

Guest Commentary

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A New Alternative for Sizing Septic Systems

When a builder, a designer, and a regulator wonder how big the septic system for a house should be, they might approach the question from different points of view. The builder might wonder, "How big does it have to be to last through my warranty period?" The designer might ask, "How much water are the people who are buying this house likely to use?" The regulator might ask, "If this house is filled to capacity with teenage obsessive-compulsive hand washers, how much water will they use?"

These points of view have fought it out in our political process and have shaped current environmental health laws. The result is that houses are not built with septic systems expected to last the life of the structure and much of the design criteria is based on water use averages (rather than worst-case scenarios), with a modest safety margin usually built in for unusual occupancy periods. What this essay will propose is a reasoned approach using statistics and measured data to design for water use flows. This approach will more evenly distribute public health risk and more fairly spread the financial burdens to builders across the different classes of single-family homes.

After years of regulatory evolution, most health jurisdictions size septic systems on the basis of 100-150 gallons per bedroom per day. Some builders, trying to minimize septic-system size so as to maximize house size on small lots, have adopted practices of building "dens," "bonus rooms," or "sewing rooms" that look suspiciously like bedrooms. This "three-bedroom mansion" phenomenon can be seen in any area where incomes are high and land is scarce.

The response of some regulators has been to require that any room that can be used as

a bedroom be counted as a bedroom. This regulation is enforced regardless of the likelihood that these rooms will be used as bedrooms. The bedroom-definition dance has stirred up a great deal of frustration and animosity for builders and regulators alike. Just how important is quantifying the number of bedrooms to a good septic-system design?

The time has come to see if the linear-gallons-per-bedroom approach does an accurate job of predicting water use. We should, at the same time, find out if quantifying other physical aspects of houses will give us better water use predictions than does simply counting bedrooms. Below is a review of two studies done by Public Health-Seattle & King County and the Washington State Department of Health that can help answer these questions.

The Q1000 and H200 Studies

In the Q1000 Study, the assessor's property records for roughly 1,000 houses served by sewers were matched with water records from 1994 to 1996 (Figure 1). Winter water use was isolated for each house (to minimize the influence of outdoor water use), and peak two-month periods and overall two-year winter averages were established for each house. The assessor's records were used to establish the number of toilets and bedrooms, and the living-area square footage for each house.

Each of those three structural parameters was statistically correlated against the water averages. They were then run through multiple-regression analysis to establish the relative importance of each structural parameter in predicting water flows.

The H200 Study did essentially the same thing as the Q1000 Study, but it used 200 houses served by septic systems and used water use figures from 2000-2001. Both studies are summarized, and their methods and findings are available, in a report posted at <http://dave.glen.home.att.net>.

Study Findings

Does the Number of Bedrooms Correlate with Average Water Use?

The simple answer is yes—but not very well.

A quick statistical review may be appropriate at this point. "Correlation" measures the tendency of one set of numbers to rise or fall in relation to another set of numbers. The R^2 is a value that represents the percentage change in one variable that is related to the change in another variable. A perfect correlation would result in an R^2 of 100 percent, while totally unrelated variables would have an R^2 of around zero. Table 1 gives the R^2 values found in the Q1000 and H200 studies.

As one can see, the R^2 values are not very impressive. They are, however, statistically significant to 99 percent, and even the small differences between variables for the Q1000 Study are real. The positive bedrooms-to-water-use correlations mean that one can expect the average three-bedroom house to use less water than the average four-bedroom house. What one cannot expect is to be able to assign a monolithic gallon-per-bedroom value that is very useful in predicting water flows. These R^2 values basically say that water use and the number of bedrooms are related, but that water use cannot be well predicted in a linear manner.

TABLE 1*R*² for Winter-Water-Use Averages

Study Group (sample size)	Toilets	Bed-rooms	Square Feet Grouped in 10s	Square Feet Grouped in 1,000s	Combined Bedroom & 1,000 Square Feet	Combined Bedroom & 800 Square Feet
Q1000 Sewer (953)	6.6%	7.5%	7.8%	6.7%	8.0%	8.7%
H200 Septic (201)	15.5%	5.6%	24.6%	26.9%	18.9%	22.4%

TABLE 2

Bedroom Classes with 1,000-Square-Foot Limits Per Class

Class	Number of Houses in Sample	84th Percentile × 1.5 Is the Design Limit
1–2 bedrooms under 2,000 sq ft	184	330 gal/day
1–2 bedrooms over 1,999 sq ft but under 3,000 sq ft and 3 bedrooms under 3,000 sq ft	499	354 gal/day
1–3 bedrooms over 2,999 sq ft but under 4,000 sq ft and 4 bedrooms under 4,000 sq ft	332	429 gal/day
1–4 bedrooms over 3,999 sq ft but under 5,000 sq ft and 5 bedrooms under 5,000 sq ft	102	512 gal/day
1–5 bedrooms over 4,999 sq ft but under 6,000 sq ft and 6 bedrooms under 6,000 sq ft	31	584 gal/day

wastes entering drainfields. Design should take this likelihood into account.

- The water data will also include houses with people who use outdoor water in the winter. This circumstance means that the house that appears to be in the 75th percentile of indoor water users will actually be in a higher percentile.
- The Q1000 and H200 studies found that only 14 percent of houses had a peak two-month period that averaged more than 150 percent of their overall winter average. This finding implies that, for the vast majority of houses, septic systems with timed dosing and surge tanks can be used to keep daily flow within design limits even during high-use periods.
- Although high water use is associated with premature septic-system failures, it does not necessarily equate with a failure. Some septic systems are quite resilient to stress periods.

Design Example

This example uses bedrooms as the design class but with a 1,000-square-foot limit per

class. The parameters include a desired 84 percent compliance rate and a 150 percent safety factor. Table 2 shows the design limits suggested by the actual water use averages from the combined H200 and Q1000 and the above parameters.

Conclusion

The insights garnered from the King County studies indicate that it is time for the design community to look at real water use figures for different classes of houses when deciding septic-system size. With statistically defensible design classes, reasonably selected compliance percentages, and justifiable “safety factors,” we can retire the inaccurate and unfair standard of 100-150 gallons per bedroom, and look at houses holistically and in context with measured expectations. 🚧

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