Chapter 8: Siting

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Siting

8.1 Introduction

Siting residential buildings to minimize their vulnerability to coastal hazards is one of the most important aspects of the development (or redevelopment) process. Unfortunately, prudent siting has often been overlooked or ignored in the past as properties have been developed and buildings have been constructed close to the shoreline, near bluff edges, and atop steep coastal ridges. There are literally hundreds, if not thousands, of examples where residential buildings have been constructed with little regard for coastal hazards, only to suffer what could have been preventable damage or loss.

WARNING

Not all coastal hazards can be mitigated through design and construction. A design and construction "success" can be rendered a failure by poor siting.

Today, there are few places along our shorelines where we lack sufficient information to make rational, informed siting decisions. Following the lessons and procedures described in Volume 1 of this manual will help designers, purchasers, developers, and community officials identify those locations where coastal residential development and buildings can be sited so that the risks associated with coastal hazards are minimized. Those who ignore siting and hazard identification issues, and who rely solely upon the design and construction recommendations contained in this manual, increase the likelihood that their structures will be damaged, destroyed, or left standing, but uninhabitable, by flooding, erosion, landslides, or other coastal hazards.

8.2 Siting Considerations

A variety of factors must be considered in selecting a specific site and locating a building on that site:

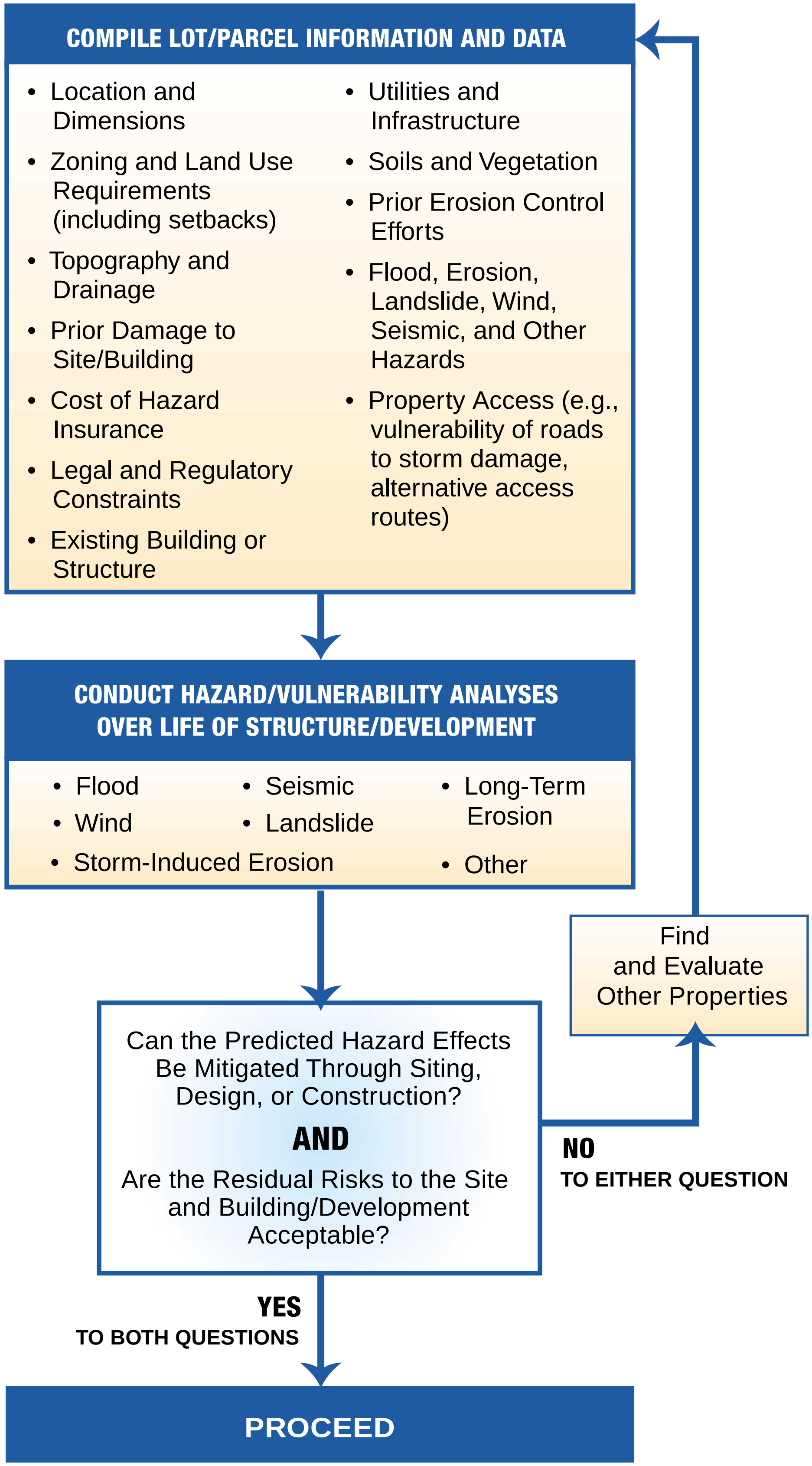
- regulatory requirements
- presence and location of infrastructure
- previous development and/or subdivision of property
- physical and natural characteristics of the property
- vulnerability of the property to coastal hazards

These factors were outlined in Figure 5-1 (repeated here as Figure 8-1) and are discussed further in this chapter.

NOTE

Proper siting and design should take into account both chronic hazards (e.g., long-term erosion) and catastrophic hazards (e.g., extreme storm events).

Figure 8-1
Evaluation of coastal property.



A thorough review of these factors will sometimes show that minimum regulatory requirements and/or previous subdivision/infrastructure decisions allow or constrain future development onto sites that will be highly vulnerable to the effects of coastal hazards. In other words, regulatory controls do not necessarily result in prudent siting of coastal buildings (see Figure 8-2). Likewise, constraints imposed by previous lot creation and infrastructure construction sometimes drive development to more hazardous locations.

