Appendix L.
Setting the Chesapeake Bay Atmospheric Nitrogen Deposition Allocations

Atmospheric Deposition Nitrogen Inputs Compared to Other Nitrogen Sources

Atmospheric deposition of nitrogen is the highest nitrogen input load in the Chesapeake watershed (Figure L-1). Other nutrient input loads are fertilizer, manures, point sources, and septic systems. Over the 1985 to 2005 Chesapeake Bay model simulation period, the Chesapeake watershed average atmospheric deposition loads of nitrogen have been declining, particularly those of oxidized nitrogen.

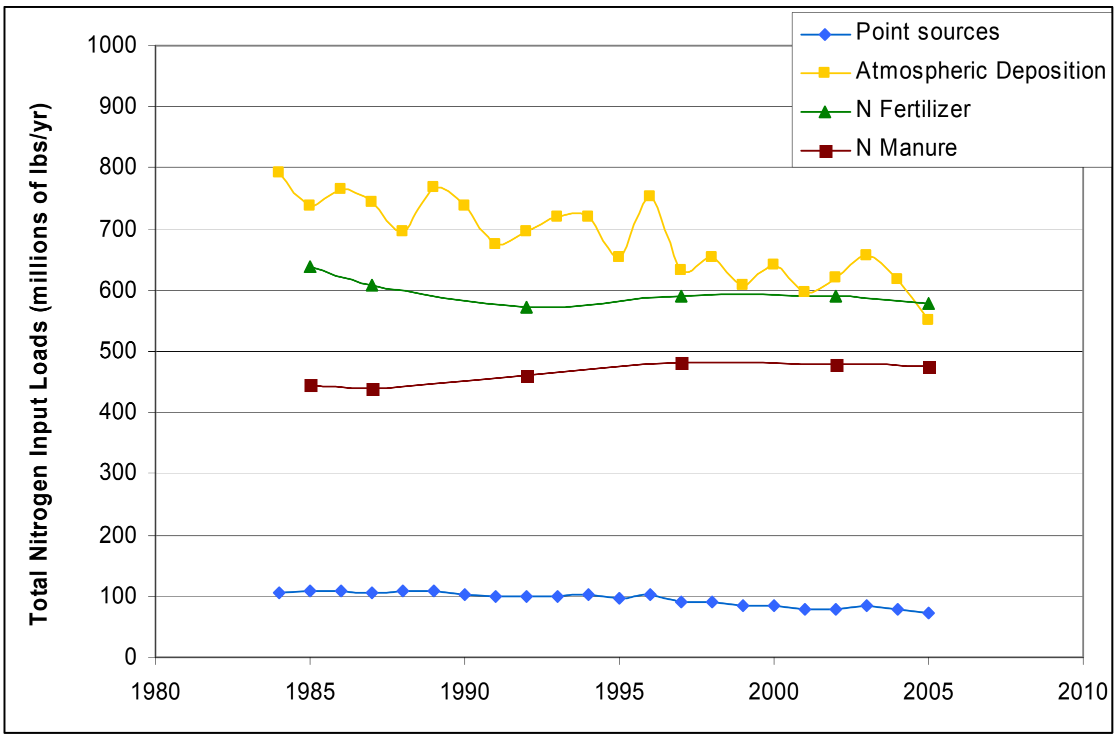


Figure L-1. 20-year (1985–2005) time series of atmospheric, fertilizer, manure, and wastewater treatment plant nitrogen input loads to the Chesapeake Bay Water Quality and Sediment Transport Model.

Atmospheric Deposition Inputs

Atmospheric loads of nitrogen are from chemical species of oxidized nitrogen, also called NOx, and from reduced forms of nitrogen deposition, also called ammonia (NH3). Oxidized forms of nitrogen deposition originate from conditions of high heat and pressure and are formed from eutrophically inert diatomic atmospheric nitrogen. The principle sources of NOx are air emissions from industrial-sized boilers such as electric power plants and internal combustion engines in cars, trucks, locomotives, airplanes, and the like.

Reduced nitrogen, or ammonia, is responsible for approximately one-third of the total nitrogen emissions that eventually end up as loads to the Bay. Ammonia sources are predominately agricultural, and ammonia is released into the air by volatilization of ammonia from manures and emissions from ammonia based fertilizers. Minor sources include mobile sources, slip ammonia released as a by-product of emission controls on NOx at power plants and industrial processes.

Two types of deposition are differentiated and both are tracked through the Chesapeake models and atmospheric deposition monitoring networks as input daily. The first is wet deposition, which occurs during precipitation events and contributes only to nitrogen loads during days of rain or snow. The other is dry deposition, which occurs continuously and is input at a constant rate daily into the Bay Watershed and Bay Water Quality models.

Because the Bay Watershed and Bay Water Quality models are mass balance models, all sources of nutrient inputs to the tidal Bay have to be accounted for including phosphorus and organic forms of nutrients. For phosphorus and organic nutrients, the models estimate loads to open water only, on the assumption that all phosphorus and organic nutrients are derived from aeolian or wind processes that result in no net change in organic nitrogen on terrestrial surfaces but result in a net gain when deposited on water surfaces.

Organic nitrogen is represented as wet fall only, i.e., dissolved organic nitrogen (DON). The magnitude of dry fall organic nitrogen is not well characterized in the literature, but the latest Community Multiscale Air Quality (CMAQ) model simulations with updated chemical mechanisms do include peroxyacyl nitrates (PAN, $CH_3COOONO_2$) and an organic nitrate group (NTR). The NTR represents several organic nitrates that are produced from ozone photochemistry. Both of these species are relatively small in magnitude and both are biologically labile. Therefore, the dryfall PAN and NTR are lumped into the oxidized nitrogen atmospheric deposition dryfall inputs. Table L-5 shows the estimated atmospheric deposition loads to the Bay's tidal surface waters of the different nutrient species.

Air sources contribute about a third of the total nitrogen loads delivered to the Chesapeake Bay by depositing directly onto the Bay's tidal surface waters and onto the surrounding Bay watershed. Direct nitrogen atmospheric deposition to the Bay's tidal surface waters is estimated to be 6 to 8 percent of the total (air and non-air) nitrogen load delivered to the Bay. The atmospheric nitrogen deposited onto the watershed and subsequently transported to the Bay is estimated to account for 25 to 28 percent of the total nitrogen loadings to the Bay.

Atmospheric Deposition Input Trends

Between 1985 and 2005, the simulation period of the Phase 5.3 Bay Watershed Model, atmospheric deposition loads of nitrate have tended to decrease overall in the Chesapeake Bay watershed. Over that 20-year period, nitrate loads have decreased by about 30 percent (Figure L-2); however, considerable variability exists across the Bay watershed, with the greatest reductions occurring in the northern and western portions. In Figure L-2, the average annual concentration is used as an adjustment to smooth out the high and low rainfall years, which bring different amounts of deposition load to the Bay watershed, primarily from the volume of precipitation. Use of the dissolved inorganic nitrogen (DIN), nitrate (NO_3), and ammonia (NH_3) concentrations provides a reasonable estimate of the trend in atmospheric deposition.

