



Protecting Manufactured Homes from Floods and Other Hazards

A Multi-Hazard Foundation and Installation Guide

FEMA P-85, Second Edition / November 2009



FEMA

3 REGULATORY REQUIREMENTS

Figure 3-2(c). Sample FIS Flood Profile.

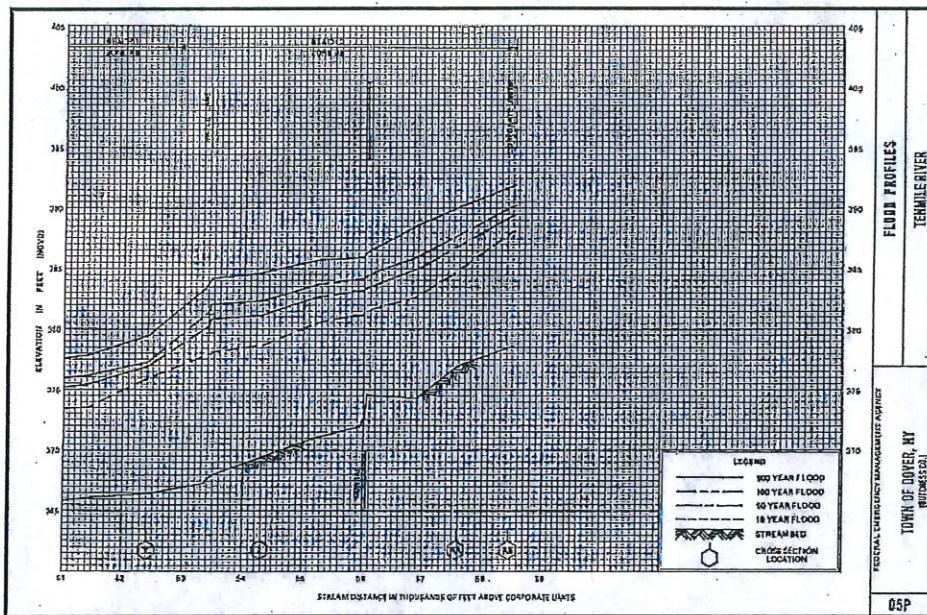


Table 3-1. Common SFHA Designations for Riverine or Inland Flood Zones

Zone	Description
Flood Risk Zones	
A	Areas subject to inundation by the 1-percent annual chance flood event. Because detailed hydraulic analyses are not used, no BFE or depths are shown.
AE and A1-30 ¹	Areas subject to inundation by the 1-percent annual chance flood event determined by detailed methods. BFEs are shown.
AH and AO	Areas subject to inundation from the 1-percent annual chance flood that have flood depths of between 1 and 3 feet. AO zones can be either ponding areas or sheet flow and are assigned a base flood depth measured in feet above the ground. AH zones are generally ponding areas and are assigned a BFE.

¹ Zone designations found on older FIRMS have been replaced by the designation listed in the same box above them.

Table 3-2. Common SFHA Designations for Coastal Flood Areas

Zone	Description
Flood Risk Zones	
V	Areas subject to inundation from the 1-percent annual chance flood in coastal areas where there is a velocity hazard due to wave action and, by definition, the entire Primary Frontal Dune. No BFEs have been determined.
VE V1-30 ¹	Areas subject to inundation from the 1-percent annual chance flood in coastal areas where there is a velocity hazard due to wave action. BFEs have been determined and are shown on the FIRM.

¹ Zone designations found on older FIRMs have been replaced by the designation listed in the same box above them.

When BFEs or floodway data are obtained for manufactured home sites, the manufactured home must meet the elevation and floodway standards described in Sections 3.6.2 and 3.6.9.

3.6.2 Elevation in A, A1-30, AE, and AH Zones

Most manufactured home placements are subject to the same performance standards as typically built residential structures. The performance standard for the placement of these manufactured homes is addressed in this section. An exception has been made for the placement of manufactured homes in existing manufactured home parks or subdivisions which is addressed in Section 3.6.3.

The NFIP requires that manufactured homes placed or substantially improved in Zones A1-30, AH, or AE on the community's FIRM on sites:

- (i) "Outside of a manufactured home park or subdivision,
- (ii) In a new manufactured home park or subdivision,
- (iii) In an expansion to an existing manufactured home park or subdivision, or
- (iv) In an existing manufactured home park or subdivision on which a manufactured home has incurred substantial damage as the result of a flood,

be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated to or above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse and lateral movement." [44 CFR 60.3(c)(6)]

This requirement establishes the basic elevation and anchoring standards that apply to most manufactured home placements, including those outside of manufactured home parks and subdivisions and in new manufactured home parks and subdivisions. These manufactured homes must have their lowest floors elevated to or above the BFE. These requirements also apply to manufactured homes placed in expansions to existing manufactured home parks and on lots where manufactured homes are substantially damaged by flood. Once a manufactured home in an existing manufactured home park or subdivision is substantially damaged by flood, from that point on all manufactured homes placed on that lot must be elevated to or above the BFE.

The best way to meet the elevation requirement described above is to elevate the bottom of the manufactured home steel frame to the BFE. The manufactured home must be securely anchored to an adequately anchored foundation system to resist flotation, collapse, or lateral movement. Section 3.6.5 and Chapter 7 address anchoring in more detail.

As with stick built housing, all parts of the manufactured home below the BFE must be constructed with

This guide recommends for A zones the best practice of placing the bottom of the manufactured home's steel frame at the BFE and not the lowest floor of the manufactured home in order to prevent flood damage to the floor and other interior finishes and contents (Figure 3-3).

