority's property appraiser has the most current market value on file. If the cost of work is less than half of that value, then the work may proceed. If the costs exceed half the value, the damage is considered "substantial" and the work may not proceed, even if the owner wishes it so. If the owner wishes to proceed, the entire structure must be updated to meet the latest Building Code in force and the current flood plain rules. Such an action can be very cost prohibitive, especially if stilts or substantial fill are required. Sometimes a stilted house surrounded by other low-lying houses looks out of character for a neighborhood. Although future insurance policy rates will be reduced for a building now built to Code and floodplain standards. If the building owner feels that the official appraisal is inaccurate, they may hire an independent licensed appraiser to submit a different market value. More about this is here:
https://www.youtube.com/watch?v=DktKFUQn0ww

Another informative video made after the 2022 Ian hurricane is here:
https://www.youtube.com/watch?v=STTNURLoOls

As an example, consider a non-conforming house near the beach that was built in the 1970's before stricter Building Codes and Floodplain minimum elevations were in force. If the appraised value is $500,000 for the entire property, and the structure itself is worth $250,000, this $250,000 allows up to $124,999 in improvement costs. These costs do count for flood and wind damage, especially to a roof that can be a substantial percentage of the improvement cost.

But the Professional's cost for plans and specifications are not included. Single family dwelling unit homeowners need not use Professional Engineering services, but residential Condominium Association buildings considered "commercial" do require Professional Engineering or Licensed Architect or Surveyor services, etc. And required Elevation Certificates do require a Professional Engineer or Licensed Surveyor or Architect. Check to see if flood insurance covers Professional Engineering fees, even if not contributory to the 50% rule. For a condominium, the Building Official might require lumping several units together to meet the FEMA intent. No owner should suffer if another owner in the same building refuses to sign.

Non-conforming structures with first floors below the flood plain level and freeboard.

The Professional Engineer's role in submitting the FEMA 50% rule documentation may be limited. While the PE may be consulting on the overall condominium damage and design, it is the licensed contractor (in Florida for example) that must submit documentation at the time of building permit application. This is uploaded through the Contractor's portal.

While each municipality may choose to apply the FEMA 50% rule as it so chooses, subject to FEMA approval, a reasonable approach involves submission of three separate forms:

Cost Form
Contractor's Affidavit
Owner's Affidavit

Besides the Cost Analysis *(to follow on the next page)*, the Licensed Contractor must submit a signed and notarized affidavit that the contractor personally inspected the building and discussed the work with the owner. Cost is to pre-damage condition, not an upgrade. Changes (not uncommon) are also to be submitted for re-evaluation. These changes should not cause total cost to exceed the 50% threshold. No work beyond that estimated may be conducted by anyone subject to a fine for the contractor, etc.

The building owner must also submit a notarized affidavit. The owner must agree to the work description submitted, and that the owner requested the contractor to prepare the Cost Estimate. The owner also agrees to re-evaluation of any changes and agrees to penalties if extra work is performed.

A typical cost form prepared by a municipality is shown:

REPAIR/IMPROVEMENT COST FORM

Job Address: _____

Property Owner: _____Property Identification #: _____

This cost estimate of reconstruction/improvement must be prepared by and signed by the contractor or by the owner if the owner acts as the contractor. Owners who act as their own contractors must estimate their labor cost as the current market value for any work they intend to perform, including construction supervision costs.

	Sub-Contractor Bids Bid Amounts	or	Contractor Or Owner Estimates Material Costs	Labor Costs
1. Masonry / Concrete	_____		12. Floor Covering	_____
2. Carpentry Material (rough)	_____		13. Plumbing	_____
3. Combined Labor	_____		14. Shower / Tub / Toilet	_____
4. Roofing	_____		15. Electrical & Light Fixtures	_____
5. Insulation and Weather-strip	_____		16. Concrete	_____
6. Exterior Finish (Stucco)	_____		17. Built-in Appliances	_____
7. Doors, Windows & Shutters	_____		18. HVAC	_____
8. Lumber Finish / Trim Carpentry	_____		19. Paint	_____
9. Hardware	_____		20. Demolition & Removal	_____
10. Drywall	_____		21. Overhead and Profit	_____
11. Cabinets & Countertops (Built-in)	_____		22. Other:	_____