Although these situations should have been discovered when the property was first evaluated for its suitability for purchase, development, or redevelopment, it is common practice for property owners to undertake detailed studies only after property has been acquired. This is especially true in the case of the development of raw land, where planning, engineering, architectural, and site development costs can be substantial.

WARNING

Compliance with minimum siting requirements imposed by local and state governments does not guarantee a building will be safe from hazard effects. To reduce risks from coastal hazards to an acceptable level, it is often necessary to exceed minimum siting requirements.

Figure 8-2
Hurricane Opal (1995). Damage to new construction in a mapped A zone. The flood and debris damage could have been avoided had the site been considered a coastal A zone and had the structure been elevated on an open foundation.

Designers should recognize situations in which poor siting is allowed or encouraged, and should work with property owners to minimize risks to coastal buildings. Depending on the scale of the project, this could involve one or more of the following:

- locating development on the least hazardous portion of the site
- rejecting the site and finding another
- transferring development rights to another parcel better able to accommodate development
- combining lots or parcels

- reducing the footprint of the proposed building, and shifting the footprint away from the hazard
- shifting the location of the building on the site by modifying or eliminating ancillary structures and development
- seeking variances to lot line setbacks along the landward and side property lines (in the case of development along a shoreline)
- moving roads and infrastructure
- modifying the building design and site development to facilitate future relocation of the building
- altering the site to reduce its vulnerability
- construction of protective structures (if allowed by the authority having jurisdiction)

8.3 Raw Land Development: Infrastructure and Lot Layout

8.3.1 Introduction

Large, undeveloped parcels available for coastal development generally fall into two classes:

- **Parcels well-suited to development**, but vacant due to the desires of a former owner, lack of access, or lack of demand for their development (see Figure 8-3)
- **Parcels that are difficult to develop**, with extensive areas of sensitive or protected resources, with topography or site conditions requiring extensive alteration, or with other special site characteristics that make development expensive relative to other nearby parcels (see Figure 8-4)

Proper development will be much easier for the former, and much harder for the latter. Nevertheless, development in both instances should satisfy the planning and site development guidelines listed in Figure 8-5, adapted from recommended subdivision review procedures for coastal development in California (California Coastal Commission 1994).

Development of raw land in coastal areas must consider the effects of all hazards known to exist and should not ignore the effects of those hazards on future property owners. Likewise, development of raw land in coastal areas should consider any local, state, or Federal policies, regulations, or plans that will affect the abilities of future property owners to protect, transfer, or redevelop their properties (e.g., those dealing with erosion control, coastal setback lines, post-disaster redevelopment, landslides, and geologic hazards).

Figure 8-3
Example of coastal development well-suited to the land: deep lots, generous setbacks, and avoidance of dune areas should afford protection against erosion and flood events for years to come.

Figure 8-4
Increasingly, coastal residential structures are being planned and constructed as part of mixed-use developments, such as this marina/townhouse development. These projects can involve a new set of environmental and regulatory issues, as well as more difficult geotechnical conditions and increased exposure to flood hazards.

Figure 8-5
Planning and site development guidelines for raw land (adapted from the California Coastal Commission 1994).

Development of Raw Land in Coastal Areas – Summary of Site Planning and Subdivision Guidelines

1. **DO** determine whether the parcel is suitable for subdivision or should remain a single parcel.
2. **DO** ensure that the proposed land use is consistent with local, regional, and state planning and zoning requirements.
3. **DO** ensure that all aspects of the proposed development consider and integrate topographic and natural features into the design and layout.
4. **DO** avoid areas that require extensive grading to ensure stability.
5. **DON'T** rely on engineering solutions to correct poor planning decisions.
6. **DO** study the parcel thoroughly for all possible resource and hazard concerns.
7. **DON'T** rely on relocation or restoration efforts to replace resources impacted by poor planning decisions.
8. **DO** identify and avoid, or set back from, all sensitive resources and prominent land features.
9. **DON'T** assume that omissions in planning can be corrected during site development.
10. **DO** consider combining subdivision elements, such as access, utilities, and drainage.
11. **DON'T** overlook the effects of infrastructure location on the hazard vulnerability of building sites and lots.
12. **DO** account for all types of erosion (e.g., long-term erosion, storm-induced erosion, erosion due to inlets) and governing erosion control policies when laying out lots and infrastructure near a shoreline.
13. **DON'T** overlook the effects to surface and groundwater hydrology from modifications to the parcel.
14. **DO** consider existing public access to shoreline and resource areas.
15. **DON'T** plan development on beaches or dunes, on ridge lines or on top of prominent topographic features, on steep slopes, or in or adjacent to streams.
16. **DO** incorporate setbacks from identified high-hazard areas.
17. **DON'T** forget to consider future site and hazard conditions on the parcel.
18. **DO** use a multi-hazard approach to planning and design.
19. **DON'T** assume that engineering and architectural practices can mitigate all hazards.
20. **DO** involve a team of experts with local knowledge, and a variety of technical expertise and backgrounds.

8.3.2 Practices To Avoid and Recommended Alternatives

A review of previous coastal development patterns and resulting damages suggests there are several subdivision and lot layout practices to avoid:

1. In the case of an eroding shoreline, placing a road close to the shoreline and creating small lots between the road and the shoreline results in buildings, roadway, and utilities being extremely vulnerable to erosion and storm damage, and can lead to future conflicts over shore protection and buildings occupying public beaches (see Figure 8-6). Figure 8-7 shows a recommended lot layout that provides sufficient space to comply with state/local setback requirements and avoid damage to dunes.