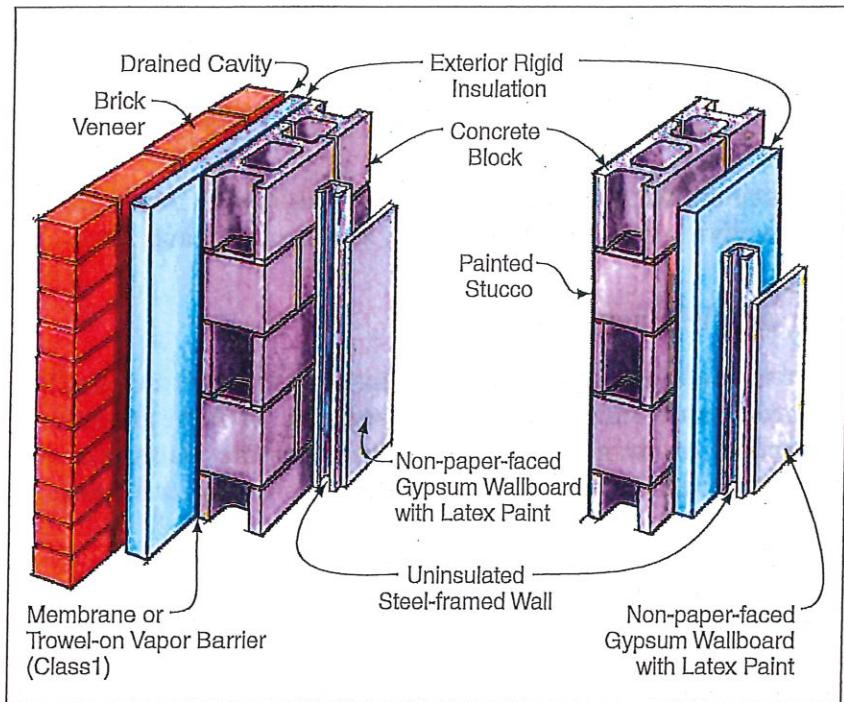


Figure 11. Recommended flood-resistant exterior mass wall construction. The following materials and methods will limit flood damage to exterior mass walls: 1) use concrete masonry with stucco or brick veneer (provide drainage cavity if brick veneer is used); 2) use rigid, closed-cell insulation; 3) use steel framing; and 4) use non-paper-faced gypsum wallboard painted with latex paint (Source: Coastal Contractor Magazine and Building Science Corporation).

- New and replacement manufactured homes should be installed in accordance with the provisions of the 2005 edition of NEPA 225, Model Manufactured Home Installation Standard (<http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=225&cookie%5Ftest=1>). The standard provides flood, wind, and seismic resistant installation procedures. It also calls for elevating A Zone manufactured homes with the bottom of the main chassis frame beam at or above the BFE, not with the top of the floor at the BFE.

How High Above the BFE Should a Building be Elevated?

Ultimately, the building elevation will depend on several factors, all of which must be considered before a final determination is made:

- The accuracy of the BFE shown on the FIRM: If the BFE is suspect, it is probably best to elevate several feet above the BFE; if the BFE is deemed accurate, it may only be necessary to elevate a couple of feet above the BFE.
- Availability of Advisory Base Flood Elevations (ABFEs): ABFEs have been produced for coastal areas following Hurricanes Ivan, Katrina, and Rita. These elevations are intended to be interim recommendations until new FISs can be completed. Some communities have adopted ABFEs, but not all (see the Hurricane Katrina Recovery Advisory posted at http://www.fema.gov/pdf/rebuild/mat/reconst_guidance.pdf).
- Future conditions: Since the FIRM reflects conditions at the time of the FIS, some owners or jurisdictions may wish to consider future conditions (such as sea level rise, wetland loss, shoreline erosion, increased storm frequency/intensity, and levee settlement/failure) when they decide how high to elevate.
- State or local requirements: The state or local jurisdiction may require a minimum freeboard through its floodplain management regulations.
- Building code requirements: The International Building Code (IBC) requires buildings be designed and constructed in accordance with ASCE 24 (*Standard for Flood Resistant Design and Construction*). ASCE 24 requires between 0 and 2 feet of freeboard, depending on the building importance and the edition of ASCE 24 referenced.³
- Critical and essential facilities: Given the importance of these facilities, some of which must remain operational during a hurricane, they should be elevated higher than most commercial and residential buildings.

³The 1998 edition of ASCE 24 is referenced by the 2003 edition of the IBC, and requires between 0 and 1 feet of freeboard. The 2005 edition of ASCE 24 is referenced by the 2006 edition of the IBC, and requires between 0 and 2 feet of freeboard.

- Single block stack (8 inch by 16 inch) on concrete footing or ABS pad
 Double block stack (16 inch by 16 inch) on concrete footing or ABS pad

Table 8-2. Recommended Manufactured Home Foundation Selection for Riverine Flood Zones (and maximum flood flow velocity)

Riverine Flooding			
Flood Zone/Foundation Type		Floodway ¹	A, AE, AE1-30, AO/AH
Steel pier			✓ $V_{max} = 1.00 \text{ fps}$
Dry-stacked masonry block	Single block stack	Do Not Use	✓ $V_{max} = 1.25 \text{ fps}^2$
	Double block stack	Do Not Use	✓ $V_{max} = 1.75 \text{ fps}^3$
Dry-stacked masonry block with surface-bonded mortar	Single block stack	Do Not Use	✓ $V_{max} = 2.00 \text{ fps}$
	Double block stack	Do Not Use	✓ $V_{max} = 3.00 \text{ fps}$
Mortar or adhesive-bonded masonry block	Single block stack	Do Not Use	✓ $V_{max} = 2.50 \text{ fps}$
	Double block stack	Do Not Use	✓ $V_{max} = 3.00 \text{ fps}$
Reinforced and grouted masonry block	Single block stack	Do Not Use	✓ $V_{max} = 5.00 \text{ fps}$
	Double block stack	Do Not Use	✓ $V_{max} = 5.00 \text{ fps}$
Fill/slab		Do Not Use	✓
Posts		Do Not Use	✓ ⁴
Perimeter foundation walls		Do Not Use	✓
Piles ⁵		✓	✓

¹ Any construction in the floodway requires certification that the construction will not cause a rise in flood levels.

² V_{max} shown for single stack block on concrete pad or footing. $V_{max} = 1.00 \text{ fps}$ for single stack block on ABS pad.

³ V_{max} shown for double stack block on concrete pad or footing. $V_{max} = 1.25 \text{ fps}$ for double stack block on ABS pad.

⁴ Scour protection is recommended around shallow foundations where velocities exceed 2 fps.

⁵ Pile foundations are suggested for all sites exposed to flood velocities greater than 5 fps unless designed by a licensed engineer or architect.

