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REVISED DRAFT: CONSIDERED AT THE OCTOBER 18, 2007 MEETING OF THE HIGHLANDS COUNCIL

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WATER RESOURCES TECHNICAL REPORT ADDENDUM
VOLUME I – WATERSHED AND WATER QUALITY
NOVEMBER 2007
Septic System Densities for the Highlands Region

Version - October 31, 2007

Septic system density is one of various factors used in determining the land use capability of areas in the Highlands Region. The goals, policies and requirements of the Highlands Act provide guidance on Regional Master Plan approaches relating to septic system density; they are prescriptive regarding the Preservation Area but general regarding the Planning Area. The Highlands Council seeks to achieve two related policy objectives – to restrict the potential for increased risks to human health from ground water that exceeds 10 milligrams per liter (mg/L) of nitrates (e.g., septic system plumes), and to restrict increased human health and ecologic impacts from other pollutants that are associated with nitrates – using the following approach:

1. Use the New Jersey Department of Environmental Protection's (NJDEP) Preservation Area rules at N.J.A.C. 7:38-1 et seq. for septic system density within that area. These nitrate targets are based on statutory requirements for nondegradation, and are supported by further analysis using statistical models.
2. Within the Planning Area, the NJDEP nitrate dilution model should be used with the standard factors for nitrate loading per residential household (or commercial equivalent), but using 2002 drought ground water recharge for each HUC14 subwatershed. The Planning Area median is approximately 9.4 inches per year.
3. The nitrate dilution models should be applied as a default approach only to the privately-owned, undeveloped, non-preserved lands (referred herein as developable lands) within each subwatershed. The following nitrate targets are proposed for the Planning Area. Actual septic system yields will vary by HUC14 subwatershed based on estimated HUC14 recharge; examples are provided here for information purposes:
    a. Existing Community Zone – **2 mg/L** (NJDEP proposed Statewide threshold). As an example, using the median recharge and a development site of 30 acres, this target results in a septic system yield of 3 units, reflecting a median density of 9.4 acres per septic system. This does not affect existing areas served by sewer or the approved expansion of these facilities.

b. Conservation Zone – **1.87 mg/L*** (estimated median concentration for the Conservation Zone). As an example, using the median recharge and developable lands of 105 acres, this target results in a septic system yield of 10 units, reflecting a median density of 10.0 acres per septic system.

c. Protection Zone – **0.72 mg/L*** (estimated median concentration for the Protection Zone). As an example, using the median recharge and developable lands of 105 acres, this target results in a septic system yield of 4 units, reflecting a median density of 26.1 acres per septic system.

d. Clustered Development – **10.0 mg/L** (NJDEP proposed Statewide threshold). Applied to the developed portion of the cluster, with application of the relevant Highlands Zone target to the entire project area (i.e., both the developed and undeveloped, preserved portions). As an example, for a 105 acre development project in the Conservation Zone, and using the median recharge, the density within the cluster itself would be no greater than one septic system per 1.9 acres per septic system, with the septic system yield for the full site still being 10 units as described above. Clustering to a higher density would require the use of community-based wastewater systems, not septic systems.

4. As an alternative approach to Step 3, municipalities may choose to include preserved lands in the analysis of septic system yields for the Conservation and Protection Zone as an alternative to the approach above if allowed by NJDEP pursuant to the Water Quality Management Planning Rules at N.J.A.C. 7:15 and where: (1) the municipality demonstrates that including the septic system yields from the preserved lands results in a development density and pattern that is not greater than that allowed by existing zoning and is compatible with the pattern of development associated with the affected Zone; and (2) the municipality implements or causes to be implemented (by development applicants benefiting from the increased septic system yields either directly or through contribution to an implementation fund) agricultural management practices that will reduce nitrate loadings to the same HUC14 subwatershed by:

   a. at least the same amount as the estimated septic system loadings from the additional density where the HUC14 subwatershed median nitrate concentration is lower than the relevant Conservation or Protection Zone median concentration, or

   b. at least equal to double the estimated septic system loadings from the additional density where the HUC14 subwatershed median nitrate concentration is higher than the relevant Conservation or Protection Zone median concentration.

5. Septic system yield in the Existing Community Zone will be determined on a project-specific basis, as most development in the zone will be either sewered or exempt. In the Conservation and Protection Zone, the RMP will provide septic system yields by zone in each HUC14 subwatershed; municipalities will be able to direct the appropriate locations for such development through the Plan Conformance process, within the constraints of other RMP policies.

6. Designated redevelopment sites, brownfields and lakes communities that use septic systems in both the Preservation and Planning Areas are most probably impaired and will require water quality restoration, in coordination with NJDEP; in general they should be protected from further degradation.

*The median nitrate values by Zone have been revised based on the Land Use Capability Map (LUCM) zones developed for the November 2007 Draft RMP.

Technical and Policy Discussion on Septic System Density

General Findings

The following findings provide the basis for the Highlands Council's septic system policies:

1. The goals and objectives of the Highlands Act require protection of designated water uses (including both human and ecological uses) in all areas of the Highlands Region. Protection can range from natural quality to strict nondegradation to a range of antidegradation approaches. Restoration is for areas that violate standards, and enhancement is appropriate for areas where waters currently meet standards but can be improved through better land use management or pollution control practices.

2. Septic system density is a useful indicator for the water quality impacts of development in areas that lack community sewer systems. Nitrate concentration is a useful surrogate for the many pollutants discharged by properly functioning septic systems. It is critical to note that addressing nitrates alone will not necessarily address the other related contaminants, requiring the use of conservative assumptions.

3. Septic system density controls are useful for regional planning purposes but do not address site-specific or even neighborhood water quality issues. The risk of localized impacts is reduced as septic system densities are reduced, but risks will still exist due to site layout, local geological conditions, well construction, etc. Guidance to municipalities on these issues would be valuable in reducing site-specific risks.