Subtotals _____

Total Estimate Cost (all three subtotals added together)_____

A. A copy of the signed construction contract must be attached to this form.

B. Subcontractor bids may be used for any item of material and/or labor cost breakdown.

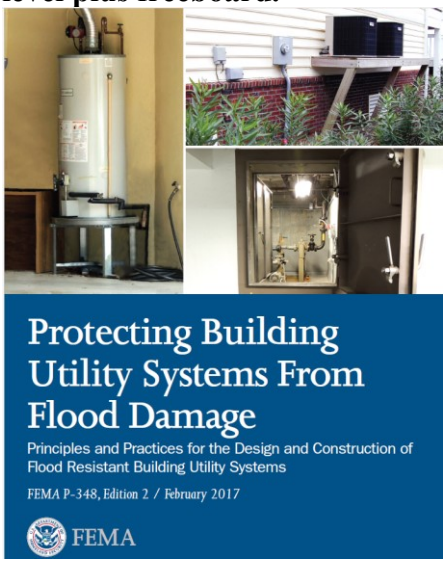
C. Cost backup must be provided for every line-item entry.

D. If any amounts appear in the "Sub-Contractor" column, a copy of each signed and dated bid must accompany this form. For all other costs, you must list the quantity of materials to be installed and their unit cost on a separate sheet that references the line number.

The three items are: Subcontractor costs, material cost and labor cost including overhead/profit. Note that Professional Engineering design plans, specifications and inspection are not included. This form may take time to process since bid and signed contracts and subcontracts must also be included. No building permit may be issued and work cannot start until the FEMA 50% rule forms are approved. Material quantities and unit costs are also included. Subcontractors must also be licensed for the work they perform.

End FEMA 50% rule section

Case Study:
Professional Engineering design to raise and secure air conditioner condensers above flood level plus freeboard.



Refer to FEMA Principles and Practices.

As part of the Elevation Certificate required for the repair of a non-conforming building and its accessories, the Professional Engineer submits the proposed elevation for the condensers in the Mechanical and Equipment section C2 e.) and described in the comments section D. These elevations are transferred to and marked off on the building siding so that the Heating Ventilating and Air Conditioning Contractor has a reference on how high to set the bottom of the condenser.

For the 8-foot flood zone shown below, the design elevation of 9.5 ft is marked on the building near the proposed new air conditioner condenser locations. While only one unit was flipped over, all three units flooded are inoperable.

Blue tape just below the siding marks proposed condenser underside elevation.

Air conditioning is not an essential dwelling requirement although heat is essential, even in warm climates like Florida. As part of the Building Permit application and FEMA 50% rule submission, the condensers are planned to be raised as required. The soft Styrofoam and light concrete standard mounting pad was not robust enough to resist flood forces. Several options were considered to avoid future flood problems. The units must be raised and secured.

Rooftop condensers

Mounting condensers on a flat roof like this was not an option because new sloped metal roofing was recently installed.

Alternatives considered were:

1. Aluminum Brackets.
2. Precast Concrete Pads
3. Cast-in Place Concrete pads

1, Aluminum Brackets.

Proposed bracket screwed into concrete floor beam

This alternative provides strength for condensers that must be installed with bottom even with the bottom of the siding as in the example photo above (at elevation 9.5 ft). Proper anchoring screws into concrete would be used.

But attaching to the building will result in some vibration felt inside the condo, even with rubber vibration dampeners.