✓ = OK

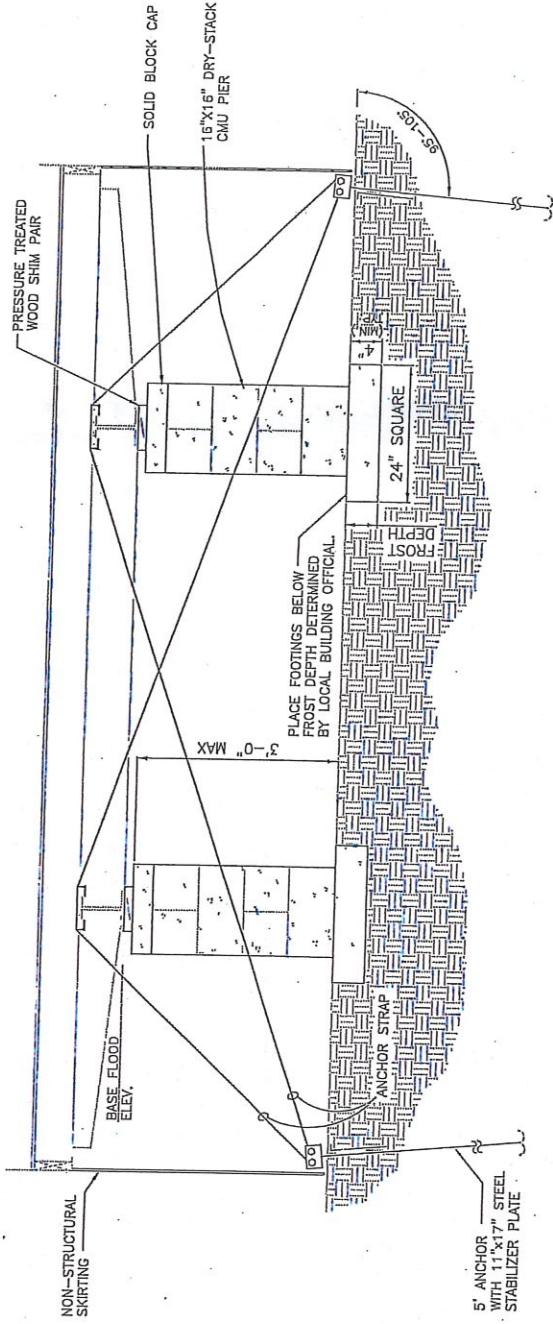
V_{max} = maximum design flood velocity (ft/sec) for foundation type

Single stack (8 inch by 16 inch)

Double stack (16 inch by 16 inch)

ANCHOR SPACING

FOR STANDARD PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 2,000 LBS
FOR ALTERNATE PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 1,500 LBS



GROUND ANCHOR AND PIER DETAIL (SINGLE UNIT)
NOT TO SCALE - PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

GASP90-1

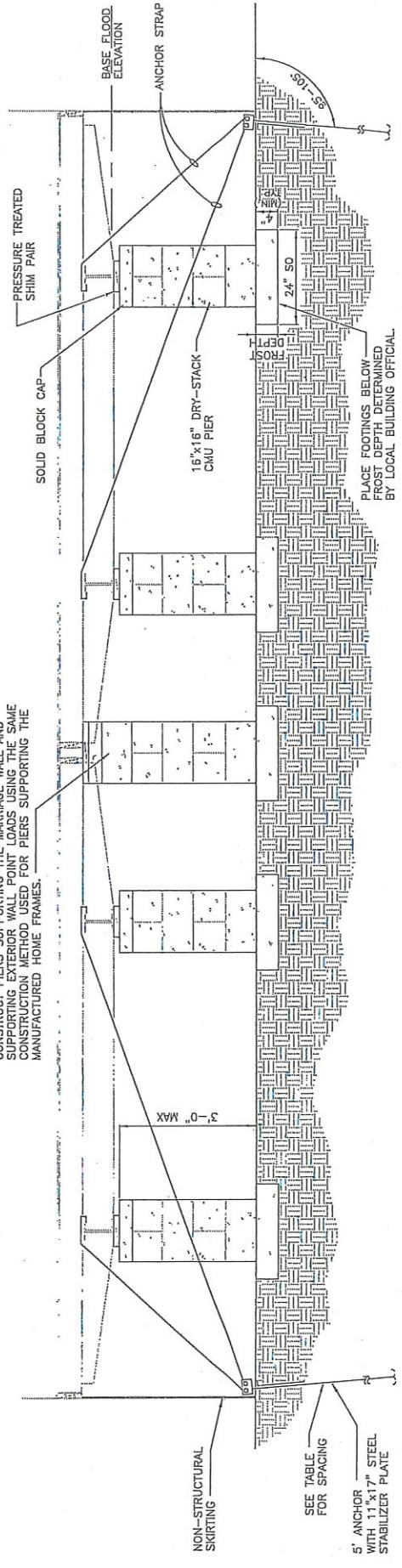
SEE ALTERNATIVE PIER DETAILS FOR FLOOD VELOCITIES GREATER THAN 1.75 FPS. SHEET APD-1.1
SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1.1

Sept 2008
FEMA 85 GASp90-1.2

ANCHOR SPACING

FOR STANDARD PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 2,000 LBS
FOR ALTERNATIVE PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 1,500 LBS

CONSTRUCT PIERS SUPPORTING THE MARRIAGE WALL AND
SUPPORTING EXTERIOR WALL POINT LOADS USING THE SAME
CONSTRUCTION METHOD USED FOR PIERS SUPPORTING THE
MANUFACTURED HOME FRAMES.



SEE ALTERNATIVE PIER DETAILS FOR FLOOD VELOCITIES GREATER THAN 1.75 FPS. SHEET APD-1.1
SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1.1

