

A Flood of Red Tape: Comparing the Floodplain Development Regulations of Port Cities

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1. Abstract

The National Flood Insurance Program (NFIP) relies on local communities to set and enforce regulations to preserve the floodplain and mitigate flood hazards. Without a clear framework or model ordinance from the Federal Emergency Management Agency (FEMA), the drafting and enforcement of these protections are left to local city councils, leading to a confusing variety of local regulations selectively adopted from FEMA, the International Building Code, and American Society of Civil Engineers (ASCE) standards. These inconsistencies create uncertainty that hampers positive development and discourages owners from performing critical maintenance on marine infrastructure. This paper compares local regulations that govern development in floodways and floodplains of several United State port cities and analyzes their impact on a several model projects. This research identifies key differences amongst the city regulations and reveals shortcomings where regulations were not developed with water dependent infrastructure in mind. ASCE can help push for these distinctions and establish a unified national code that acknowledges the differences between buildings and in-water structures to better serve waterfront property owners and the general public.

2. Introduction

This paper presents the first formal examination of local floodplain regulations undertaken by members of ASCE COPRI. The paper aims to educate fellow engineers about the range of local floodplain regulations and present the challenges facing waterfront development projects. The paper first discusses the origin of the regulations that govern floodplain development, both nationally and locally, and defines common terms and concepts. The authors then survey the local floodplain regulations in four large port cities: Philadelphia, PA; Baltimore, MD; New York, NY; and San Francisco, CA. Several model projects are then presented and discussed to demonstrate the differing regulatory practices between cities. Finally, the paper offers the authors' opinions of best practices, and provides recommendations for standardization and improvement of the regulations, as well as suggestions for future research.

3. Background

Regulatory

Development in flood prone areas is governed by a variety of local and national codes, which are often informed by ASCE design standards. This wide range of authorities and sources leads to overlap between codes and standards, as well as gaps and confusion where provisions don't align. To better understand how the patchwork of regulations and standards apply to projects in flood prone areas, it is helpful to review the hierarchy of the various codes and standards.

In 1968, the US Congress created the NFIP to manage the risk of flood losses and promote sound land use in the floodplain. The NFIP provides federal flood insurance for businesses and residents in communities that agree to adopt and enforce regulations consistent with the FEMA criteria for

floodplain management. These FEMA criteria, which are laid out by statute in the Code of Federal Regulations (44 CFR Parts 59-80), aim to reduce the risk of hazards to public safety and flood driven economic losses. This is accomplished primarily through Part 60, which requires that new construction is designed to be resilient, raised above predicted flood elevations, and sited outside of particularly flood prone areas. The statute also promotes the protection of existing buildings by restricting new construction that would obstruct or reduce the flood carrying capacity of watercourses and thereby raise surrounding floodwaters.

Many communities and municipalities in the US have joined the NFIP, either enacting state-drafted model ordinances or writing specific provisions intended to satisfy the FEMA criteria into their local building, zoning, and land use codes. FEMA requirements are not always accurately reflected in the local code, however, as municipalities can fall short when FEMA performs an audit.

These FEMA-driven provisions tend to overlap with provisions from the International Building Code (IBC), § 1612 - Flood Loads, and Appendix G - Flood Resistant Construction. While many municipalities adopt the bulk of IBC and its appendices as the base structure for their local building codes, there is no legal requirement to do so. For instance, Baltimore, MD, adopts much of IBC but pointedly does not adopt § 1612 or Appendix G, having instead enacted its own separate floodplain management code.

At the outer reaches of the hierarchy are ASCE design standards - principally, ASCE 7 and 24 – that give prescriptive design guidance for structures and fill in various flood prone areas. Unlike the provisions of FEMA, NFIP, IBC, and legally binding local codes, ASCE design standards are written exclusively by Engineers to provide the technical basis for sound design. Crucially, they contain valuable commentary sections that provide nuance and background for each standard. While IBC § 1612 specifically calls for design to be performed in accordance with ASCE 7 and 24, it is worth remembering that these standards are not universally legally binding on their own. In practice, the design requirements of ASCE 7 and 24 are likely to be incorporated into local building codes, however, the important nuance found in their commentaries is usually absent.

