



STATE OF CONNECTICUT
DEPARTMENT OF AGRICULTURE
BUREAU OF AQUACULTURE & LABORATORY



Connecticut Department of Agriculture Bureau of Aquaculture
Marina Dilution Analysis Background
Effective Date: 01/31/13

Background:

According to the 2009 National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish (NSSP-MO and guidance documents), a “marina” is defined as “any water area with a structure (docks, basin, floating docks, etc.) which is: (a) Used for docking or otherwise mooring vessels; and (b) Constructed to provide temporary or permanent docking space for more than ten boatsⁱ.

Because every discharge from a boat has the potential to transmit pathogens, every watercraft (barge, houseboat, or boat) that can produce a discharge shall be considered when determining the potential impact on shellstock growing waters. The detection of low levels of fecal coliforms from waste discharge by water quality monitoring sampling does not provide sufficient information to properly classify waters in or adjacent to a marina.ⁱⁱ It is for this reason that the FDA developed guidance to establish a uniform national approach for the evaluation and classification of shellfish growing waters in and around docks, marinas and mooring areas.ⁱⁱⁱ

The guidance provided by the NSSP is intended to be applied by the State Shellfish Authority based on the best professional judgment of qualified individuals. There are significant regional differences in factors that affect pollution loading from marinas. It is expected that the Authority will apply local knowledge gained during shoreline survey and monitoring work to account for regional differences.

DA/BA has implemented a modified dilution calculation that is based on the total number of slips rather than documented occupancy. Documenting occupancy would require DA/BA staff to visit every marina (or mooring area) in the state annually during peak occupation times. Peak occupation times are during evening, weekend and holiday hours. DA/BA staff is not authorized to perform routine work duties during these times, except in case of emergency or as required to enact closures.

FDA has evaluated the current procedures used by DA/BA to perform marina dilution analyses and has found them to meet NSSP criteria.

Application of NSSP Criteria to the Calculation of a Dilution Analysis

The dilution analysis calculates the theoretical fecal coliform load of a marina area and the volume of water required to bring that load below 14 CFU/100 ml (Equation 1). Then, based on average depth of the marina, liters are converted into square meters of surface area needed (Equation 2). If the area that is needed for dilution is greater than the marina proper area, then impact extends into adjacent areas, and they must be classified accordingly; Conditionally Approved, Conditionally Restricted, or Prohibited. GIS is used to draw a

polygon over the marina and surrounding waters the size of the area necessary for dilution, which is then used to ensure that the marina area and adjacent waters are correctly classified.

Information required to perform a dilution calculation:

1. Total occupancy = Permitted number of boat slips (N)

This number is the maximum permitted number of slips or moorings and is taken from the marina's Department of Energy and Environmental Protection Structures, Dredging and Fill Permit and is updated via DA/BA interviews of marina staff and observations made during sanitary survey work. DA/BA is notified of changes to the permitted number of slips via the permitting process, and adjusts dilution calculations as needed. We also observe when marinas have added boats and encroached past their permitted area when doing field observations. Total occupancy rates are updated on a triennial basis for inclusion in each town's Triennial Assessment of Shellfish Growing Waters, and classifications revised as needed.

2. Number of people per boat (N1 = 2 x N)

According to the NSSP Guide Ch. IV@.05: If the Authority chooses not to determine a specific occupancy per boat rate by investigation in specific areas or sites, the Authority shall assume a minimum occupancy rate of two persons per boat.

3. Depth of water in marina vicinity (D)

Assume a half tide water level (Mean low water + half of the tidal range). Dilution is calculated using areas having similar depths. GIS and nautical charts are used to determine the depth.

4. Fecal Coliform Load (N2) = Number of Fecal Coliforms generated per person^{iv} X Number of people per boat (N1)

Accepted literature value of 2×10^9 FC as recommended in FDA Guideline (1989).

5. VIMS Occupancy Discharge Model^v

The FDA Guideline (1989) dilution formula is based on the total number of slips with an assumed rate of discharge of 100%. The VIMS (Virginia Institute of Marine Sciences) Model allows us to use a significantly reduced occupancy, and therefore discharge rate. The VIMS model assumes a rate of occupancy in which 50% of slips (or moorings) are occupied by an inhabited boat, and 50% of these boats are discharging (i.e. 25% discharge rate). This 50% occupancy rate is extremely conservative, and in CT we have determined that a 10% rate of occupancy is more realistic, yet provides an adequate measure of safety. According to the FDA Guideline (1989)^{vi}, a 10% rate of occupancy is the minimum factor that may be used, even if overboard discharges are prohibited. If we assume that 50% of occupied boats are discharging (according to the model), this correlates to an overall discharge rate equal to 5% of the total number of slips. Long Island Sound is an EPA Designated No Discharge Zone, and this is where that factor is taken into account.

