Water Resources

This guidance is intended to clarify how the Water Resources Goal and Objectives of the Regional Policy Plan (RPP) are to be applied and interpreted in Cape Cod Commission Development of Regional Impact (DRI) project review. This technical bulletin presents specific methods by which a project can meet these goals and objectives.

Water Resources Goal: To maintain a sustainable supply of high quality untreated drinking water and protect, preserve or restore the ecological integrity of fresh and marine surface waters.

- ***Objective WR1*** *– Protect and preserve groundwater quality*
- ***Objective WR2*** *– Protect, preserve and restore fresh water resources*
- ***Objective WR3*** *– Protect, preserve and restore marine water resources*
- ***Objective WR4*** *– Manage and treat stormwater to protect and preserve water quality*
- ***Objective WR5*** *– Manage groundwater withdrawals and discharges to maintain hydrologic balance and protect surface and groundwater resources*

The applicability and materiality of these goals and objectives to a project will be determined on a case-by-case basis considering a number of factors including the location relative to Water Resource Areas (identified on page WR-4), context (as defined by the Placetype of the location), scale, use, and other characteristics of a project.

THE ROLE OF CAPE COD PLACETYPES

The RPP incorporates *a framework for regional land use policies and regulations based on local form and context* as identified through categories of Placetypes found and desired on Cape Cod.

The Placetypes are determined in two ways: some are depicted on a map contained within the RPP Data Viewer located at www.capecodcommission.org/RPPDataViewer adopted by the Commission as part of the Technical Guidance for review of DRIs, which may be amended from time to time as land use patterns and regional land use priorities change, and the remainder are determined using the character descriptions set forth in Section 8 of the RPP and the Technical Guidance.

The project context, as defined by the Placetype of the location, provides the lens through which the Commission will review the project under the RPP. Additional detail can be found in the Cape Cod Placetypes section of the Technical Guidance.

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NOTE ON APPLICATION MATERIALS AND WATER RESOURCE AREAS MAPS

Application materials should provide sufficient detail to demonstrate that the project meets the applicable goals and objectives, but typically include:

A. Project description including site location, applicable Water Resource Areas, and narrative of proposed wastewater, stormwater and drinking water systems
B. Site-wide nitrogen loading calculation
C. Site plan including applicable grading, drainage, and utilities
D. Stormwater treatment and capacity calculations
E. Operations and maintenance plan(s)

*These items may not be required for all projects. See guidance on page WR-31 for more information.

The Water Resource Areas, which are defined on page WR-33, can be viewed in the RPP Data Viewer, and include:

- Wellhead Protection Areas (WHPA)
- Fresh Water Recharge Areas (FWRA)
- Marine Water Recharge Areas (MWRA)
- Potential Public Water Supply Area (PPWSA)
- Impaired Areas

INTRODUCTION

Cape Cod's water resources include fresh and marine waters as well as natural and built systems. The Cape Cod Aquifer, which serves as the primary link between all of the water resources on Cape, is relied upon to provide drinking water and wastewater disposal capacity for the human population, plays an integral role in maintaining plant and animal habitat in marine and freshwater settings, and ultimately underlies many of the scenic and recreational opportunities that serve as the primary economic driver for the region. Consistent with the Cape Cod Area Wide Water Quality Management Plan (the "208 Plan), maintaining the integrity and health of the aquifer and the various systems connected to it while encouraging provision of water resource infrastructure and growth that is appropriate in form and location is the primary purpose of the Water Resources goal and objectives.

This Technical Guidance provides examples of various methods and strategies that DRI projects may use to satisfy the Water Resources Goal and Objectives of the RPP. Through implementation of these methods and strategies, DRI projects can support the protection of critical water resources through development that is consistent with the vision for the region. Although the majority of methods discussed in this Technical Guidance are intended to be flexible, certain methods will be required of all DRIs where a particular Water Resources objective is applicable.

SUMMARY OF METHODS

GOAL | WATER RESOURCES

To maintain a sustainable supply of high quality untreated drinking water and protect, preserve or restore the ecological integrity of fresh and marine surface waters.

OBJECTIVE WR1 – Protect, preserve and restore groundwater quality

METHODS

All DRIs must employ the following methods to meet Objective WR1:

- Project is limited to a maximum site-wide nitrogen loading concentration of 5 parts per million (ppm) except as provided below for Impaired Areas and Potential Public Water Supply Areas (PPWSA),
- No adverse impacts on downgradient existing or proposed drinking water wells.
- Septic systems and other sources of contamination are sited to avoid adversely impacting downgradient existing or proposed drinking water wells.

Additional methods to meet Objective WR1:

- Utilize site design and operational best practices to preserve groundwater quality
- Review existing Environmental Site Assessment(s) as available for previously developed properties and incorporate findings into project design

For projects in an Impaired Area outside of other mapped water resource areas (see RPP Data viewer):

- If proposed site-wide nitrogen loading concentration exceeds 5 ppm, demonstrate no adverse impact on ponds, wetlands, marine waters, public or private drinking water supply wells, and potential water supply wells.

For projects in Potential Public Water Supply Areas:

- Site wide nitrogen loading must be less than 1 ppm.

All projects proposing private wastewater systems designed for flows greater than 2,000 gallons per day (gpd) and requiring greater treatment efficiency than specified by Massachusetts Department of Environmental Protection (MassDEP) permit or approval letter must:

- Enter into an Operation, Monitoring, and Compliance agreement with the Cape Cod Commission and local Board of Health.

All Wastewater Treatment Facility DRIs must:

- Consistently achieve 5 ppm or lower total nitrogen in wastewater effluent or in groundwater at downgradient property boundary.

Additional methods for wastewater treatment facility DRIs to meet Objective WR1:

- Utilize wastewater treatment facilities including private treatment facilities to protect and/or restore ground water quality provided that such facilities will not adversely impact water or other natural resources.

All DRIs within Wellhead Protection Areas (WHPA) or Potential Public Water Supply Areas (PPWSA) (see WHPA and PPWSA layers in the RPP Data Viewer) must employ the following methods to meet Objective WR1:

- All development, construction, clearing, and staging occurs at least 400 feet from identified future well sites.
- Projects with a high risk of contaminating groundwater, such as fleet storage, vehicle maintenance areas and loading docks, include a mechanical shut-off valve or other flow-arresting device in stormwater systems between the stormwater capture structures and the leaching structures.

Additional Methods for DRIs within WHPA and/or PPWSA's to meet Objective WR1:

- Do not use, treat, generate, handle, store or dispose of Hazardous Materials or Hazardous Wastes, except for Household Quantities by the following:
    - Redevelopment projects reduce the quantity of hazardous materials on the project site from the prior use and adequately document that reduction

  - Permanently eliminate the same or greater quantity of Hazardous Materials or Wastes at another facility, project, or site within the same WHPA or PPWSA and adequately document that reduction
- Does not discharge effluent from private wastewater treatment facilities, unless private wastewater treatment facilities remediate existing water quality problems in the water supply area.
- Non-residential development and redevelopment employs integrated pest management and/or biorational landscape management practices protective of water quality
- Roadway and parking area designs and materials minimize impervious surfaces

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OBJECTIVE WR2 – Protect, preserve and restore fresh water resources

METHODS

All DRIs within a Freshwater Recharge Area (FWRA) must employ the following methods to meet Objective WR2:

- New development prevents loading of nutrients and other contaminants to fresh water resources.
- Redevelopment maintains or reduces loading from nutrients and other contaminants to fresh water resources.
- Maintain or enhance vegetated buffer zones along shorelines to ponds and lakes

All projects within a FWRA where wastewater disposal is proposed must maintain a 300 foot buffer to the high water level of a freshwater pond unless they demonstrate that phosphorus transported by groundwater does not discharge into the pond or its tributaries.

Discharges of wastewater effluent over 2,000 gallons per day proposed anywhere in the watershed to a freshwater pond must evaluate the impact of phosphorus transported by groundwater on the pond.

OBJECTIVE WR3 – Protect, preserve and restore marine water resources

METHODS

All DRIs in a Marine Water Recharge Area (MWRA) where a critical nitrogen load has been determined through either a Total Maximum Daily Load or Massachusetts Estuaries Project (MEP) Technical Report must employ the following methods to meet Objective WR3:

- Not add nitrogen to a MWRA watershed unless:
    - There is a MassDEP Watershed Permit or locally adopted nutrient management plan, deemed consistent with the 208 Plan by the Cape Cod Commission, in the sub-watershed in which the project is proposed, and the approved nutrient management plan calls for initiation of nutrient reduction actions or strategies sufficient to offset nutrient contribution(s) from the project within five years of project approval; or
    - the project is in an area with available sewer connections, or is in a Placetype where nitrogen additions may be offset through a monetary contribution to address water quality problems in the affected surface waters.
- Further the goals of a local nitrogen management plan in areas subject to a MassDEP-approved wastewater or watershed permit.