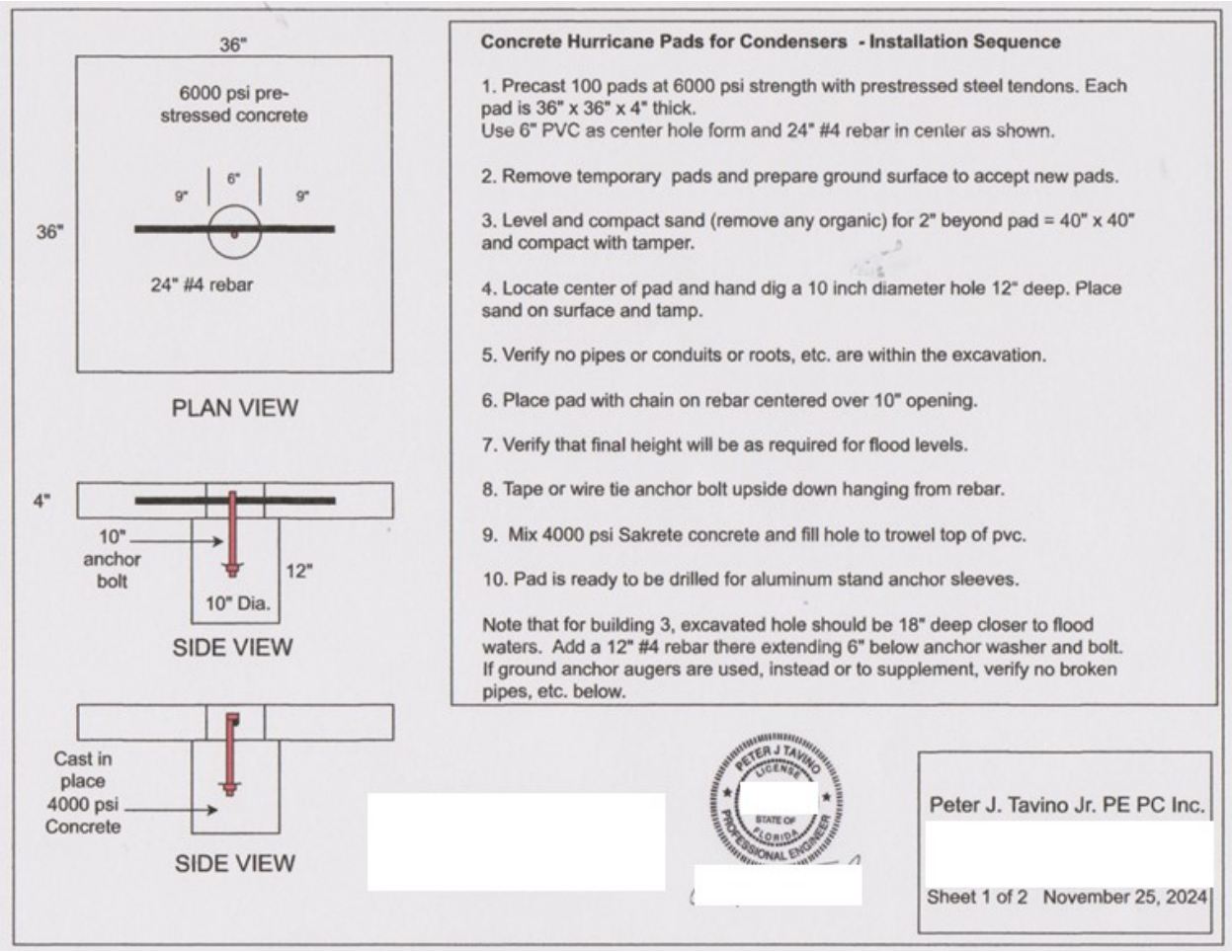
Blue tape marks required elevation at 11.5 ft in 10 ft flood zone

For higher areas, attaching to the siding two by four wood stud walls also presents vibration and waterproofing challenges. Flat boards of ¾ inch pressure treated plywood or plastic sheathing mounts into the wall studs would contribute extra strength and help minimize water intrusion through the siding. But mounting a bracket with top at the blue tape elevation and dampening the vibration was not preferred by the homeowners for vibration and aesthetic reasons despite the potential cost savings.

