

WQMP Rule N.J.A.C. 7:15: Development of the NJGS HUC11-Scale Nitrate-Dilution Model to Determine Regional Septic Densities

03-09-10

Background:

First, what is a nitrate-dilution model? As applied here, it is a mass-balance equation that follows the basic concept:

Mass in = mass out

This approach assumes that the mass being tracked doesn't accumulate in the system and no chemical or biological activity transforms it into something else. As applied to water-quality concerns about nitrate (NO₃) concentrations this becomes:

Mass of nitrate in = mass of nitrate out

This equation can be written in various ways and solved for what is unknown.

Figure 1 shows one simplified approach that solves for the area needed to generate enough recharge to dilute the nitrate to a specified concentration target.

This approach can be used to define the number of

individual subsurface septic disposal systems (ISSDSs) that can be placed in an area without causing a violation of the designated water-quality target. This leads to an estimate of 'septic density.' It is necessary to keep in mind that a septic density is an *average* lot size and not necessarily an area assigned to each ISSDS. For example, Figure 2 shows 3 examples of possible lot sizes where a 200 acre parcel has been assigned a septic density of 5 acres per ISSDS.

Figure 1. A simplified nitrate dilution model

Mass in = mass out

-or-

$PN = cART$

where:

P = population (number of persons per household)

N = nitrate loading rate (pounds per person per year)

A = area (average size of a household lot in acres)

R = recharge rate (inches per year)

T = nitrate target (mg/L)

c = conversion factor

Assuming the other values are known, this then can be rewritten:

$A = PN / (cRT)$

Figure 2. Three examples of how 40 ISSDSs can be placed on 200 acres, each with an allowable septic density of 5 acres per ISSDS.

<u>Example 1</u>			<u>Example 2</u>			<u>Example 3</u>		
# ISSDSs	Lot size (acres)	Total acres	# ISSDSs	Lot size (acres)	Total acres	# ISSDSs	Lot size (acres)	Total acres
25	2	50	10	2	20	25	1	25
15	10	150	20	5	100	15	5	75
40		200	10	8	80	Open space		100
			40		200	40		200

The mass of nitrate entering the system is either defined by a mass loading rate (pounds of nitrate per person, for example) or a concentration input (concentration of nitrate in input stream) and a flow (the volume of the input stream). In this approach the estimated concentration of nitrate discharged in the effluent is the mass divided by the recharge on the site. Quantifying the recharge rate is thus a critical component of the mass-balance application.

The NO₃-dilution modeling first used in New Jersey is based on the 1978 Trela-Douglas NO₃-dilution model. A modified version of this model was adopted into the Pinelands Comprehensive Management Plan (CMP) in 1981. The Pinelands variation of the Trela-Douglas approach was the first NO₃-dilution model used in New Jersey to establish septic densities in a regulatory framework.

The Pinelands version of the Trela-Douglas model uses a single recharge rate. This rate was based on a reasonable assessment of recharge data for the Pinelands Region available at the time. However, recharge varies across New Jersey based on differences in precipitation, soils and land use. The NJDEP needed a more comprehensive approach to nitrate dilution modeling that could take this variability into account.

The NJ Geological Survey, a research branch of the NJDEP, had developed in the early 1990's a model that could be used to predict site-specific average annual groundwater recharge. This was published in 1993 as *A Method for Evaluating Ground-Water-Recharge Areas*

Figure 3. What is GSR-32

- *'A Method for Evaluating Ground-Water-Recharge Areas in New Jersey'* (Charles and others, 1993).
- A comprehensive groundwater recharge model that accounts for differing land cover, climate differences, and soil types specific to New Jersey.
- Original model resulted in an estimate of average annual groundwater recharge. Modified later to add an estimate of drought groundwater recharge.

in New Jersey (Charles, *et al.*, 1993) and is commonly referred to as GSR-32 (Figure 3). This model has been used for numerous water supply studies across the State.

Once the GSR-32 method was available, the next step was to incorporate the lot-specific groundwater recharge estimates (the 'R' value in Figure 1) into a nitrate dilution model. This allows for more accurate estimates of the area needed to dilute the nitrate load to a set standard. The resulting tool was published by the NJGS/NJDEP initially in 2002 as

an Excel workbook and a technical guidance document. These were superseded in 2004 by *A Recharge-Based Nitrate-Dilution Model for New Jersey* (Hoffman and Canace). This model is commonly referred to as OFR 04-1 and calculates septic densities based on site-specific parameters. While it is a nitrate-dilution model, OFR 04-1 is actually a synthesis of two completely separate and comprehensive modeling applications: a nitrate-dilution modeling component (based on the Trela-Douglas approach) and a groundwater-recharge modeling component (based on GSR-32). It is thus unique to New Jersey and very sophisticated.