All DRIs in a MWRA where there are water quality problems that are scientifically documented and a critical load has not been determined must employ the following methods to meet Objective WR3:

- Maintain or reduce nitrogen loading relative to existing levels.

OBJECTIVE WR3 AREAS OF EMPHASIS BY PLACETYPE

Natural Areas | Development is discouraged in Natural Areas and monetary N-offsets are not permitted.

Rural Development Areas | Sewer is generally not anticipated in rural areas, therefore monetary N-offsets are not permitted.

Suburban Development Areas | Monetary N-offsets may be permitted at Commission’s discretion.

Historic Areas | Monetary N-offsets may be permitted in Historic Areas at Commission’s discretion.

Maritime Areas | Monetary N-offset are permitted in Maritime Areas where sewer is not yet available.
Community Activity Centers | Monetary N-offsets are permitted in Community Activity Centers where sewer is not yet available.
Industrial Activity Centers | Monetary N-offset are permitted in Industrial Areas where sewer is not yet available.
Military and Transportation Areas | Monetary N-offset are permitted in Military / Transportation Areas where sewer is not yet available.

* The nitrogen offset rate is based on cost efficiencies associated with wastewater collection and municipal treatment as described in Appendix C.

OBJECTIVE WR4 – Manage and treat stormwater to protect and preserve water quality

METHODS

All DRIs, with the exception of redevelopment projects as discussed below, must employ the following methods to meet Objective WR4:

- Provide a stormwater management system that prevents adverse impacts to water resources and other natural resources.
- Prevent discharge of untreated stormwater to marine and fresh surface water and natural wetlands by treating runoff from development, including areas located outside the jurisdiction of the Massachusetts Wetlands Protection Act
- Provide storage and treatment capacity sufficient to store, treat, and infiltrate all runoff from parking areas and roadways onsite
- Locate new infiltration to maintain a minimum two-foot separation between points of infiltration and the maximum high water table.
- Design stormwater systems according to the Massachusetts Stormwater Handbook to:
    - accommodate the 25-year 24-hour storm
    - remove at least 80% total suspended solids (TSS)
    - provide water quality treatment capacity for the first inch of stormwater runoff using biofiltration, bioretention, or other Treatment BMPs as detailed in the Stormwater Handbook

For redevelopment projects:

- Reduce impervious area coverage and improve site conditions to enhance stormwater retention, water quality treatment, and recharge over existing conditions.
- Include natural areas in stormwater system design.

Additional methods to meet Objective WR4:

- Manage and directly infiltrate roof runoff separately where site constraints limit capacity for water quality treatment, unless there is an identified rooftop water quality concern requiring additional treatment or management.
- Design stormwater systems to remove at least 44% total suspended solids prior to discharge into subsurface leaching facilities.

OBJECTIVE WR4 AREAS OF EMPHASIS BY PLACETYPE

Natural Areas and Rural Development Areas | Prioritize protection of mature trees and wooded areas and utilize natural drainage features to manage stormwater. Minimize construction footprint, land disturbance during and after construction, and impervious area creation to maintain natural filtration and recharge processes. Use LID features that provide water quality treatment during storm events and environmental or recreational function at other times, and optimize BMPs for nitrogen removal.

Suburban Development Areas | Cluster development to maximize contiguous natural areas. Minimize stormwater runoff by reducing road/driveway widths and using permeable features to break up large impervious areas.

Historic Areas and Maritime Areas | Utilize permeable material choices when designing roadways, parking, and walkways where land area and subsurface access may be limited. Employ rainwater re-use techniques in ways that maintain local character. Explore opportunities for development of off-site shared district or community scale stormwater treatment.

Community Activity Centers | Prioritize inclusion of green space that can provide treatment and infiltration capacity for redevelopment / infill projects. Utilize subsurface storage and infiltration measures where site constraints limit above ground treatment capacity. Where applicable maintain or improve gray infrastructure to support development of shared off-site district or community scale stormwater treatment.

Industrial Activity Centers and Military and Transportation Areas | Prioritize inclusion of green space that can provide treatment and infiltration capacity for redevelopment / infill projects. Utilize permeable material choices when designing lower traffic roadways, parking, and walkways, and subsurface storage and infiltration measures where site constraints limit above ground treatment capacity. Where applicable maintain or improve gray infrastructure to support development of shared off-site district or community scale stormwater treatment. Design sites to minimize exposure of stormwater runoff to hazardous materials, hazardous wastes, and other potential contaminants. Design stormwater systems to treat higher potential pollutant loads and contain runoff via flow arresting device or otherwise in the event of a spill / release.

OBJECTIVE WR5 – Manage groundwater withdrawals and discharges to maintain hydrologic balance in a way that is protective of surface and groundwater resources

METHODS

All DRIs must employ the following methods to meet Objective WR5:

- Design water withdrawals and wastewater discharges in a manner that protects surface water and wetland habitat from groundwater pumping and, in the case of effluent disposal from water table mounding issues (e.g., breakout, flooding, water table separation).

For projects proposing to withdraw >20,000 gallons of water per day from the site must:

- Provide a groundwater study that demonstrates the project will not have adverse impacts on groundwater levels or adjacent surface waters and wetlands.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR1

Objective WR1 *– Protect and preserve groundwater quality*

NITROGEN LOADING

Protection of Cape Cod's groundwater resources is critical for the protection of human health. The Cape Cod aquifer was designated as a Sole Source Aquifer (47 FR 30282) by the US Environmental Protection Agency (USEPA) in 1982, recognizing the complete dependence of the population on groundwater as its source for drinking water. The aquifer is primarily recharged by precipitation but also receives discharges of wastewater and stormwater, which can introduce contaminants into Cape Cod's primary source of drinking water. Nitrate-nitrogen (NO_3-N) is a primary contaminant of concern due to its potential human health effects, for which USEPA has established a maximum contaminant level (MCL) of 10 parts per million (ppm). In addition, high NO_3 concentrations in groundwater have also been correlated with higher concentrations of drinking water contaminants (e.g., volatile organic compounds and compounds of emerging concern). For these reasons the nitrogen loading requirements must be met by all DRIs.

Detail on the methods for meeting Objective WR1 is provided below:

For all projects

Under the Safe Drinking Water Act, public supply wells which exceed 5 ppm NO_3-N are subject to additional monitoring requirements, and wells that exceed the MCL (10 ppm NO_3-N) cannot obtain variances or exemptions, thus requiring expensive treatment or being removed from operation. In aerobic subsurface environments like Cape Cod's unconfined aquifers, nitrate is highly persistent with natural chemical reactions providing minimal removal. Consequently, limiting the amount of nitrogen introduced to the aquifer is the most effective way to reduce NO_3-N concentrations in groundwater and protect Cape Cod's drinking water.

5 PPM NITROGEN LOADING STANDARD

The Cape Cod Commission has adopted a loading standard of 5 ppm NO_3-N which based on a statistical analysis is designed to keep violations of the USEPA MCL for NO_3-N to less than 1 in 10 samples, while maintaining an additional margin of safety during times of simultaneous low recharge (i.e., drought conditions) and high loading (summer peak season). This standard is designed to protect human health, as well as current and potential future drinking water resources. A site-wide nitrogen loading calculation takes into account all sources of nitrogen from the project site post-development and divides this cumulative nitrogen input by the water input (recharge) for the entire project site. Instructions on the information required and method for calculating site-wide nitrogen loading are available in Appendix A – Nitrogen Loading. Applicants seeking to reduce site-wide nitrogen loading may do so by providing advanced treatment of wastewater flows to remove additional nitrogen, reducing the volume of wastewater flows, increasing natural area on-site, decreasing fertilized lawn area, and incorporating stormwater Best Management Practices (BMPs) optimized for nitrogen removal.