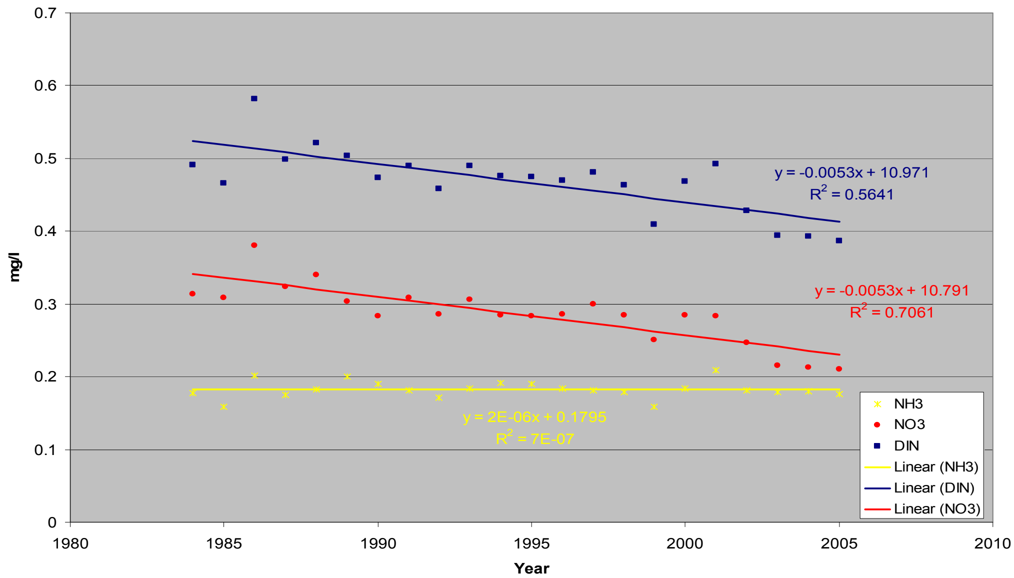


Figure L-2. Trend of estimated average NO_3, NH_3 and DIN deposition concentrations input to the Phase 5.3 Chesapeake Bay Watershed Model.

Much of the reduction has been due to point source air emission reductions, particularly from electric generating units (EGUs) as shown in Figure L-3. More rapid declines in air emissions are expected between 2008 to 2010 as the Clean Air Transport Rule (previously the Clean Air Interstate Rule [CAIR]) controls on power plant emissions and the air quality standards for ozone and particulate matter come into enforcement deadlines by 2010 (Figure L-3). Further reductions are expected with the reduced ozone air quality standard announced in August 2010. Reductions from mobile sources are another large contributor to the downward trend. Reductions from mobile sources will continue past the year 2020 as large off-road diesel and marine diesel fleets are replaced.

Table L-1 shows the estimated portion of deposited NO_x loads on the Chesapeake Bay watershed from four sectors including EGUs, mobile sources, industry, and all other sources. From 1990 to 2010, considerable reductions have been made in the electrical generation sector. In addition, both on road and off-road mobile sources have ongoing fleet turnover and replacement, which is putting cleaner spark and diesel engines in service; that is expected to continue beyond 2020. Note that some NOx sources like mobile sources seem to increase in percentage relative to other sources like EGUs. Both sources are actually decreasing and the total projected deposition load in 2020 is less than 1990, however, EGU emission reductions are relatively more than mobile reductions.

Average ammonia atmospheric deposition loads over the Chesapeake Bay watershed have followed the trend in overall manure loads in the watershed and have remained steady over the 1985 to 2005 simulation period (Figure L-2). Ammonia deposition is very site specific and strongly influenced by local emissions. Local and regional trends in manure, such as the rise of poultry animal units in the Eastern Shore and Shenandoah, and dairy's diminishment in the northern portions of the watershed in the late 1980s, affect regional ammonia deposition in the Bay watershed.

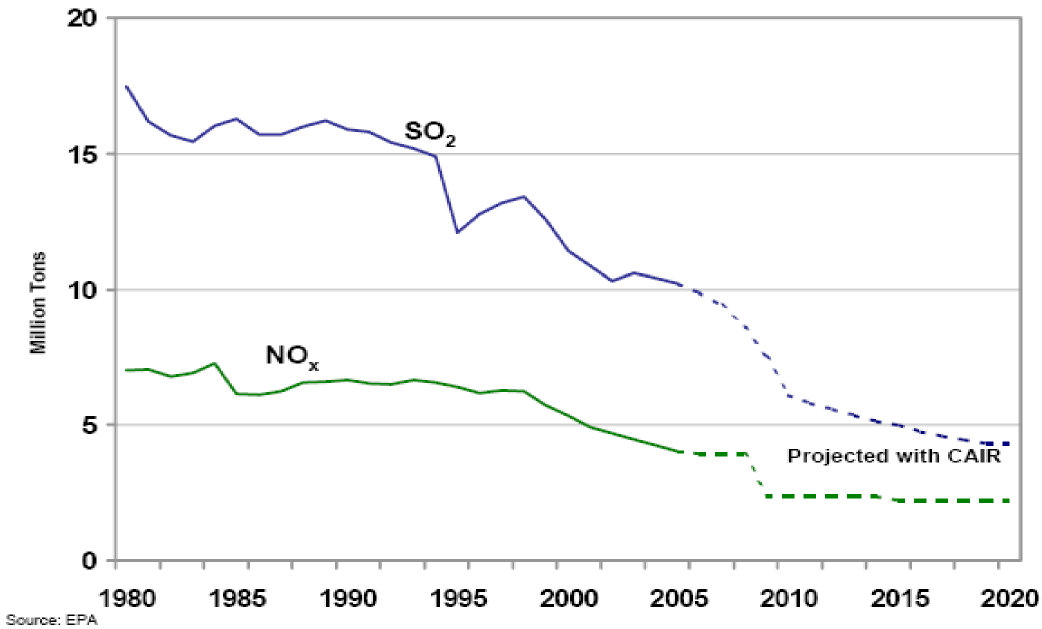


Figure L-3. Estimated nationwide emissions of NOx and SO_2 from EGUs since 1980 and estimated emissions to 2020.

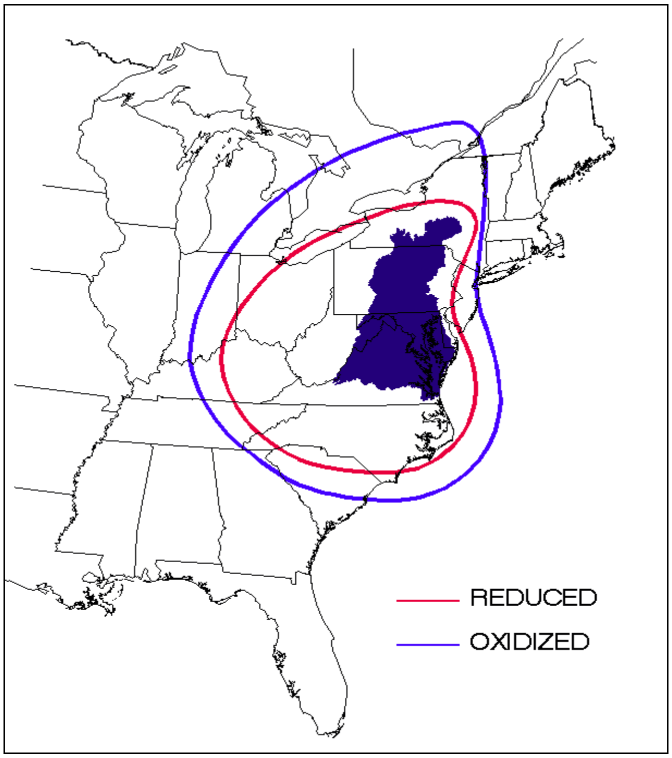
Table L-1. Estimated portion of atmospherically deposited NOx loads on the Chesapeake watershed from four sectors including EGUs, mobile sources, industry, and all other sources in 1990 and projected out to 2020

Sectors	1990	2020 (Preliminary)
Power Plants (EGUs)	40%	17%
Mobile Sources (on-road)	30%	32%
Industry	8%	20%
Other (off-road construction; residential & commercial)	21%	31%

The Bay's NOx airshed—the area where emission sources that contribute the most airborne nitrates to the Bay originate—is about 570,000 square miles, or seven times the size of the Bay's watershed. The ammonia airshed is slightly smaller (Figure L-4). Close to 50 percent of the NOx deposition to the Bay is from air emission sources located in the seven Bay watershed jurisdictions. Another 25 percent of the atmospheric deposition load to the Chesapeake Bay watershed is from the remaining area in the airshed and the remaining 25 percent of deposition is from the area outside the airshed. The ammonia airshed is similar to the NOx airshed, but slightly smaller (Figure L-4).