4. Allowable septic system densities for new development should be tailored to each LUCM zone, recognize the legislative distinction between the Preservation and Planning Areas, and address issues such as lakes communities, brownfields and redevelopment sites where a combination of restoration and alternative treatment technology may be appropriate.

5. Allowable septic system densities should be calculated using nitrate dilution models, using NJDEP's factors for nitrate loads from septic systems.

6. Recharge by HUC14 subwatershed should be used as the basis for nitrate dilution, consistent with other RMP analyses. Drought ground water recharge should be used as a conservative factor to address nitrate impacts in smaller watersheds, headwaters areas and aquifers with limited storage capacity, all of which are common in the Highlands Region. Recharge values should be based on 2002 land use/land cover, as the data most closely related to the 2004 adoption of the Highlands Act and the most recent information available to the Council.

7. The models should be applied to privately owned, undeveloped, non-preserved areas only; municipalities may be allowed to use alternative septic system yield methods if allowed by NJDEP regulation, but subject to special conditions for protection of existing zoning and Highlands ground water quality.

8. The nitrate target for the Conservation Zone in the Planning Area should recognize that existing nitrate concentrations are elevated in significant part by agricultural practices. There is an opportunity for water quality enhancement through more thorough implementation of agricultural best management practices (BMPs).

9. The nitrate target for the Protection Zone in the Planning Area should recognize that existing low nitrate concentrations reflect minimal agriculture and development land uses. The impacts of additional development will be more difficult to offset through improvements to existing land management practices.

Highlands Act Goals

The Highlands Act includes a goal for the protection, enhancement and restoration of water quality. It then establishes specific regulatory approaches for the Preservation Area, including an objective of nondegradation for ground water regarding new septic systems, using dilution associated with "deep aquifer recharge" and allowing only standard septic system designs. This policy resulted in the 88 and 25 acre septic system densities for forested and non-forested Preservation Area lands, respectively. The Act does not provide specific approaches for the Planning Area.

Therefore, the most appropriate source of guidance regarding the requirement to "protect, enhance and restore" water quality comes from the New Jersey Water Quality Planning Act, which authorizes NJDEP to establish water quality standards for both ground and surface waters. The meaning of the three terms is important to understanding how the regulations work.

"Restore" is the easiest – where waters violate water quality standards, their quality must be improved to the point where they at least meet the water quality criteria established to protect designated water uses such as drinking water, fishing, swimming and ecosystems. The Highlands Region includes areas of both localized and wider scale contamination where restoration would be appropriate, ranging from the effects of intensive agriculture, to the impacts of communities with many septic systems on small lots, to areas of industrial contamination.

"Enhance" is also fairly clear but less used for regulatory purposes – it means improving water quality even where the waters currently meet all standards. The laws do not provide a direct mechanism for doing so, but some regulatory programs (e.g., uniform requirements for secondary treatment of sanitary sewage, industrial treatment standards, municipal stormwater permits) enhance water quality. Voluntary efforts (e.g., agricultural improvement cost-share programs, public education) or indirect efforts (e.g., where efforts to control one contaminant achieve improvements for a non-targeted contaminant) also enhance water quality.

"Protect" is the most variable in meaning, but is a critical focus of water pollution control programs. Existing regulations, case law and legislative history at both the state and federal level make clear that "protect" covers a wide range of policies, from natural quality (no non-natural pollutant loadings of any type) to nondegradation (no reduction in water quality from a baseline condition) to various levels of antidegradation (allowing some level of reduction in water quality but never beyond the water quality criteria and always controlled to protect public interests). What becomes clear from historic use is that "protect" refers to the protection of water uses ranging from highly sensitive ecosystems that tolerate no degradation, to other water uses that will tolerate some limited degradation under some situations.

Given that the Highlands Act clearly calls for the RMP to identify areas appropriate for new development, redevelopment or sustainable agricultural uses, application of one or more "antidegradation" policies will be more appropriate for those areas of the Highlands. Conversely, areas where no existing or future development will exist are appropriate for "natural quality" policies. Areas where water quality already violates water quality standards should be targeted for restoration, not further degradation. This policy does not necessarily prohibit any new pollutant loads (though it can), but rather might require mitigation or offsets of existing pollutant loads. All areas are appropriate for water quality enhancement where feasible within the goals and objectives of the Highlands Act, such as improved management of existing land uses and stormwater systems.

Rationale for Using Septic System Density

Septic system density controls are commonly used in New Jersey and elsewhere as a method of minimizing the potential for contamination of ground water. Discharges of effluent to ground water have the potential to damage the quality of aquifers, reducing their utility as drinking water supplies. They also can damage surface water quality, through the flow of contaminated ground water to natural discharge points as springs, seeps or stream baseflow.

It should be noted that septic system density is one indicator of the potential for such impacts, but is not the sole cause of aquifer or stream contamination from discharges to ground water. Lawn and home care create the potential for nutrients (fertilizer) and pesticides (herbicides, insecticides and fungicides) to reach ground water. Agricultural applications have a similar potential. Finally, commercial or industrial discharges to ground water can include contaminants of concern. However, the commercial and industrial discharges are directly regulated by NJDEP, while the discharges of septic systems, lawn care and agricultural applications are not.

Septic system density is closely associated with lawns and homes, and so septic system density is a good indicator of the impacts of non-sewered residential development. Agricultural and sewered development impacts are not closely associated with septic systems, and therefore must be addressed as separate policies.

Selection of an Indicator Contaminant

Septic systems can discharge a wide range of contaminants to ground water, including bacteria, viruses, organic materials, household chemicals, pharmaceutical products, and various nutrients. The septic systems are designed to treat organic matter and bacteria, but not other contaminants that are less easily treated. NJDEP's septic system design standards are primarily focused on ensuring that septic system effluent does not clog the distribution box or leaching field, does not migrate to the land surface and cause a direct public health threat, and does have sufficient contact time within the leaching field to reduce bacterial pathogens. The standards also ensure that septic system leaching fields are at least 100 feet from any neighboring well.