   Some communities have land development regulations that help achieve this goal. For example, the Town of Nags Head, North Carolina, modified its subdivision regulations in 1987 to require all new lots to extend from the ocean to the major shore-parallel highway (Morris 1997). Figure 8-8 compares lots permitted in Nags Head prior to 1987 with those required after 1987. The town also has policies and regulations governing the combination of nonconforming lots (Town of Nags Head 1988).

Figure 8-6
View along a washed-out, shore-parallel road in Bay County, Florida, after Hurricane Opal. Homes to the left are standing on the beach and have lost upland access; some homes to the right have also lost their roadway access.

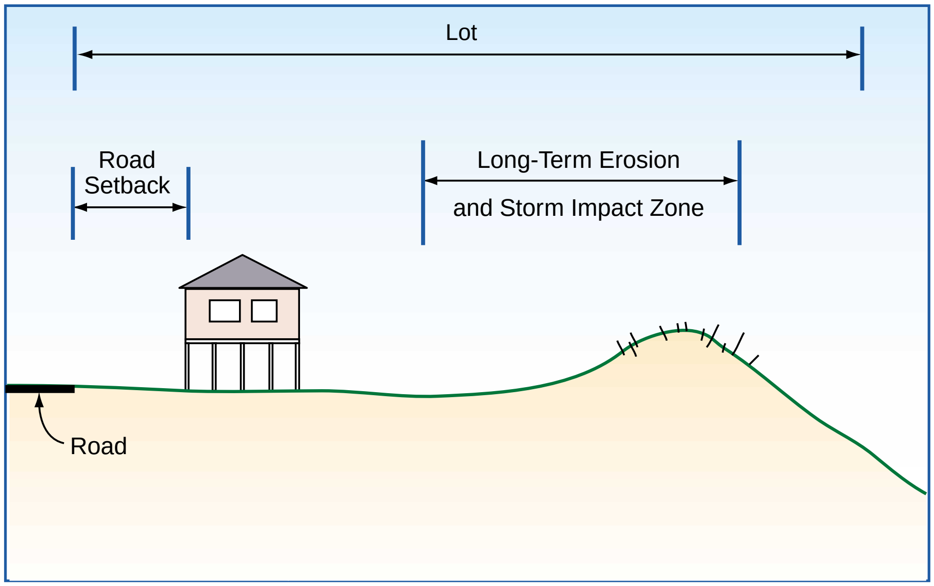


Figure 8-7
Recommended lot layout. Sufficient space is provided to comply with state/local setback requirements and avoid dune damage.

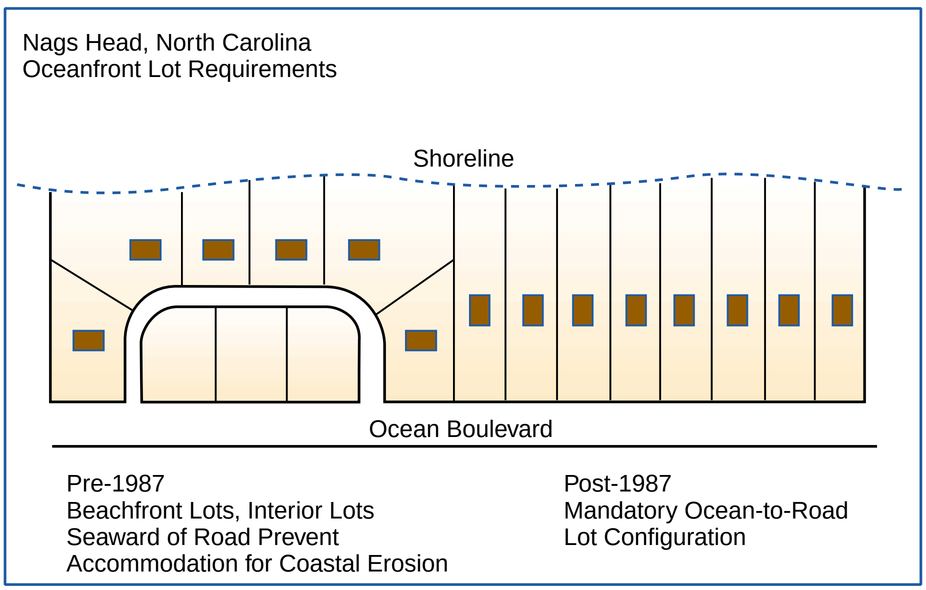


Figure 8-8
Comparison of Nags Head, North Carolina, oceanfront lot layouts permitted before 1987 and post-1987 oceanfront lot requirements (Morris 1997).

WARNING
Proper lot layout and building siting along an eroding shoreline are critical. Failure to provide deep lots and to place roads and infrastructure well away from the shoreline only ensures future conflicts over building reconstruction and shore protection.

2. A second problem associated with a shore-parallel road close to the shoreline is storm erosion damage to the road and associated utilities. Some infrastructure damage can be avoided by reconfiguring the seaward lots (so they all have access from shore-perpendicular roads), eliminating the shore-parallel road, and eliminating the shore-parallel utility lines (see Figure 8-9).