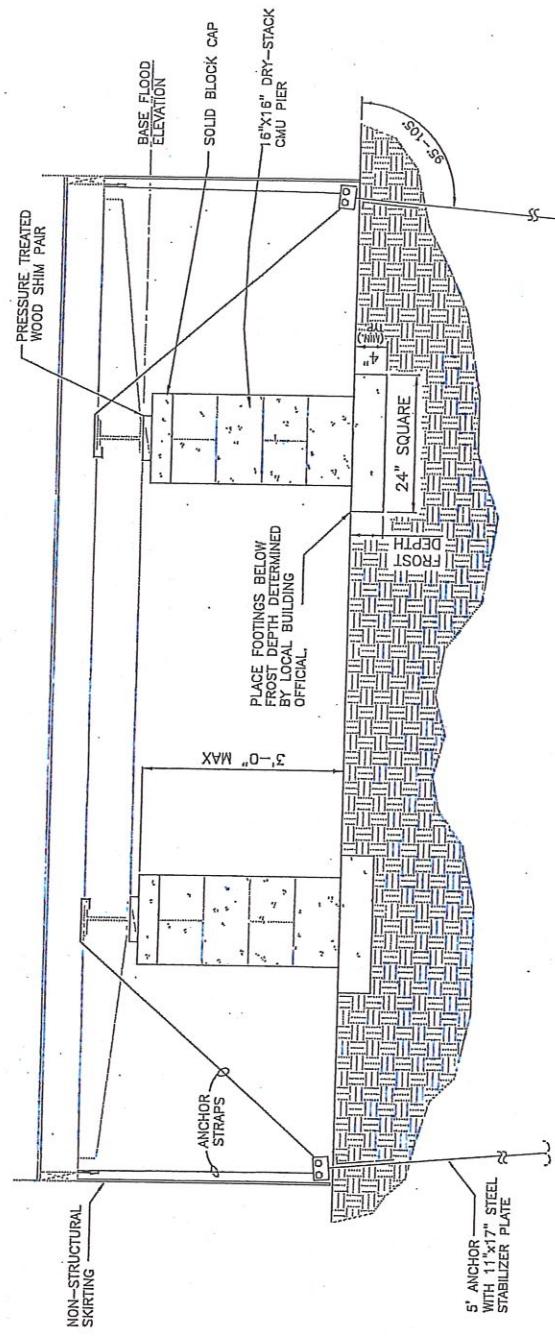
NOT TO SCALE - PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

FEMA 85 GASP90-2.2

Sept 2009

ANCHOR SPACING

FOR STANDARD PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 2,000 LBS
FOR ALTERNATIVE PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 1,500 LBS



GROUND ANCHOR AND PIER DETAIL (SINGLE UNIT)
NOT TO SCALE

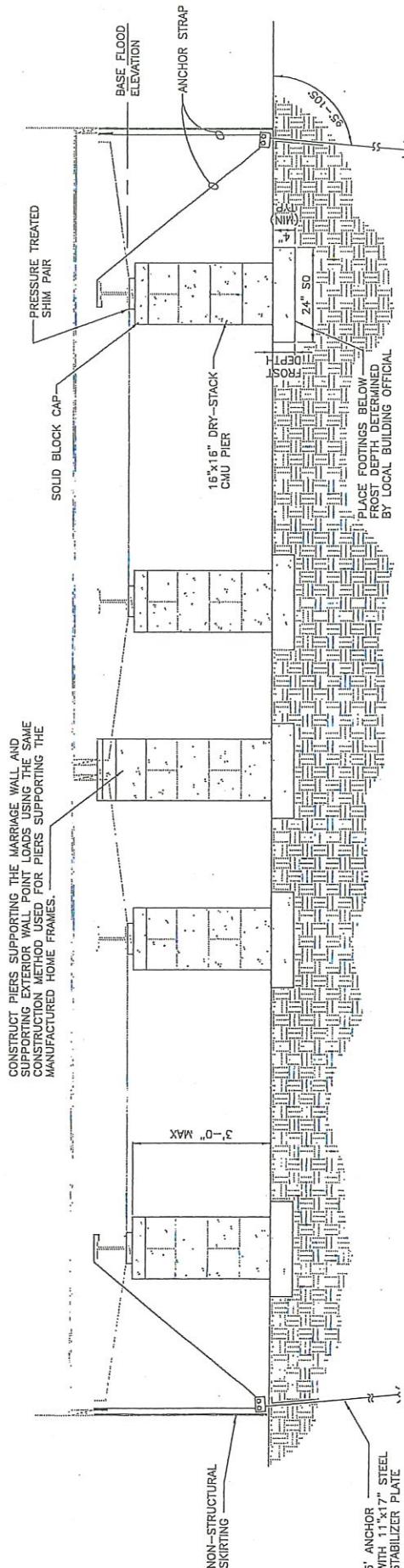
GASP110/130/150-1

SEE ALTERNATIVE PIER DETAILS FOR FLOOD VELOCITIES
GREATER THAN 1.75 FPS. SHEET APD-1.1
SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1.1

Sept 2009
FEMA 85 GASP110/130/150-1.2

ANCHOR SPACING

FOR STANDARD PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 2,000 LBS
FOR ALTERNATE PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 1,500 LBS



SEE ALTERNATIVE PIER DETAILS FOR VELOCITIES GREATER THAN 1.75 FPS. SHEET APD 1.1
SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1-1.

NOT TO SCALE - PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

Sept. 2009

FEMA 85 GASPI10/130/150-2.2

SP10/130/150-1

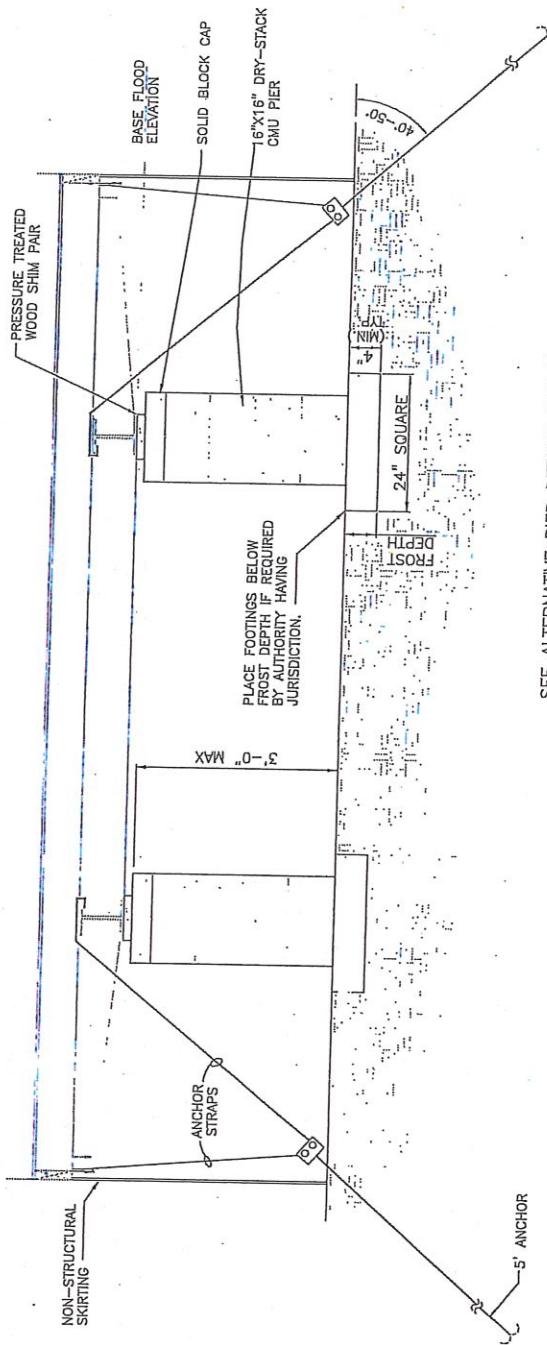
SEE ALTERNATIVE PIER DETAILS FOR VELOCITIES GREATER THAN 1.75 FPS. SHEET APD 1.1

SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,

DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1-1.