CBP Airshed Model

The Chesapeake Bay Airshed Model is a combination of a regression model of wet deposition (Grimm and Lynch 2005) and a continental-scale air quality model of North America called the CMAQ for estimates of dry deposition (Dennis et al. 2007; Hameedi et al. 2007). The Bay Airshed Model is represented in Figure L-5.



Source: Chesapeake Bay Program Office

Figure L-4. The oxidized nitrogen airshed (blue line) is the principle area of NO_X emissions that contribute nitrogen deposition to the Chesapeake Bay and its watershed. The reduced nitrogen airshed (red line) of ammonia deposition is slightly smaller.

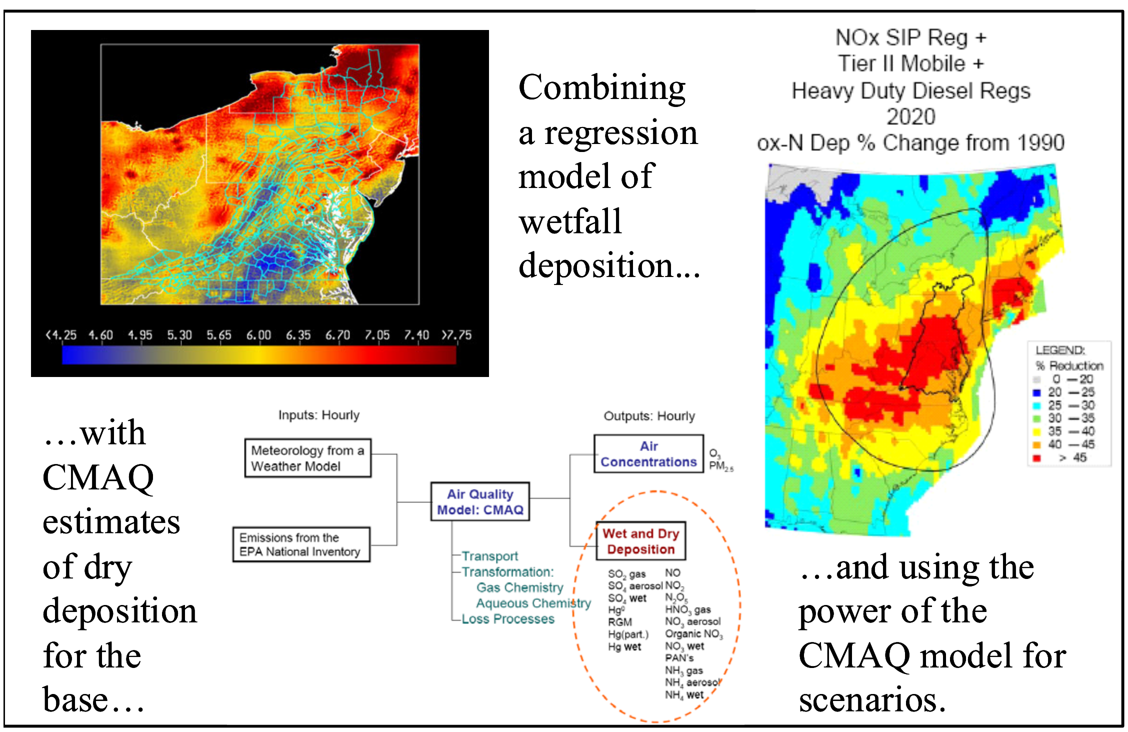


Figure L-5. The Chesapeake Bay Airshed Model is a combination of a regression model of wet deposition and the Community Multi-scale Air Quality Model of dry deposition.

The regression and deterministic airshed models that provide atmospheric deposition input estimates, have gone through a series of refinements with increasingly sophisticated models of both applied over time (Linker et al. 2000; Grimm and Lynch 2000, 2005; Lynch and Grimm 2003). The amount and timing of the wet atmospheric deposition input in the Phase 5.3 Bay Watershed Model is hourly, and is related to the timing and amount of hourly rainfall in the Phase 5.3 Bay Watershed Model precipitation input data. The dry deposition estimates are monthly constants that are input daily and are based on the CMAQ model (Dennis et al. 2007; Hameedi et al. 2007).

Wet Deposition Regression Model

Wet deposition is simulated using a regression model developed by Grimm and Lynch (2000, 2005; Lynch and Grimm 2003). The regression model provides hourly wet deposition loads to each land segment on the basis of each land segment's rainfall. The regression model uses 29 National Atmospheric Deposition Program (NADP) monitoring stations and 6 AIRMoN stations to form a regression of wetfall deposition in the entire Chesapeake Bay watershed over the entire simulation period (Figure L-6).

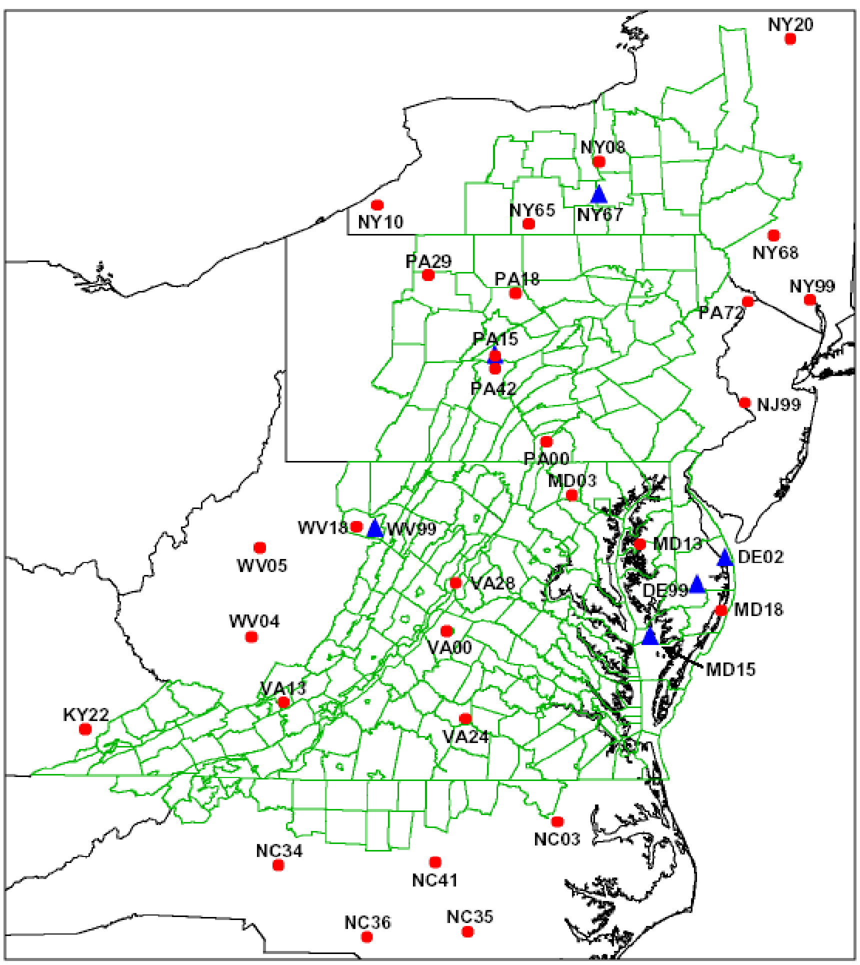


Figure L-6. Atmospheric deposition monitoring stations used in developing the wet deposition regression model.