The nitrate dilution model OFR 04-1 is built on a number of assumptions, some from the Trela-Douglas nitrate dilution component and some from the GSR-32 groundwater recharge component. Table 1 summarizes some of the concepts and assumptions built into these components.

OFR 04-1 was developed in response to Executive Order 109 (January, 2000) and adoption of Subchapter 8 from the 2000

proposal of the WQMP rules, which required determination of carrying capacities for septic systems to address secondary and cumulative impacts of projects proposing the equivalent of 6 or more units on septic systems. The previous threshold for review of the impact of septic systems on water quality was construction of 50 or more realty improvements requiring a New Jersey Department of Environmental Protection (Department) certification under the Realty Improvement Sewerage and Facilities Act, N.J.S.A. 58-11-23 et seq.

A Recharge-Based Nitrate-Dilution Model for New Jersey has since been supplemented and amended as necessary. Version 6.1 of the Excel modeling tool is currently posted online at:

http://www.nj.gov/dep/watershedmgt/DOCS/WQMP/NJ_NO3_DILUTION_V6.1.xls .

Figure 5 shows the data input screen for the modeling tool. The user must input several parameters: population density, nitrate concentration target, municipality, and each applicable soil type. Population density and nitrate target are typed in directly. The user specifies the soil types (out of 329 choices) and the municipality (out of 566 choices) using drop-down menus.

Figure 4. What is OFR 04-1

- *A Recharge-Based Nitrate-Dilution Model for New Jersey* (Hoffman and Canace, 2004)
- A model for land-use decisions based on a nitrate dilution carrying capacity analysis.
- Merges Trela-Douglas mass balance approach with GSR-32 groundwater recharge model.
- Originally applied to NJDEP regulations appropriate for developments of 6 units or more.
- Allows user to assess each soil type present based on NRCS soils surveys.
- Proposed development is automatically assigned a percent impervious surface cover (%-IC) based on an algorithm extrapolated from TR-55.
- Labor intensive for regional analyses of large areas (HUC14s, HUC11s and counties, for example).

Table 1. NJGS Recharge-Based, Nitrate-Dilution Model for New Jersey, with notes on application

<p>When rainfall hits the ground it does one of three things: runs off impervious surfaces, infiltrates into pervious surfaces, or runs off saturated pervious surfaces. The runoff often collects into a stormwater drainage network that takes it offsite. Impervious cover is factored into this NJGS methodology because it reduces the recharge potential for a developed area.</p>	
NO3-Dilution Component	Ground-Water-Recharge Component
<p>Dilution is the only process accounted for that reduces NO₃ concentration, i.e., no dispersion, adsorption, or decay. This is reasonable for a methodology that can reflect local conditions and also be applied consistently on a statewide basis.</p>	<p>Rainfall in inches per year does not equal recharge. The water must travel through the soil profile between the surface and ground water table before it will “recharge” the ground water. This is why soil type can have so much influence on septic densities.</p>
<p>The volume of water added per dwelling unit (wastewater discharge) and ground-water withdrawals (private wells) are not considered. Again, this approach is reasonable for an application intended for uniform usage statewide.</p>	<p>The amount of evaporation varies across the state. Average annual evaporation, based on meteorological observations, is built into a municipality-specific climate factor.</p>
<p>Nitrate loading in the NJGS methodology is a function of the number of persons per household only—nitrate from other potential sources such as applied fertilizers is not considered. <u>The water quality impacts of pre-existing nitrate loading are captured in the statewide average nitrate concentration target of 2 mg/L.</u></p>	<p>Plant uptake of water is factored in using estimated root depths for five vegetation categories -- shallow, moderate, deep-rooted, orchard, and mature forest. Soil types for calculation of these factors were also classified into five major categories: fine sand, fine sandy loam, silt loam, clay loam, and clay.</p>
<p>Note that in NJDEP applications the amended WQMP rule stipulates that a nitrate target of no more than 2 mg/L be used with a population density of no less than 3 persons per household. The exception to this is in the Highlands Preservation and Planning Areas, where the targets specified in the Highlands Water Protection and Planning Act rules (N.J.A.C. 7:38-1 <u>et seq.</u>) or the Highlands Regional Master Plan, respectively, prevail. The WQMP rule stipulates that a lead entity can make environmental standards more restrictive as local conditions or particular circumstances may warrant, such as has been determined for the Highlands Planning Area.</p>	

The user-specified population density is used to calculate nitrate load while the nitrate concentration target applies the concentration that must be met (Figure 5). The municipality choice applies the appropriate climate factor that is necessary to properly estimate recharge for the applicable soil type(s) of that area. More detail on how average and drought climate variations are handled are given in Charles and others (1993), Hoffman and Canace (2004), and Hoffman and French (2008).