To summarize: the legal hierarchy begins with local city codes, which are intended to satisfy FEMA provision; these local codes generally adopt the IBC, with some omissions or alterations; and all the more binding codes are only loosely tied to the technical guidance and nuance of the ASCE standards.

Special Flood Hazard Area - Key Definitions and Terms

- V Zone: Areas along coasts subject to a 1% or greater annual chance of flooding in any given year that also have additional hazards associated with velocity wave action. V Zones are also known as Coastal High Hazard Areas (CHHAs).
- A Zone: Areas subject to a 1% or greater annual chance of flooding in any given year. These areas are not subject to high velocity wave action but are still considered high risk flooding areas.
- Coastal A Zone: A sub-zone of the A Zone where wave heights are expected to be between 1.5 and 3 feet high. This zone is indicated by the Limit of Moderate Wave Action (LiMWA) line on the latest FEMA FIRMs.
- Shaded X Zone: Area of moderate flood risk outside the 1% annual chance flood but within the limits of the 0.2% annual chance flood level (the 500-year floodplain).
- Base Flood Elevation (BFE): Elevation of the 100-year flood event.
- Floodplain: The land area that is susceptible to flooding from an adjacent body of water.

- Floodway: The channel of a river or watercourse and the adjacent land areas where water would be discharged during the base flood.
- Hydrologic & Hydraulic (H&H) Study: Study of the movement of water. Typically required when a new project may impact the floodway.
- Letter of Map Revision (LOMR): An official change of the issued FEMA FIRM panel that is typically issued because a site has been inadvertently mapped in the floodplain. (LOMR can be used interchangeably with CLOMR/LOMA/CLOMA in this paper).
- No-Rise: The idea that a new project will not result in an increase in the BFE.
- Sea Level Rise (SLR): The relative increase in the elevation of the world's oceans.
- Special Flood Hazard Areas (SFHA): Area that will be inundated by the 1% chance flood (i.e. V Zones and A Zones).
- Watercourse: Refers to only the channel and banks of a body of water. This does not include any adjacent floodplain area.

4. Code Survey

Floodplain regulations in the following major port cities were selected for further analysis: Philadelphia, PA; Baltimore, MD; New York, NY; and San Francisco, CA. These cities were selected for their variations in both types of watercourses and regulatory climate. Philadelphia is an inland port city with two major watercourses - one of which is a floodway - and its own set of permit application forms written by the city's floodplain manager; Baltimore is a coastal bay city at the confluence of multiple waterways with its own floodplain management code, and special regulations governing the so-called Chesapeake Bay Critical Area that covers most of the floodplain; New York City is a major coastal port city with floodways and coastal flooding and is in the process of developing a waterfront building code; San Francisco is a major coastal port city on the west coast with special standards set by the San Francisco Bay Conservation and Development Commission (BCDC). Table 1 highlights and compares provisions in the codes of each of these cities that would likely affect developers and engineers in planning and designing waterfront infrastructure.

The provisions that are most likely to impact development - construction prohibitions, the requirement to perform H&H studies, and the requirement to obtain CLOMRs from FEMA - are highlighted below along with their code bases:

- New construction is prohibited waterward of the reach of mean high tide in V Zones (CHHA) and Coastal A Zones:
 - *FEMA (NFIP)* - 44 CFR 60.3(e)(3)
 - *ASCE 24* - 4.3.1
 - *IBC* - Appendix G401.2
- Requirement for H&H showing no rise:
 - *FEMA (NFIP)* - 44 CFR 60.3(d)(3) - *Only in the Floodway*
 - *IBC* - Appendix G103.5; Appendix G401.1 - *Only in the Floodway*
- Requirement for H&H showing cumulative rise less than 1 foot for proposed development in SFHA where no floodway is designated:
 - *FEMA (NFIP)* - 44 CFR 60.3(c)(10)
 - *IBC* - 1804.5(4) - *Only grading and fill*
 - *IBC* - 1612.3.2; G103.4 - *All development in riverine SFHAs w/o Floodways*
- Allowance to cause a rise in BFE, after obtaining a CLOMR from FEMA:
 - *FEMA (NFIP)* - 44 CFR 60.3(c)(13) - *Rise of more than one foot where no Floodway has been designated*