The question is what contaminant to use as an indicator. NJDEP has determined through a variety of rules and rule proposals (including the Highlands Preservation Area Rules at N.J.A.C. 7:38) that nitrates are the best indicator to use for septic system density. Nitrates are stable in ground water, can travel long distances within the septic system plume, are a commonly measured contaminant with inexpensive analytical methods, and have been shown to have a good association with other contaminants (i.e., where the other contaminants are found, nitrate levels tend to be elevated above natural levels). Further, nitrate modeling has been used for decades at the municipal, county, regional and State level both in New Jersey and elsewhere. The Highlands Council also uses nitrates in the Highlands Regional Master Plan. It is important, though, to recognize that nitrates are used as an indicator, and are not the only contaminant of concern.

Natural Levels, Anthropogenic Impacts, Current Watershed Levels

The Highlands Council with assistance from the United States Geological Survey (USGS), analyzed current nitrate levels in the Highlands Region, based on the same dataset provided to NJDEP for its Highlands Rules. The estimated median nitrate concentration for undeveloped areas in the Highlands Region is 0.1 mg/L, which is essentially equivalent to natural concentrations.

The Highlands Council used a statistical analysis of nitrate levels and land use to estimate the median nitrate concentrations for each of the HUC14 subwatersheds in the Highlands Region. The estimated subwatershed median values range from 0.17 to 3.69 mg/L, with 0.83 mg/L as a regional median and nearly all HUC14 subwatersheds having a median below 2.0 mg/L. For HUC14 subwatersheds where either the Conservation Zone or Protection Zone predominates, the zone median concentrations are 1.87 mg/L and 0.72 mg/L, respectively (see charts at the end). The elevated nitrate concentrations were most frequently associated with agricultural lands uses, urban development and septic systems. The statistical relationship with septic system density is sufficiently strong to use for analysis.

It is important to note that these are medians – every HUC14 subwatershed will have actual values ranging from natural or near-natural concentrations to the 35-40 mg/L concentrations typical of septic system plumes, and may even have higher concentrations in some places. Some percentage of the total ground water volume already exceeds the nitrate criterion of 10 mg/L – typical of septic system plumes and intensive agriculture. Regional analyses cannot substitute for site-specific information when siting new wells, etc. (This issue is addressed in a separate RMP policy.) The primary use of nitrate dilution models is as a basis for policy making regarding new septic system densities or for targeting restoration needs. The first question, then, is not whether any ground water will exceed that level, but to what extent it will do so. The second question, addressed below, is what constitutes an acceptable threshold.

Types of Nitrate Targets

Four types of nitrate targets (i.e., the target concentration that nitrate in the ground water should not exceed) were investigated for use in the RMP. One of them is inappropriate – site-specific fate and transport modeling, which is used for industrial discharge analysis and major remedial efforts. Two others require additional work and have not been proven as useable concepts – defining an allowable incremental change in concentration, and defining an allowable statistical change in concentration. Accordingly, the Highlands Council determined to use target concentrations at this time, with variations based on the LUCM zone involved.

Target Concentration is common in regulations such as NJDEP's Ground Water Quality Standards (N.J.A.C. 7:9C) or proposed Water Quality Management Planning rules (N.J.A.C. 7:15), where a specific concentration is established as the maximum permissible level. For septic systems, this approach relies on mass balance equations such as nitrate dilution models. This method is useful because it treats all similar waters alike. It also can be used to define a maximum tolerable concentration. Subwatersheds that exceed the threshold can be targeted for enhancement. The policy issue here is what allowable concentration is appropriate in a target area. Given that the policy is applied to developable parcels, it should be noted that the median HUC14 nitrate levels, even in build-out conditions, generally would be less than the allowable concentration because some lands (e.g., preserved open space) will not have septic systems. The exception to this generalization will occur where existing septic systems are at much higher densities than the RMP allows for new development. The nitrate targets can be established based on medians by HUC14 subwatershed, LUCM zone, Planning or Preservation Area, or the entire Highlands Region.

Plumes, In-ground Treatment, and Dilution

Ground water contaminants tend to move in plumes from their source to their discharge point in surface waters or wells. Plumes tend to be more concentrated if the source is localized or

concentrated, the movement of ground water is smoother (causing less spreading of the contaminants away from the main plume), or the distance from the source to the discharge point is shorter.

Natural soil and subsurface conditions will result in some attenuation or treatment of ground water contaminants. The contaminants may be broken down into other substances by bacteria or chemical action, they may be bound to soil particles (adsorption) or drawn into organic or other matter (absorption), or they may move into the atmosphere through plants (transpiration) or evaporation.

These processes of plume movement and attenuation address the "fate and transport" of the contaminants. For major ground water contamination cases, such as Superfund or Spill Fund sites, enormous and expensive efforts go into mapping and modeling these processes to help predict the plume's potential impacts and determine what remedial approach may be most appropriate. However, the cost of monitoring or modeling the actual movement of septic system plumes at any level, from local to regional, is far beyond available funds. Therefore, simplified models are routinely used that make assumptions appropriate for determining allowable septic system densities. These models are all variations on a theme, but basically compare nitrate loadings to available dilution over a large area. The variations relate to the loading assumptions, the available dilution and the size of the area in question. Dilution cannot be directly measured, and therefore is estimated through the use of recharge analyses. Nitrate dilution models, such as those for the Pinelands Comprehensive Management Plan, have survived many court challenges. However, it must be noted that such models cannot predict the actual nitrate concentrations at any one point, such as a downgradient well that may or may not be within the actual plume of a septic system.

The nitrate dilution model approach is used for septic system density calculations, based on specific nitrate targets.

Nitrate Dilution Modeling Variables

Pollutant loadings to ground water vary over time for several reasons. Loadings will vary based on housing occupancy, the type of treatment technology, and system maintenance. Other loadings associated with residences will also vary based on lawn size, condition and chemical applications.