IMPACTS OF DEVELOPMENT ON LOCAL DRINKING WATER WELLS

The 5 ppm nitrogen loading standard is designed to protect the Cape Cod aquifer as a whole, but localized impacts of a project on the groundwater resources also need to be considered. As nitrogen and other wastewater constituents will follow the flow of groundwater, the direction of groundwater flow at the project site will determine where wastewater effluent travels. The location of septic and other wastewater disposal systems, direction of groundwater flow, and proximity of public or private drinking water wells at the site and on neighboring parcels must be examined, as applicable, to verify that a project even when complying with site-wide loading standards is not contaminating nearby drinking water resources. Applicants must identify existing or proposed drinking water wells within 400 feet of project boundaries, when this method is applicable. Groundwater flow direction should be determined using a water table map, which may be generated from groundwater elevation data (possible sources might include the United States Geological Survey, Massachusetts Department of Environmental Protection, or the town). The direction of groundwater flow should be used to locate wastewater treatment systems (including septic) appropriately so that effluent does not flow directly into downstream drinking water sources.

SITE ASSESSMENTS FOR PREVIOUSLY DEVELOPED PROPERTIES

Sites that have been previously developed, particularly those with uses that historically have used/generated hazardous materials or hazardous wastes (e.g., gas stations, auto repair facilities, dry cleaners, manufacturing facilities) may contain contaminated soil or groundwater even if site assessment and remediation activities have been conducted under the Massachusetts Contingency Plan (MCP). To prevent the unintentional mobilization of contaminants into groundwater, documentation of all Environmental Site Assessments and remedial actions must be supplied for Commission review when this method is utilized to ensure the best available information regarding surface and subsurface site conditions is considered when evaluating the project design.

BEST DEVELOPMENT PRACTICES FOR SITE DESIGN

Low impact development is the practice of using innovative stormwater management systems that are modeled after natural hydrologic features. Low impact development techniques manage rainfall at the source using uniformly distributed decentralized micro-scale controls, and small cost-effective landscape features located at the lot level. They also facilitate compact, clustered development and minimize impervious surfaces.

Environmentally sensitive site design incorporates low impact development techniques to prevent the generation of stormwater and non-point source pollution by reducing impervious surfaces, disconnecting flow paths, treating stormwater at its source, maximizing open space, minimizing disturbance, protecting natural features and processes, and/or enhancing wildlife habitat.

Additional resources regarding site design best practices are available from the United States Environmental Protection Agency (https://www.epa.gov/sites/production/files/2015-11/documents/region3_factsheet_lid_esd.pdf), the Metropolitan Area Planning Council (https://www.mapc.org/resource-library/low-impact-development-toolkit/), and other State and regional environmental and planning agencies (e.g. https://growsmartmaine.org/wp-content/uploads/2015/08/Enviro_Sensitive_Design-Final-21-Nov-06.pdf).

USE OF SHARED INFRASTRUCTURE

Shared wastewater treatment utilizes a single system to treat wastewater from multiple units of development. This practice can facilitate higher density development, reduce environmental impacts and treatment costs, and enhance open space preservation as it only requires a single location for wastewater disposal and may require less total area for disposal. In cases where a parcel is subdivided or residential lots are to be sold individually, a covenant will need to be entered into by the homeowners for operation and maintenance of a shared system in order to meet Objective WR1 via this method.

Multi-unit development is also encouraged to include community or public water supplies as alternatives to multiple private wells, in order to avoid potential impacts from wastewater disposal and challenges of siting and associated setback requirements for multiple water supply wells.

For Projects Proposing Private Wastewater Systems

OPERATION, MONITORING, AND COMPLIANCE AGREEMENTS

When a wastewater system of sufficient capacity (greater than 2,000 gallons per day design flow) is proposed to operate with greater removal efficiency than currently certified by MassDEP permit or letter of approval in order to meet Water Resources objectives, an Operation Monitoring and Compliance (OMC) Agreement is required to ensure treatment goals are met. The OMC agreement should be entered into between the applicant, Cape Cod Commission, and the local Board of Health, and generally consists of:

- Treatment specifications
    - Wastewater flow limit
    - Effluent quality limits
- Monitoring requirements
    - Sampling locations
    - Analyses required
    - Sampling frequency
- Reporting requirements
    - Frequency of reporting
    - Enforcement actions
- Operations and maintenance plan and staffing

For Projects Proposing Wastewater Treatment Facilities

WASTEWATER TREATMENT FACILITIES

Wastewater collection and treatment systems that have a design flow of greater than 10,000 gallons per day are considered a wastewater treatment facility (WWTF).

LOCATION OF WASTEWATER TREATMENT FACILITIES

WWTFs are likely to play a role in many towns' nutrient reduction strategies, therefore it is important that public and private facilities are deployed in a coordinated and strategic manner. Nutrient reduction strategies may be laid out in a town's Comprehensive Waste Management Plan (CWMP), a Targeted Watershed Management Plan (TWMP) that may involve several towns, or in other planning documents. When a nutrient reduction strategy has been deemed consistent with the Cape Cod Area Wide Water Quality Management Plan Update (208 Plan Update) by the Cape Cod Commission, private WWTFs that are not owned or operated by a town, municipality or district may be located in areas where a) no public WWTF is proposed within five years of the proposed project construction date under the nutrient reduction strategy, or b) where the nutrient reduction strategy relies upon the proposed private WWTFs to achieve nutrient reduction goals. In areas where an approved nutrient management plan is not yet in place, private WWTFs are an encouraged strategy for maintaining or improving groundwater quality.

5 PPM NITROGEN CONCENTRATION LIMIT IN EFFLUENT OR AT DOWNGRADIENT BOUNDARY

Projects proposing WWTFs are required to maintain nitrogen at 5 ppm or lower when measured at the downgradient property boundary. As it can be assumed that nitrogen discharged to groundwater will flow advectively without dilution to the property boundary, nitrogen concentrations generally remain constant or decrease slightly following discharge. WWTF effluent nitrogen is monitored as part of a MassDEP groundwater discharge permit (GWDP), and projects with 5 ppm nitrogen or less in effluent are deemed to have met this requirement. Projects proposing to discharge nitrogen at concentrations greater than 5 ppm may use a groundwater model, or groundwater monitoring data to demonstrate that nitrogen concentration in groundwater at the downgradient property boundary will not exceed 5 ppm and the results must be submitted to the Commission for review and confirmation.

For Projects within Wellhead Protection Areas (WHPAs) and Potential Public Water Supply Areas (PPWSAs)

PROTECTION OF EXISTING AND FUTURE DRINKING WATER WELLS (WHPAS AND PPWSAS)

As additional development on land areas that contribute (or may contribute in the future) to drinking water wells will directly impact drinking water quality, certain additional protections are required to prevent excessive nutrient loading and minimize the risk of contamination.

Lands receiving precipitation that contribute to the recharge of public drinking water supply wells are considered Wellhead Protection Areas (WHPA). These include MADEP approved Zone IIs, interim wellhead protection areas, and certain town delineated water protection districts that extend beyond the Zone II limits.

Potential Public Water Supply Areas (PPWSAs) were first identified in the Priority Land Acquisition Assessment Project (PLAAP) as areas that may be suitable for future development of drinking water supplies. These land areas meet various requirements including minimum parcel size, surrounding land uses that are protective of groundwater quality, and the absence of incompatible upgradient or nearby land uses (e.g., landfills, hazardous waste sites or contaminant plumes, dense development).

Discharging effluent from private wastewater treatment facilities in WHPAs or PPWSAs may negatively impact those resources by degrading water quality and/or modifying natural hydrologic processes. Private wastewater treatment facilities may be proposed in a WHPA or PPWSA only when designed to specifically tie-in and treat existing sources of wastewater within that same water supply area.

HAZARDOUS MATERIALS LIMITATIONS

Any chemical or substance that when released into the environment will pose a significant contaminant threat to groundwater and drinking water supplies is considered a hazardous material. Examples include petroleum products, petroleum distillates, organic and inorganic solvents, oil-based paints, oil-based stains, insecticides, herbicides, rodenticides, and pesticides. Any Hazardous Waste, Universal Waste, or Waste as defined in the Massachusetts Hazardous Waste Regulations (310 CMR 30.010) are considered Hazardous Wastes. Hazardous Wastes do not include Hazardous

Materials or biomedical wastes regulated under the Massachusetts State Sanitary Code (105 CMR 480.00). Hazardous Materials do not include Hazardous Wastes, Articles, Consumer Products, or Cosmetics.

In order to minimize the potential risk of introducing contamination to existing or future water supplies, the following limits on hazardous materials / hazardous wastes apply in WHPAs and PPWSAs.

(a) 275 gallons of oil on site at any time to be used for heating of a structure, or to supply an emergency generator
(b) 25 gallons or equivalent dry weight, total, of Hazardous material(s) on site at any time (excluding oil as classified in part (a))
(c) 55 gallons of Hazardous Waste generated at the Very Small Quantity Generator level as defined in Massachusetts Hazardous Waste Regulations (310 CMR 30.000) and accumulated or stored on-site at any time.