To improve the accuracy of the regression estimates over previous regression analyses (Linker et al. 2000) a number of improvements in the sampling and representation of spatial and temporal patterns of land use activities and intensities and of emission levels were made. Also, detailed meteorological data were assimilated into the regression model to identify contributing emission source areas and to estimate the impact of the contributions on daily deposition rates on a per-event basis.

This version of the regression model included nine additional NADP/NTN sites in the regression estimates (DE99, MD07, MD08, MD15, MD99, PA47, VA10, VA27, VA98, and VA99) that were placed in operation in and around the Chesapeake Bay watershed since 2001, providing a comprehensive representation of agricultural influences.

Refinements also involved developing a more accurate and comprehensive representation of the spatial and temporal distribution and intensity of livestock production and other agricultural activities across the Bay watershed. An improved accounting of livestock production activities was achieved by combining county- and watershed unit-specific livestock production statistics with high-resolution (30 meters) land use data from the USGS's National Land Cover Database (NLCD). Estimates of local ammonia emissions from fertilizers and manure applications to croplands were also assimilated into the model using EPA inventories and high resolution NLCD to identify likely cropland areas. Last, localized estimates for NH_3 and NO_x emissions for the Phase 5 Chesapeake Bay Watershed Model domain and surrounding states were developed by combining facility and county-specific emissions reports from the EPA's National Emissions Inventory (NEI) database with the NLCD classifications.

For each day of rain, wetfall atmospheric deposition is estimated by the regression that has the general form

$$Log10(c) = b_o + b_1 log10(ppt) + \sum b_{2s} season + b_3 v_3 + \ldots + b_n v_n + e$$

where

c = daily wet-fall ionic concentration (mg/L)
b_o = intercept
ppt = daily precipitation volume (inches)
b_1 = coefficient for precipitation term
season = vector of 5 binary indicator variables encoding the 6 bi-monthly seasons
b_{2s} = vector of 5 coefficients for season terms
$v_3 \ldots V_n$ = additional predictors selected through stepwise regression

- National Land Cover Data (NLCD)
  - Within proximities of 0.8, 1.6, 3.2, 8.0, and 16.1 km of each NADP/NTN site: open water, forested, residential, industrial/transportation, croplands, and vegetated wetlands
- Local emission levels of ammonia and nitrous oxides from EPA National Emission Trends (NET)
  - County emission totals 1985-2005
  - County containing each NADP/NTN monitoring site and for the nearest three counties

$b_3 \ldots b_n$ = coefficients corresponding to $v_3 \ldots V_n$

The daily precipitation nitrate and ammonium concentration models were developed using a linear least-squares regression approach and single-event precipitation chemistry data from the 29 NADP/NTN sites and six AIRMoN stations in Figure L-6. The most significant variables in both models included precipitation volume, the number of days since the last event, seasonality, latitude, and the proportion of land within 8 km covered by forests or devoted to transportation and industry. (Local and regional ammonia and nitrogen oxides emissions were not as well correlated as land cover.) The abilities of these variables to predict wet deposition arise primarily from their relationship to either (1) the spatial and temporal distribution of emissions of ammonium and nitrate precursors from sources within or upwind of the Bay watershed; or (2) the chronology and characteristics of precipitation events. Modeled concentrations compared very well with event chemistry data collected at six NADP/AIRMoN sites within the Chesapeake Bay watershed. Wet deposition estimates were also consistent with observed deposition at selected sites.

Volume, duration, and frequency of precipitation events have obvious roles in determining wet deposition rates. However, these parameters alone do not completely describe all of the characteristics of a precipitation event. In particular the intersection of a precipitation event and a volume of air with a particular history is also important in determining wet deposition flux, so the interactions between storm trajectories and emission sources were also incorporated into the wet deposition regression model.

Using metrological data from the National Center for Environmental Prediction's North American Regional Reanalysis (NARR), components were added to daily ammonium and nitrate wet deposition models that predict the rate at which emissions from area and point sources are emitted, dispersed, and transported to specific deposition locations. Surface and upper-level vertical and horizontal air movement data from the NARR allowed estimates of the extent to which emissions were transported and mixed into surface and upper-level atmospheric layers; and, thereby, enabled construction more realistic multilevel air mass trajectories with which to predict the movement of emissions from multiple source locations to deposition points of interest.

Dry Deposition - Community Multi-scale Air Quality Model (CMAQ)

The CMAQ Model is a fully developed air simulation of North American (Dennis et al. 2007; Hameedi et al. 2007). The CMAQ model simulates atmospheric deposition to the Chesapeake Bay watershed (indirect deposition) and tidal Bay (direct deposition) for every hour of every day for the representative year. A variety of input files are needed that contain information pertaining to the modeling domain which is all North America. Those include hourly emissions estimates and meteorological data in every grid cell and a set of pollutant concentrations to initialize the model and to specify concentrations along the modeling domain boundaries. The initial and boundary concentrations were obtained from output of a global chemistry model.

The CMAQ model simulation period is for one year, 2002, because 2002 is characterized as an average precipitation year and, therefore, an average deposition year. The 2002 CMAQ simulation year was used to provide the monthly dry deposition estimate for all years of the 1985 to 2005 Phase 5.3 Bay Watershed Model simulation. Phase 5.3 Bay Watershed Model dry deposition input estimates are derived from the CMAQ model as monthly average inputs expressed as a daily load.

An adjustment for the 20-year trend in atmospheric deposition loads was applied by using the trend developed in the wet deposition regression model, and assuming the dry deposition trend to be the same as the wet in the separate nitrate and ammonia estimates. Figure L-7 shows the 12-km grid used to provide better resolution of the Phase 5 Chesapeake Bay Watershed Model's atmospheric deposition loads. The improved spatial resolution of direct atmospheric deposition of loads to tidal surface waters and the atmospheric deposition of loads to the watershed adjacent to tidal waters from metropolitan and mobile sources was an important improvement (STAC 2007).

