16. Develop Harbor Layout

Because a well-designed harbor maximizes function while minimizing cost, design and evaluate alternative harbor layouts against established criteria. Consider non-point source pollution controls and Americans With Disabilities Act (ADA) access when evaluating the harbor layout. Explore various geometric shapes to optimize the design around site-specific features, and incorporate upland facilities into the total harbor plan.

16.10 Basin Geometry

Optimize the basin planform geometry for the design fleet while maintaining protected moorage, good upland access, and water quality through good circulation and flushing. The plan should make effective use of site-specific features and natural water depths to reduce costs and improve construction.

Consider BASIN GEOMETRY when:

1) Laying out a new harbor or modifying an existing one

Note 1. Investigate various basin shapes. Curvilinear and circular planforms will enhance circulation and flushing while optimizing space requirements. Rectilinear shapes are more traditional but tend to have areas with poor water quality. Freeform or non-geometric shapes are normally considered most aesthetic and can be most easily shaped to an irregular shoreline.

Note 2. An in-depth knowledge of sub-bottom soil conditions, with emphasis on boulders and bedrock, is necessary to optimize the basin and breakwater alignments. Soil conditions will affect dredging, breakwater foundations, and pile driving.

Note 3. Harbors often require a mix of dredging and breakwater construction to provide a protected harbor of adequate depth. As the mooring basin is moved offshore into deeper water, the cost of breakwater construction increases and the cost of dredging goes down. Moving the basin landward has the opposite effect. Knowledge of both breakwater costs and dredging costs is required for basin optimization.

REFERENCES:

1. Nece, Ronald; Richey, Eugene; Rhee, Joonpyo; and Smith, Harvey. 1979. “Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas,” Technical Report 62, Department of Civil Engineering, University of Washington, Seattle, Washington, 98195.

16.20 Water Quality

Water quality is one of the most important environmental design considerations because it is essential for a healthy marine habitat. Water quality depends on good circulation and flushing as well as controlling sources of pollutants. Developing the harbor layout to preserve water quality can be achieved through creative design. Harbor layout should consider sediment transport of any rivers or streams and long shore transport in the area of the harbor. Also, the layout should consider the mixing of ambient water with the water inside the harbor for proper flushing and circulation.

Consideration of WATER QUALITY during harbor layout may be necessary when:

1) A 401 clean water certificate is required for construction
2) The harbor is being built in an area where preserving marine habitat is considered important
3) Flow from freshwater streams near the site exchange with basin water
4) Storm runoff may flow into basin
5) Breakwater design includes breaches or breaks that may decrease mixing velocities

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Note 1. Appendix C provides information on non-point source pollution (NPSP) permitting for water quality.

Note 2. Basin design that creates a greater exchange rate with the ambient water will greatly improve flushing and circulation and improve water quality.

Note 3. The Environmental Protection Agency recommends that in tidal waters, marina design should replace conventional rectangular boat basin geometry with curvilinear geometry to eliminate the stagnation effects of sharp-edged corners, and to exploit the natural hydraulic patterns of flow.

Note 4. Both numerical and physical models can be used to evaluate flushing and circulation. Normally, several alternatives are modeled and evaluated based on *relative* performance.

REFERENCES:

1. ASCE Manual No.50. Task Committee on Marinas 2000. 1982. *Planning and Design Guidelines for Small Craft Harbors.* New York. Pg.50-52.

2. Nece, Ronald; Richey, Eugene; Rhee, Joonpyo; and Smith, Harvey. 1979. *"Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas,"* Technical Report 62, Department of Civil Engineering, University of Washington, Seattle, Washington, 98195.

3. Tobiasson, B.O. & Kollmeyer, R.C. 1991. *Marinas and Small Craft Harbors.* New York: Van Nostrand Reinhold. Pg. 200-201, 216-219.

4. Smith, H.; Jones, D.; Carter, R., 2002. *"Achieving and Maintaining Water Quality in Small Boat Harbors"*

16.30 Float Layouts

Float layouts are normally determined by basin geometry as well as wind and wave directions. Although Cartesian (or rectilinear) layouts are traditional; spoked, radial, or other configurations are becoming popular in many contemporary harbors. A blend of several layouts can be used to fit freeform or other complex geometric shapes. It is important to maintain good access and fairway widths when laying out a harbor float system.