Applicants should provide to the Commission an inventory which includes the identities and quantities of expected and potential hazardous materials/wastes that will be generated, used, or stored on site for the proposed use. Similar inventories should be provided for the previous use (when applicants propose to reduce the quantity of hazardous materials present on site through redevelopment) or for the proposed offset site (when applicants propose to eliminate the same or greater quantity of hazardous materials from another project, site, or facility within the same WHPA or PPWSA).

Certain types of development even when remaining within the above limits on hazardous materials and hazardous wastes may present a greater potential for contaminating groundwater. Stormwater systems serving areas used for fleet storage, vehicle maintenance, electrical transmission/generation. loading docks, waste handling, and any other use with greater potential for groundwater contamination must include a means to halt discharge from the stormwater system (flow arresting device) in the event of a spill, accident, or release of any source of contamination.

1 PPM NITROGEN LIMIT

PPWSAs are a finite and increasingly limited resource that require extra levels of protection to ensure they remain available to provide a stable drinking water system able to meet future water supply needs.

In order to maintain the suitability of PPWSAs to supply drinking water in the future, site wide nitrogen loading is limited to 1 ppm in these areas.

LANDSCAPE MANAGEMENT PRACTICES

Landscaping is an important part of development that may play a role in screening, stormwater treatment and overall visual aesthetics. Proper maintenance of landscaping is necessary to maintain its continued function, and several approaches are encouraged to minimize the environmental impacts presented by chemical fertilizer and pesticide usage during these activities. Additional detail regarding landscaping is provided in the Community Design Technical Bulletin.

Integrated pest management and biorational landscape management make use of an inspection and monitoring approach, along with a variety of pest control measures to maintain pest populations below levels that can cause significant damage or loss to installed landscaping. Soil nutrient and moisture testing should be employed with fertilization and irrigation methods tailored to the specific site conditions. Accurate identification of pests and monitoring of their populations should be used to determine rate and frequency for applying pest control (which may include chemical, cultural, and biological controls) to maintain pest population levels below identified thresholds. If no effective non-pesticide control measures are available, a key concept of integrated pest management is that selected pesticides should result in the lowest possible risk to health or the environment. The University of Massachusetts Extension provides a more detailed background and ongoing guidance regarding integrated pest management at (http://ag.umass.edu/integrated-pest-management).

ROADWAY AND PARKING AREA DESIGN

In WHPAs and PPWSAs, roadways and parking areas should be designed to minimize impervious area, with pervious construction materials used whenever possible to minimize the impact of stormwater on drinking water supplies.

PROJECTS IN IMPAIRED AREAS

Areas where water quality has been degraded by land uses such as high-density residential, commercial, or industrial development; landfills, septage, and wastewater treatment discharges; and areas downgradient of these sources that are similarly impacted are considered Impaired Areas.

Projects located in Impaired Areas that are outside other mapped water resource areas including WHPA's, PPWSA, MWRAs and FWRAs may use existing groundwater quality data, distance from existing natural or built water resources, and position upstream or downstream of those resources relative to groundwater flow direction to demonstrate that nitrogen loading above 5 ppm will not adversely impact those resources.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR2

Objective WR2 *– Protect, preserve and restore fresh water resources*

Prevent loading of phosphorous to fresh water resources

Phosphorous, unlike nitrogen, is attenuated in the subsurface through sorption to soil minerals or uptake during microbial or plant growth. Studies of phosphorous transport support regionally accepted use of a 300 foot buffer for purposes of protecting freshwater resources from wastewater discharges. Therefore, siting septic systems outside a 300 foot upgradient buffer to fresh surface waters, and maintaining or increasing the width of vegetative buffers with active plant growth will be protective of water quality. For projects with sufficiently large flows in pond recharge areas, the phosphorous load may exceed the attenuation rate of the soils and ultimately result additional phosphorous loading to the pond even when the discharge is located greater than 300 feet upgradient of the pond. In these situations, additional modeling which looks at groundwater flow, soil characteristics, and wastewater characteristics will be required to characterize the site and evaluate the expected extent of phosphorous transport, as appropriate.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR3

Objective WR3 *– Protect, preserve and restore marine water resources*

Prevent and mitigate loading of nutrients and other contaminants to marine water resources

Cape Cod's marine waters provide a variety of complex habitats necessary to support shellfish populations, marine fisheries, migratory birds, and many other plant and wildlife populations. Less than 25% of the Cape Cod land surface drains to open marine waters (e.g., Cape Cod Canal, Cape Cod Bay, Nantucket Sound, Atlantic Ocean). Instead, the majority of land surfaces discharge to estuaries or coastal embayments through groundwater flow in the Cape Cod aquifer. Marine Water Recharge Areas (MRWA) are defined as watershed areas that contribute to a marine embayment as defined by the topography of the water table.

As of 2018, the Massachusetts Estuary Project (MEP) has studied 40 of Cape Cod's 53 coastal embayments. MEP continues to study coastal embayments on Cape Cod to determine the critical nitrogen load for each embayment, which is the maximum amount of nitrogen input that can be assimilated without negatively impacting ecosystem function and provision of habitat. A total maximum daily load (TMDL) is the maximum amount of a pollutant that a waterbody can assimilate on a daily basis and still support a healthy ecosystem, which for Cape Cod's coastal embayments is determined by MassDEP based on the results of the MEP studies. Four of the embayments studied to date have been found to have assimilative capacity for nitrogen; therefore, no TMDL is necessary at this time. The remaining watersheds that have been studied require nitrogen reduction to achieve healthy ecosystem function.

Additional information about the MEP, embayment reports, and applicable TMDLs is available at the MassDEP website (https://www.mass.gov/guides/the-massachusetts-estuaries-project-and-reports).

The Cape Cod Section 208 Area Wide Water Quality Management Plan (208 Plan Update) was completed in 2015 in response to the need for a new approach to planning for and implementing nitrogen reduction plans and projects to achieve the critical nitrogen loads. The 208 Plan Update expands the available nutrient reduction strategies beyond source reduction to include remediation and restoration approaches. This allows for a range of strategies to be employed, depending on the placetype and context within the watershed of the area where nitrogen reduction is needed (ex. in-embayment strategies, such as the use of aquaculture, may be used in watersheds where low density development causes inefficient source reduction from a cost perspective). The 208 Plan Update provides a framework for applying watershed based solutions to reduce nitrogen in impaired embayments. CWMPs, TWMPs, and other municipal nutrient management plans and projects deemed consistent with the 208 Plan Update and those that are permitted by MassDEP through a watershed permit determine the approach and timing of solutions within an individual watershed or sub-watershed, and development that conforms with the approved nutrient management plan is considered to meet Objective WR3.

Development is generally prohibited from adding nitrogen to areas that contribute to nitrogen-overloaded coastal waters. Embayments which have nitrogen loading greater than or equal to their critical nitrogen loads are considered nitrogen-overloaded and may or may not have a TMDL associated with them. Documented water quality problems may also exist (e.g., shellfish or beach closures, failure to meet Massachusetts Surface Water Quality Standards) in areas where a critical nitrogen load or TMDL has not yet been established, in which case projects are required to mitigate or offset any proposed nitrogen load as described below. Nitrogen additions from the proposed project may be mitigated by connecting existing development to an existing sewer system, by tying-in and providing wastewater treatment to existing development currently served by septic systems, or by other means that result in the overall nitrogen load within the (sub)watershed being maintained or reduced. Applicants proposing to use this form of mitigation should provide a calculation of the expected nitrogen load generated by the project, the existing nitrogen sources (number, type, estimated load) proposed for mitigation, and a detailed description of the means by which treatment of those sources will be implemented (which could include financing of sewer tie-ins, a contract to provide wastewater treatment, installation and operation of I/A systems at existing properties, or other means of demonstrating how the proposed mitigation will ultimately be achieved).

Projects proposed in Placetype areas where development is encouraged and infrastructure needed to meet nitrogen reduction requirements is lacking may provide a monetary offset of the project's nitrogen load which can be used to support expansion of wastewater treatment operations.