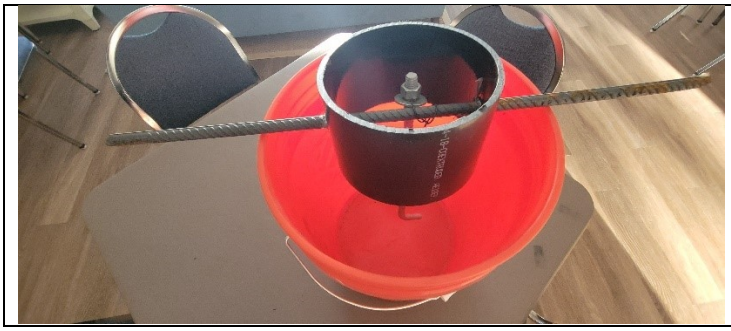
2. Precast Concrete Pads

Because conventional store-bought condenser pads with Styrofoam were not preferred, a heavier concrete pad was considered as Alternative 2. Connecting to the ground within the flood level, where a few feet of seawater and sand could be expected to act upon the assembly below the base flood level presents challenges. Having an anchoring key attached to the 36" x 36" concrete pad complicates the precast process and transport. One design proposed flat precast pads that could be formed, poured and shipped easily. Each 4" thick pad weighs about 400 pounds. The center would be left hollow with a # 4 rebar 24^ long running through the center. This is used as a lifting bar for a chain attached to a tractor. The 6000-psi precast concrete with pretension steel tendons is robust.

Once on site, the anchoring key can be dug and the anchoring portion of concrete is cast in place. A vertical anchor bolt connects the key to the horizontal rebar. Design plan is as follows:



Design plan sheet 1 of 2 for precast concrete pad with cast-in-place anchor key



Rebar and anchor bolt form with bucket size pit to be dug

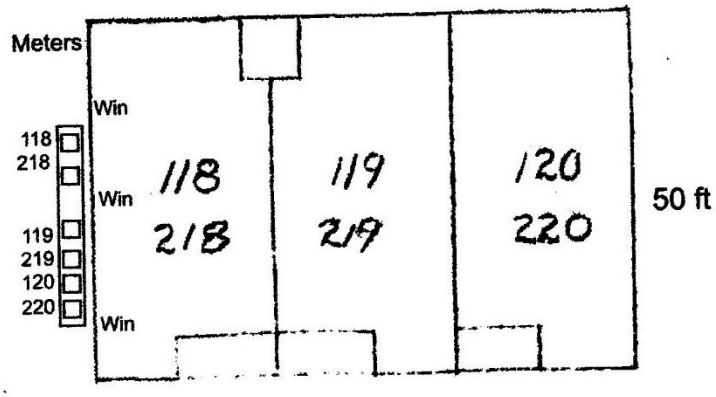
Auger anchors

Auger anchors are not preferred because of unknown plastic underground pipes that could be pierced unknowingly. Underground water can drain into sand without notice until water bill goes up.

A precast concrete plant operation

3. Cast-in-Place Concrete

The third alternative for Professional Engineers to study is Cast-in-place Concrete. Instead of glueing precast pads together for additional support, wood forms can be set and concrete poured into larger castings. A typical site plan for three first floor and three second floor units is shown. Line set runs are of efficient length. Accessing the concrete truck to the residential sites on parking lot pavement is a consideration.