The OFR 04-1 model estimates impervious cover that will result from development by incorporating an algorithm extrapolated from the Natural Resources Conservation Service’s *Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds*. For

Figure 5. Nitrate dilution model OFR 04-1 data input screen, with notes.

<u>Input Screen</u>			<u>Notes on Inputs</u>
Adjusted Trela-Douglas Model Input Parameters			<ul style="list-style-type: none"> • User inputs parameters into the yellow boxes. • Directly input values into the population density and NO3 target boxes. • Soil and municipality are specified by drop-down menus. • For NJDEP applications outside the Highlands, population density should be 3 people/home with a NO3 target of 2 mg/L, if no other stricter conditions apply. • The nitrate loading rate of 10 pounds/person/year is based on literature values and should not be changed.
parameter	value	units	
population density:	4	people/home	
human nitrate loading rate	10.0	pounds/person/year	
NO ₃ target:	2.00	mg/l	
Ground-Water Recharge Methodology Input Parameters			
Soil	Boonton		
Municipality	Mountain Lakes Boro. (Morris Co.)		

example, TR-55 assumes a ¼-acre lot averages 38%-IC, a 1-acre lot 20%-IC, and a 5-acre lot 7.1%-IC. The TR-55 estimates are based on a survey of typical residential development at the time TR-55 was developed (1986). More information on this relationship is in Hoffman and Canace (2004).

The impervious surface is significant because of the assumption that all runoff from impervious surfaces was diverted off site and thus was unavailable to dilute the nitrate. The model determines the amount of pervious area needed to generate the necessary recharge to dilute the nitrate loading to the set standard, and then modifies this by the estimated impervious cover percentage to yield the net septic density.

Application of OFR 04-1 for Planning

While the basic model is set up to calculate the septic density for a given soil in a given municipality, it can be used to estimate a net septic density for an area that contains multiple soils, some of which are hydric and thus are unsuitable for an ISSDS. Tables 2 and 3 below illustrate this application for one sample scenario.

In the first example (Table 2) the goal is to determine an overall septic density appropriate for a particular HUC11 watershed in a particular municipality. First, each soil type within the HUC11 of interest is listed (Column B) along with acres (Column C). In this case some soil variants listed in the soil survey are lumped together for entry into the nitrate dilution model (for example, the highlighted Birdsboro and Dunellen soils). For these, the sum of the area is used (Column D). For each entry in Column D, the nitrate dilution model OFR 04-1 is run, yielding a septic density by soil type (Column E). Dividing the SUM-acres of each soil type by the correlating septic density yields the number of ISSDSs that can be supported on that area of soil (Column F). The sum of Column F yields the total number of ISSDSs that the area of interest can support.

In the case shown in Table 2, the hypothetical area of 214.8 acres can support a total of 30.5 ISSDSs.

Table 2. Net septic density calculation example, not accounting for wetlands.

A	B	C	D	E	F	G
HUC 11	Soil Map Unit Name	Acres	SUM Acres	Septic Density by Soil Type	#-ISSDSs (Column-D/Column-E)	Average Septic Density for this Area
020301...	Abbotstown silt loam, 2-6% slope	3.32	3.3	5.7	0.6	
	Birdsboro silt loam, 2-6% slope	47.08				
	Birdsboro silt loam, 6-12% slope	10.34	57.4	5.0	11.5	
	Bowmansville silt loam, 0-2% slope	48.60	48.6	NA-Hydric	---	
	Buck silt loam, 2-6% slope	0.89	0.9	5.1	0.2	
	Dunellen sandy loam, 3-8% slope	16.78				
	Dunellen moderately well-drained	74.02	90.8	5.0	18.2	
	Lamington silt loam, 0-2% slope	13.78	13.8	NA-Hydric	---	
	Example HUC11 Totals:	214.81	214.8		30.5	7.0

* Shaded cells illustrate how there can be redundancy within the same soil series and must be combined—either sum them each once as shown in Column-D or plan on entering the correlating Septic Density in Column-E as many times as the primary soil classification is listed, e.g., *Birdsboro*, *Dunellen*, etc.
 * Column-F is set to divide Column-D by Column-E (except for Totals-Row, where Column-G = Total SUM acres divided by Total # ISSDSs).
 * NA = not applicable.