MONETARY NITROGEN OFFSET

Natural Areas | No monetary nitrogen offset available

Rural Development Areas | Monetary nitrogen offset available where appropriate

Suburban Development Areas | Monetary nitrogen offset available where appropriate

Historic Areas | Monetary nitrogen offset available where appropriate

Maritime Areas | Monetary nitrogen offset available

Community Activity Center | Monetary nitrogen offset available

Industrial Activity Center | Monetary nitrogen offset available

Military and Transportation Areas | Monetary nitrogen offset available

Activity centers may have existing sewer collection and treatment systems, or have sufficient density of development and other infrastructure to justify future connection to sewer systems. To promote the desired development density and facilitate future sewering, projects in Community Activity Centers, Maritime Areas, Industrial Activity Centers or Military and Transportation Areas without available sewer connections may contribute a monetary offset calculated as up to $8,290 per kilogram per year nitrogen load to be offset. The monetary offset is based on the cost of removing one kilogram of nitrogen per year for 20 years using a conventional sewer collection system and municipal wastewater treatment and applies to all project nitrogen sources (ie. wastewater, stormwater, fertilizer). The monetary offset is calculated based on reductions from 26.25 ppm, consistent with the MEP assumption for a standard septic system and with values used for planning purposes in watershedMVP. See Appendix C for further information on the methodology. An alternative analysis of per kilogram nitrogen costs may be submitted so long as it is consistent with a locally approved plan. The Commission may utilize a proposed alternative analysis to determine offset costs, as appropriate.

Patterns of development in Suburban Development Areas are generally too spread out to make centralized wastewater collection financially feasible, while Historic Areas may present special challenges to sewering in terms of access below grade and age of existing infrastructure. For these reasons monetary offsets are allowed in limited circumstances at the discretion of the Commission in those Placetype Areas. Factors that will be considered in determining offsets in these placetypes might include, but are not limited to, existing development, business and community activity, a community's vision for the area as described in their Local Comprehensive Plan or other planning documents, and any plans for construction of infrastructure that will take place within five years.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR4

Objective WR4 *– Manage and treat stormwater to protect and preserve water quality*

Undisturbed natural areas generally slow the velocity of runoff, allowing natural processes to remove nutrients and contaminants and facilitating recharge so that rain largely stays where it falls. When natural areas are covered by impervious surfaces, the resulting stormwater runoff from rainfall or snow melt travels at higher velocities and in more concentrated flows, making both infiltration and removal of nutrients or contaminants more challenging. As rainfall amounts and patterns continue to change, the increased frequency of high intensity storms present challenges and risks to many forms of infrastructure. Stormwater systems designed to handle increased runoff in a distributed and decentralized manner should be an integral part of community planning for water quality, flood protection, climate resilience, and capital infrastructure. Across the Commonwealth of Massachusetts, untreated stormwater runoff is the single largest source of water body impairment. In order to maintain and improve the health of Cape Cod's water resources and the communities that depend on them, it is critical to manage both the quantity and quality of stormwater runoff that is generated by development.

Stormwater system design

To protect existing water resources and maintain safety by preventing flooding/ponding of water on roadways, stormwater systems must be designed to both capture and infiltrate rainfall from roadways, parking lots, and rooftops on the project site. Stormwater runoff collects sediment, bacteria, nutrients, and pollutants from the impervious surfaces it flows over, which negatively impact ground and surface water resources if not adequately treated. Properly designed and maintained treatment BMPs minimize the amount of these pollutants that are ultimately discharged to surface waters and groundwater. The Massachusetts Stormwater Handbook (https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards) provides guidance for designing stormwater structures to meet the water quality treatment and storage/infiltration aspects of Objective WR4. To best account for changing patterns in precipitation, updated projections for extreme precipitation events should be used whenever designing new stormwater systems. The Massachusetts Stormwater Handbook currently uses precipitation data from U.S.

Weather Service Technical Paper 40, which was published in 1961. Projections from the National Oceanic and Atmospheric Administration (NOAA Atlas 14, published 2015) and Northeast Regional Climate Center (Extreme Precipitation Analysis, http://precip.eas.cornell.edu/) utilize much more recent data than Technical Paper 40, and MassDEP currently recommends using the most conservative (largest) rainfall volume from among the three resources.

Applicants should provide a stormwater maintenance and operation plan certified by a Professional Engineer that details a schedule for inspection, monitoring, and maintenance; and identifies the party responsible for implementation. The applicant should also agree to provide a Professional Engineer certified letter that details inspection of the stormwater facilities one year after completion and certifies that the system was installed and continues to function as designed and approved.

SEPARATION FROM HIGH GROUNDWATER

A calculation of the high groundwater level is required to be performed when this method is applicable to ensure that stormwater facilities are designed to maintain the proper 2 foot separation from the water table under all conditions. Appendix B – Estimation of High Groundwater Levels describes a calculation that may be used to adjust water levels measured at discrete Cape Cod locations and estimate high groundwater levels at those same locations. The approach was developed in cooperation with the US Geological Survey and is based on historic long-term groundwater-level measurements at index wells located across Cape Cod.

TOTAL SUSPENDED SOLIDS REMOVAL AND WATER QUALITY TREATMENT VOLUME

Stormwater systems are required to be designed to remove 80% of Total Suspended Solids (TSS) and provide water quality treatment for the first inch of precipitation from all impervious surfaces on the site. An estimate of the TSS removal achieved in the stormwater treatment train(s) can be performed using MassDEP's TSS Removal Calculation Worksheet. (https://www.mass.gov/files/documents/2016/08/nn/tss.xls)

The required water quality treatment volume can be calculated using the following equation.

$$\textit{WQ treatment volume } (ft^3) = \textit{impervious area } (ft^2) * (\textit{1 inch / 12 inches per foot})$$

Storage/treatment volume provided by most stormwater BMPs can be calculated with a stage-storage table, where the incremental volume of each stage is given by

$$\textit{Incremental volume } (ft^3) = (elevation_2 - elevation_1) * ((area_2 + area_1)/2)$$

Table 1: Example stage-storage volume calculation

ELEVATION (FT)	SURFACE AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
72.5	210	0	0
73	660	217.5	217.5
73.5	1,020	420	637.5
74	1,500	630	1267.5

The *Massachusetts Stormwater Handbook* contains detailed explanations, examples, and guidance for additional methods which may be used to calculate required volume(s) in Volume 3, Chapter 1 – Standard 4.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR5

Objective WR5 *– Manage groundwater withdrawals and discharges to maintain hydrologic balance in a way that is protective of surface and groundwater resources*

Projects that exceed 20,000 gpd withdrawals must provide adequate groundwater characterization to demonstrate that drawdown of the groundwater due to pumping will not negatively impact nearby surface waters and wetlands, which may be connected to and fed by groundwater. The study should include mapping of surface water morphology and comparison of existing and affected water-table fluctuations. In addition, wastewater discharges should provide adequate groundwater characterization to determine the maximum expected height of groundwater mounds and the potential for groundwater with this additional mounding to breakout above the land surface. Projects should provide a high groundwater estimation consistent with the methodology of Appendix B –Estimation of High Groundwater Levels to incorporate into modeling of potential mounding.

DETAILED WATER RESOURCES APPLICATION REQUIREMENTS

1. The project narrative should include a description of the site location and any applicable resource areas, existing site conditions, and how the proposed project will change those conditions during and after construction. Areas that should be considered include:
    a. Presence of existing and proposed drinking water wells within 400 feet of project boundaries
    b. Quantity of wastewater generation expected and proposed treatment
    c. Source of drinking water supply
    d. Changes in natural and impervious area cover
    e. Stormwater management and treatment
    f. for previously developed sites a description of historical site usage, and if a reportable release under the MCP has occurred at the project site or if a Site Release Tracking Number (RTN) has been assigned for the site by MassDEP, a Chapter 21E site assessment or other Environmental Site Assessment information is required to be submitted for Commission review when method is utilized.
2. A calculation of site-wide nitrogen loading should be performed using the method described in Appendix A.
3. The site design should specify the location of the proposed septic system or wastewater treatment facility and identify downgradient resources as described in WR1 – detailed methods.
4. The stormwater report should include a description of the proposed system (for small systems, the description in the project narrative may be sufficient) and the following information as necessary:
    a. Soil survey and / or boring logs
    b. Calculation of high groundwater level to ensure that stormwater facilities are designed with proper separation from the water table as described in WR4 – detailed methods.
    c. Estimate of TSS removal achieved in stormwater treatment train(s) using MassDEP's TSS Removal Calculation Worksheet (https://www.mass.gov/files/documents/2016/08/nn/tss.xls)
    d. Calculation of required water quality treatment volume and treatment volume provided as described in WR4 – detailed methods.

    e. Engineering design drawings or cut sheets for proposed stormwater system components

5. Operations and maintenance plans for all proposed water systems (drinking water supply, stormwater, and wastewater treatment) should be submitted for Commission review

DEFINITIONS

Best Management Practice (BMP) – structural or procedural control measures implemented to reduce the quantity and velocity of stormwater runoff, and improve water quality

Fresh Water Recharge Area (FWRA) – Watershed area that contributes to a fresh water pond as defined by the topography of the water table.