ANCHOR SPACING

FOR STANDARD PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 3,150 LBS
FOR ALTERNATE PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 2,000 LBS



GROUND ANCHOR AND PIER DETAIL (SINGLE UNIT)

NOT TO SCALE

PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

SEE ALTERNATIVE PIER DETAILS FOR FLOOD VELOCITIES
GREATER THAN 1.75 FPS. SHEET APD-1.1
SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1.1

FEMA 85 GA110/130/150-1.2

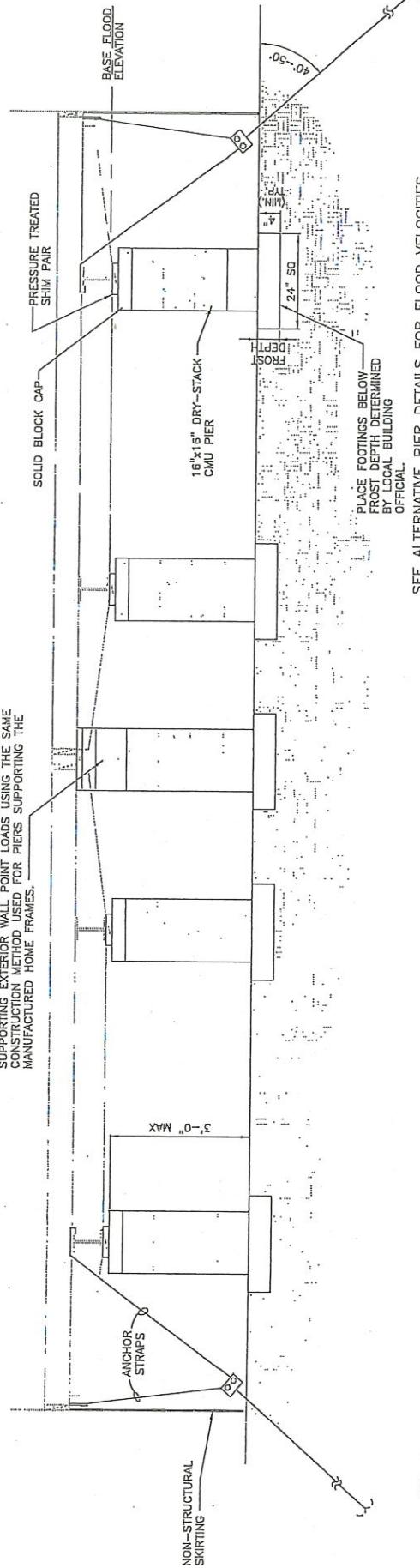
Sep. 2009

GA110/130/150-1

ANCHOR SPACING

FOR STANDARD PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 3,150 LBS
FOR ALTERNATE PIER - PLEASE SEE TABLES IN SHEET AS1.1 WITH ANCHOR STRENGTH 2,000 LBS

CONSTRUCT PIERS SUPPORTING THE MARRIAGE WALL AND
SUPPORTING EXTERIOR WALL POINT LOADS USING THE SAME
CONSTRUCTION METHOD USED FOR PIERS SUPPORTING THE
MANUFACTURED HOME FRAMES.



GROUND ANCHOR AND PIER DETAIL (DOUBLE UNIT)

NOT TO SCALE - PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

FEMA 85 GA110/130/150-2.2

Sept 2008

SEE ALTERNATIVE PIER DETAILS FOR FLOOD VELOCITIES
GREATER THAN 1.75 FPS. SHEET APD-1.1

SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,

SHEET GN-1.1

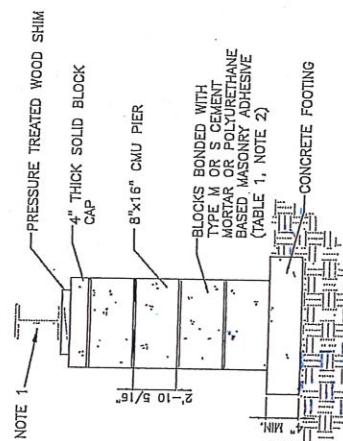
Table 1:Summary of Maximum Flood Velocities for Alternative Masonry Pier Designs.

Masonry Pier Construction	Dry-Stack	Dry-Stack Face Mortar	Bonded ² Stack	Fully Grouted, Reinforced and Anchored to Concrete Foundation
Single Stack	1.00 fps ³	2.00 fps	2.50 fps	5.00 fps
Double Stack	1.25 fps ⁴ 1.75 fps	3.00 fps	3.00 fps	5.00 fps

Velocities are the maximum design flood flow for each masonry block pier shown. Design velocity applicable to piers up to 36 inches high. Bonded piers use Type M or S Portland cement and lime mortar to adhere horizontal and vertical joints between block. Polyurethane based masonry adhesive certified by a recognized national agency for use in masonry construction in accordance with the IRC and IBC also may be used. Single block dry-stack pier design velocity applies to piers supported on pads as well as concrete foundations. Design velocity of 1.25 ft/s applies to double block dry-stackd pier supported on pads.