6 air conditioner condensers on a single cast-in-place pad

Cast-in-place pad at grade level with expansion joints

Vertical Stands

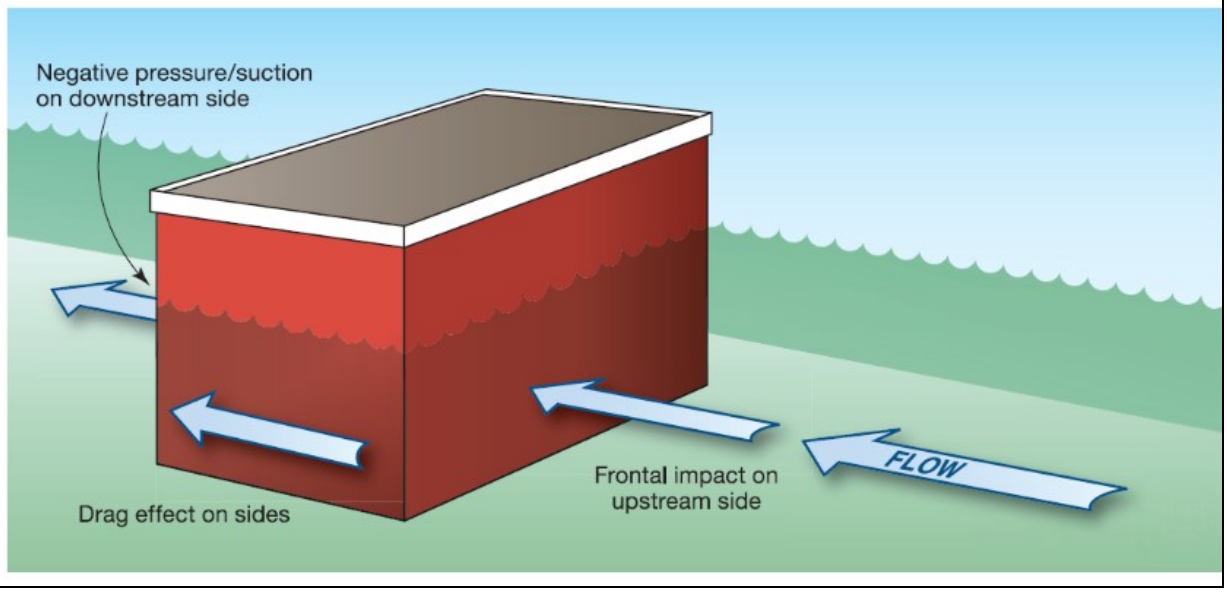
One way to avoid building vibration is to use concrete pads and lift the condenser units onto sturdy aluminum stands or pedestal as shown below.

Typical 24" riser stand

Figure 3-1. Air conditioning compressor elevated on a pedestal.