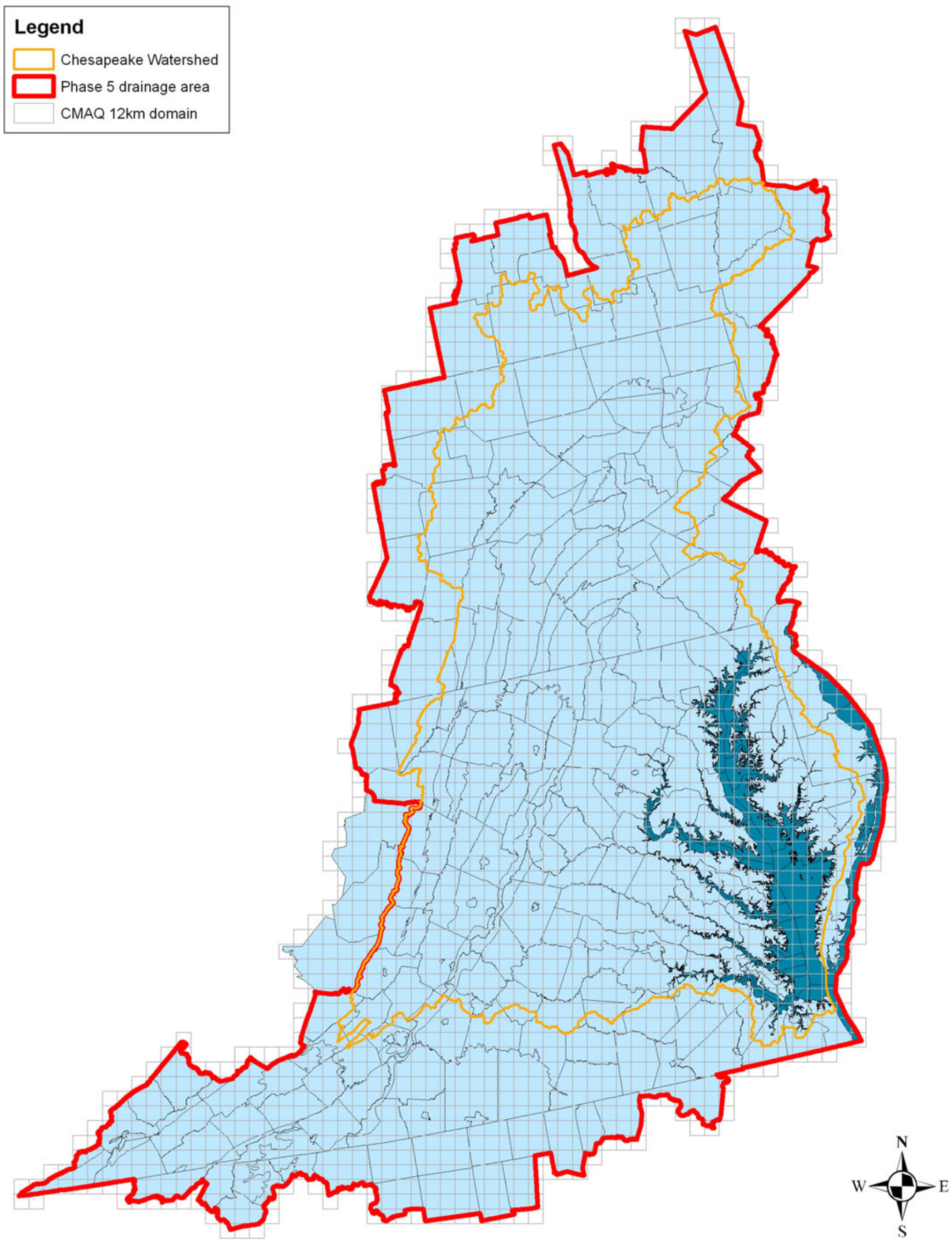


Figure L-7. The CMAQ model's 12-km grid over the Phase 5 Chesapeake Bay Watershed Model domain.

Organic Nitrogen Deposition

The Phase 5.3 Bay Watershed Model accounts for estimated loads of atmospheric organic nitrogen to the open water land use on the assumption that all organic nitrogen is derived from aeolian or wind processes that result in no net change in organic nitrogen on terrestrial surfaces but do result in a net gain when deposited on water surfaces. Organic nitrogen is represented as wet fall only, i.e., DON. The magnitude of dry fall organic nitrogen is unknown.

Dryfall Organic Nitrogen Deposition

The dryfall organic nitrogen is likely to be sorbed onto large and small particles or even to be particles themselves, like pollen. Such dryfall organic carbon species can be involved in long-range transport, such as the pollens and organic nitrates found on the dust coming over from Africa, but EPA does not have a good estimate of the fraction of the dry deposition that these particles compose.

Also, the latest CMAQ simulations with updated chemical mechanisms include peroxyacyl nitrates **(**PAN, $CH_3COOONO_2$) and an NTR. The NTR represents several organic nitrates that are produced from ozone photochemistry. Both of these species are relatively small in magnitude, and both are biologically labile. Therefore, the dryfall PAN and NTR are lumped into the oxidized nitrogen atmospheric deposition dryfall inputs.

Wetfall Organic Nitrogen Deposition

In the 1992 Phase 2 version of the Chesapeake Bay Watershed Model, organic nitrogen was assumed to be about 670 micrograms per liter (µg/L) (as nitrogen) based on data summarized by Smullen et al. (1982). The data showed considerable seasonal variability. The organic nitrogen load was constant in all watershed model segments. An equivalent annual load was used in the tributary model with application of the seasonal variability suggested by Smullen et al. (1982).

Organic nitrogen measurements from Bermuda are calculated at about 100 µg/L (as nitrogen) (Knap et al. 1986). Moper and Zita (1987) reported an average DON concentration from the western Atlantic and Gulf of Mexico of about 100 µg/L (as nitrogen). That is consistent with the reported range from the North Sea and northeast Atlantic of between 90 µg/L to 120 µg/L (Scudlark and Church 1993). Scudlark et al. (1996) reported an annual volume-weighted average DON concentration in the mid-Atlantic coastal areas to be about 130 µg/L (as nitrogen). Measurements in this study are consistent with the interannual variation (maximum in spring) reported by Smullen et al. (1982).

A later study identified methodological problems with some of the previous studies and suggests the wet deposition of organic nitrogen in the Chesapeake watershed would be closer to 50 µg/L on an annual average basis (Keene et al. 2002). This study also documented the highest concentrations of organic nitrogen in the spring.

On the basis of Keene et al. (2002), a value of 50 µg/L (as nitrogen) was selected as representative of an average annual wet deposition concentration to the watershed and tidal waters with the seasonal loading pattern suggested by Smullen (1982) and Scudlark et al. (1996). That applies an average concentration of 40 µg/L from July to March in rainfall and an average concentration of 80 µg/L from April to June. The load of organic nitrogen would depend on the precipitation in a particular land segment, but assuming 40 inches of precipitation, the load would be on the order of 0.4 lb/ac-yr.

Total Atmospheric Deposition Inputs of Nitrogen from Wet and Dry Deposition

The annual rate of total atmospheric deposition to Phase 5 land segments is shown in Figure L-8 and Table L-2.

Table L-2. Annual average atmospheric deposition of reduced DIN, oxidized DIN and total DIN on land segments in the entire Phase 5.3 Chesapeake Bay watershed model

Land Segment	NH4	NO3	Total DIN
A10001	2.50	3.21	**5.71**
A10003	1.68	2.87	**4.55**
A10005	5.62	4.55	**10.16**
A11001	0.24	0.44	**0.68**
A24001	0.41	1.37	**1.78**
A24003	1.02	2.99	**4.01**
A24005	2.02	4.42	**6.44**
A24009	0.40	1.29	**1.69**
A24011	1.60	1.64	**3.25**
C51071	0.17	0.53	**0.69**
C51165	0.45	0.28	**0.72**
Total	**264.07**	**556.59**	**820.66**

Organic and Inorganic Phosphorus Deposition

The Phase 5.3 Bay Watershed Model accounts for estimated loads of atmospheric organic and inorganic phosphorus to the open water land use on the assumption that, like organic nitrogen, the load is derived from aeolian or wind processes that result in no net change in organic nitrogen on terrestrial surfaces but do result in a net gain when deposited on water surfaces. Following Smullen (1982), annual loads of organic and inorganic phosphorus are set at 47 µg/L and 16 µg/L, respectively. Seasonally, those loads are treated in the same way as organic nitrogen, assuming that organic phosphorus will follow a pattern similar to organic nitrogen and that an aeolian source of inorganic phosphorus might well increase during the bare ground of spring agricultural practices. Accordingly, organic and inorganic phosphorus concentrations are set at 74 µg/L and 25 µg/L, respectively, from April to June, and at half those concentrations for the other nine months of the year.