- *IBC - Appendix G103.5.1 - Any rise in a Floodway*
- Requirement to notify FEMA and adjacent jurisdictions, and perform an H&H study to demonstrate that flood carrying capacity is preserved when altering a watercourse:
 - *IBC - Appendix G103.6*
 - *FEMA (NFIP) - 44 CFR 60.3(b)(7)*

Table 1: Local Code Survey

<i>City</i>	<i>Universal</i>	<i>Philadelphia</i>	<i>Baltimore</i>	<i>New York</i>	<i>SF Bay Area</i>
<i>Within Regulatory Floodway</i>		-Only Docks, Public Utilities, Trails, Roadways and Bridges allowed, with H&H showing no rise.	-No new private principal structure in Floodway. Some public projects and repairs or non-principal structures may be allowed with H&H showing no rise. -Private repairs & improvements may be allowed with A variance, alternatives analysis, and H&H showing no rise.	-No development unless H&H shows no rise. -Development may be authorized with rise in BFE with approved FEMA CLOMR.	-Development may be authorized with rise in BFE with approved FEMA CLOMR.
<i>Special Flood Hazard Area (SFHA) V Zones & A Zones</i>	-New construction must be above DFE, or anchored and dry floodproofed. Utilities and electrical systems must be elevated or designed to prevent flood damage. -In V Zone & Coastal A Zones, no new construction waterward of mean high tide, and no use of fill for structural support.	-Where a floodway has not been designated, H&H must show a rise of less than 1 ft for all proposed development.	-New structures must be for water-dependent uses in the CBCA, (most of A and V Zones). -No dwellings, floating entertainment/lodging; restaurants, shops, landfills, etc. in CBCA (some grandfathering). -Fill may require H&H in nontidal A Zones (but not in tidal or coastal A Zones). -Stormwater offset (10% Phosphorous reduction) requirement for new or redevelopment.	-Grading or fill is not permissible, unless the fill is compacted to minimize shifting and erosion, with no rise in BFE, and in A and V Zones it is placed to avoid diversion of water and waves towards any structures.	-Thorough evaluation of tidal hydrology and sediment movement encouraged for all watercourse encroachment.
<i>All Areas</i>	-Development in AE Zones without floodway requires H&H showing rise of <1 ft. -Alteration of watercourse requires H&H showing no rise, and FEMA CLOMR. -Changes to SFHA (elevations or boundaries, shown in H&H) require FEMA CLOMR.	-No chemical storage/production, Hospitals, other uses.	-No manufactured homes or fences. No chemicals, hazmats, or buoyant storage.	-Preliminary maps were developed after Sandy but are not approved in NYC. Developers must use the more stringent of the effective or preliminary maps, but preliminary maps can't be interpreted or modified by FEMA through CLOMR.	-DFE must include the predicted SLR. -Development requires a risk assessment by a PE, based on BFE+SLR -Public hearings required for all development (except for emergency or minor repairs). Consideration given to Priority Uses. -Seismic analysis required per ASCE 61.

As shown in Table 1, these provisions are sometimes explicitly restated and highlighted in local codes and permit forms, but not always. Some local codes also suggest that applicants are required to obtain a CLOMR/LOMR from FEMA for any development in the SFHA, but this is not supported by IBC or the FEMA statutes. Part 65 of 44 CFR, which lays out the procedures for revision to FEMA flood maps, only requires that new technical data and map revision requests be submitted if physical changes are expected to affect flooding conditions. In more concrete terms, FEMA only requires that developers apply for CLOMR/LOMR if a project intends to change the BFE or boundaries of different zones - for instance, by elevating an area above BFE, thereby creating a new boundary line around the area.

IBC Appendix G105 does allow for variances to the above requirements, both for repairs of designated historic structures, and for the construction or substantial improvement of functionally dependent facilities. This allows municipalities that have adopted IBC Appendix G to permit things like new construction waterward of the high tide line in V Zones. While Baltimore, MD, has not adopted IBC Appendix G, or IBC §1612, it permits functionally dependent uses in its own floodplain management code.