General Equations:

Equation 1: Liters needed to dilute theoretical waste to <14CFU/100ml

Dilution Volume (V) required =

$$\frac{\text{(N2 or Fecal Coliform load)}}{14\text{FC}} \times \frac{1000\text{ ml}}{100\text{ ml}} \times \text{Liter}$$

Equation 2: Convert liters needed into square meters of surface area

$$\frac{\text{Liters needed}}{\text{Avg depth}} \times \frac{1000\text{ml}}{\text{Cubic Meters}}$$

Example:

Below is an example of the difference in a marina calculation performed using the FDA Guideline (1989) formula (based on total number of slips with an assumed rate of discharge of 100%) and using the Modified VIMS formula that we have adopted in CT (based on the total number of slips with an assumed overall rate of discharge of 5%).

In this example we will use a marina with a 3 meter depth. For the purposes of this example we will assume that half the tidal range is included in that depth. 50 boat slips, 2 people per boat, and the assumed fecal coliform rate of 2×10^9 FC.

FDA Guideline (1989) (Assumes rate of discharge of 100%)

$$\frac{(50\text{ slips} \times 2\text{ people}) \times (2 \times 10^9)}{14\text{FC}} \times \frac{1000\text{ ml}}{100\text{ ml}} \times \frac{200 \times 10^9\text{FC}}{140\text{ FC/L}} = 1.4 \times 10^9\text{ Liters}$$

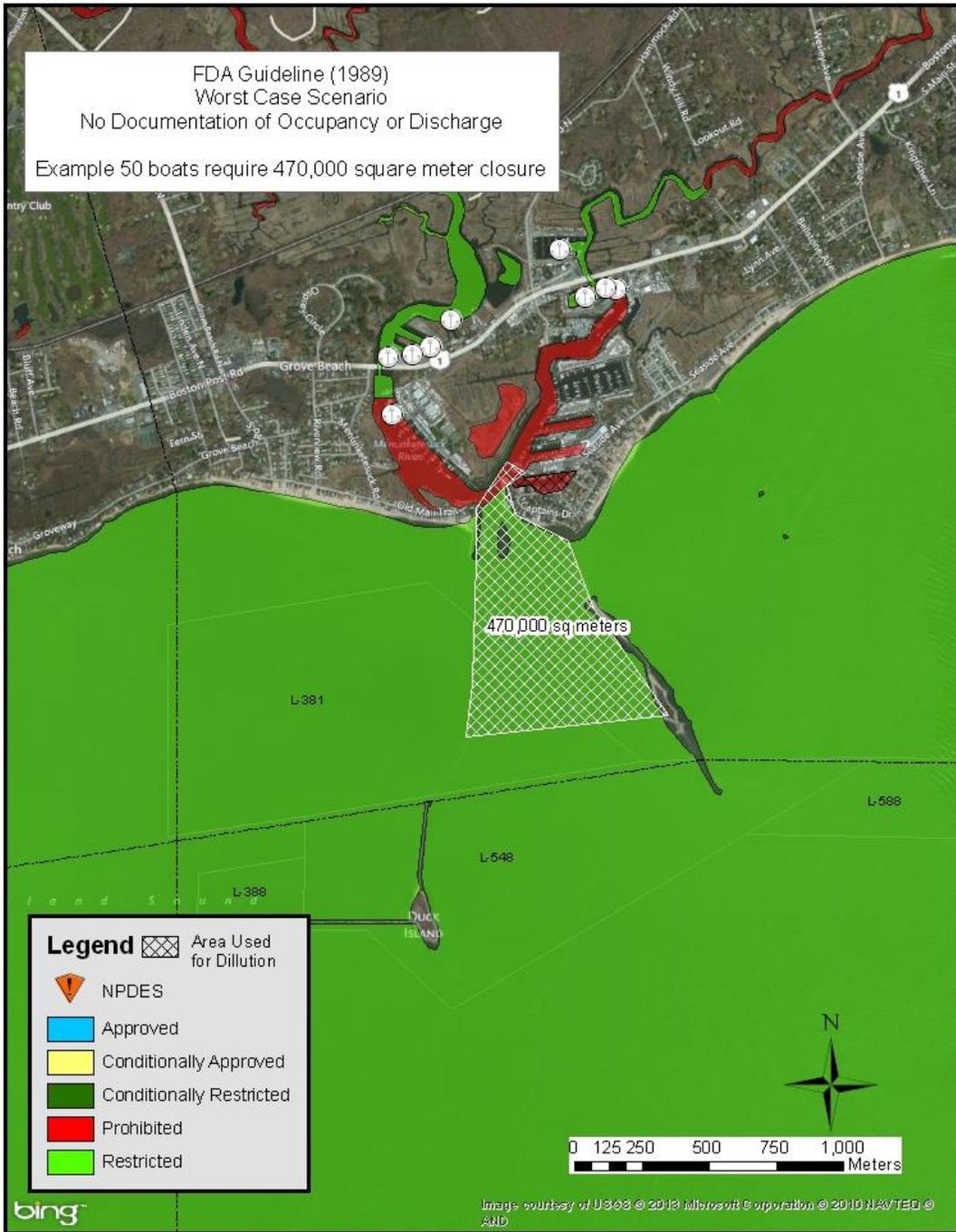
$$\frac{1.4 \times 10^9\text{ Liters}}{3 \times \frac{1000\text{ Liters}}{\text{Cubic Meter}}} = 476,190\text{ square meters of surface area needed}$$