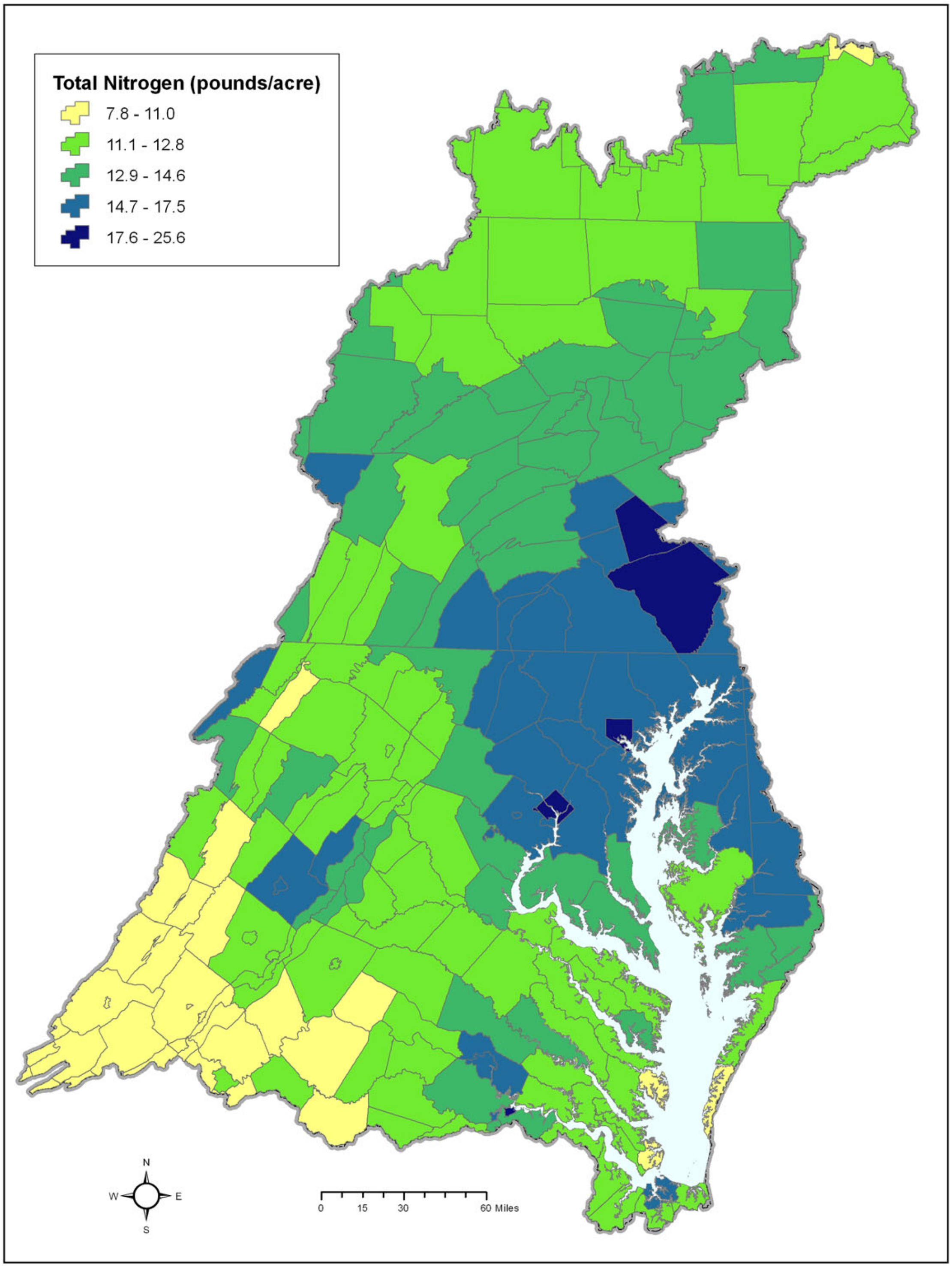


Figure L-8. Annual average DIN atmospheric deposition on land segments in the entire Phase 5.3 Chesapeake Bay Watershed Model domain.

CMAQ Airshed Scenarios

The CMAQ model also provides estimates of nitrogen deposition resulting from changes in emissions from utility, mobile, and industrial sources due to management actions or growth. For the CMAQ model the base deposition year is 2002 and scenarios include the management actions required by the Clean Air Act in 2010, 2020, and 2030. The future year scenarios reflect emissions reductions from national control programs for both stationary and mobile sources, including the CAIR, the Tier-2 Vehicle Rule, the Nonroad Engine Rule, the Heavy-Duty Diesel Engine Rule, and the Locomotive/Marine Engine Rule. Although CAIR has been remanded to EPA, it will remain in place pending a rulemaking to replace it. It is unclear how the replacement rule will compare to the remanded rule. However, EPA anticipates that NOx emissions reductions close to those originally projected will occur.

To develop a Bay watershed model scenario using one of the CMAQ model air scenarios below, a monthly factor is determined by the CMAQ model by comparing the CMAQ model's atmospheric deposition loads in the scenario year to the CMAQ 2002 base year. The CMAQ scenario factor is then used to adjust the base atmospheric deposition conditions in the Phase 5.3 Bay Watershed Model over the 1991 to 2000 scenario years.

CMAQ 2010 Scenario

The 2010 Scenario represents emission reductions from regulations implemented through the Clean Air Act authority to meet National Ambient Air Quality standards for criteria pollutants in 2010. This includes National, Regional and available State Implementation Plans (SIPs) for NOx reductions. Other components of the 2010 Scenario include Tier 1 vehicle emission standards reaching high penetration in the vehicle fleet for on-road light duty mobile sources along with Tier 2 vehicle emission standards that were fully phased in by the 2006 model year and will begin to show an impact in 2010. For EGUs the 2010 controls assume that the NOx SIP call, NOx Budget Trading Program, and the CAIR program that regulates the ozone season NOx are all in place and that the CAIR program is designed for annual NOx reductions to match the ozone season reductions under the 2010 CAIR first phase conditions.

CMAQ 2020 Scenario

The 2020 Scenario has all components of the 2010 Scenario and includes the Clean Air Mercury Rule (CAMR), the Best Available Retrofit Technology (BART) used for reducing regional haze and the off-road diesel and heavy-duty diesel regulations. The 2020 scenario represents emission reductions from regulations implemented through the Clean Air Act authority to meet National Ambient Air Quality standards for criteria pollutants in 2020. Those include:

- On-Road mobile sources: For on-road light duty mobile sources, this includes Tier 2 vehicle emissions standards and the Gasoline Sulfur Program that affects SUVs pickups, and vans, which are now subject to same national emission standards as cars.
- On-Road Heavy Duty Diesel Rule – Tier 4: New emission standards on diesel engines starting with the 2010 model year for NOx, plus some diesel engine retrofits.

- Clean Air Non-Road Diesel Rule: Off-road diesel engine vehicle rule, commercial marine diesels, and locomotive diesels (phased in by 2014) require controls on new engines. Off-road large spark ignition engine rules affect recreational vehicles (marine and land-based).
- EGUs: CAIR second phase in place (in coordination with earlier NOx SIP call); Regional Haze Rule and guidelines for BART for reducing regional haze; CAMR all in place.
- Non-EGUs: Solid Waste Rules (Hospital/Medical Waste Incinerator Regulations).

CMAQ 2020 Maximum Feasible Scenario

The 2020 Maximum Feasible scenario includes additional aggressive EGU, industry, and mobile source controls. Emissions projections were developed that represented incremental improvements and control options (beyond 2020 CAIR) that might be available to states to meet a more stringent ozone standard. The more stringent standard is due to a reconsideration of the national ambient air quality standards for ozone that were promulgated in 2008 along with a review of the secondary national ambient air quality standards for oxides of nitrogen and sulfur. The new ozone standard was proposed in 2010 of between 0.070 ppm and 0.060 ppm. EPA now expects that the ozone standards will be final by the end of July 2011. The 2020 Maximum Feasible Scenario was designed to meet a 0.070 ppm ozone standard, which is less than the 0.075 ppm ozone standard in place since 2008.

Incremental control measures for five sectors were developed:

- EGUs: lower ozone season nested emission caps in OTC states; targeting use of maximum controls for coal fired power plants in or near non-attainment areas.
- Non-EGU point sources: new supplemental controls, such as low NOx burners, plus increased control measure efficiencies on planned controls and step up of controls to maximum efficiency measures, e.g., replacing SNCRs (Selective Non-Catalytic Reduction) with SCRs (Selective Catalytic Reduction) control technology.
- Area (nonpoint area) sources: switching to natural gas and low sulfur fuel.
- On-Road mobile sources: increased penetration of diesel retrofits and continuous. Inspection and maintenance using remote onboard diagnostic systems.
- Non-Road mobile sources: increased penetration of diesel retrofits and engine rebuilds.
- Reduced NOx emissions from marine vessels in coastal shipping lanes.