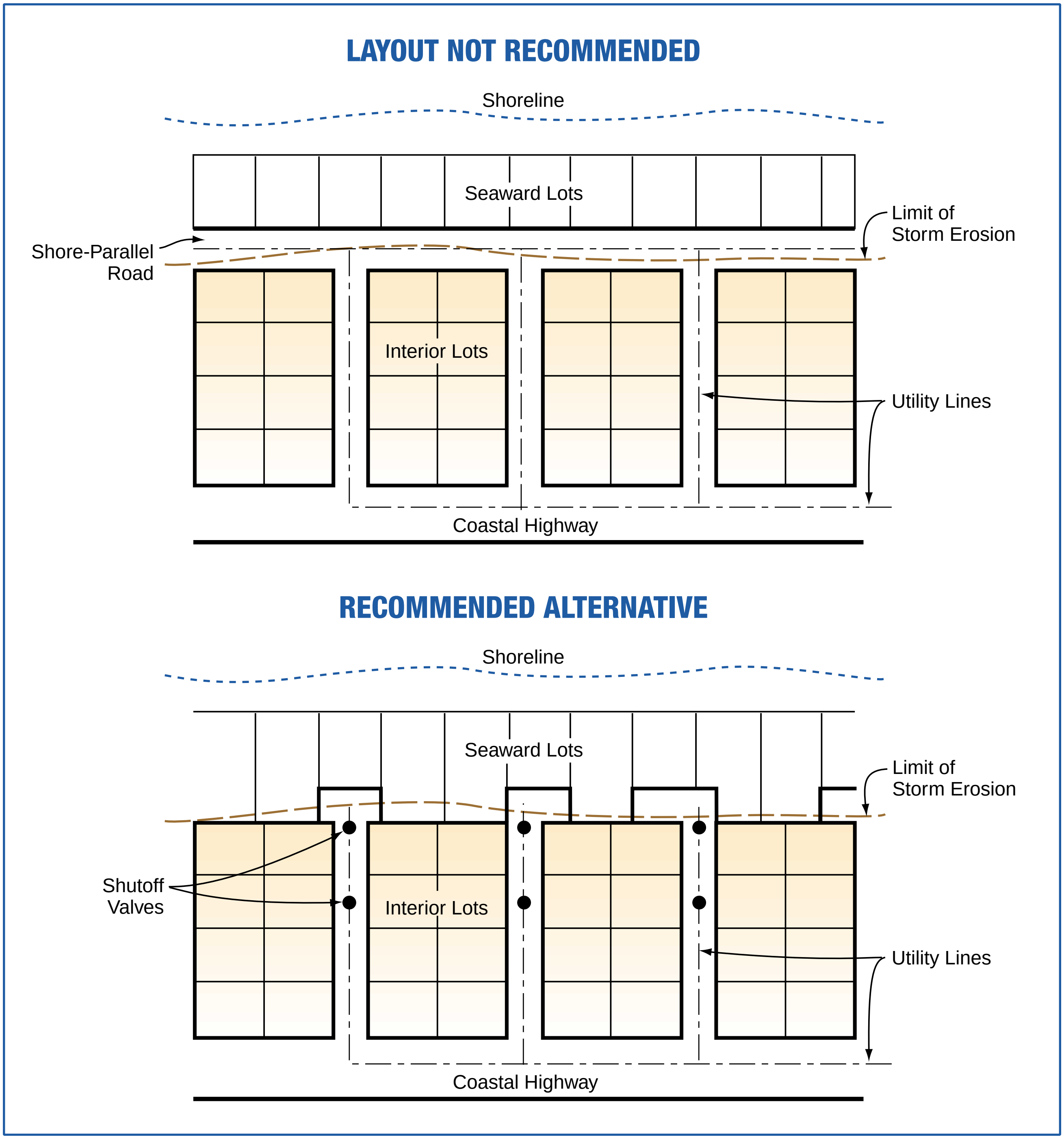


Figure 8-9
Shore-parallel roadways and associated utilities may be vulnerable to storm effects and erosion (upper). One alternative is to create lots and infrastructure without the shore-parallel road; install shutoff valves on water and sewer lines (lower).

3. Another type of lot layout not recommended for vulnerable or eroding coastal shorelines is the “flag” lot or “key” lot illustrated in Figure 8-10. This layout is used to provide more lots with direct access to the shoreline, but limits the ability of half of the property owners to respond to coastal flood hazards and erosion by constructing or relocating their buildings farther landward. Again, the recommended alternative is to locate the shore-parallel road sufficiently landward to accommodate coastal flooding and future erosion and to create all lots so that their full width extends from the shoreline to the road.