GENERAL NOTE

2. Footing dimensions (W , L , and D) shall be as indicated on applicable foundation type detail sheets.

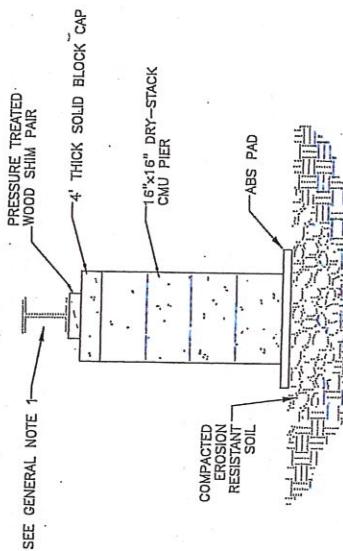


ALTERNATIVE MASONRY PIER DETAIL FOR

FLOOD VELOCITIES UP TO 2.5 FT/SEC

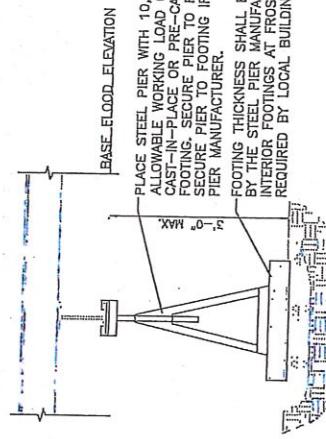
ALTERNATIVE MASONRY PIER DETAIL FOR

EL-900D VEHICULAR UHF TO 1.25 METERS



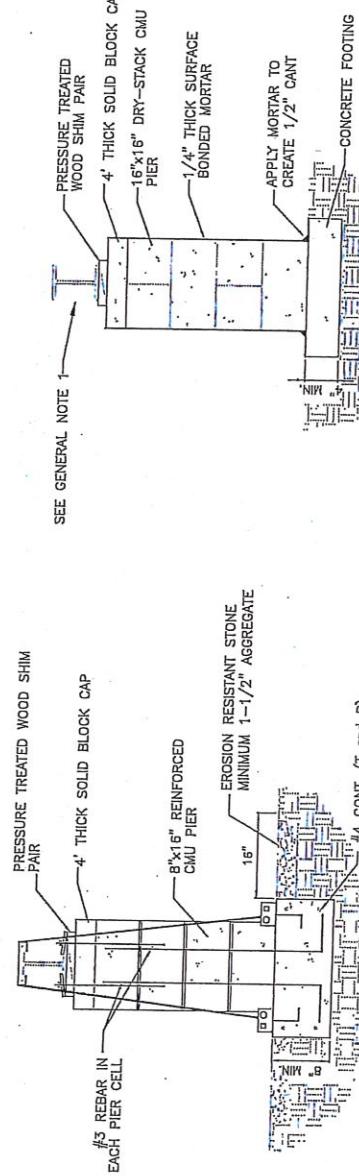
STEEL PIER
ALTERNATIVE FOR EARTH RETAINING

ALTERNATIVE FOR FLOOD VELOCITIES UP TO 1 FT/SEC



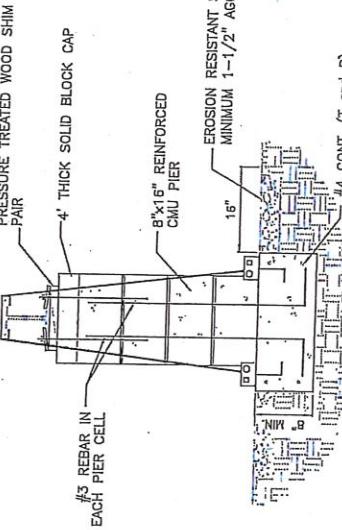
STEEL PIER
ALTERNATIVE FOR

ALTERNATIVE FOR



ALTERNATIVE MASONRY PIER DETAIL FOR

FLOOD VELOCITIES UP TO 3 FT/SEC

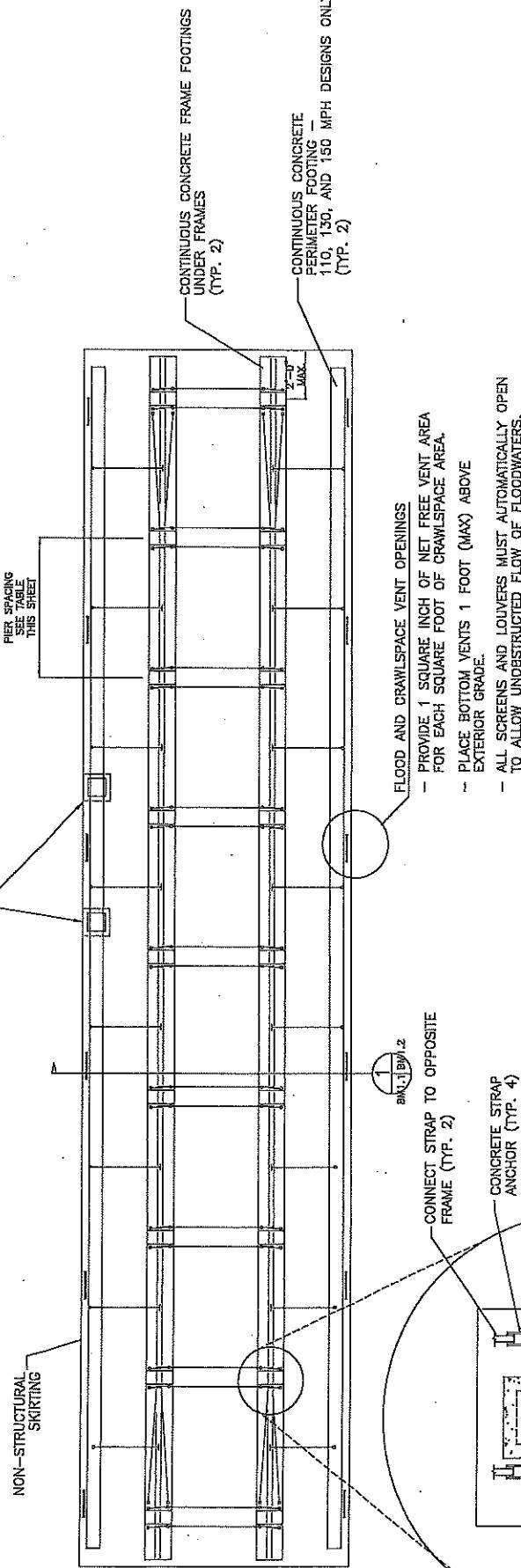


ALTERNATIVE MASONRY PIER DETAIL FOR FLOOD VELOCITIES UP TO 100 MPH

16" BY 8" MASONRY PIER AND CONCRETE FOOTING:
SECURE PIER, FOOTING, AND FRAME WITH STRAPS, FRAME CLIPS,
AND CONCRETE ANCHORS. PROVIDE FRAME CLIP FOR EACH STRAP.
PROVIDE SCOUR PROTECTION AROUND PIERS IN AREAS WHERE
FLOOD VELOCITIES EXCEED 3 FT/SEC USING NON-ERODIBLE SOILS
OR BY PLACING FOOTINGS BELOW THE MAXIMUM SCOUR DEPTH
FOR THE FLOOD VELOCITIES PRESENT.