Note that the hydric soils do not contribute any ISSDSs to the final number. Hydric soils are those that are nearly saturated or have a very shallow water table most of the year (commonly one foot or less below land surface). In many cases these soils are regulated wetlands pursuant to the Freshwater Wetlands rules at N.J.A.C. 7:7A, administered by the Division of Land Use Regulation (DLUR). Regulated wetlands are either protected outright or their development is severely limited. Due to their unique characteristics, recharge potential for hydric soils cannot be determined using the NJGS methodology. Development of criteria to distinguish between hydric soils that act as net discharge or recharge areas is beyond the scope of GSR-32. Such detailed analyses would require site-specific assessment at the time of proposed development. What this means with regard to the NJGS methodology to determine septic densities is that hydric soils cannot be accurately assessed at a planning level.

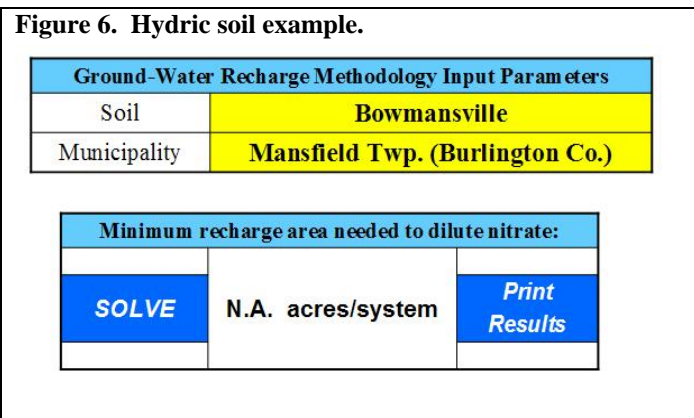


Figure 6 depicts the calculation window of the NO₃-dilution model when a hydric soil is entered. The abbreviation for “Not Applicable” automatically appears instead of a number when a hydric soil is selected.

For planning purposes, the most relevant number is often a net septic density. This number depends on the size of the planning area. This calculation is complicated by the presence of hydric soils that cannot support an ISSDS. If the goal is to determine a septic density for the entire area, regardless of the suitability of soil types, then Table 2 shows this calculation. In this approach, the total area (sum of Column D) is divided by the total number of allocated ISSDSs (sum of Column F). In this case the final answer is an overall septic density of 7.0 acres (Column G) per ISSDS for the entire area.

Note in Table 2, however, that the acreage of hydric soils is not subtracted from the total SUM-Acres, even though no ISSDSs are allotted to that acreage. To put this conceptually, consider how typical development proposals are already designed to avoid wetlands, but the wetlands are still part of the development site and incorporated into the site design, e.g., designated as common open space or by being parceled out onto one or more lots. Column G represents the average septic density for the *entire* area of interest. The more important number in Table 2 is at the bottom of Column F: the total number of ISSDSs that this area of interest can support, which is based only on acres that are known to provide recharge. It is for this reason that the number of acres per ISSDS for this hypothetical area of interest (Column G) is larger than those listed in Column E per soil type, because the number of acres per ISSDS for the entire area of interest incorporates those acres of wetlands that cannot support ISSDS in calculating the overall average septic density for the entire area.

In contrast, if the wetlands acres were subtracted and the septic density is derived for only the recharging acres (Table 3), the average septic density would be reduced from 7.0 acres to 5.0 acres, but the total number of ISSDSs would remain the same. Thus a net septic density of 5.0 acres/ISSDS is the result when considering only the non-hydric soils in the selected area of interest. For areas that contain large percentages of hydric soils, removing them prior to calculating the net septic density can avoid exorbitantly large septic densities, which can be misleading. However, where this approach is used, it must be made clear that the hydric soil acreage was removed prior to calculating the net septic density *ergo*: that acreage must also be removed from the SUM-Acres that is ultimately divided by that net septic density to determine total number of allowed ISSDSs. Regardless of the approach selected: it is the total number of ISSDSs—the sum of Column F in both tables—that is the most relevant number.