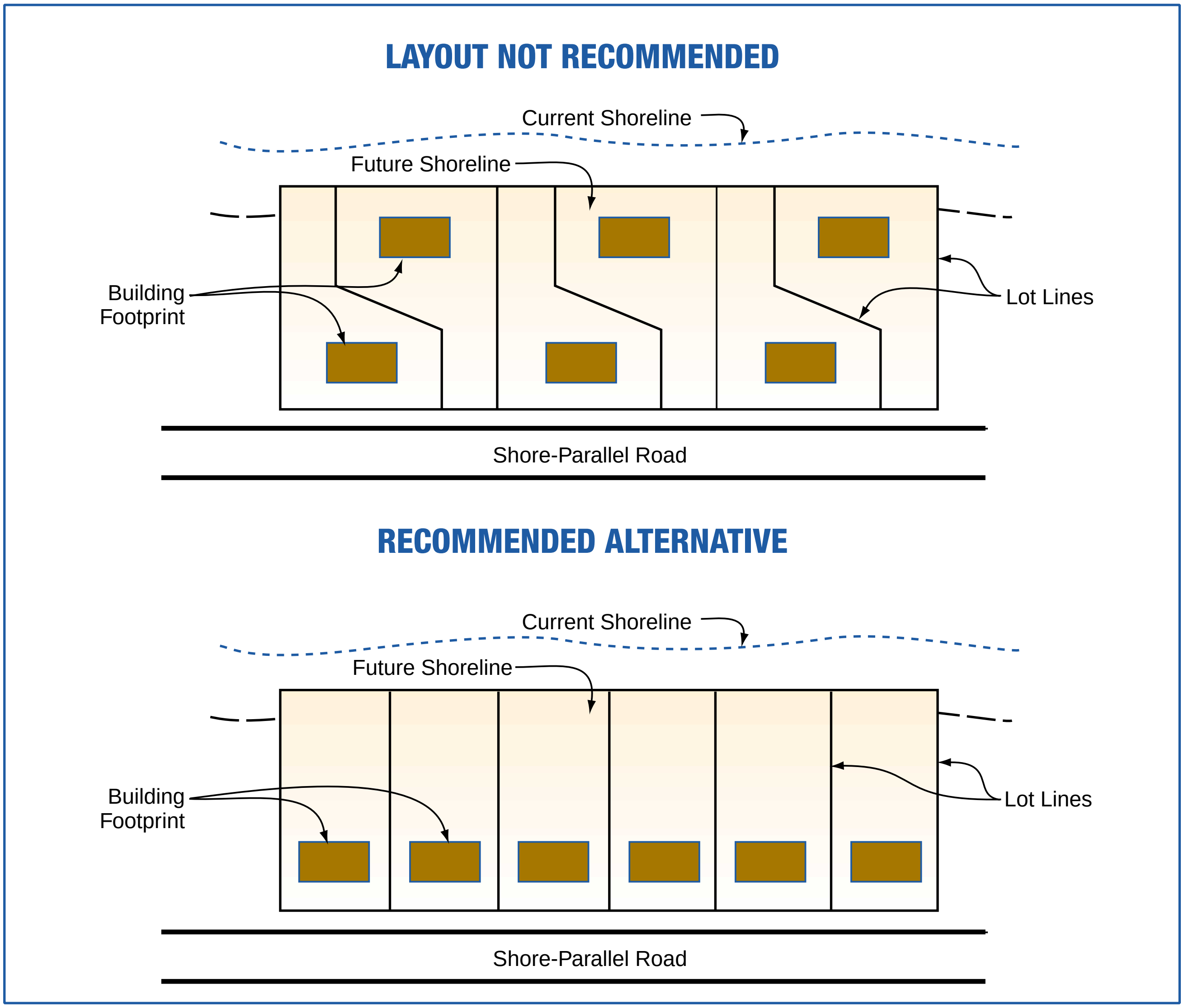


Figure 8-10
Typical layout of “flag” lots or “key” lots, which are NOT RECOMMENDED for use along eroding shorelines (upper). Suggested alternative layout (lower).

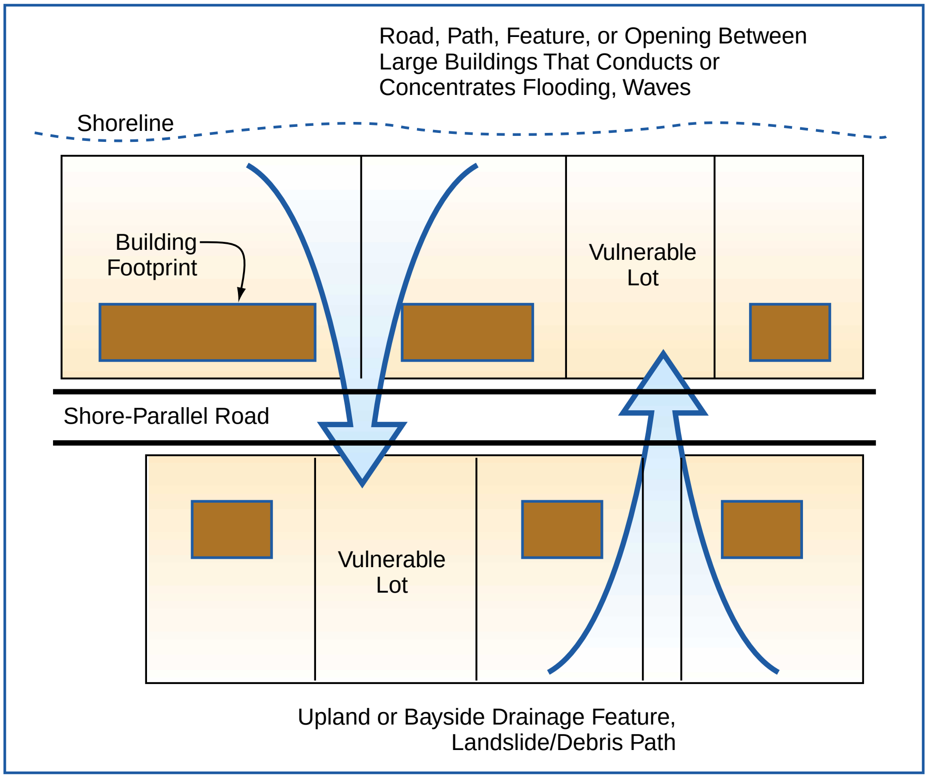
4. Creation of lots along narrow sand spits and low-lying landforms (see Figure 8-11) is not recommended, especially if the shoreline is eroding. Any buildings constructed there will be routinely subject to coastal storm effects, overwash, and other flood hazards.

Figure 8-11
Construction along this narrow, low-lying area of St. Johns County, Florida, is routinely subjected to coastal storm effects (photo following November 1984 northeast storm). The lots and buildings are landward of a previous state highway location, now abandoned.

5. Lots should not be created in line with natural or manmade features that concentrate floodwaters (see Figure 8-12). These features can include areas of historic shoreline breaching, roads or paths across dunes, drainage features or canals, and areas of historic landslides or debris flows. One alternative is to leave these vulnerable areas as open space and/or to modify them to reduce associated hazards to adjacent lots.

   Care should also be exercised when lots are created between or landward of gaps between large buildings or objects capable of channeling floodwaters and waves (see Figures 7-10, 7-11, and 7-12 in Chapter 7).

Figure 8-12
Lot landward of opening between dunes or obstructions may be more vulnerable to flooding and wave effects. Front-row lot waterward of interior drainage feature may be vulnerable to concentrated flooding from upland or bay side.