ALTERNATIVE PIER DETAILS FOR FLOOD VELOCITIES NOT SHOWN ON PLANS

PROVIDE ADDITIONAL SUPPORT AND ANCHORAGE UNDER ENDS OF LARGE OPENINGS AND UNDER CONCENTRATED LOADS AS REQUIRED BY THE MANUFACTURER'S INSTALLATION INSTRUCTIONS. SELECT PIERS TO RESIST THE DESIGN FLOOD VELOCITY PRESENT AT THE SITE.



Braced Masonry Pier Foundation - Pier, Footing and Tie Schedule (Minimum 1,000 lb/ft ² Soil Bearing Capacity Required)					
Wind Speed	Frame Footing (W by D)	Perimeter Footing (W by D)	Pier Spacing ¹	Wall Tie Spacing ^{2,3}	Frame Tie Spacing ^{2,3}
90 mph	16" by 10"	Not Required	10'-0"	Not Required	8'-0"
110 mph	16" by 12"	8" by 16"	10'-0"	10'-8"	5'-4"
130 mph	16" by 12"	12" by 16"	8'-0"	8'-0"	4'-0"
150 mph	16" by 12"	12" by 24"	8'-0"	5'-4"	2'-8"

- 1 Locate end piers within 2'-0" of the ends of the home.
- 2 Wall and frame ties may be connected to a single concrete anchor.
- 3 Install wall and frame straps in other locations if required by the manufacturer.

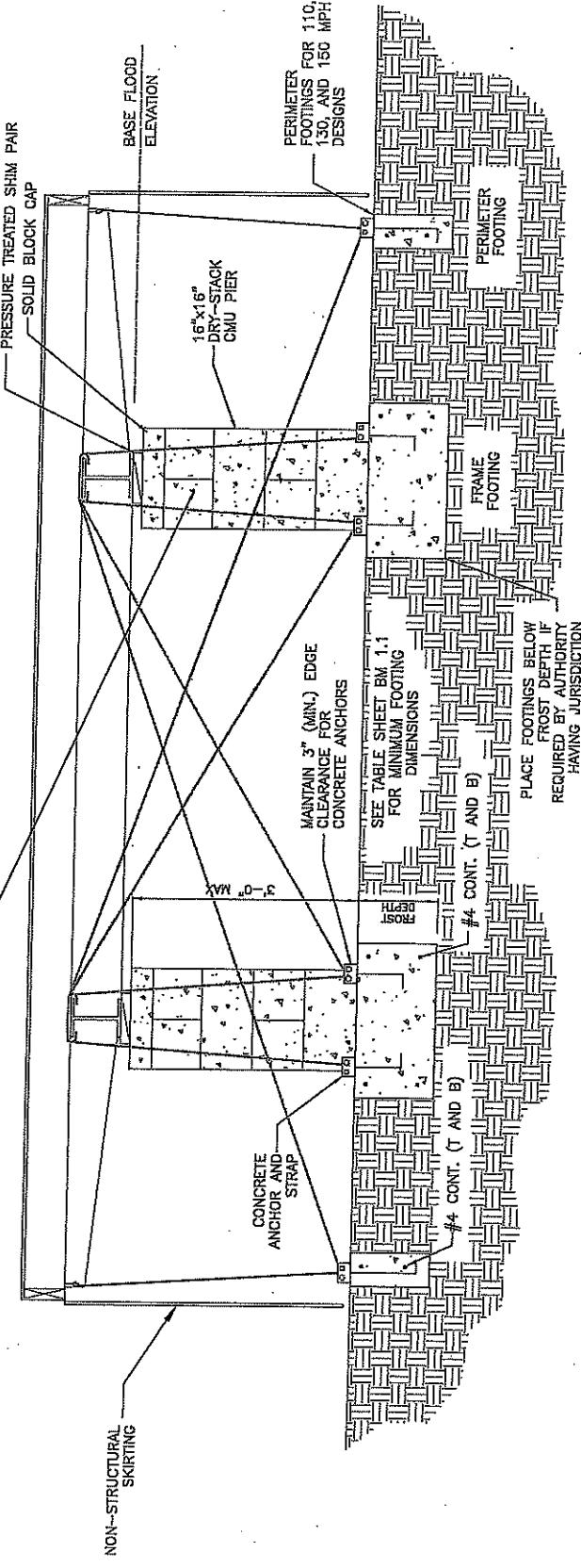
SINGLE UNIT BRACED MASONRY PIER FOUNDATION PLAN

NOT TO SCALE - CONTINUOUS SPREAD FOOTING

SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION.
DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1.1

Sept. 2008
FEMA 85 BM-1.1

16" BY 16" MASONRY PIER AND CAST-IN-PLACE FOOTING.
 SECURE PIER, FOOTING AND FRAME WITH STRAPS, FRAME CLIPS, AND CONCRETE
 ANCHORS. PROVIDE FRAME CLIP FOR EACH STRAP.
 FOOTINGS SHALL BE CONTINUOUS CAST-IN-PLACE CONCRETE. PROVIDE FOOTINGS
 UNDER HOUSE FRAMES FOR ALL WIND ZONES UNDER PERIMETER WALLS FOR 110,
 130, AND 150 MPH WIND ZONES. CONTINUE ALL FOOTINGS TO APPROXIMATELY 6"
 FROM THE ENDS OF THE HOME. SEE BRACED MASONRY PIER FOUNDATION - PIER,
 FOOTING, AND TIE SCHEDULE FOR PIER SPACING AND FOOTING DIMENSIONS.