The various codes and regulations often overlap, but there are key differences at both the local and national level. For instance, while IBC and ASCE share similar provisions that prohibit certain types of development in floodways, the commentary in ASCE provides more nuance on the intent and scope of the design standards. In the commentary to its scope section (C1.1), ASCE 24 notes that the “standard is not intended to preclude construction of piers, docks, wharves, and other water-dependent (functionally dependent) structures.”

5. Case Studies

Several case studies were evaluated to assess the differences and similarities between regulations in major port cities in the US. The cases selected and described below are examples of projects that are often proposed in coastal cities. The results presented in Table 2 are based on the authors’ interpretations of existing codes as of 2021, along with the authors’ direct project experience and feedback from local code officials in the subject cities.

1. Construction of a new restroom building on an existing public pier. The Pier is located in an A Zone or V Zone and is below BFE. The restroom would be unoccupied during storm events, as the public pier would be closed during inclement weather.
2. Construction of a new recreational pier or ferry landing (fishing pier/water taxi/recreational) in a V Zone.
3. Repair of an existing bulkhead with outboard piles in the floodway.
4. Repair of an existing bulkhead with outboard piles in an A Zone.

Table 2: Case Studies

City	<i>Philadelphia</i>	<i>Baltimore</i>	<i>New York</i>	<i>SF Bay Area</i>
Case 1 - Construction of New Restroom on an Existing Pier below BFE (A/V Zone)	-Allowed in an A Zone, if raised above DFE; or floodproofed and anchored with egress above DFE. -Not allowed in V Zone because it is beyond MHW.	-Not allowed because it is a non-water-dependent use in the CBCA buffer.	-Allowed in an A Zone, if raised above DFE; or floodproofed and anchored with egress above DFE. -Not allowed in V Zone because it is beyond MHW.	-Allowed in an A Zone, if raised above DFE; or floodproofed and anchored with egress above DFE. -Not allowed in V Zone because it is beyond MHW.
Case 2 - Construction of New Recreational Pier or Ferry	-Ferry allowed in A Zone with an H&H showing no rise (floodway) or 1 ft rise	-Ferry landing may be allowed in an A Zone with 10% runoff reduction. Only	-Ferry allowed in A Zone with an H&H showing no rise -Not allowed in V	-Allowed in A Zone with H&H showing no rise, sediment transport study.

Landing (A/V Zone)	(Delaware River). Recreational Pier must be a trail or recreational dock. -Not allowed in V Zone because it is beyond MHW.	passive/non-commercial recreation pier allowed. -Not allowed in V Zone because it is beyond MHW.	Zone because it is beyond MHW	-Allowed in V Zones through a variance for dependent use .
Case 3 - Repair of Bulkhead with Outboard Piles (Floodway)	-Allowed with H&H showing no rise, but only for docks, public utilities, trails, roadways or bridges. Not allowed for docks that store chemical or petroleum products.	-Allowed with an H&H showing no rise and alternatives analysis proving minimum required fill.	-Allowed with an H&H showing no rise.	-Allowed with an H&H showing no rise to BFE. OR allowed with FEMA FIRM update.
Case 4 - Repair of Existing Bulkhead with New Outboard Piles (A/V Zone)	-Allowed if H&H shows rise of less than 1 ft.	-Allowed.	-Allowed with an H&H showing no rise.	-Allowed with an H&H showing no rise and no increase in flood damage potential

Table 2 demonstrates some of the nuances and variations that municipalities have adopted into their local building codes from IBC, ASCE and FEMA. The following case studies help provide examples of such local variations:

Case 1: In all of the studied cities, the restroom structure is prohibited in the V Zone because it would be waterward of the mean high tide line. This is based on the provisions from IBC, ASCE 24, and FEMA, which are reproduced in local building codes. Three of the four cities would allow the restroom on the existing pier in an A Zone, if the restroom is elevated above the required DFE, or dry floodproofed with a means of egress above DFE in accordance with chapter 6 of ASCE 24. The lone exception, Baltimore, has additional restrictions on allowable uses in the Chesapeake Bay Critical Area. In San Francisco, the DFE must incorporate SLR projections based on the service life of the project.