6. Lot configurations should not be created where small lots are concentrated along an eroding or otherwise hazardous shoreline. It is preferable to create deeper lots along the shoreline, locate building sites farther landward on the lots, or cluster development away from the shoreline. Figure 8-13 (Morris 1997, adapted from the California Coastal Commission 1994) illustrates this progression, from a “conventional” lot layout, to a “modified” lot layout, to a “cluster development” layout with lot line changes. The California Coastal Commission (1994) has also developed similar alternatives for a parcel on a ridge top with steep slopes and for a parcel bisected by a coastal lagoon.

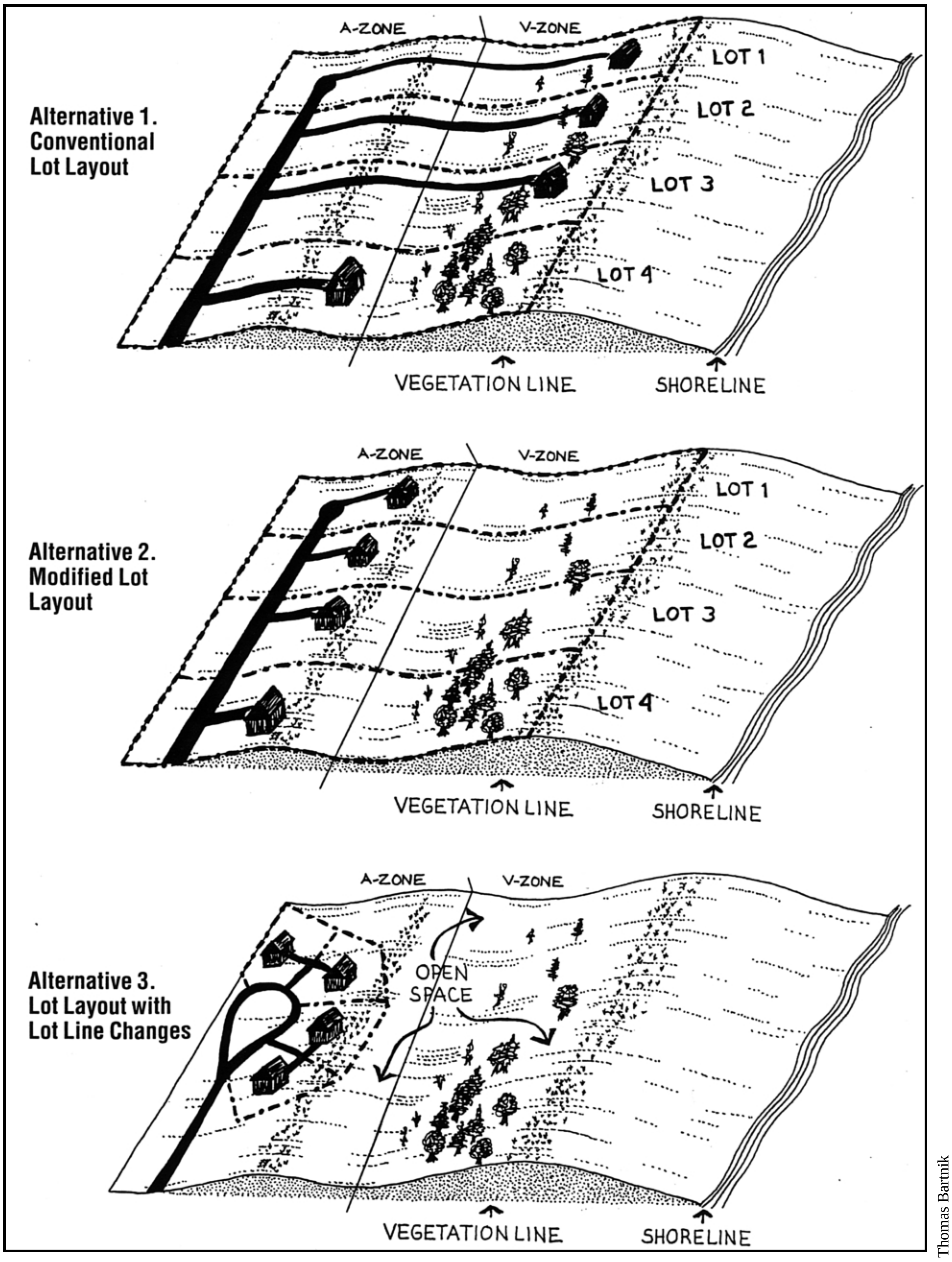


Figure 8-13
Coastal lot development scenarios (Morris 1997, adapted from California Coastal Commission 1994).

7. Another related approach is to occupy a small fraction of the total buildable parcel and to accommodate erosion by moving threatened buildings to other available sites on the parcel. A small Pacific Ocean community in Humbolt County, California, has successfully employed this approach (Tuttle 1987). Figure 8-14 shows a community of 76 recreational cabins on a 29-acre parcel, jointly owned by shareholders of a corporation. As buildings are threatened by erosion, they are relocated (at the building owner's expense) to other sites on the parcel, in accordance with a cabin relocation policy adopted by the corporation.

Figure 8-14
Humbolt County, California, parcel fronting the Pacific Ocean. As buildings are threatened by bluff erosion, they are moved to other sites on the parcel.

CROSS-REFERENCE

Some states and communities have adopted regulations requiring that buildings sited in erosional areas be movable. The State of Michigan has such a requirement; see Appendix G.

In extreme cases, entire communities have been threatened by erosion and have elected to relocate. For example, the village of Shishmaref, Alaska, voted in November 1998 to relocate their community of 600 after recent storm erosion threatened several houses and after previous shore protection efforts failed.

More information on specific examples of relocation of threatened buildings can be found in *Mitigation of Flood and Erosion Damage to Residential Buildings in Coastal Areas* (FEMA 1994). That report also presents several examples of flood and erosion mitigation through other measures (e.g., elevation, foundation alterations).