Hazardous Material – Any chemical or substance that when released into the environment will pose a significant contaminant threat to groundwater and drinking water supplies.

Hazardous Materials / Hazardous Wastes, Household Quantity of – quantities less than the following limits are considered Household Quantities:

(a) 275 gallons of oil on site at any time to be used for heating of a structure, or to supply an emergency generator
(b) 25 gallons or equivalent dry weight, total, of Hazardous material(s) on site at any time (excluding oil as classified in part (a))
(c) 55 gallons of Hazardous Waste generated at the Very Small Quantity Generator level as defined in Massachusetts Hazardous Waste Regulations (310 CMR 30.000) and accumulated or stored on-site at any time.

Hazardous Waste – Any Hazardous Waste, Universal Waste, or Waste as defined in the Massachusetts Hazardous Waste Regulations (310 CMR 30.010), not including Hazardous Materials or biomedical wastes regulated under the Massachusetts State Sanitary Code (105 CMR 480.00).

Impaired Area –Impaired Areas are where groundwater may have been degraded by point and non-point sources of pollution, including but not limited to areas with unsewered residential developments with an average lot size of less than 20,000 square feet; landfills, septage, and wastewater treatment plant discharge sites; and areas of high-density commercial and industrial development and those downgradient areas where groundwater may have been degraded by those sources.

Impervious Area – Land area that is covered by surfaces which do not permit precipitation to naturally recharge. Typically includes paved surfaces, roadways, parking areas, and rooftops.

Infill – Development of new housing, commercial, or other amenities on scattered or discontinuous sites within existing substantially built-up areas.

Marine Water Recharge Area (MWRA) – Watershed area that contributes to a marine embayment as defined by the topography of the water table, and determined by United States Geological Survey (USGS) modeling as part of the Massachusetts Estuaries Project (MEP)

Potential Public Water Supply Area (PPWSA) – Land identified as suitable for the development of public water supplies.

Wastewater treatment facility (WWTF) – Wastewater treatment and collection systems that are designed to treat flows greater than 10,000 gallons per day.

Wellhead Protection Area (WHPA) - Lands receiving precipitation that contribute to the recharge of public drinking water supply wells are considered Wellhead Protection Areas (WHPA). These include MADEP approved Zone IIs, interim wellhead protection areas, and certain town delineated water protection districts that extend beyond the Zone II limits.

REFERENCES

Cape Cod Commission, 1992. Estimation of High Groundwater Levels for Construction and Land Development, Technical Bulletin 92-001

Cape Cod Commission, 1999. Priority Land Acquisition Assessment Project – A guide to evaluating the suitability of land for future water supply sites

Cape Cod Commission, 2001. Priority Land Acquisition Assessment Project Phase II

Massachusetts Estuaries Project and Reports https://www.mass.gov/guides/the-massachusetts-estuaries-project-and-reports

The Massachusetts Stormwater Handbook and Stormwater Standards (https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards)

National Weather Service, 1961. Technical Paper 40: Rainfall Frequency Atlas of the United States

National Oceanic and Atmospheric Administration, 2015. Atlas 14 Precipitation Frequency Data Server https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

Northeast Regional Climate Center, 2011. Extreme Precipitation Analysis. http://precip.eas.cornell.edu/

USGS, 1986. Ground-Water Resources of Cape Cod, Massachusetts Hydrologic Investigations Atlas-692

United States Environmental Protection Agency, 2009. Incorporating Environmentally Sensitive Development into Municipal Stormwater Programs https://www.epa.gov/sites/production/files/2015-11/documents/region3_factsheet_lid_esd.pdf

Metropolitan Area Planning Council, 2014. Low Impact Development Toolkit https://www.mapc.org/resource-library/low-impact-development-toolkit/

Grow Smart Maine, 2015. Building "Smart": Environmentally Sensitive Design https://growsmartmaine.org/wp-content/uploads/2015/08/Enviro_Sensitive_Design-Final-21-Nov-06.pdf

University of Massachusetts Extension, 2018. Integrated Pest Management Program http://ag.umass.edu/integrated-pest-management

APPENDIX A: NITROGEN LOADING GUIDANCE FOR WATER RESOURCES

The Water Resource Goal of the Cape Cod Commission's Regional Policy Plan is "to maintain a sustainable supply of high quality untreated drinking water and protect, preserve or restore the ecological integrity of fresh and marine surface waters." The Water Resources Technical Bulletin contains five (5) Objectives that are distinguished by Water Resource Area and Placetype. The Water Resource Areas are: Wellhead Protection Areas, Fresh Water Recharge Areas, Marine Water Recharge Areas, and Potential Water Supply Areas. The Water Resources Technical Bulletin also recognizes Impaired Areas where water quality may have been impaired from existing development.

The applicant will need to know specific project information to complete a nitrogen loading calculation

A methodology has been adopted by the Commission for calculating groundwater nitrogen loading concentrations. The methodology is based on information and parameters describing wastewater flows; stormwater runoff volumes; lawn sizes, fertilization and leaching rates; respective nitrogen masses and concentrations attributable to these nitrogen sources, and precipitation dilution factors as described below and shown in the example calculations.

WORKSHEET INSTRUCTIONS

The applicant will need to know the information listed below to complete a Nitrogen Loading calculation:

Identify the Water Resource Area the project is located in, if any (RPP Data Viewer);

1. Upland area of site (square feet);
2. Wastewater flow rate (calculated pursuant to 310 CMR 15.203);
3. Actual Flow rate determined by occupancy rate;
4. Average residential flow rate, calculated from the Title 5 design + the Actual Flow rate
5. Type of septic system proposed (e.g. alternative design pursuant to 310 CMR 15.280);
6. Paved and roof areas (assumed 2,500 square feet for residential projects);

7. Proposed lawn area (assumed 5,000 square feet for residential projects);

A summary of Nitrogen Loading conversion factors and sample calculations are shown on the following pages.

A Nitrogen Loading and Mitigation Worksheet is available at www.capecodcommission.org/NitrogenWorksheet.

SUMMARY OF NITROGEN LOADING VALUES

TARGET CONCENTRATION: 5 ppm (milligram/liter) NO3-N

WASTEWATER

Residential Concentration:	35 ppm NO3-N
Flow:	Title 5 (310 CMR 15.02)
Non-residential Concentration:	35 ppm NO3-N
Flow:	Title 5 Design or actual documented flows

OCCUPANCY: Range (Actual town rate to 2 people per bedroom)

LAWNS

Area: 5,000 ft2
Fertilizer: 3 lbs/1,000 ft2 of lawn
Leaching: 25%

RECHARGE

From impervious surfaces: 40 inches per year

Concentrations

Road runoff:	1.5 ppm NO3-N
Roof runoff:	0.75 ppm NO3-N

Natural areas

Barnstable:	18 inches per year
Bourne:	21 in/yr
Brewster:	17 in/yr
Chatham:	16 in/yr
Dennis:	18 in/yr
Eastham:	16 in/yr
Falmouth:	21 in/yr
Harwich:	17 in/yr
Mashpee:	19 in/yr
Orleans:	16 in/yr
Provincetown:	16 in/yr
Sandwich:	19 in/yr
Truro:	16 in/yr
Wellfleet:	16 in/yr
Yarmouth:	18 in/yr

EXAMPLE RESIDENTIAL LOADING CALCULATIONS

Home (3 bedrooms)

Lot Size: 1 acre (43,560 ft^2)
Impervious Surfaces: Roof Area: 2,000 ft^2; Paving Area: 500 ft^2
Natural Area: 41,060 ft^2; Lawn Area: 5,000 ft^2
Title V Flow: 110 gallons/day per bedroom

WASTEWATER

Title V (2 people per bedroom)

$$3\text{ bedrooms}\left[\frac{110\text{ gpd}}{\text{bedroom}}\right]\left[\frac{3.785\text{ L}}{\text{gal}}\right] = 1{,}249.0\text{ L/d}\quad\left[\frac{35\text{ mg}}{\text{L}}\right] = 43{,}716.8\text{ mg/d}$$