Consider FLOAT LAYOUT when:

1) Determining the required basin size for a specific design fleet
2) Aligning breakwaters and entrance channels
3) Determining the location of upland access
4) Aligning the floats for waves and currents
5) Aligning the floats for prevailing winds
6) Considering percentages of transient moorage and individual slips
7) Locating a sewage pump-out, floatplane facility, or fuel dock

Note 1. The mooring density, determined by stall float and fairway spacing, is often based on required revenue but should also factor in winds, currents, type of boats, and skill of the operators. Recreational and weekend boaters normally require more room for navigation than commercial fishing vessels.

Note 2. There should be an allowance for transient (parallel) moorage and individual stall (permanent) moorage. Transient moorage offers flexibility in vessel size but also requires more oversight by management. Stall moorage is more convenient to the boat owner and management but is less flexible and has a higher initial cost. State policy recommends at least 20 percent of the moorage be designated for transient use.

Note 3. The Americans with Disabilities Act (ADA) requires that accessible slips are representative of the various types of slips available and closest to an accessible route and services (see Appendix H).

REFERENCES:

1. Tobiasson, B.O. & Kollmeyer, R.C. 1991. *Marinas and Small Craft Harbors.* New York: Van Nostrand Reinhold. Pg. 73-74.

2. ASCE Manual No.50. Task Committee on Marinas 2000. 1982. *Planning and Design Guidelines for Small Craft Harbors.* New York. Pg.39-45.

16.40 Upland Area

Develop a basic upland use plan to ensure there is an adequate area set aside to support current and future requirements of the harbor. Situate the uplands to provide convenient access between the float system and upland facilities, such as parking and restrooms. Commercial harbors require areas for gear storage and repairs, while recreational harbors may need to provide for restaurants and green areas. Regardless of use, uplands should be at least two-thirds the size of the tidal basin.

UPLAND AREA evaluation for harbor layout may be necessary when:

1) Designing new facilities or expanding existing ones
2) Designing upland amenities such as harbormaster office, restrooms, showers, laundry, fuel service station, supply stores, or other specialized needs
3) Providing parking or storage areas
4) Conforming to non-point source pollution guidelines

Note 1. Remote communities often rely on all-terrain vehicle (ATV) transportation and don't require large upland areas for parking. However, they may have greater requirements for vessel haul-out and repair or storage of subsistence fishing gear.

Note 2. Floats used primarily for transient vessels may need less upland area.

Note 3. Recreation and public use facilities and green areas can be designed creatively to provide both aesthetics and function.

Note 4. We recommend a 20-foot, vegetated buffer around the perimeter of the basin to mitigate the impacts of surface runoff and compliance with non-point source pollution guidelines (see Appendix I).

Note 5. If uplands are being created from beneficial use of dredged material, set aside a portion for habitat—for example, create nesting areas for shorebirds.

REFERENCES:

1. Tobiasson, B.O. & Kollmeyer, R.C. 1991. *Marinas and Small Craft Harbors.* New York: Van Nostrand Reinhold. Pg. 73-74.

2. ASCE Manual No.50. Task Committee on Marinas 2000. 1982. *Planning and Design Guidelines for Small Craft Harbors.* New York. Pg.45-48.

16.50 Wave Resonance/Seiche

The phenomenon of a standing wave oscillating, or resonating, in a closed basin is called a seiche. It occurs in small boat harbors when long-period waves enter the basin and the energy is poorly dissipated. Seiche may also occur in large water bodies, such as the Great Lakes, by atmospheric pressure gradients moving across the water body.

Consider WAVE RESONANCE/SEICHE when:

1) The site is exposed to ocean swell
2) The site has locally generated wind waves with periods exceeding about 6 seconds
3) The basin's least dimension is less than 2 wave lengths
4) The site is exposed to long period waves and the basin has low energy absorbing shorelines.

Note 1. To minimize seiche and internal reflection, one should:

a. Avoid basins with parallel sides. Irregular shapes are best.
b. Avoid reflective boundaries such as vertical walls. Mildly sloping armor rock is good; flat beaches with slopes less than 10 to 1 are best.
c. Avoid constant depth basins.

Note 2. Small basins near the open coast are most susceptible to seiche.

REFERENCES:

1. Muir Wood, A.M., Flemming, C.A. 1981. *Coastal Hydraulics*, Second Edition, A Halsted Press Book, John Wiley & Sons, New York.

2. *Shore Protection Manual.* 1984. 4th ed., 2 vols. U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, U.S. Government Print. Off., Washington, D.C.