As Table 2 (or 3) indicates, using OFR 04-1 to determine septic densities can be labor intensive and is most appropriate for site-specific applications. To provide for more efficient determinations of carrying capacity on a municipal and county-wide level, the Department has developed a HUC11-scale NO₃-dilution model which is described in the next section. The OFR 04-1 approach, however, is an acceptable option and WMP applications utilizing it will be accepted, with one very important caveat: **only one of the two models may be used within any given HUC11 for planning purposes**. Using both

Table 3. Net septic density calculation example, accounting for wetlands.

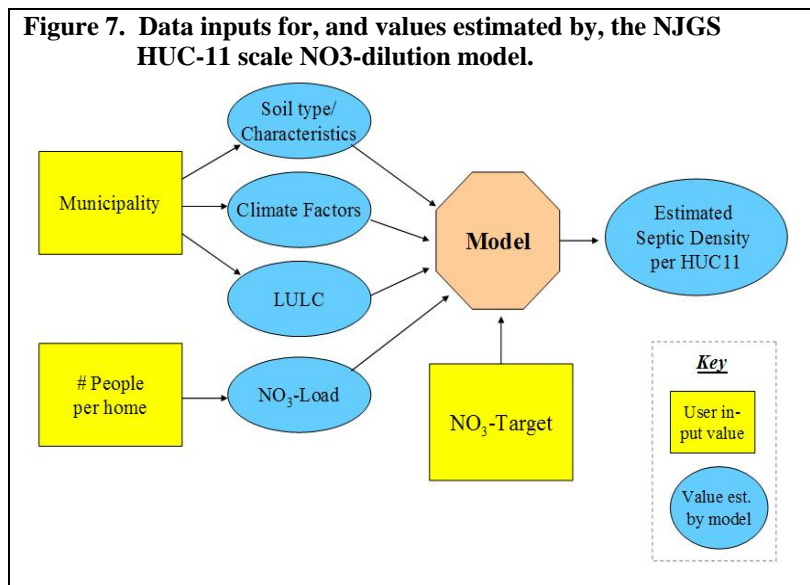
A	B	C	D	E	F	G
HUC 11	Soil Map Unit Name	Acres	SUM Recharging Acres ONLY	Septic Density by Soil Type	#-ISSDSs (Column-D/Column-E)	Average Septic Density for this Area
020301...	Abbotstown silt loam, 2-6% slope	3.32	3.3	5.7	0.6	
	Birdsboro silt loam, 2-6% slope	47.08				
	Birdsboro silt loam, 6-12% slope	10.34	57.4	5.0	11.5	
	Bowmansville silt loam, 0-2% slope	48.60	---	NA-Hydric		
	Buck silt loam, 2-6% slope	0.89	0.9	5.1	0.2	
	Dunellen sandy loam, 3-8% slope	16.78				
	Dunellen moderately well-drained	74.02	90.8	5.0	18.2	
	Lamington silt loam, 0-2% slope	13.78	---	NA-Hydric		
	Example HUC11 Totals:	214.81	152.4		30.5	5.0

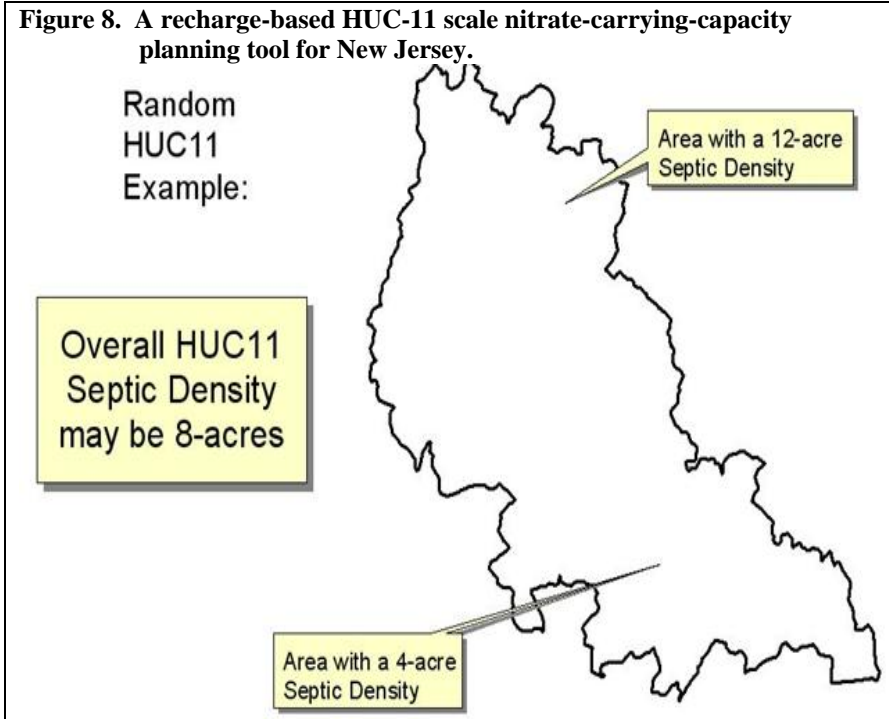
models within the same HUC11 would invalidate the averaging effect of the HUC11-scale version. There are exceptions to this caveat. For instance, in cases where WMP responsibility is separated by specific, jurisdictional boundaries, such as where a HUC11 is shared between neighboring counties, or a municipality has adopted a WMP that precedes the county-wide effort. The Department acknowledges that such exceptions will occur—to assume otherwise would, in effect, implement a “first-come-first-serve” policy whereby one entity would be dictating what another entity could select to do.