Loading assumptions require consideration of three major factors:

- Concentration and loading of nitrates emanating from septic systems – In general, the literature supports the Council's use of 35 to 40 mg/L nitrates emanating from septic systems. NJDEP used this average to generate an annual loading of 10 pounds nitrates per person.

- Household size – Given that regional models cover households of many different sizes, a single value is usually selected to represent average household size, with some models rounding up to a somewhat higher level to ensure that the septic system density will still be valid even if household size increases marginally. In addition, the use of a higher household size offsets the potential for nitrate loadings from other sources, such as lawn fertilizers, that may exist in the same area. The Council is proposing to use this latter approach, at four persons per household as used by the NJDEP Highlands Rules.

- Other nitrate sources associated with the household – Some models include lawn care contributions to the nitrate loadings, but others do not because (unlike nitrates from human sewage) such nitrate loadings can be changed by management approaches. NJDEP did not include other contributions explicitly, but did include a number of conservative assumptions that reduced the need to include a new contribution to the model, including the use of four persons per household, as discussed above. The Council determined that the conservative factors in the model should be used to account for these loadings. Educational programs and other management approaches should be used to reduce such loadings over time.

The second major factor, dilution, is critical to the model. Several alternatives can be considered in determining dilution for the model:

- Scale of impact – Some ground water systems are small in scale, providing mostly baseflow to headwaters streams and little recharge to significant aquifers. Others are very large, providing both baseflow and major aquifer recharge. Smaller systems are much more sensitive to periodic changes in loadings and dilution. Dilution is critical to the use of nitrate dilution models. The Council determined that dilution should be based upon ground water recharge by HUC14 subwatershed. This is appropriate and feasible given technical analyses performed for the RMP, and the fact that other aspects of the RMP (e.g., water availability) are also based on HUC14 analyses.

- Dilution from properties not using septic systems – Where used on a broad scale, such as a municipality or watershed, some models incorporate dilution from properties that may be in public ownership, sewered development, or otherwise protected from later development with septic systems. The Council determined that, as a default approach, the development yields for septic systems should be based only on privately-owned, undeveloped, non-preserved lands in septic system areas of the HUC14 subwatershed, for three reasons:

    - Public lands are often purchased for the purpose of environmental protection, and downgradient private property owners should not receive an equity benefit from that public expenditure;
    - Sewered development will still contribute ground water contaminants, including from more concentrated lawn care activities, and it is impossible to accurately measure that impact; and
    - Where the protected lands are agricultural, there is a significant potential for ground water contaminant loads that are not associated with septic systems.

  However, as discussed below, an alternative approach for septic system yield analysis may be used if allowed by NJDEP regulations, but with special conditions for the Highlands Region.

- Climate factors – Climate, as seen in annual precipitation patterns, has a direct impact on recharge potential. In New Jersey, the two most commonly used factors for climate have been annual average rainfall (used in the original NJGS GSR-32 method) and drought rainfall from the 1961-1966 drought of record (used in the NJDEP Highlands Rules). Drought recharge is used to estimate actual aquifer recharge, which cannot be directly measured. Annual average recharge includes shallow recharge that moves more quickly to surface waters, and does not ever enter deeper ground water systems (aquifers). The recharge from the 1960's drought is estimated at approximately two-thirds of the annual average rainfall. The drought period was determined by an analysis of precipitation records,

and is regarded as beginning on May 1961 (Jeffrey Hoffman, personal communication, 26 October 2007). The choice between these two climate factors is closely related to the scale of impact issue described above. A multi-year drought is likely to result in more concentrated septic system plumes in small ground water systems, where there is less potential for ground water storage from pre-drought periods. The Highlands Region, with its many headwaters, subwatersheds and hard rock formations with limited ground water storage capacity, will be more prone to such effects than, say, New Jersey's Coastal Plain watersheds. Most of the larger aquifers and watersheds are in areas served by public sewerage. NJDEP's septic system basis and background document for the Highlands Rules demonstrated that the GSR-32 method, when modified to incorporate climate factors based on 1960's drought conditions, provided recharge estimates that corresponded very well to another method (the Posten method) of estimating long-term (deep) aquifer recharge. The Highlands Council has determined that drought recharge should be used based upon 2002 land use/land cover. The use of 2002 data is appropriate, as it is the most recent available and is also close to the 2004 adoption date of the Highlands Act. The regional median for drought ground water recharge based on 2002 land use/land cover is 9.4 inches/year.

Policy Options for Nitrate Targets

There are many options and considerations for selecting nitrate targets, which in turn will affect the allowable or recommended septic system densities. The options discussed here are all constrained by scientific information. For instance, it is not feasible to set a nitrate target for septic systems that is lower than natural levels. Further, if an area is to have agricultural or developed land uses, natural levels cannot be maintained and therefore are not a feasible target; any introduction of contaminants to natural quality waters will elevate the average concentration above natural levels. As another example, it is not possible to have a policy for septic system density where no ground water may have a site-specific concentration greater than 10 mg/L, as septic system plumes routinely have much higher concentrations. However, given the constraints imposed by science and logic, there are several considerations:

- Applicability – Thresholds have different purposes. The NJDEP Highlands Rules address site-by-site regulation of development, where each development has to meet the standards. The proposed Water Quality Management Planning Rules, on the other hand, are focused on septic system density at the watershed level, with variations allowed for clustering and for different zoned densities within the broader area, as long as the average allowable density is not exceeded. The Highlands RMP septic system densities are more analogous to the WQMP rules. The Council is proposing that the RMP as a default policy provide average septic system densities for privately-owned, undeveloped, non-preserved portions of HUC14 subwatersheds, which may be apportioned within the target area through the municipal Plan Conformance process. However, the NJDEP is considering a policy that would provide an optional, alternative approach to septic system yield analysis. This alternative approach could be used within the Planning Area, with special Highlands conditions, as follows:
    - Municipalities may choose to include preserved lands in the analysis of septic system yields for the Conservation and Protection Zone as an alternative to the approach above if allowed by NJDEP pursuant to the Water Quality Management Planning Rules at NJAC 7:15 and where: (1) the municipality demonstrates that including the septic system yields from the preserved lands results in a development density and pattern that is not greater than that allowed by existing zoning and is compatible with

the pattern of development associated with the affected Zone; and (2) the municipality implements or causes to be implemented (by development applicants benefiting from the increased septic system yields either directly or through contribution to an implementation fund) agricultural management practices that will reduce nitrate loadings to the same HUC14 subwatershed by:

- at least the same amount as the estimated septic system loadings from the additional density where the HUC14 subwatershed median nitrate concentration is lower than the relevant Conservation or Protection Zone median concentration, or
- at least equal to double the estimated septic system loadings from the additional density where the HUC14 subwatershed median nitrate concentration is higher than the relevant Conservation or Protection Zone median concentration.

- Nitrate Targets – Targets of natural water quality (no anthropogenic contaminants at all), nondegradation (no increase in contaminant concentration) and antidegradation (controlled allowance for a limited increase in contaminant concentration but not beyond water quality criteria) all could be applicable to parts of the Highlands Region. Antidegradation policies at the State, regional and local levels include:
  - the Highlands Rules (N.J.A.C. 7:38) apply the regional median nitrate quality for forested or non-forested lands, weighted as appropriate to the development site in question, as the nitrate target for individual projects;
  - the Pinelands CMP uses 2 mg/L for the Protection Area (which correlates to an minimum lot size of 3.2 acres) and a target of 0.17 mg/L for the Preservation Area, which correlates to an average lot size of 23 acres;
  - the current Ground Water Quality Standards (N.J.A.C. 7:9C) antidegradation policy generally results in a nitrate target of 5.2 to 5.4 mg/L using a method devised for regulated point sources but applied to septic systems; it is applied as a municipal or sub-municipal average through either NJDEP or municipal rules;
  - the Reality Improvement Act certification by NJDEP (for developments of 50 units or more), requires that each development meet 5.2 mg/L as an average;
  - the proposed Ground Water Quality Standards (N.J.A.C. 7:9C) and Water Quality Management Planning Rules (N.J.A.C. 7:15) both include a nitrate threshold of 2 mg/L to be applied either by project (GWQS) or by watershed (WQMP);
  - the proposed Water Quality Management Planning Rules (N.J.A.C. 7:15) includes a nitrate threshold of 10 mg/L to be applied to the developed portion of proposed cluster developments. Note that rule proposal requires that the full area of the cluster development (both the developed and preserved lands) meet the 2 mg/L nitrate target.

The Highlands RMP should not have a nitrate target greater than 2 mg/L (other than for clusters), for consistency with the two proposed NJDEP rules. It should be noted that any introduction of new nitrate loadings, such as septic systems, into any area will increase the average concentration of nitrates unless mitigation or enhancement occurs within the target area.

NJDEP's Highlands Preservation Area Rules allow for very limited additional septic systems on the assumption, among other things, that nitrate loadings from existing and past land uses are declining over time, resulting in an offset to minor additional loadings. It should be noted that a policy requiring that "new development not increase average nitrate concentrations" is a nondegradation policy – no new loadings would be allowed unless full mitigation is provided.

- Areal Scale of Threshold – The RMP policy or policies can be applied at different areal scales, including HUC11 watershed (as proposed by NJDEP in the WQMP Rules), the HUC14 subwatershed (using the USGS analyses), LUCM zone or municipality. Any of the multi-municipality scales could be disaggregated to the affected municipalities or zones. Given that the RMP has analyses to the HUC14 level, this scale is most appropriate for septic system densities, with further disaggregation as necessary. The Council proposes the use of HUC14 subwatersheds, disaggregated to LUCM zone and then to municipality as needed.

- Mitigation Requirements – As alluded to above, it may be appropriate to require that additional loadings in some areas be offset by reduced loadings within the same site or target area. A major policy question is whether mitigation credits should be allowed for reduction of loadings from an illegal source or one that is not using best management practices. For instance, should the development of a poorly managed farm provide mitigation for the septic systems of a new development? Mitigation requirements, if used, should be based on mitigation from the loadings that would exist if the mitigated sources were both legal and managed according to normally accepted BMPs. The Council determined not to use this approach due to excessive uncertainty and complexity.

- Restoration – USGS modeling indicates that the higher nitrate concentrations of HUC14 subwatersheds in the Conservation Zone are primarily related to agricultural land uses. Cooperative efforts in such subwatersheds will be critical in offsetting any increased impacts of development on septic systems. Other restoration opportunities may exist in lake communities and other dense developments using septic systems, where transition to community wastewater systems (e.g., Hopatcong Borough) would reduce loadings. The Council proposes that restoration through improved management practices and the retrofit or elimination of densely placed septic systems be explored and implemented as feasible.

Given these considerations, the following table discusses potential nitrate targets and policies for various areas within the Highlands Region. Note that there is some overlap in areas, but this overlap occurs deliberately to fully inform the discussion. In addition, the Highlands Act specifically treats the Preservation Area and the Planning Area distinctly. While the delineation of the various LUCM zones in the Regional Master Plan is "blind to the line," the policies for septic system density must recognize that the two areas have different legislative requirements.