The 2020 Maximum Feasible Scenario also includes a reduction of ammonia deposition of 15 percent from estimated ammonia emission programs in the Bay watershed jurisdictions. Estimates of up to about 30 percent ammonia emission reductions from manures can be achieved through rapid incorporation of manures in to soils at the time of application, biofilters on poultry houses, and other management practices (Mark Dubin 2009, personal communication). From a state and sector analysis of NOx emissions and deposition, an estimated 50 percent of emissions from Bay states becomes deposition to the Chesapeake Bay watershed, along with a further 50 percent of the ammonia deposition load coming from outside the Bay watershed. Assuming that only 50 percent of the emissions are from watershed sources, a 30 percent reduction of emissions results in an estimated 15 percent decrease in wet and dry ammonia deposition for the Maximum

Feasible Scenario from ammonia emission control management practices in the Bay watershed jurisdictions.

CMAQ 2030 Scenario

The 2030 scenario is in some areas a further decrease in emissions beyond the 2020 Maximum Feasible Scenario due to continuing fleet replacement of heavy diesels, off road diesels, and mobile sources of all types. These emission decreases are offset by continued growth in the Chesapeake Bay region. The emissions projections assume continued stringent controls are in place, such as:

- Tier 2 vehicle emissions standards fully penetrated in the fleet.
- Heavy Duty Diesel vehicle fleet fully replaced with newer heavy-duty vehicle that comply with new standards.
- On-Road mobile sources: Increased penetration of diesel retrofits maintained.
- Non-Road mobile sources capped at 2020 Maximum Feasible Scenario levels.
- EGUs and Non-EGUs emissions capped at 2020 Maximum Feasible Scenario levels.
- Area sources emissions capped at 2020 Maximum Feasible Scenario levels, assuming energy efficiency and control efficiencies keep up with growth.
- Marine Vessels: Further reductions in NOx emissions from marine vessels in coastal shipping lanes.

Atmospheric Deposition Loads to the Watershed and Tidal Bay

Nitrogen loads atmospherically deposited to the Chesapeake Bay watershed by jurisdiction and by nitrogen species of wet and dry deposition for key scenarios are tabulated in Table L-3. Table L-4 lists the loads delivered to the Bay from the key scenarios, in millions of pounds, using the Phase 5.2-August 2009 version of the Chesapeake Bay Watershed Model.

All the scenarios in Table L-4 use the 2002 scenario as a base year. The point sources, human and animal populations, septic system loads and so on, are the same 2002 levels in all these scenarios. Only the atmospheric deposition changes. The 1985 CMAQ scenario uses the trend of atmospheric deposition described in Figure L-2, and the same trend was used for the 2002 atmospheric deposition in the 2002 scenario. The scenarios of 2010, 2020, 2020 Maximum Feasible, and 2030 used estimated atmospheric deposition loads from the CMAQ model.

Atmospheric Deposition of Nitrogen to the Tidal Chesapeake Bay

The regression and CMAQ models provide estimates of direct atmospheric deposition to the Bay's tidal surface waters. Table L-5 lists the estimates of direct atmospheric deposition to the Bay's tidal surfaces for seven key scenarios.

Two key factors in the relative increase in the estimated reduced nitrogen deposition over time are the downward pressure on oxidized nitrogen emissions and the lack of controls on ammonia emissions. It is notable that changes in atmospheric chemistry of SO_X and NO_X in the seven key

Table L-3. Atmospheric deposition loads of nitrogen (millions of pounds as nitrogen) to the Chesapeake watershed for key scenarios by jurisdiction

	STATE							Chesapeake
Total Nitrogen	**DE**	**DC**	**MD**	**NY**	**PA**	**WV**	**VA**	**Watershed**
1985 Scenario	7.8	0.8	97.4	53.7	221.7	30.6	179.8	591.8
1985-2000 Calibration	7.1	0.7	84.0	46.0	192.2	26.2	159.3	515.4
2002 Scenario	6.5	0.6	73.0	39.5	167.3	22.5	142.3	451.6
2010 Scenario	6.3	0.5	59.6	30.6	133.3	17.2	112.8	360.2
2020 Scenario	6.6	0.4	54.6	26.2	117.6	15.3	99.9	320.6
2020 Maximum Feasible	6.5	0.4	51.9	24.8	111.2	14.5	95.0	304.3
2030 Scenario	7.4	0.4	56.9	26.1	121.4	15.4	100.0	327.6
Dry NOx Deposition								
1985 Scenario	3.1	0.5	51.0	23.1	102.1	15.7	97.5	293.0
1985-2000 Calibration	2.6	0.4	42.2	19.2	84.9	13.1	83.2	245.4
2002 Scenario	2.2	0.3	35.2	16.2	71.3	10.9	71.8	207.8
2010 Scenario	1.6	0.2	23.1	10.8	46.2	6.7	46.7	135.4
2020 Scenario	1.3	0.1	16.6	7.9	32.5	4.8	33.3	96.5
2020 Maximum Feasible	1.1	0.1	14.3	6.9	28.2	4.2	29.6	84.5
2030 Scenario	1.0	0.1	13.7	6.7	27.0	4.1	28.9	81.6
Dry NH_3 Deposition								
1985 Scenario	2.1	0.1	12.2	5.0	25.3	2.9	18.2	65.8
1985-2000 Calibration	2.2	0.1	12.1	4.7	25.3	2.8	18.5	65.7
2002 Scenario	2.3	0.1	12.1	4.5	25.4	2.8	18.7	65.7
2010 Scenario	3.0	0.1	15.8	5.3	32.0	3.7	24.8	84.7
2020 Scenario	3.7	0.1	18.7	5.6	36.5	4.4	29.2	98.3
2020 Maximum Feasible	3.9	0.1	19.4	5.8	37.2	4.5	29.8	100.7
2030 Scenario	4.8	0.1	23.9	6.6	45.5	5.2	34.0	120.3
Wet NOx Deposition								
1985 Scenario	1.6	0.1	22.2	17.0	63.4	8.1	42.0	154.4
1985-2000 Calibration	1.3	0.1	17.9	13.9	51.7	6.6	35.4	126.9
2002 Scenario	1.1	0.1	14.1	11.0	40.9	5.2	29.4	101.8
2010 Scenario	0.7	0.1	9.4	7.3	26.7	3.4	19.6	67.2
2020 Scenario	0.6	0.0	7.2	5.3	19.3	2.5	14.7	49.6
2020 Maximum Feasible	0.5	0.0	6.4	4.7	16.9	2.2	13.3	44.1
2030 Scenario	0.5	0.0	6.2	4.6	16.7	2.2	13.0	43.3
Wet NH_3 Deposition								
1985 Scenario	0.9	0.1	12.0	8.7	30.9	3.9	22.0	78.6
1985-2000 Calibration	1.0	0.1	11.8	8.2	30.3	3.7	22.3	77.4
2002 Scenario	1.0	0.1	11.7	7.8	29.7	3.6	22.5	76.4
2010 Scenario	1.0	0.1	11.3	7.3	28.3	3.5	21.7	73.0
2020 Scenario	1.0	0.1	12.0	7.4	29.2	3.6	22.7	76.1
2020 Maximum Feasible	1.0	0.1	11.8	7.4	28.9	3.6	22.4	75.1
2030 Scenario	1.1	0.1	13.0	8.1	32.2	3.9	24.1	82.4

Source: Phase 5.2-August 2009 Version of the Chesapeake Bay Watershed Model
Note: This table does not include the 15 percent decrease in wet and dry ammonia deposition for the Maximum Feasible scenario due to ammonia emission.

scenarios also affect ammonia dry deposition. In the scenarios with decreased SO_X and NO_X emissions, the dry deposition of ammonia increases, even though the total nitrogen deposition is decreasing. The interplay of how decreased SO_X and NO_X emissions affect an increase of NH_3 dry deposition is seen in Figure L-9.