Actual (assume 2.5 people/unit average occupancy within the town)

$$3\text{ bedrooms}\left[\frac{110\text{ gpd}}{\text{bedroom}}\right]\left[\frac{3{,}785\text{ L}}{\text{gal}}\right]\left[\frac{2.5}{6}\right] = 520.4\text{ L/d}\quad\left[\frac{35\text{ mg}}{\text{L}}\right] = 18{,}214.6\text{ mg/d}$$

IMPERVIOUS SURFACES

$$2{,}000\text{ ft}^2\left[\frac{40\text{ in}}{\text{yr}}\right]\left[\frac{\text{ft}}{12\text{ in}}\right]\left[\frac{28.32\text{ L}}{\text{ft}^3}\right]\left[\frac{1\text{ yr}}{365\text{ d}}\right] = 517.3\text{ L/d}\quad\left[\frac{0.75\text{ mg}}{\text{L}}\right] = 387.9\text{ mg/d}$$

$$500\text{ ft}^2\left[\frac{40\text{ in}}{\text{yr}}\right]\left[\frac{\text{ft}}{12\text{ in}}\right]\left[\frac{28.32\text{ L}}{\text{ft}^3}\right]\left[\frac{1\text{ yr}}{365\text{ d}}\right] = 129.3\text{ L/d}\quad\left[\frac{1.5\text{ mg}}{\text{L}}\right] = 194.0\text{ mg/d}$$

LAWN

$$5{,}000\text{ ft}^2\left[\frac{3\text{ lbs}}{1{,}000\text{ ft}^2\text{*yr}}\right]\left[\frac{1\text{ yr}}{365\text{ d}}\right]\left[\frac{454{,}000\text{ mg}}{\text{lb}}\right]\left[0.25\right] = 4{,}664.4\text{ mg/d}$$

NATURAL

$$43{,}560\text{ ft}^2 - 2{,}500\text{ ft}^2 = 41{,}060\text{ ft}^2$$

$$41{,}060\text{ ft}^2\left[\frac{1.5\text{ ft}}{\text{yr}}\right]\left[\frac{28.32\text{ L}}{\text{ft}^3}\right]\left[\frac{1\text{ yr}}{365\text{ d}}\right] = 4{,}778.7\text{ L/d}$$

SUMMARY

Title V Flow

$$\frac{43{,}716.8 + 387.9 + 194.0 + 4{,}664.4\text{ mg}}{1{,}249.0 + 517.3 + 129.3 + 4{,}778.7\text{ liters}} = \frac{48{,}963.1\text{ mg}}{6{,}674.3\text{ liters}} = 7.34\text{ ppm}$$

Actual

$$\frac{18{,}214.6 + 387.9 + 194.0 + 4{,}664.4\text{ mg}}{520.4 + 517.3 + 129.3 + 4{,}778.7\text{ liters}} = \frac{23{,}460.9\text{ mg}}{5{,}945.7\text{ liters}} = 3.95\text{ ppm}$$

Final Calculation $(7.34 + 3.95)/2 =$ **5.65 ppm**

EXAMPLE NONRESIDENTIAL LOADING CALCULATIONS

Office Building:

Lot Size: 5 acres (217,800 ft^2)
Impervious Surfaces: Roof Area: 15,000 ft^2; Paving Area: 30,000 ft^2
Natural Area: 172,800 ft^2; Lawn Area: 10,000 ft^2
Title V Flow: 75 gallons/day per 1,000 ft^2

WASTEWATER

$$15{,}000\ ft^2 \left[\frac{75\ gpd}{1{,}000\ ft^2}\right]\left[\frac{3.785\ L}{gal}\right] = 4{,}258.1\ L/d \qquad \left[\frac{35\ mg}{L}\right] = 149{,}034.4\ mg/d$$

IMPERVIOUS SURFACES

$$15{,}000\ ft^2 \left[\frac{40\ in}{yr}\right]\left[\frac{ft}{12\ in}\right]\left[\frac{28.32\ L}{ft^3}\right]\left[\frac{1\ yr}{365\ d}\right] = 3{,}879.5\ L/d \qquad \left[\frac{0.75\ mg}{L}\right] = 2{,}909.6\ mg/d$$

$$30{,}000\ ft^2 \left[\frac{40\ in}{yr}\right]\left[\frac{ft}{12\ in}\right]\left[\frac{28.32\ L}{ft^3}\right]\left[\frac{1\ yr}{365\ d}\right] = 7{,}758.9\ L/d \qquad \left[\frac{1.5\ mg}{L}\right] = 11{,}638.4\ mg/d$$

LAWN

$$10{,}000\ ft^2 \left[\frac{3\ lbs}{1{,}000\ ft^2 * yr}\right]\left[\frac{1\ yr}{365\ d}\right]\left[\frac{454{,}000\ mg}{lb}\right]\left[0.25\right] = 9{,}328.8\ mg/d$$

NATURAL

$$5\ acres \left[\frac{43{,}560\ ft^2}{acre}\right] = 217{,}800\ ft^2; \quad 217{,}800\ ft^2 - 45{,}000\ ft^2 = 172{,}800\ ft^2$$

$$172{,}800\ ft^2 \left[\frac{1.5\ ft}{yr}\right]\left[\frac{28.32\ L}{ft^3}\right]\left[\frac{1\ yr}{365\ d}\right] = 20{,}111.1\ L/d$$

SUMMARY

$$\frac{149{,}304.4 + 2{,}909.6 + 11{,}638.4 + 9{,}328.8\ mg}{4{,}258.1 + 3{,}879.5 + 7{,}758.9 + 20{,}111.1\ liters} = \frac{172{,}911.2\ mg}{36{,}007.6\ liters} = \boxed{4.80\ ppm}$$

DRAFT

Water Resources Nitrogen Loading and Mitigation Worksheet

See Technical Bulletin 91-001 for further details: http://www.capecodcommission.org/regulatory/NitrogenLoadTechbulletin.pdf

Project Nitrogen Load — ***Wastewater*** — ***Proposed development*** | ***Existing (if redevelopment)***

Calculate (A') through (P') as w/ (A) through (P):

1.

	Proposed development				Existing (if redevelopment)		
Enter value	Project Title-5 wastewater flows:	gpd		(a)	Title-5 wastewater flows:	gpd	
Enter value	Actual wastewater flows:	*		(b)	Actual wastewater flows:	*	
Calculated value	Average wastewater flows:	gpd	(a)+(b) ÷2=	(A)	Ave. wastewater flows:	gpd	(A')

* Title-5 flows prescribed by TB91-001 for commercial uses

Place √ in applicable box:

Yes	No	
☐	☐	Will the project be connected to sewer ?
☐	☐	Is project Title-5 wastewater flow 10,000 gpd or greater ? ***(If 'Yes', then the project must be reviewed for consistency with MPS WR6)***

Existing — Place √ in applicable box:

Yes	No	
☐	☐	Is existing development on sewer ? (If 'Yes', then go to line 2.)

Place √ in applicable box and multiply unsewered wastewater flow by applicable conversion factor:

	System		Factor
☐	Standard Title-5 System (35-ppm-N)	x	0.048359
☐	DEP-approved I/A System (25-ppm-N)	x	0.034542
☐	DEP-approved I/A System (19-ppm-N)	x	0.026252
☐	Groundwater Discharge (10-ppm-N)	x	0.013817

} Type of system: _______________

Existing:

☐	Standard Title-5 System
☐	DEP-approved I/A System (commercial)
☐	DEP-approved I/A System (residential)
☐	Wastewater Treatment Facility (GWDP)

Calculated value	Wastewater nitrogen load (**Title-5 flows**) =	kg-N/yr	(B)	kg-N/yr	(B')
Calculated value	Wastewater nitrogen load (**Actual flows**) =	kg-N/yr	(C)	kg-N/yr wastewater offsets	(C')

Stormwater Runoff

Town: __________________ Recharge rate for town (inches; for natural areas from Technical Bulletin 91-001): : **(RECH)** — Enter value

	Proposed					Existing		
Enter value	Project site area:	acres		(D)		Project site area:	acres	(D)
Enter value	Project site wetland area:	acres		(E)		Project site wetland area:	acres	(E)
Calculated value	Project site upland area:	acres		(F)		Project site upland area:	acres	(F)
Calculated value	Pervious unpaved upland:	acres		(G)		Pervious unpaved upland:	acres	(G')
Enter values (% using LID)	Paved area:	s.f.		(H)		Paved area:	s.f.	(H')
Factor may be adjusted for employment of LID →	x 1.4158E-04							
Calculated value	=	kg-N/yr		(I)		Paving runoff offset:	kg-N/yr	(I')
Enter value	Roof area:	s.f.		(J)		Roof area:	s.f.	(J')
	x 7.0792E-05							
Calculated value	=	kg-N/yr		(K)		Roof runoff offset:	kg-N/yr	(K')