Septic System Density Policy Options by RMP Area (Grey Shading Indicates Recommended Approach)			
RMP Area	**Natural Quality** (no non-natural pollutant loadings)	**Nondegradation** (no reduction in water quality)	**Antidegradation** (allow some quality reduction but not beyond water quality criteria)
Existing Community Zone (Planning Area)	Inappropriate to a developed area	Sewers assumed for new development. Restoration should apply where GWQS violated	Development with sewers; if septic systems used, meet WQMP rule provisions for 2 mg/L average nitrates for each development project
Conservation Zone (Planning Area)	Inappropriate to an area of major agricultural use	Inappropriate to an area of major agricultural use. Restoration should apply where GWQS violated	Septic system density based on a Nitrate Dilution Target calculated as 1.87 mg/L (the Zone median concentration)
Protection Zone (Planning Area)	Inappropriate to an area with significant human land uses	Inappropriate for the Planning Area	Septic system density based on a Nitrate Dilution Target calculated as 0.72 mg/L (the Zone median concentration)
Clustered Development (Planning Area)	Inappropriate to an area with significant human land uses	Inappropriate to an area with significant human land uses	Septic system density for the cluster development area based on a Nitrate Dilution Target calculated as 10.0 mg/L, with application of the relevant Zone target to the entire cluster development project area
Existing Community Zone (Preservation Area)	Inappropriate to a developed area	NJDEP Highlands Rules – either modified nondegradation method for septic systems, or sewered as infill	Inappropriate to Preservation Area
Conservation Zone (Preservation Area)	Inappropriate to an area of major agricultural use	NJDEP Highlands Rules – modified nondegradation method	Inappropriate to Preservation Area
Protection Zone (Preservation Area)	NJDEP rules apply	NJDEP Highlands Rules – modified nondegradation method	Inappropriate to Preservation Area
Lakes Community Zone (Planning Area)	Inappropriate to a developed area	If reliant on septic systems, average nitrate levels probably exceed 10 mg/L. This policy applicable, plus restoration efforts.	Inappropriate for area that either is sewered or already exceeds GWQS for nitrates based on existing loadings

Septic System Density Policy Options by RMP Area (Grey Shading Indicates Recommended Approach)			
RMP Area	**Natural Quality** (no non-natural pollutant loadings)	**Nondegradation** (no reduction in water quality)	**Antidegradation** (allow some quality reduction but not beyond water quality criteria)
Lakes Community (Preservation Area)	Inappropriate to a developed area	If zone on septic systems, average nitrate levels probably exceed GWQS. This policy applicable, plus restoration efforts.	Inappropriate for area that either is sewered or already exceeds GWQS for nitrates based on existing loadings
Brownfields or Redevelopment Area (Planning Area)	Inappropriate to a developed or contaminated area	Inappropriate to nature of area, unless GWQS exceeded, requiring remedial work as part of redevelopment plan	Apply policy from Existing Community Zone (Planning Area)
Brownfields or Redevelopment Area (Preservation Area)	Inappropriate to a developed or contaminated area	Appropriate policy given Highlands Act policies. Coordination with NJDEP required.	Inappropriate to Preservation Area

Median Lot Sizes for Planning Area Nitrate Targets

The recommended nitrate targets have been used to calculate median lot sizes for the various target concentrations discussed above, using the median drought ground water recharge for the Planning Area, and then for each Protection Zone and Conservation Zone area in each HUC14 subwatershed in the Planning Area. The actual median lot sizes vary by HUC14 subwatershed based on drought ground water recharge differences. For each HUC14 subwatershed, the relevant median lot size was multiplied by the acreage available for new septic system development in both the Conservation and Protection Zones. In the final step, the septic system yield for each Zone in each HUC14 subwatershed is apportioned among the municipalities that share that subwatershed, proportional to developable acreage within each municipality.

Median Results for Recommended Nitrate Targets, in Average Acres per Septic System

Nitrate Target	**0.72 mg/L** (acres/septic system)	**1.87 mg/L** (acres/septic system)	**2.0 mg/L** (acres/septic system)	**10.0 mg/L** (acres/septic system)
Basis	Median for Protection Zone (Planning Area)	Median for Conservation Zone (Planning Area)	NJDEP Proposed WQMP Rule (Watershed)	NJDEP Proposed WQMP Rule (Cluster Area)
Median	26.1	10.0	9.4	1.9

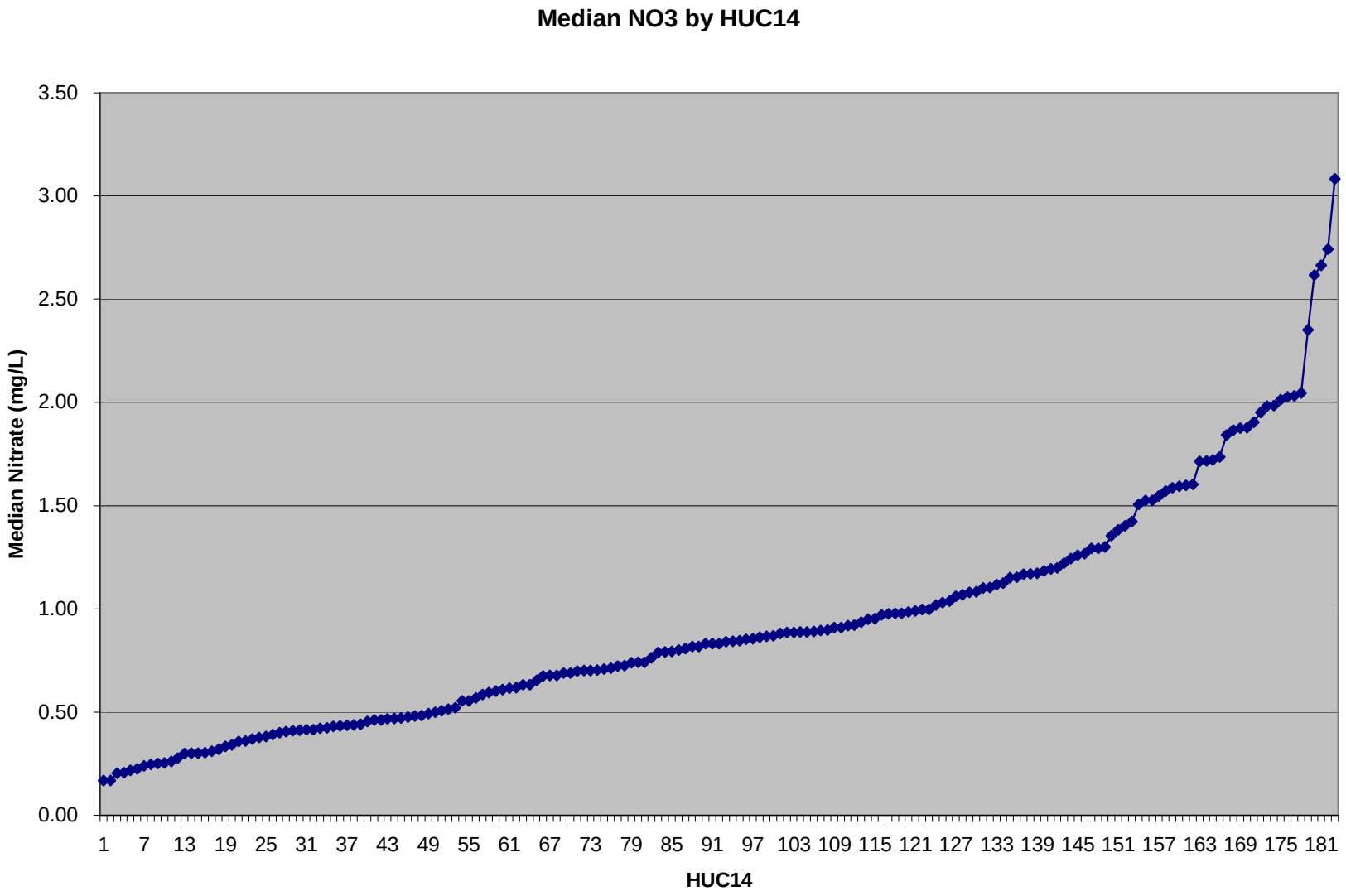
Policy Options for Model Variables and Treatment Technology