A Recharge-Based HUC11-Scale Nitrate-Carrying-Capacity Planning Tool for New Jersey

Another adaptation of the NJGS methodology provides HUC11-scale septic densities almost instantly. It is based on the same NJGS methodology as that of OFR 04-1—a synthesis

Figure 7. Data inputs for, and values estimated by, the NJGS HUC-11 scale NO3-dilution model.



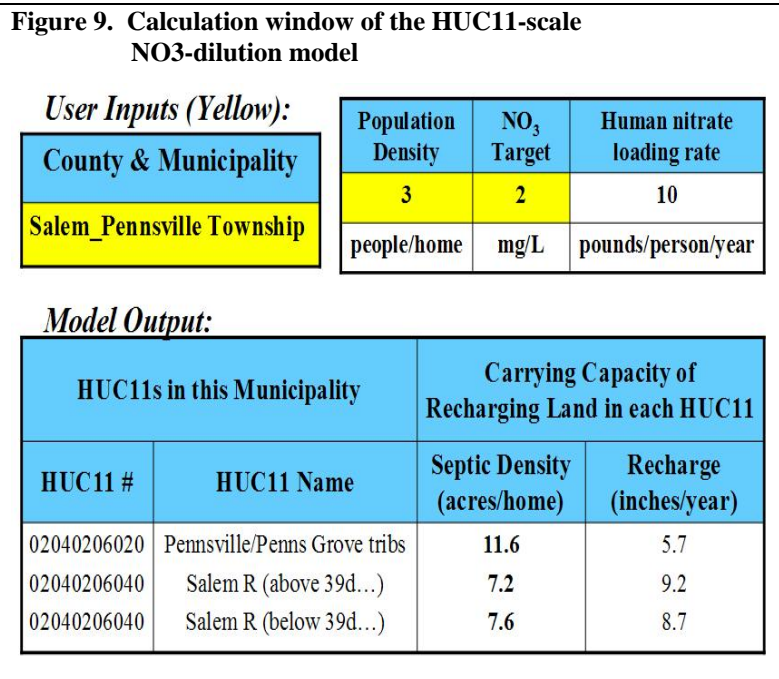


of both the Trela-Douglas NO₃-dilution model and the GSR-32 ground-water recharge model (Figure 7). However, for this tool many of the calculations have already been performed for the HUC11 as a whole, taking into account climatic differences, soil type variations, and land use within the HUC11. The detailed

results are averaged into one groundwater recharge volume and one representative septic density per HUC11 (Figure 8).

For the HUC11 tool, the user inputs nitrate loading factors (people per home, nitrate target, and municipality). This tool then applies pre-generated recharge rates to the user-provided nitrate loading parameters to estimate the average septic density for each HUC11 relevant to the selected municipality (Figure 9).

The recharge pre-generation process used a state-wide GIS data layer for ground-water-recharge estimates. This data was



created through the combination and generalization of three individual GIS data layers: municipalities, state soils, and the 1995/97 land-use/land cover (LULC). The municipal boundaries correlate with the municipal climate factors, which vary subtly across the state. Incorporation of the 1995/97 LULC allows the HUC11-scale model to integrate contemporary levels of existing impervious cover into its recharge calculations. Development of the NJGS ground water recharge data layer, however, preceded release of the 2002 and 2007 land use/land cover (LULC) data coverages. While there has been increased impervious cover that has occurred during the interim, the effect on the HUC11-scale NO₃-dilution model septic densities is believed to be *de minimus* because the ranges in recharge that the data layer utilizes were calculated and ranked over areas as large as counties and WMAs (French, 2002).