8. Layout of lots and infrastructure along shorelines near tidal inlets, bay entrances, and river mouths is especially problematic. Figures 4-2 and 4-3, in Chapter 4, and Figures 7-45, 7-46, 7-47, 7-48, and 7-49, in Chapter 7, all show instances where the recent subdivision and development of oceanfront parcels near ocean-bay connections has led to buildings being threatened by inlet-caused erosion. Infrastructure development and lot layout in similar cases should be preceded by a detailed study of historical shoreline changes, including development of (at least) a conceptual model of shoreline changes. Projections of potential future shoreline positions should be made, and development should be sited well-landward of any areas of persistent or cyclic shoreline erosion.

8.4 Infill Development: Siting a Building on an Existing Lot

8.4.1 Introduction

Many of the same principles discussed in the raw land scenario also apply to the construction or reconstruction of buildings on existing lots. Building siting on a particular lot should take site dimensions, site features (e.g., topographic, drainage, soils, vegetation, sensitive resources), coastal hazards, and regulatory factors into consideration. However, several other factors must be considered at the lot level that are not a primary concern at the subdivision level:

- buildable area limits imposed by lot line setbacks, hazard setbacks, and sensitive resource protection requirements
- impacts of coastal hazards on lot stability
- location and extent of supporting infrastructure, utility lines, septic tanks and drain fields, etc.
- impervious area requirements for the lot
- prior development of the lot
- need for future building repairs, relocation, or protection
- regulatory restrictions or requirements for on-site flood or erosion control

Although the local regulations, lot dimensions, and lot characteristics generally define the maximum allowable building footprint on a lot, the designer should not assume construction of a building occupying the entire buildable area is a prudent siting decision. The designer should consider all those factors that can affect an owner's ability to use and maintain the building and site in the future (see Figure 8-15).

Figure 8-15
Guidelines for siting buildings on existing lots.

Development or Redevelopment of Existing Lots in Coastal Areas – Summary of Guidelines for Siting Buildings

1. **DO** determine whether the lot is suitable for its intended use; if not, alter the use to better suit the site or look at alternative sites.
2. **DON'T** assume engineering and architectural practices can mitigate poor lot layout or poor building siting.
3. **DO** study the lot thoroughly for all possible resource and hazard concerns – seek out all available information on hazards affecting the area and prior coastal hazard impacts on the lot.
4. **DON'T** assume that siting a new building in a previous building footprint or in line with adjacent buildings will protect the building against coastal hazards.
5. **DO** account for all types of erosion (e.g., long-term erosion, storm-induced erosion, erosion due to inlets) and governing erosion control policies when selecting a lot and siting a building.
6. **DON'T** rely on existing (or planned) erosion or flood control structures to guarantee long-term stability of the lot.
7. **DO** avoid lots that require extensive grading to achieve a stable building footprint area.
8. **DON'T** overlook the constraints that site topography, infrastructure and ancillary structures (e.g., utility lines, septic tank drain fields, swimming pools), trees and sensitive resources, and adjacent development place on site development, and (if necessary) future landward relocation of the building.
9. **DO** ensure that the proposed siting is consistent with local, regional, and state planning and zoning requirements.
10. **DON'T** overlook the constraints that building footprint size and location place on future work to repair, relocate or protect the building – allow for future construction equipment access and room to operate on the lot.
11. **DO** identify and avoid, or set back from, all sensitive resources.
12. **DON'T** overlook the effects to surface and groundwater hydrology from development of the lot.
13. **DO** consider existing public access to shoreline and resource areas.

8.4.2 Practices To Avoid and Recommended Alternatives

Experience shows that—just as there are certain subdivision development practices to avoid in hazardous coastal areas—there are individual lot siting and development practices to avoid as well. These include the following:

1. One of the most common siting errors is placing a building as far seaward or waterward as allowed by local and state regulations. Although such siting is permitted by law, it can lead to a variety of avoidable problems, including increased building vulnerability, damage to the building, encroachment onto a beach. On an eroding shoreline, this type of siting often results in the building owner being faced with one of three options: loss of the building, relocation of the building, or (if permitted) protection of the building through an erosion control measure.

   Alternatives to this practice include siting the building farther landward than required by minimum setbacks, and designing the building so it can be easily relocated. Siting a building farther landward also allows (in some cases) for the natural episodic cycle of dune building and storm erosion to occur without jeopardizing the building itself.

2. Siting a building too close to a coastal bluff edge can result in building damage or loss (see Figure 4-3, in Chapter 4, and Figures 7-38 and 7-39, in Chapter 7). Keillor (1998) provides excellent guidance regarding selection of appropriate construction setbacks for bluffs on the Great Lakes shorelines, but the general concepts are applicable elsewhere (see Figure G-17, in Appendix G).

3. Some sites present multiple hazards, which designers and owners may not realize. For example, Figure 8-16 shows southern California homes that have been constructed along the Pacific shoreline at the mouth of a coastal stream. The homes may be subject to storm waves and erosion, stream flooding and debris flows, and earthquakes.

4. Siting a building too close to an erosion control structure, or failing to allow sufficient room for such a structure to be built, is another siting practice to avoid. Figure 8-17 shows an example of buildings that were constructed near the shoreline, only to be damaged by storm effects and erosion. Subsequent construction of a rock revetment will provide some protection to the buildings, but not as much as if there were a greater distance between the revetment and buildings. Storm waves can easily overtop the revetment and damage the buildings. An alternative to this situation is simply to plan ahead by siting the building farther landward and providing enough room between the building and the erosion control structure to dissipate the effects of wave and flood overtopping.

Figure 8-16
This site near Malibu, California, is an example of a coastal building site subject to multiple hazards—storm waves and erosion, stream flooding and debris flows, and earthquakes. Photo courtesy of *Journal of Coastal Research* (Griggs 1994, in Finkl 1994).