Case 2: Based on the intended use of the new structure, variances from the studied cities may allow building within the V Zone. The building codes for Baltimore and San Francisco have adopted language to grant the project through a variance for new construction based on the intended use. Pointedly, Baltimore would allow a new pier (but no buildings) in the V Zone, because its code does not treat piers as structures from a floodplain management perspective. While New York would not allow a new pier structure in the V Zone, the project might allow for the rehabilitation of an existing pier into a ferry landing, with additional documentation to claim the structure as historic. The four port cities would allow a new pier or ferry landing in A Zones, provided a documented H&H demonstrates that the new structure does not affect nearby structures by raising the BFE. However, the depths sufficient for ferry vessels to use the facility don't typically exist in A Zones.

Case 3: Repairing an existing bulkhead with new outboard piles in the floodway is allowed in three of the cities if an H&H study demonstrates that the new structure does not increase the BFE. Philadelphia's code is more stringent, only allowing the repair piles (encroachment) in the floodway if the bulkhead supports docks, public utilities, trails, roadways or bridges and does not support chemicals or petroleum products.

Case 4: Repairing an existing bulkhead with new outboard piles in the A and V Zones is allowed in all four cities, provided a documented H&H demonstrates the new structure does not increase the BFE. Case 4 is the clearest case study analyzed, resulting in little scrutiny by municipalities and permitting authorities. As an example, where Philadelphia had restrictions on the intended use in the floodway, it places no such restriction on development in A or V Zones.

6. Discussion

Tables 1 and 2 demonstrate that regulatory requirements are inconsistent across different cities and can be confusing within each city. New water-dependent development projects may be approved within grey areas of interpretation, face protracted variance processes, or be rejected outright. The difference may ultimately depend on the reviewer to which a project is assigned. Under the more onerous local regulations, even repairs to structurally deficient piers can trigger the need for costly H&H studies and attorney-led zoning variance appeals.

The various codes and regulations are certainly well-intended: aiming to promote public safety and prevent commercial and insurance losses by prohibiting homes and businesses in flood-prone areas, yet inconsistencies and confusion remain. For instance, ASCE 24 agrees with IBC and FEMA regulations that prohibit new construction waterward of MHW in V Zones and Coastal A Zones, but the same code cautions that it is not intended to preclude the construction of piers, docks and other water-dependent structures. This sentiment appears to also be reflected in the Baltimore floodplain management code and FEMA regulations, which define “structures” as walled or roofed buildings, for the purposes of floodplain management. However, IBC’s definition offers no such exemption for piers, defining a structure simply as “that which is built or constructed.” In another example, the overlapping provisions of IBC and FEMA lead to an odd contrast depending on whether floodways have been designated: where they have, H&H studies are required only for development in said floodway; where they have not, H&H studies are required for any development in the SFHA. In places like Philadelphia’s Delaware River, where no floodway has been designated and the SFHA extends far from the river’s edge, this imposes an H&H requirement on development up to a half mile inland of the river’s edge. In another example of local incongruity, New York City requires projects to conform to the more stringent of the current effective flood maps and the preliminary maps developed in 2013. However, because FEMA has not adopted the newer maps, FEMA has no way of revising them, leaving projects to comply with preliminary maps that may not be correct.

Putting aside questions of confusion and inconsistency, it is not clear that the existing regulations serve the public interest. Looking at Case 1 in Table 2, how does prohibiting a new public restroom on an existing pier in a V Zone promote public safety or wellbeing? Even where this is allowed in A Zones, does it make sense to require a means of egress above DFE for a structure that would not be occupied during a flood? While the restroom case may seem insignificant, the restriction on construction in V Zones has a tremendous impact. Most, if not all, maritime shipping and commerce locations must be located in V Zones and Coastal A Zones because that’s where the navigable water exists. Wouldn’t the public be better served if construction of new maritime facilities were not expressly prohibited in these areas?