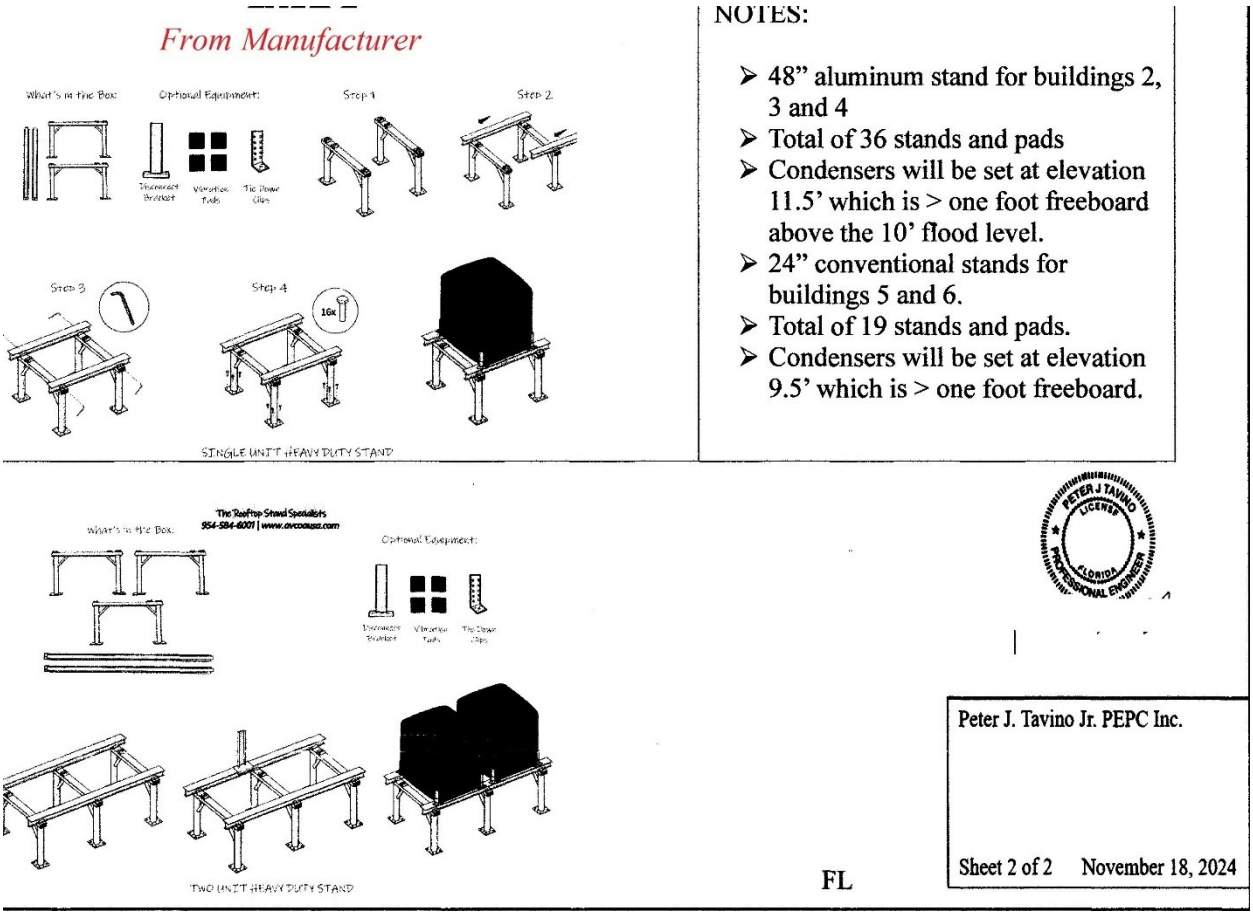
Pedestal image from FEMA

Moving floodwater imposes hydrodynamic forces on submerged foundations and building elements, including utility system components located below flood levels. Hydrodynamic forces can destroy solid walls and dislodge buildings with inadequate connections or load paths. Moving floodwater can also transport large quantities of sediment and debris that can cause additional damage.



Moving water narrative description above & Forces diagram are from FEMA P-348 cited above

Note that stands pass these forces through compared to pedestals that must resist them.



Riser Stand design plan

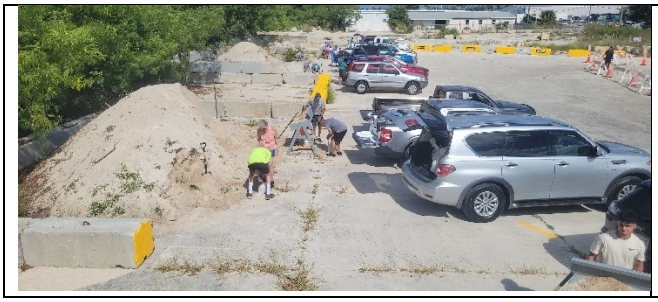
For higher aluminum stand requirements (in the VE 10 flood zone), a 48-inch stand can be conventionally supplied without additional Professional Engineer design review. An elevation table shows where 24-inch stands can be used and where 48-inch stands must be used. In order to deter mold and add to resident comfort, temporary building permits can be issued to install condensers below the required higher elevation and matching indoor air handling units above such level. The Building Department may give time until the next hurricane season to complete the necessary improvements.

Building Departments have also been known to defer building permit application fees in certain flood damaged circumstances. While this primarily affects the Contractor, the knowledgeable consulting Professional Engineer can be aware accordingly.