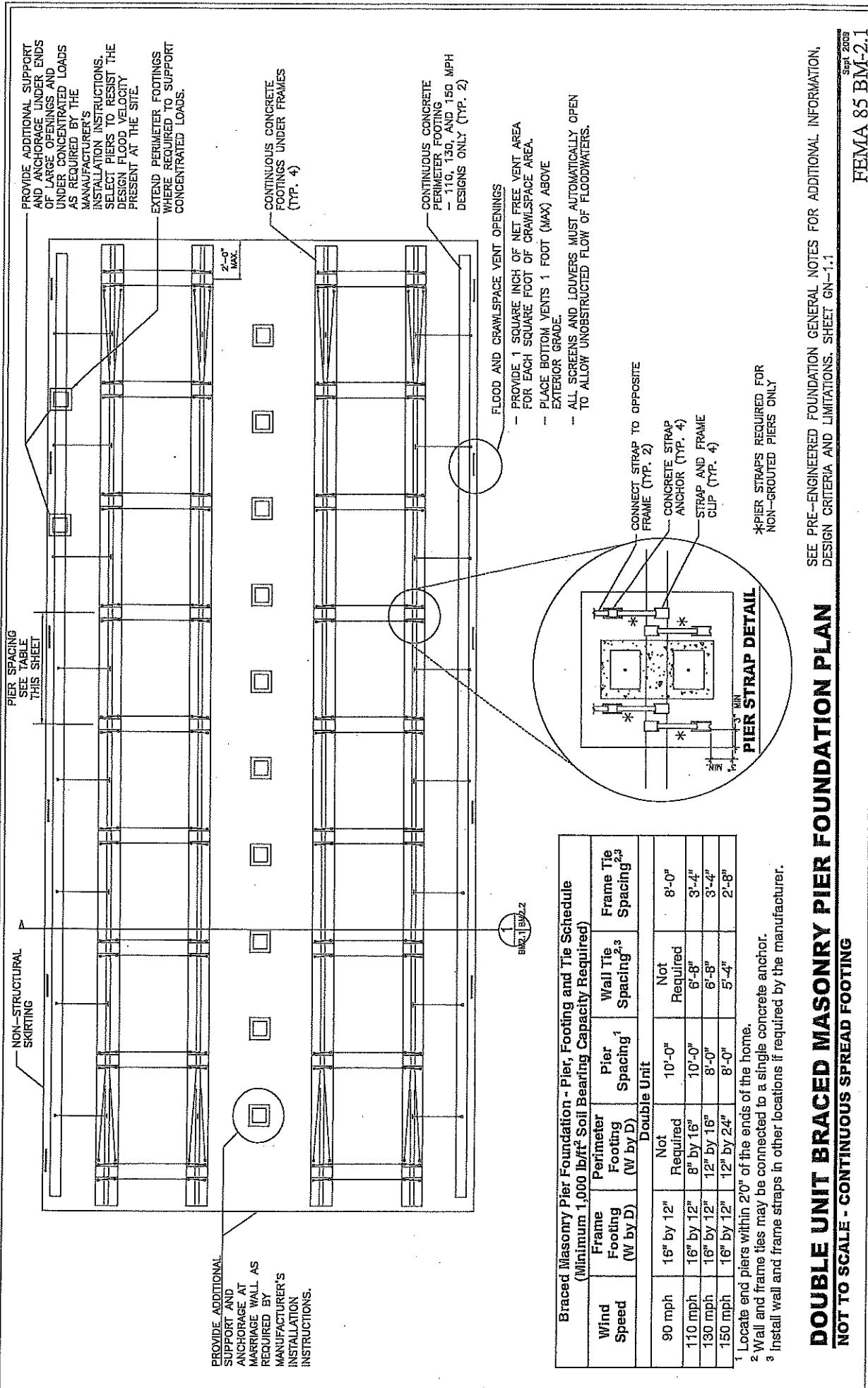
1
B-1-B-2

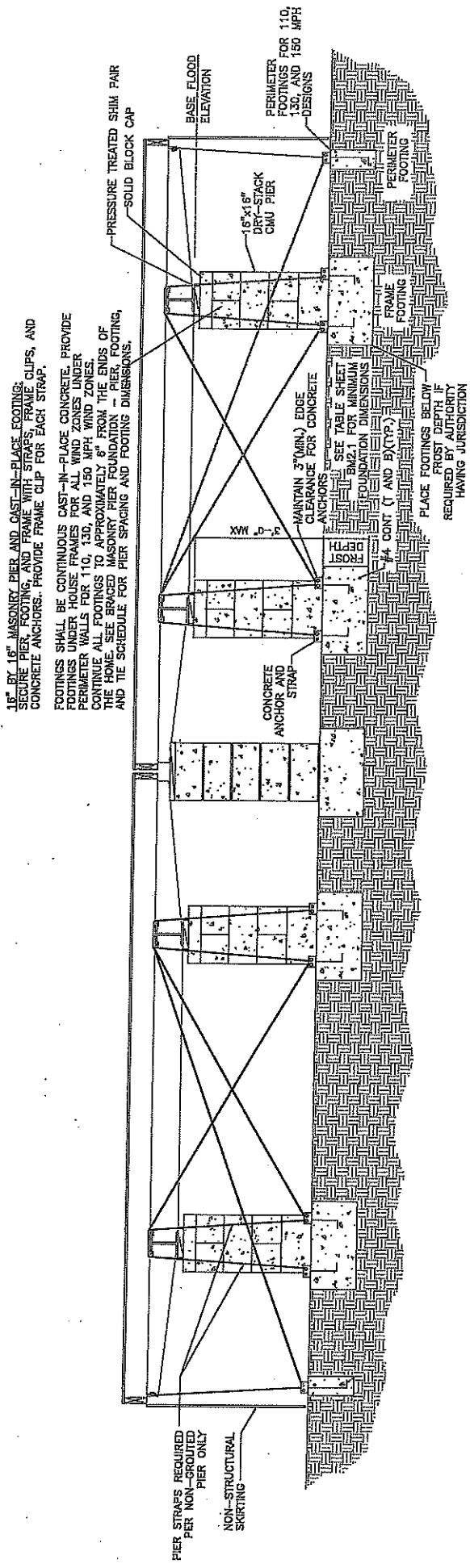
BRACED MASONRY PIER DETAIL

NOT TO SCALE - PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
 DESIGN CRITERIA AND LIMITATIONS. SHEET GN-1.1

FEMA 85 BM-1.2
Sept 2008





BRACED MASONRY PIER DETAIL
NOT TO SCALE - PIER CONSTRUCTION FOR FLOOD VELOCITIES UP TO 1.75 FEET PER SECOND SHOWN

SEE PRE-ENGINEERED FOUNDATION GENERAL NOTES FOR ADDITIONAL INFORMATION,
DESIGN CRITERIA AND LIMITATIONS, SHEET GN-1.1

Sept 2008
FEMA 85 BM-2.2