Modified VIMS used in CT (Assumes 10% rate of occupancy and 50% of occupancy discharge = 5% discharge overall)

$$\underline{(50 \text{ slips} * 0.1 \text{ Rate of Occ} * 0.5 \text{ Occ DC} * 2 \text{ people}) * (2 \times 10^9)} = 1.0 \times 10^{10} \text{ FC} = 7.1 \times 10^7 \text{ Liters}$$

$$\frac{14\text{FC}}{100 \text{ ml}} * \text{Liter} = \frac{1000 \text{ ml}}{1000} = 140 \text{ FC/L}$$

$$\frac{7.1 \times 10^7 \text{ Liters}}{3 \times \frac{1000 \text{ Liters}}{\text{Cubic Meter}}} = \mathbf{23,810 \text{ square meters of surface area needed}}$$



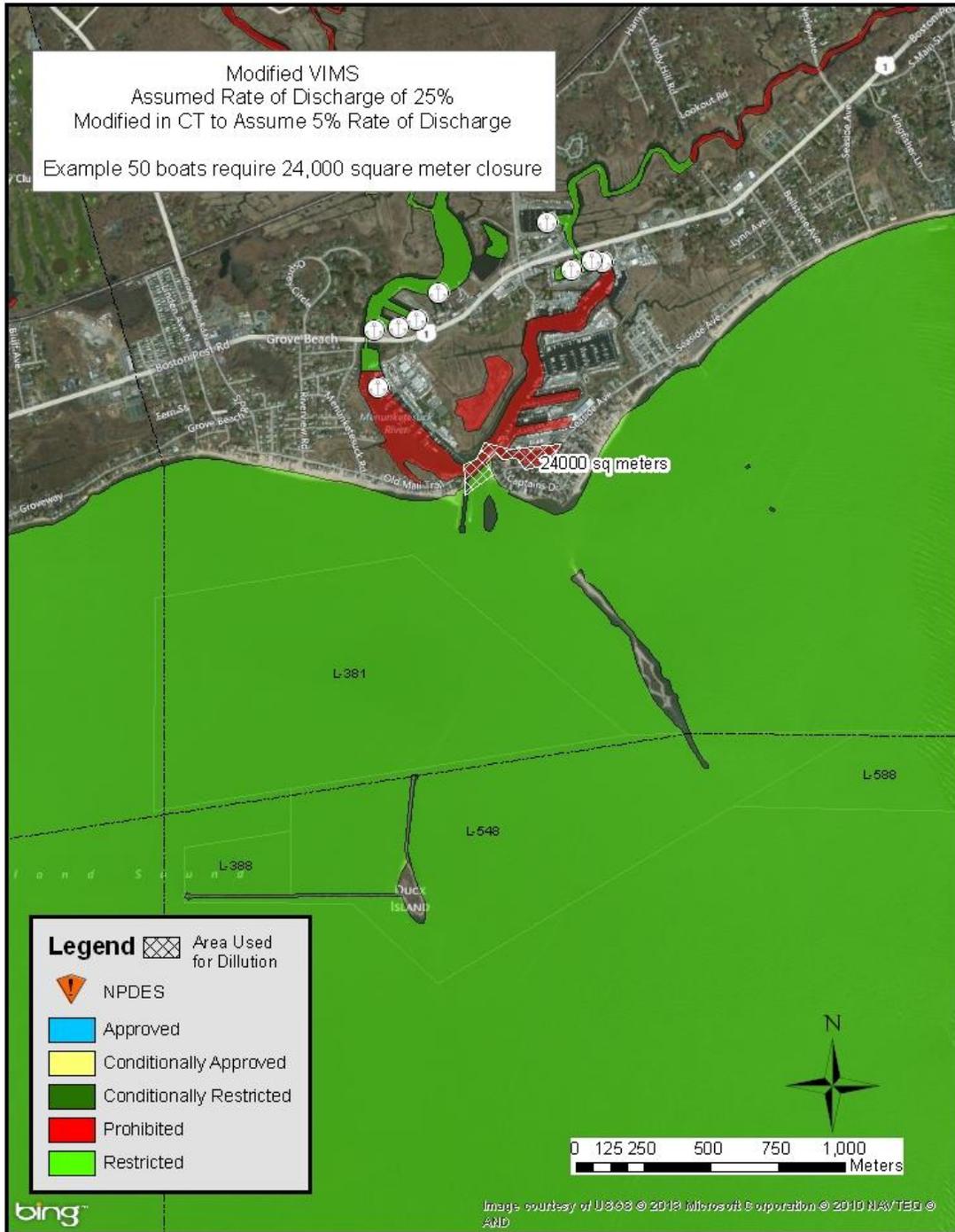


Table 1. Example of dilution calculations as applied using Excel. ArcMAP is used to calculate areas. Data in red is entered, other fields are calculated by formula.