End Case Study section

Preparation Steps ahead of a forecast Flood event

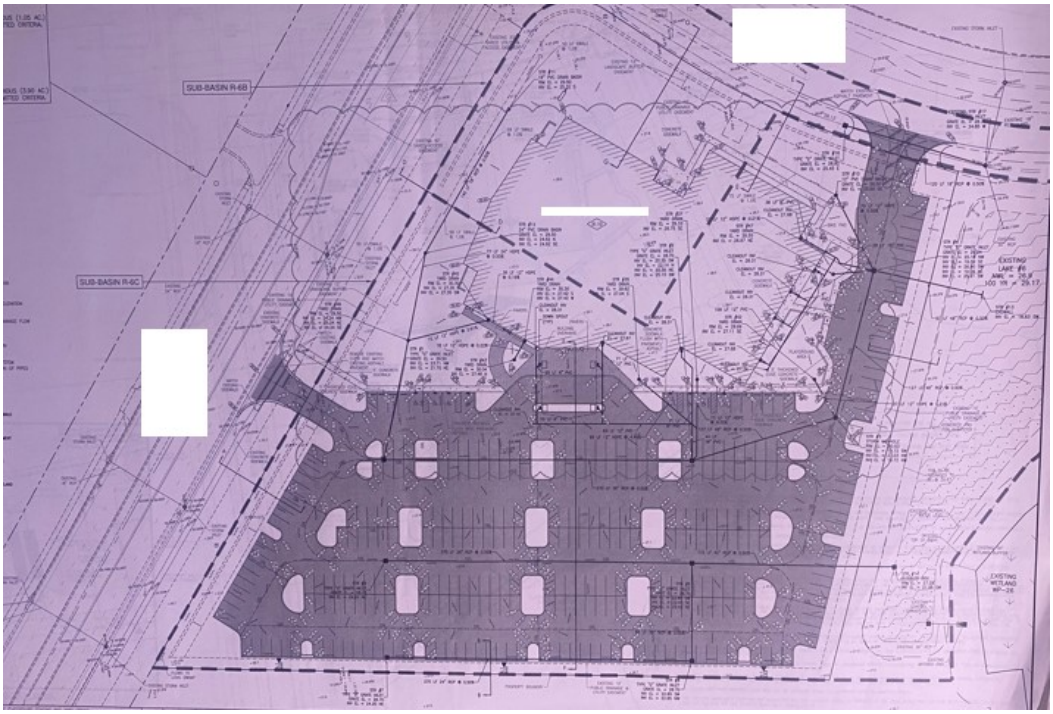
Communities get adequate warning when severe weather events will occur. Professional Engineers should be aware that sandbag resources may be available to residents who are willing to fill canvas bags themselves. These sandbags can sometimes make the difference between water entering an unsealed doorway or not. They should be available to the public over the weekend before the forecast storm.



Unsalted sand and shovels provided by the municipality

A carful of the allowed 10 bags

This is a typical engineered site and drainage plan. Prepared by a Professional Engineer, it is reviewed for approval by the governing municipality. Grade and pipe invert elevations are shown to keep flood waters off the first floor. Before a storm, catch basin grates and outfalls should be checked to be clear of flow stopping debris.



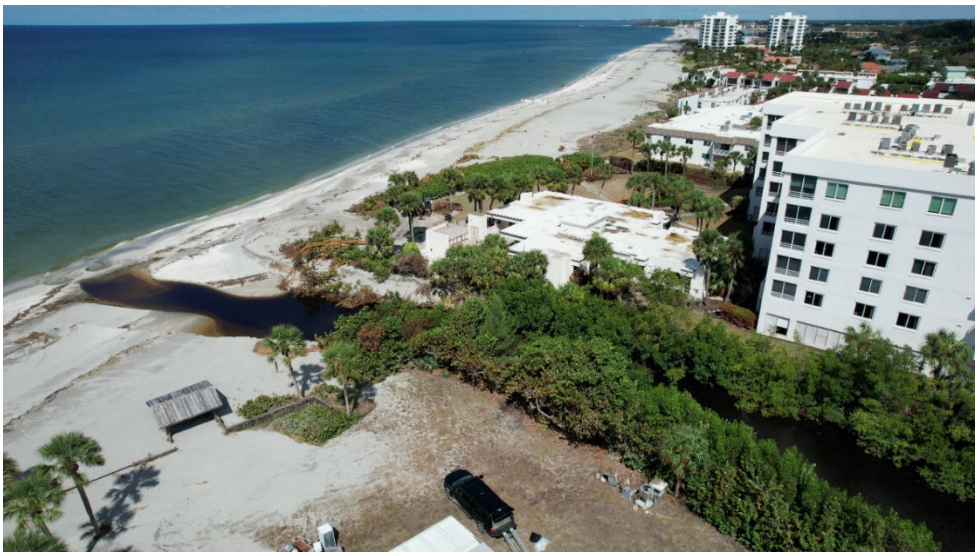
Typical on file site plan showing stormwater conveyance system beneath a parking lot.