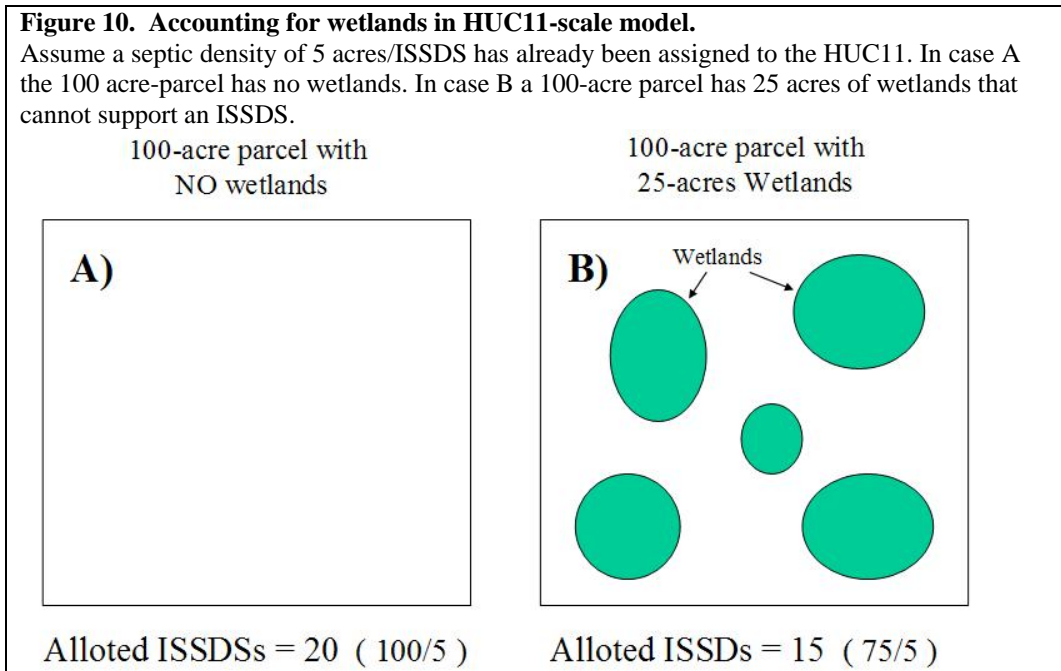
Using all of the above information represented spatially with GIS, the GSR-32 ground-water-recharge component of the model can delineate and average relevant data on a HUC11-basis to calculate recharge estimates on that scale¹. Then, the NO₃-dilution model component incorporates the estimated recharge value into its mass balance equation along with the nitrate loading value and nitrate concentration target, and calculates the septic density for each HUC11. The TR-55 algorithm that estimates post-development impervious cover percentages for OFR-04-1 was not incorporated into the HUC11 tool, because there is no practical way to predict post-development levels of impervious cover on as large a scale as a HUC11 or HUC14.

The HUC11 septic density information is disaggregated by municipal area and the model output automatically provides septic densities for each HUC11 that is located in the selected municipality. Figure 9 depicts the final HUC11-scale model calculation-window and the ease with which the HUC11 and septic density information can be accessed. As in the OFR 04-1 NO₃-dilution model, the yellow boxes indicate where user inputs are required, either as direct insertions or selection from a drop-down menu.

The HUC11 model does not assign a recharge value to hydric soils, and this needs to be taken into consideration when using this tool. As stated previously, due to their unique characteristics, recharge potential for hydric soils cannot be determined using GSR-32. This is not readily evident using the HUC11-scale model, because the manual steps required by the underlying nitrate dilution model have been automated. This does not, however, negate the need to account for those acres of wetlands that are not generating recharge in a given area of interest. Consider the examples A & B shown in Figure 10. Example A is an area that contains no wetlands and is a straightforward calculation to determine the total allotment of ISSDSs, i.e., total SUM-Acres divided by the septic density. The area in example B, however, does contain wetlands, which are afforded no

¹ NJGS created a similar interpretation of its methodology at a HUC14-scale limited to the Highlands Region, developed in the same manner using the same GIS ground-water-recharge data layer. It was provided after formal adoption of the Highlands Regional Master Plan in 2008, and is further detailed in Appendix A.

recharge value and consequently no ISSDS allotment. In this case the 25-acres of wetlands must be subtracted from the total acres before dividing it by the average septic density to determine the allowable number of ISSDSs. Failure to deduct those 25-acres of wetlands would allocate 5 more ISSDSs than the estimated carrying capacity can reliably sustain, and repeating this inaccuracy over an area as large as a HUC11 would further increase the threat to groundwater quality.