Fertilizer

	Proposed			Existing		
Enter value	Managed turf:	s.f.		Managed turf:	s.f.	
	x 3.4019E-04					
Calculated value	=	kg-N/yr	(L)	Fertilizer offset:	kg-N/yr	(L')

Total Nitrogen Load

	Proposed				Existing		
Calculated value	Total project nitrogen load (**Title-5 flows**):	kg-N/yr	**(M)=**	**(B)+(I)+(K)+(L)**	Existing nitrogen load (Title-5 flows):	kg-N/yr	(M')
Calculated value	Total project nitrogen load (**Actual flows**):	kg-N/yr	**(N)=**	**(C)+(I)+(K)+(L)**	Existing nitrogen load (Actual flows):	kg-N/yr	(N')
Calculated value	Nitrogen load per acre (**Average**):	kg-N/yr/acre	**(O)=**	**(M)+(N) ÷2 ÷(F)**	Nitrogen offset per acre:	kg-N/yr/acre	(O')

Nitrogen Loading Concentration

Existing nitrogen loading concentrations:

	Proposed				Existing		
Calculated value	Project nitrogen loading concentration (**Title-5 flows**):	ppm-N	**(P)=**	**(M)** / **(a)÷723.76 + (G)x(RECH)÷9.7286 + (H)÷10,594 + (K)÷0.75**	Title-5 flows	ppm-N	(P')
Calculated value	Project nitrogen loading concentration (**Actual flows**):	ppm-N	**(Q)=**	**(N)** / **(b)÷723.76 + (G)x(RECH)÷9.7286 + (H)÷10,594 + (K)÷0.75**	Actual flows	ppm-N	(Q')
Calculated value	Project nitrogen loading concentration (**Average**):	ppm-N	**(R)=**	**(P)+(Q) ÷2**	Average	ppm-N	(R')

next page -->

Resource/ Impact Based Criteria

Marine Water Recharge Areas

2. Yes ☐ No ☐ Is the project in Marine Water Recharge Area (MWRA, Map WR3) with a nitrogen-loading limit OR in a MWRA that discharges to coastal waters with documented impaired water quality** ?
(If 'No', then go to line 3.)

Name of Marine Water Recharge Area sub-embayment
(*from RPP Water Resource Classification Map II*):

Enter value Fair Share nitrogen-loading limit** : ☐ kg-N/year/acre **(S)**

☐ ☐ Does project's nitrogen load **(O)** exceed the existing load **(O')** AND the critical nitrogen load **(S)** ?
(If 'No', then go to line 3.)
Calculated value Excess project nitrogen load to be mitigated: ☐ kg-N/yr **(T)=** LESSER OF **(O)-(S) x(F)** AND **(O)-(O') x(F)**
x 1,550
Calculated value = $ ☐ **(U)**

☐ Place √ in box if applicant intends to make this payment **(S)**
(If not checked, then the project must provide an alternative strategy for meeting its Fair Share nitrogen load pursuant to MPS WR3.4)

*** Fair Share nitrogen-loading limit is determined through either a Total Maximum Daily Load (TMDL), a Massachusetts Estuaries Project-accepted technical report, or specified by a Commission-approved comprehensive wastewater management plan pursuant to MPS WR3.1 & WR3.3. If a nitrogen-loading limit is unavailable and impaired water quality has been documented for the receiving coastal waters, the nitrogen loading limit shall be 0 kg-N/yr per acre pursuant to MPS WR3.2.*

Groundwater Quality

3. Yes ☐ No ☐ Does the project's nitrogen loading concentration in groundwater **(R)** exceed the greater of **5 ppm** *or* the existing concentration **(R')** ?
(If 'Yes' and the project is located in a Water Quality Improvement Area (Map WR5), the project may need to provide an alternative strategy for meeting MPS WR1.1 and WR5.4)

Potential Public Water Supply Areas

4. Yes ☐ No ☐ Is project in a Potential Public Water Supply Area (PPWSA, Map WR2) ?
(If 'No', then go to line 5.)

☐ ☐ Has the Town or local water district documented the release of the site from consideration as a PPWSA ?
(If 'Yes', then go to line 5.)

☐ ☐ Does the project's nitrogen loading concentration **(R)** exceed the greater of **1 ppm** *or* the existing concentration **(R')** ?
(If 'Yes', the project must provide an alternative strategy for meeting MPS WR2.6)

☐ ☐ Does the project use, treat, generate, store or dispose of hazardous materials in excess of the greater of a) household quantities or b) existing quantities ?
(If 'Yes', the project must provide an alternative strategy for meeting MPS WR2.2)

Wellhead ProtectionAreas

5. Yes ☐ No ☐ Is project in a Wellhead Protection Area (WHPA, Map WR2) ?
(If 'No', then go to line 6.)

☐ ☐ Does the project's nitrogen loading concentration **(R)** exceed the greater of **5 ppm** *or* the existing concentration **(R')** ?
(If 'Yes' and the project is located in a Water Quality Improvement Area (Map WR5), the project must provide an alternative strategy for meeting MPS WR2.1)

☐ ☐ Does the project use, treat, generate, store or dispose of hazardous materials in excess of the greater of a) household quantities or b) existing quantities ?
(If 'Yes', the project must provide an alternative strategy for meeting MPS WR2.2)

Fresh Water Recharge Areas

6. Yes ☐ No ☐ Is project wastewater disposed of within 300 feet of a stream or fresh surface water body (Map WR4)?
(If 'No', then go to line 7.)

☐ ☐ Is the project located hydraulically upgradient of a stream or fresh surface water body ?
(If 'Yes', the project must provide an alternative strategy for meeting MPS WR4.1)

Other Potential Impacts

7. Yes ☐ No ☐ Will the project withdraw more than 20,000 gallons of water per day ?
(If 'Yes', then the project must provide documentation demonstrating that there will not be significant impacts to water levels, surface waters and wetlands)

8. ***The project must demonstrate compliance with MPS WR1 and MPS WR7, including use of Low Impact Development to mitigate impacts of stormwater runoff and O & M plans for maintaining stormwater infrastructure and landscaping.***

APPENDIX B: ESTIMATION OF HIGH GROUND-WATER LEVELS

The Water Resources Technical Bulletin Appendix B - Estimation of High GW is available at
https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/regulatory/HighGroundH20TechBulletin.pdf

APPENDIX C: MONETARY NITROGEN OFFSET

For projects that will not connect to sewer, monetary nitrogen offsets may be allowed in certain circumstances. The appropriate Placetypes and methods for providing a monetary nitrogen offset are generally set forth in the 2018 Water Resource Technical Bulletin.

Nitrogen Management Policy

The 2018 RPP encourages growth in certain areas, such as Community Activity Centers, and discourages growth in other areas, such as in Natural Areas. For that reason, the per kilogram nitrogen monetary offset may be applied up to the maximum amount of $8,290; however, a lesser dollar amount per kilogram of nitrogen ($0 to less than $8,290) may be applied in areas where growth is encouraged.

The maximum dollar per kilogram amount of $8,290 for nitrogen offsets is based on Capital and 20-year O&M costs for nitrogen removal by conventional sewering as derived from the Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod, updated in 2014. The infrastructure and operational costs in the 2014 report have not been adjusted for inflation to present day costs. In this regard, the $8,290 per kilogram figure is a conservative estimate of actual costs in that todays costs will be higher.

Calculation of Monetary Nitrogen Offset

Calculated cost to remove nitrogen with a typical wastewater treatment facility:

Capital cost (assumed design flow of 1.5 mgd; 100 linear feet per parcel connected)

$181 million (present worth based on 2014 Cost Report numbers)

- Operations & Maintenance

$1.50 million per year (20-yr planning period)

- Total present worth based on 2014 Cost Report numbers (capital + O&M)

$206 million

- Load removed (20-yr planning period)

24,800 kg-N per year

- Cost efficiency

$8,290 / kg-N removed per year

EXAMPLE OFFSET

- 30-unit residential sub-division (mix of 2- and 3-bedroom)
- Actual flow: 125 gpd per unit; 3,760 gpd total
- Wastewater load to be offset: 136 kg-N/yr
- Calculation of monetary offset

$1.13 million = $206 million x 136 kg-N/yr / 24,800 kg-N/yr

= $8,290 / kg-N per year x 136 kg-N/yr