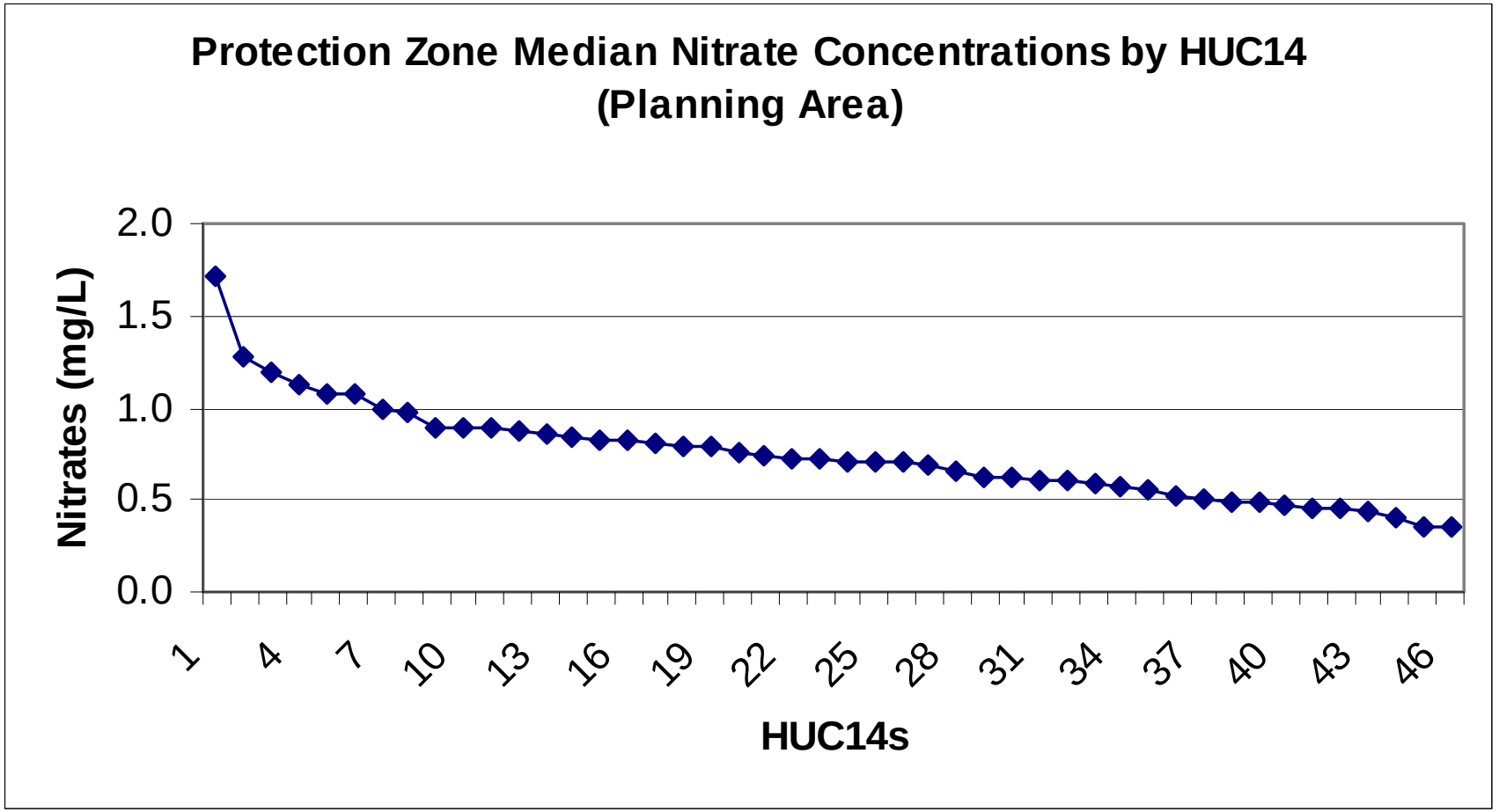
Although models are simplifications of the real world, they can provide reasonably accurate predictions that can be used to help formulate appropriate decisions and management policies.