It is important, therefore, to understand that the GSR-32 component of the HUC11-scale model has, in effect, automatically subtracted all hydric soils and that the septic densities provided are based only on the recharging acres of each HUC11. This, in turn, requires the removal of wetlands acreage from the total acres of a given area of interest before using a septic density determined by the HUC11-scale NO₃-dilution model to calculate the ISSDS allotment.

The presence of preserved open space in a municipality may also affect the calculation of total number of allowed ISSDSs. The Department allows recharge afforded by open space to be used in calculating the total number of ISSDS that can be accommodated in a specified HUC11, or, at the discretion of the municipality, of omitting the recharge afforded by open space in calculating the allowable number of ISSDSs. This option has been provided by the Department to allow flexibility in municipal planning for future development. Inclusion of the open space recharge would allow a larger number of ISSDS within a HUC11, while exclusion of the open space recharge would be a more conservative approach that may be appropriate in consideration of the investment of public money to preserve the open space, along with all of the natural resource protection it provides.

In order to calculate how many more ISSDSs can be sustained based on preserved open space, the wetlands acres within the open space must be removed from the calculation (as they are not considered to contribute recharge). Using this recharge credit, additional development can then be allocated to other acreage that is developable.

References:

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APPENDIX A:

Development of the NJGS Recharge-Based Nitrate-Dilution Model at a HUC14-Scale for the Highlands Planning Area Requested by the Highlands Council

As stated in the footnote on page 10 of this narrative, upon formal adoption of the Highlands Regional Master Plan (RMP) in 2008, the Highlands Council requested that the New Jersey Geological Survey (NJGS) create a recharge-based, nitrate-dilution model application specific to the Highlands Region, which would assess and delineate recharge volumes and septic densities on a HUC14-scale. The Highlands Council selected HUC14s as their areas of interest in order to further refine their analyses to more localized conditions and considerations. Pursuant to the authority granted under the Highlands Water Protection and Planning Act (HWPPA), it is within the Highlands Council's purview to make such determinations within the Highlands Planning Area.

The HUC14-scale model was created for comparative purposes so that municipalities within the Highlands Planning Area could assess the potential differences in septic densities based on whether they chose to conform with the Highlands RMP or not. The only modeling parameter that was affected was that of the annual recharge estimate: non-conforming municipalities could use the average annual recharge based on the long term record, while conforming municipalities were limited to an annual average based on drought conditions. In addition, the nitrate concentration target is dependent on the land use classification as determined by the Highlands Council (Table 4). No other model parameters were affected, such that the other inputs are as follows: persons per household = 4; nitrate loading rate per person per year = 10 pounds.

The development of the NJGS HUC14-application follows that of the HUC11-scale methodology detailed on pages 8 – 11, *verbatim*—the only difference being that the state-wide GIS data layer developed to estimate ground-water-recharge was delineated on a HUC14 rather than HUC11-basis. As with the HUC11-scale model, the HUC14s are disaggregated by municipal area so that the model will automatically provide septic densities for each HUC14-area that applies to the Highlands municipality selected. With a Land Use Capability Map provided by the Highlands Council, the Department ran the model for each land use classification applicable to each municipality that contained area within the Highlands Planning Area, regardless of whether the municipality had as yet formally decided whether or not to conform with the mandates of the Highlands RMP. Septic densities by county were developed and shared as tables.

Table 4. Break-down of Highlands Region land use classifications and correlating nitrate concentration targets.

Predominant Land Use “Zone”	“Sub-zone(s)” within (as applicable)		Nitrate Concentration Target (mg/L)	Source of delineation and NO3-target
Preservation Area	Mixed Land Use		0.76	NJDEP
	Forest		0.21	
Planning Area:	Existing Community Zone	Includes Existing Community-Environmentally Constrained sub-zone <u>AND</u> Lake Community sub-zone	2.0	Highlands Council
	Conservation Zone	Includes Conservation-Environmentally Constrained sub-zone	1.87	
	Protection Zone	Includes Wildlife Management Area sub-zone	0.72	