Looking at Case 4 in Table 2, the codes effectively require an H&H study simply to perform necessary structural repairs. While these H&H studies can be relatively affordable where watershed models from previous studies are publicly available, they are rather expensive when new watershed models are needed. It is easy to imagine that pier owners or public trusts that have allowed marine structures to fall into disrepair might not have the resources to spend on the repairs, let alone the H&H studies necessary for the permits. It is much harder to imagine how the public

is served by discouraging such repairs. Even when the underlying marine structures are in fair condition, many urban waterfronts are blighted by abandoned industrial uses, and the existing regulations can pose a large, if not insurmountable, hurdle to public reinvestment and reclamation.

7. Conclusion / Best Practices Recommendations

Even after much research, the regulatory variations, both between and within different cities, create confusion because each code uses unique wording, organization and implementation. In this uncertain environment, it's difficult for design engineers, developers, and owners to assess the risk of proceeding with design costs. Project teams can spend significant resources attempting to understand local regulations, designing, permitting, and seeking variances or interpretations for a project only to ultimately have the project rejected. Even if owners are willing to proceed with these risks, it can be difficult for engineers to accurately estimate the design and permitting fees, which in turn depresses the market.

As shown by the case studies assessed in this paper, building codes typically do not acknowledge the difference between occupied and unoccupied structures. While the codes intend to promote public safety and well-being, they unintentionally prevent structures, like public restrooms that would be closed to the public during severe storms, from being developed in areas where they may be needed. The authors recommend that provisions allowing for such unoccupied structures in flood zones should be added to local and national codes.

Carve outs for repairs to existing waterfront infrastructure should also be more uniformly viewed as reasonable, necessary, and permissible without forcing applicants to shoulder the costs and delays associated with variance processes, H&H studies, and public hearings. Repairs are often needed to protect life and safety by preventing more serious damage from occurring due to prolonged deterioration. Regulations need to be better designed to encourage and support such repairs.

Building Codes are written for just that - buildings - often making it difficult to uniformly apply them to waterfront infrastructure that is dependent on water access and informed by specialized design criteria and testing. A dock, marina, or a marginal bulkhead should not be treated as a multi-story building, and FEMA agrees that such waterfront infrastructure should not be considered a "structure" for floodplain management. The commentary of ASCE 24 also acknowledges this, and yet other provisions of ASCE 24 are used by IBC and local codes to prohibit the construction of these same water-dependent structures in the only places they can really exist: V Zones and Coastal A Zones with navigable water depths. The authors recommend that this important distinction be elevated from the commentary to the scope section, and that Chapter 4 be amended to include a provision that exempts water-dependent facilities from the prohibition on new construction waterward of MHW.

To improve marine infrastructure regulations, a unified waterfront specific code should be established nationally to better define construction requirements in areas that are intended to be inundated with water. The unified code should take components of the best crafted local regulations - those that recognize docks, piers and other waterfront infrastructure as being distinct from shore homes and condo buildings - and carve out allowances for water-dependent uses intended for both maritime commerce and public recreation. Waterfront specific codes would be a helpful first step in developing a clear set of requirements that are useful and specific to marine infrastructure, to bridge the gap between safe marine engineering practices and current regulations.

8. Future Work

Most waterfront development projects are also subjected to regulation from state environmental agencies, the Army Corps of Engineers, and others. These agencies may impose a variety of restrictions, like seasonal work windows to protect endangered species. While these kinds of regulations often apply to projects in flood prone areas, they do not specifically address flooding concerns and were not assessed as part of this paper. Under 44 CFR Part 75, state port authorities, which are on state-owned land, are often exempt from FEMA regulations, provided the state port lands are self-insured. These state ports also do not always follow local permitting requirements. Study of these environmental regulations could be assessed as part of a future paper. Additional research to provide a more comprehensive assessment of all regions in the US is recommended to fully evaluate the regulations and make recommendations to increase efficiency and clarity. The research contained herein is limited to a few major port cities throughout the country; however, future research on the subject of floodplain regulations can be expanded to include additional US port cities. Ports in the Southeast US were not assessed through this paper due to limited time and resources, but could present an interesting point of comparison. Research could also be expanded to compare US regulations to those in other countries to understand how other waterfronts are developed.

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