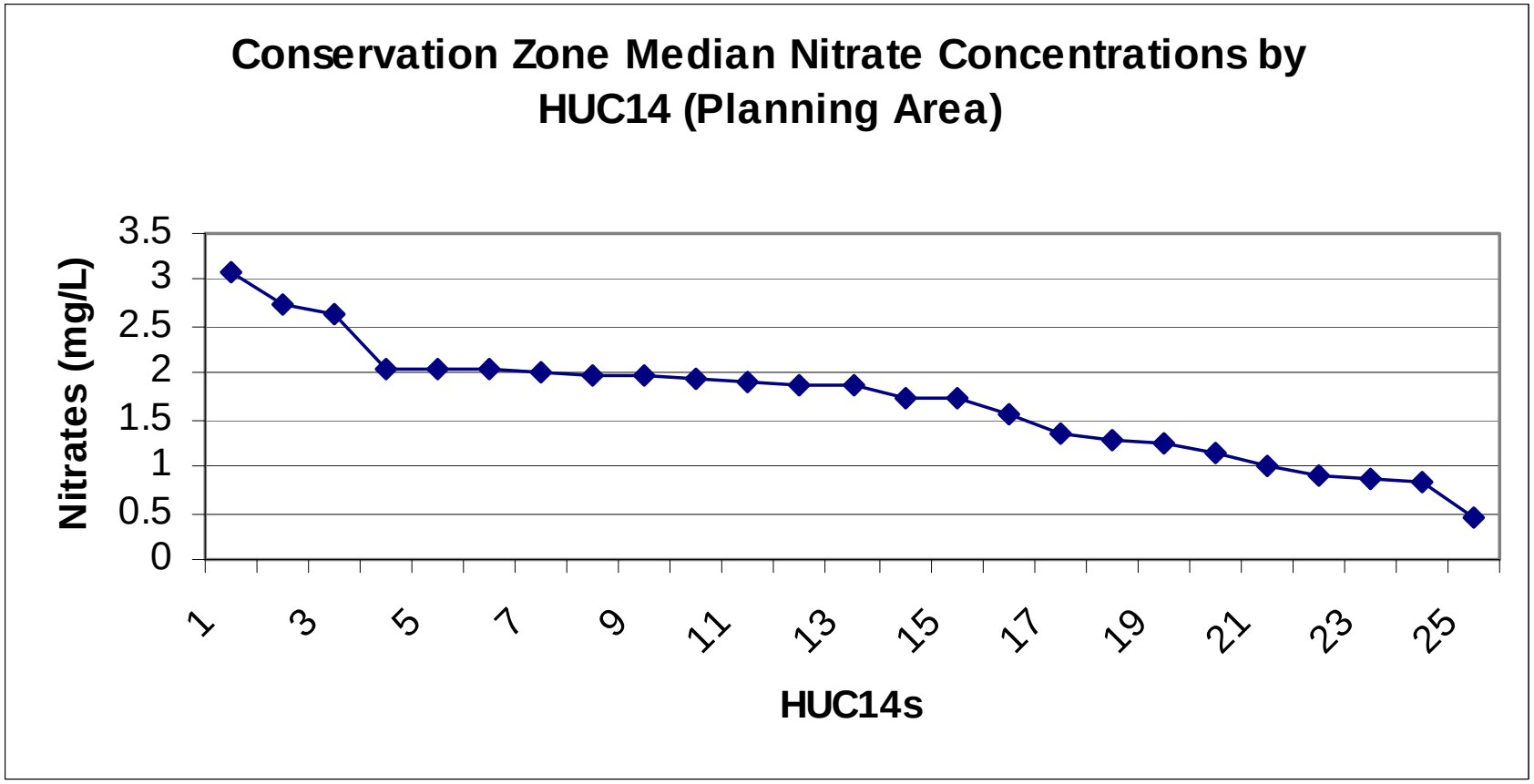
What should happen regarding septic system density if someone proposes to modify the basic assumptions? There are two major variables that can be affected: dilution and nitrate loadings.

- Dilution – A development could propose to increase recharge well beyond previously existing levels as a method to increase dilution and therefore increase septic system density. Many technical questions arise, such as whether the increased recharge would occur during the drought periods of concern, whether there is ground water storage capacity, whether ground water mounding would damage nearby structures or flood basements, etc. We anticipate few situations where this option would be feasible. Further, any regional analysis assumes that some areas have higher and lower recharge rates. Using site-specific analyses or methods to change a regional antidegradation policy is inappropriate. Accordingly, the Council determined not to use this approach.

- Nitrate Loadings – A development in the Planning Area could propose to provide advanced septic system designs or communal treatment systems to provide better nitrate treatment. (Neither of these options is allowed in the Preservation Area, per the Highlands Act. NJDEP can only allow standard septic system designs, and a communal system would be considered an extension of public wastewater capacity.) Should the development yield (total units allowed) be changed? The Council proposes that the RMP not allow for such increases for three reasons. First, both options require more sophisticated management to ensure that the systems retain their treatment capacity. Second, better treatment of nitrates does not ensure better treatment of other contaminants of concern. It is critical to remember that nitrates were selected as an indicator, not as the sole contaminant of concern. Third, like public sewerage, community systems are regulated more stringently by NJDEP than septic systems, and nitrate dilution modeling for septic systems is not applicable or appropriate.


Median NO3 by HUC14
Median Nitrate (mg/L)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1 7 13 19 25 31 37 43 49 55 61 67 73 79 85 91 97 103 109 115 121 127 133 139 145 151 157 163 169 175 181
HUC14


Protection Zone Median Nitrate Concentrations by HUC14
(Planning Area)
Nitrates (mg/L)
2.0
1.5
1.0
0.5
0.0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
HUC14s


Conservation Zone Median Nitrate Concentrations by HUC14 (Planning Area)
Nitrates (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
1
3
5
7
9
11
13
15
17
19
21
23
25
HUC14s