Clogged Drainage System

Flooding can also be accompanied by sand deposits over grass and pavement. Sand cover then occupies space that forces seawater to surge higher above it, resulting in greater damage by sand cover and flooding. Returning the sand to the beach involves heavy equipment but not Professional Engineering.

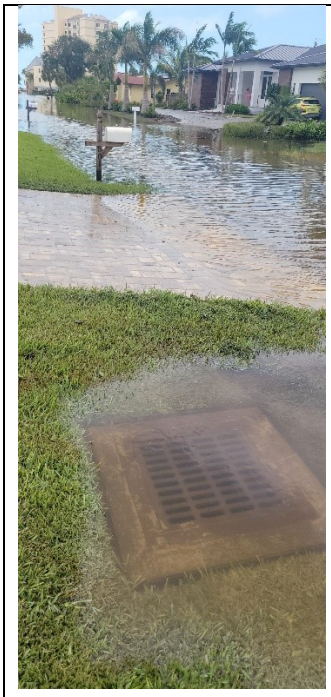
Before and after pictures.
Sand from flood covers the grass.

Beach sand can also dam up natural and pipe drainage outlets where they intersect they shoreline.



Drainage channel outfall that is part of a network of swales and pipes draining into it.

This outfall shown above was rendered inoperable after sand pushed up over the outlet at the beach water line on the left. Because the channel was clogged, catch basins draining to the channel were still not working the day after a storm when most other waters had receded. This caused water on roadways to have no drainage at all. Residents tried in vain to shovel a pathway at the shoreline that was later cleared by machine excavator.



Inoperable catch basin due to clogging at the distant beach *A field inlet backed up elsewhere*

Professional Engineers tasked with floodwater preparation should ensure that all aspects of the drainage system are unclogged with palm tree branch fronds, etc. For outlets into the sea, excavating contractors should be on call as soon as possible to keep waterways open to flow. Consider the use of robotic excavator or dozer equipment to clear outlets that are dammed with surged beach sand if conditions are too hazardous for human operators. Speedy removal of beach sand from damming up outfalls and causing water backup onto first floors can save countless dollars and distress. The Professional Engineer understands storage capacity of low areas that can detain water until it is properly allowed to drain free by an unimpeded outfall.

Flood water, which entered a residential dwelling.

Conclusion

After a major flood event, there can be much work for the Professional Engineer to help expedite repairs and improvements to damaged buildings. Expecting to ask a busy municipal building or flood department for guidance on how to prepare an Elevation Certificate for the first time is unfair to the personnel. It is wise to understand how to set a certifiable elevation to a building and how to complete the FEMA Elevation Certificate required. Practicing before an emergency call is made to your firm can help.

If you are working with a condominium community that requires Professional Engineering, unlike a single-family homeowner who does not, stay in good communication with the Board of Directors to be sure to design sturdy flood resistant facility components that are aesthetically pleasing to them.

Be aware of flood preparation measures that can be undertaken ahead of forecast flooding to minimize damage. Especially ensure that drainage conduits are clear and will be re-cleared quickly to convey water flow.

Thank you to all Professional Engineers who help make our low-lying buildings safer for future use.