Marina Name	Enter # Slips	N=VIMS DC 10% Occ $D2 \cdot 0.1 \cdot 0.5$	Number of people $N1 = Nx2$	Number of $FC = N2 = N1x2x10^9$	Dilution Volume (v) Needed Liters	Enter Mean Low Water (feet)	Enter 1/2 Tidal Range	Water Depth (D) meters	Closed Area (A) Needed (Meter ²)
EXAMPLE	50	2.5	5	1.00E+10	71,428,571	6.4	3.6	3.0	23810.0

APPENDIX

1. From the NSSP Guide Section III. Public Health Reasons and Explanations:

@.05 Marinas

A. Marina Proper. Under the NSSP, any growing area within the confines of the marina proper is presumed to be contaminated for some period of time. Therefore, no growing area within the marina proper can be placed in the approved classification.

B. Adjacent Waters. **The microbiological and chemical contamination associated with marina facilities may result in the contamination of adjacent shellfish growing waters.** The NSSP has developed a set of evaluation criteria to be used in determining if the growing waters adjacent to a marina are affected by microbiological contaminants associated with sewage. Since there are significant regional differences in all factors that affect pollution loading from marinas, sufficient flexibility must be allowed to account for these differences. The Authority has the option of applying the specified occupancy and discharge rates necessary to conduct a dilution analysis. The Authority may also opt to conduct studies to document different rates for specific areas. Best professional judgment of qualified individuals and best available technology must be applied to determine adequate restrictions on harvesting in and around marinas.

2. The NSSP Guide specifies how shellstock growing areas that are in or adjacent to marinas shall be classified, and offers guidance on conducting a dilution analysis. From the NSSP Section II. Model Ordinance Chapter IV. Shellstock Growing Areas:

@.05 Marinas.

A. Marina Proper. The area within any marina which is in or adjacent to a shellstock growing area shall be classified as:

- (1) Conditionally approved;
- (2) Conditionally restricted; or
- (3) Prohibited.

B. Adjacent Waters. Waters adjacent to marina waters classified under §A. may be impacted by pollution associated with the marina.

- (1) A dilution analysis shall be used to determine if there is any impact to adjacent waters.
- (2) The dilution analysis shall be based on the volume of water in the vicinity of the marina.
- (3) The dilution analysis shall incorporate the following:
 - (a) A slip occupancy rate for the marina;
 - (b) An actual or assumed rate of boats which will discharge untreated waste;
 - (c) An occupancy per boat rate (i.e., number of persons per boat);
 - (d) A fecal coliform discharge rate of 2×10^6 fecal coliform per ninth power per day; and
 - (e) The assumption that the wastes are completely mixed in the volume of water in and around the marina.

- (4) If the dilution analysis predicts a theoretical fecal coliform loading greater than 14 fecal coliform MPN per 100 ml, the waters adjacent to the marina shall be classified as:
- (a) Conditionally approved;
 - (b) Restricted;
 - (c) Conditionally restricted; or
 - (d) Prohibited.
- (5) If the dilution analysis predicts a theoretical fecal coliform loading less than or equal to 14 fecal coliform MPN per 100 ml, the waters adjacent to the marina may be classified as:
- (a) Approved; or
 - (b) Conditionally approved.
- (6) If the Authority chooses not to determine a specific occupancy per boat rate by investigation in specific areas or sites, the Authority shall assume a minimum occupancy rate of two persons per boat.

ⁱ 2009 National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish. U. S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC).

ⁱⁱ FDA Guideline: Evaluation of Marinas by State Shellfish Sanitation Control Officials, June 1989. FDA Shellfish Sanitation Branch.

ⁱⁱⁱ FDA Guideline: Evaluation of Marinas by State Shellfish Sanitation Control Officials, June 1989. FDA Shellfish Sanitation Branch.

^{iv} 2009 National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish. U. S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC).

^v Sanitary Survey of Shellfish Growing Areas, Training materials, 2012

^{vi} FDA Guideline: Evaluation of Marinas by State Shellfish Sanitation Control Officials, June 1989. FDA Shellfish Sanitation Branch.