Figure 8-17
Hurricane Hugo (1989). Damage to buildings sited close to an eroding shoreline at Garden City Beach, South Carolina. Storm waves often overtop revetments and damage buildings.

A related siting problem (also observed along bay or lake shorelines, canals, manmade islands, and marina/townhouse developments) is the construction of buildings immediately adjacent to bulkheads (see Figure 8-18). The bulkheads are rarely designed to withstand a severe coastal flood and are easily overtopped by floodwaters and waves. During severe storms, landward buildings receive little or no protection from the bulkheads. In fact, if such a bulkhead fails, the building foundation will be undermined and the building may be sustain additional damage or be a total loss.

Figure 8-18
Damage at Bonita Beach, Florida, from June 1982 subtropical storm. Had this building not been supported by an adequate pile foundation, it would have collapsed. Buildings sited close to an erosion control structure should not rely on the structure to prevent undermining. Photograph by Judson Harvey

In both of the above cases, it may be difficult to repair the erosion control devices in the future, because of limitations on construction access and equipment operation. If erosion control devices are permitted and are employed, they should be sited far enough away from any nearby buildings so that there is room to access the site and complete any repairs.

5. Although preservation of vegetation and landscaping are an important part of the siting process, designers should avoid siting and design practices that can lead to building damage. For example, designs that "notch" buildings and rooflines for placement of large trees should be avoided (see Figure 8-19). This siting practice may lead to avoidable damage to the roof and envelope during a high-wind event. Additionally, the potential consequences of siting a building immediately adjacent to existing large trees (capable of falling and damaging structures) should be evaluated carefully.

6. Pedestrian access between a coastal building and the shoreline is often overlooked when siting decisions and plans are made. Experience shows, however, that uncontrolled access can damage coastal vegetation and landforms, providing weak points upon which storm forces to act. Dune blowouts and breaches during storms often result, and buildings landward of the weak points can be subject to increased flood, wave, erosion, or overwash effects. Several options exist for controlling pedestrian (and vehicular access) to shorelines. Guidance for the planning, layout, and construction of access structures and facilities can be found in a number of publications (California Coastal Commission 1982, California State Coastal Conservancy 1987, Florida Department of Environmental Protection 1998 [see Appendix I], Walton and Skinner 1983 [see Appendix I]).

Figure 8-19
Siting and designing buildings to accommodate large trees is important for a variety of reasons. However, notching the building and roofline to allow placement around a tree can lead to roof and envelope damage during a high-wind event and is not a recommended practice.

8.5 Influence of Beach Nourishment and Dune Restoration on Siting Decisions

NOTE
Beach nourishment and dune restoration projects are temporary. Although they can mitigate some storm and erosion impacts, they should not be used as a substitute for sound siting, design, and construction practices.

Beach nourishment was discussed in Section 7.5.2.3.1, in Chapter 7, as a means of mitigating potential adverse impacts of shore protection structures. Beach nourishment and dune restoration can also be carried out alone, as a way of replacing beach/dune sediments already lost to erosion or of providing nourishment in anticipation of future erosion (National Research Council 1995).

Beach nourishment projects typically involve dredging or excavating hundreds of thousands to millions of cubic yards of sediment, and placing it along the shoreline. Beach nourishment projects are preferred over erosion control structures by many states and communities, largely because the projects add sediment to the littoral system and provide recreational beach space.

The longevity of a beach nourishment project will depend upon several factors: project length, project volume, native beach and borrow site sediment characteristics, background erosion rate, and the incidence and severity of storms following construction. Thus, most projects are designed to include an initial beach nourishment, followed by periodic maintenance nourishment (usually at an interval of 5 to 10 years). The projects can provide protection against erosion and storms, but future protection is tied to a community's commitment to future nourishment efforts.

Beach nourishment projects are expensive and often controversial (the controversy usually arises over environmental concerns and the use of public monies to fund the projects). Although this manual will not take sides on the matter, suffice it to say planning and construction of these projects can take years to carry out, and economic considerations usually restrict their use to densely populated shorelines. Therefore, as a general practice, designers and owners should not rely upon future beach nourishment as a way of providing significant and continuous relief that can compensate for poor siting decisions.

As a practical matter, however, beach nourishment is the only viable option available to large, highly developed coastal communities, where both upland protection and preservation of the recreational beach are vital. Beach nourishment programs have been established and are ongoing in many of these communities—infill development and redevelopment will continue landward of nourished beaches. Owners and designers should realize, however, while the nourishment programs will reduce potential storm and erosion damage to upland development, they will not eliminate all damage, and sound siting, design, and construction practices must be followed.

WARNING

Although dune vegetation serves many valuable functions, it is not very resistant to coastal flood and erosion forces.

Dune restoration projects typically involve placement of hundreds to tens of thousands of cubic yards of sediment along an existing or damaged dune. The projects can be carried out in concert with beach nourishment, or alone. Smaller projects may fill in gaps or blowouts caused by pedestrian traffic or minor storms, while large projects may reconstruct entire dune systems. Dune restoration projects are often accompanied by dune revegetation efforts, where native dune grasses or ground covers are planted to stabilize the dune against windblown erosion, and to trap additional windblown sediment.

The success of dune restoration and revegetation projects depends largely on the condition of the beach waterward of the dune. Property owners and designers are cautioned that dune restoration and revegetation projects along an eroding shoreline will be short-lived—without a protective beach, high tides, high water levels, and minor storms will erode the dune and wash out most of the planted vegetation.

In some instances, new buildings are sited so that there is not sufficient space waterward to construct and maintain a viable dune. In many instances, erosion has placed existing development in the same situation. A dune restoration project waterward of these structures will not be effective; those buildings in greatest need of protection will receive the least protection. Hence, as in the case of beach nourishment, dune restoration and revegetation should not be used as a substitute for proper siting, design, and construction practices.

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