Table L-4. Total nitrogen delivered to the Bay (millions pounds per year) from the nine major river basins under different key CMAQ atmospheric deposition scenarios.

Basins	CMAQ Atmo. Deposition 1985 Scenario	CMAQ Atmo. Deposition 2002 Scenario	CMAQ Atmo. Deposition 2010 Scenario	CMAQ Atmo. Deposition 2020 Scenario	CMAQ Atmo. Deposition 2020 Maximum Feasible Scenario	CMAQ Atmo. Deposition 2030 Scenario
Susquehanna	160.4	148.1	141.4	138.7	137.6	139.3
West Shore	15.7	15.3	15.07	15.0	14.9	15.0
Potomac	77.0	72.2	69.4	68.3	67.9	68.6
Patuxent	4.8	4.5	4.4	4.3	4.3	4.3
Rappahannock	11.0	9.8	10.0	9.8	9.8	9.8
James	37.9	36.7	35.6	35.2	35.	35.1
York	9.3	8.9	8.6	8.4	8.4	8.4
East Shore MD-DE	31.6	29.8	29.2	29.2	29.1	29.7
East Shore VA	3.0	2.9	2.8	2.8	2.8	2.8
Total	350.7	328.1	316.5	311.7	309.7	313.0

Note: All the scenarios were applied to a 2002 Base condition of land use, BMPs, and point source discharges in order to show the relative effect of changing atmospheric deposition.

Table L-5. Direct atmospheric deposition loads of nitrogen (millions of pounds as nitrogen) to Chesapeake Bay's tidal surface waters for seven key scenarios

Scenario	Wet NOx Deposition	Dry NOx Deposition	Wet NH3 Deposition	Dry NH3 Deposition	Total Inorganic Nitrogen Deposition	Wet Organic Nitrogen Deposition	Total Nitrogen Deposition	Wet PO4 Deposition	Wet Organic Phosphorus Deposition	Total Phosphorus Deposition
1985 Scenario	6.57	13.15	3.34	1.97	25.03	1.05	26.08	0.33	0.98	1.31
2002 Scenario	4.81	10.04	3.57	2.12	20.54	1.05	21.59	0.33	0.98	1.31
2010 Scenario	3.27	6.85	3.49	2.76	16.37	1.05	17.42	0.33	0.98	1.31
2020 Scenario	2.56	5.11	3.72	3.24	14.63	1.05	15.68	0.33	0.98	1.31
2020 Maximum Feasible Scenario	2.30	4.48	3.64	3.41	13.83	1.05	14.88	0.33	0.98	1.31
2020 Max Feas w/ 15% NH4 Drop	2.30	4.48	3.09	2.90	12.77	1.05	13.82	0.33	0.98	1.31
2030 Scenario	2.22	4.30	3.96	4.08	14.56	1.05	15.61	0.33	0.98	1.31

Note: This table includes two entries for the Maximum Feasible Scenario. The 2020 Max Fes w/15% NH4 Drop scenario includes the 15% decrease in wet and dry ammonia deposition for the Maximum Feasible Scenario due to ammonia emission control management practices in the Bay watershed jurisdictions described in CMAQ 2020 Maximum Feasible Scenario; the 2020 Maximum Feasible Scenario does not.

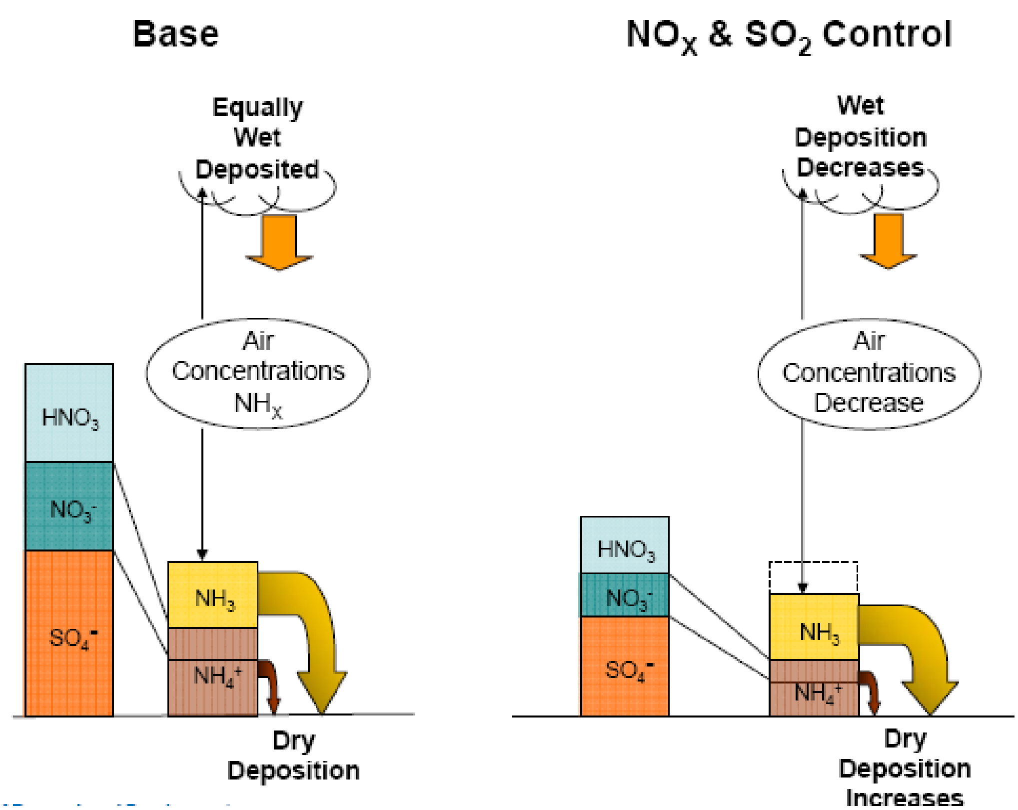


Figure L-9. Decreased SO_X and NO_X emissions cause increased NH_3 dry deposition.

How the percentage of ammonia, or reduced atmospheric deposition, to total nitrogen deposition is changing can be seen in Table L-5. For the 1985 Scenario, the percent ammonia deposition compared to the total DIN deposition was estimated to be 21 percent. For the 2010 and 2030 scenarios, the percentage of ammonia deposition to the tidal Chesapeake was estimated to increase to 38 percent for the 2010 scenario and 55 percent for the 2030 scenario. The respective estimated ammonia deposition on the watershed for these same three scenarios—1985, 2010, and 2030—are 24 percent, 44 percent, and 64 percent.

Atmospheric Deposition of Nitrogen to the Coastal Ocean

The CMAQ Model allows us to estimate atmospheric deposition loads to the coastal ocean at the mouth of the Chesapeake Bay, which contributes to the coastal ocean nutrient budgets made by others (Fennel et al. 2006; Howarth et al. 1995; Howarth 1998). The estimated distribution of 2001 atmospheric deposition loads to North America and adjacent coastal ocean is shown in Figure L-10. Howarth (1998) reported that atmospheric deposition loads are roughly equivalent to watershed loads in the northeast United States (Maine to Virginia). Howarth (1998) estimated that the watershed inputs of nitrogen to the northeast coastal waters to be 0.27 teragram. Inputs from direct atmospheric deposition to coastal waters are 0.21 teragram, and inputs from deep ocean upwelling are 1.54 teragrams, for a total input to the coastal ocean of 2.02 teragrams (Howarth 1998).

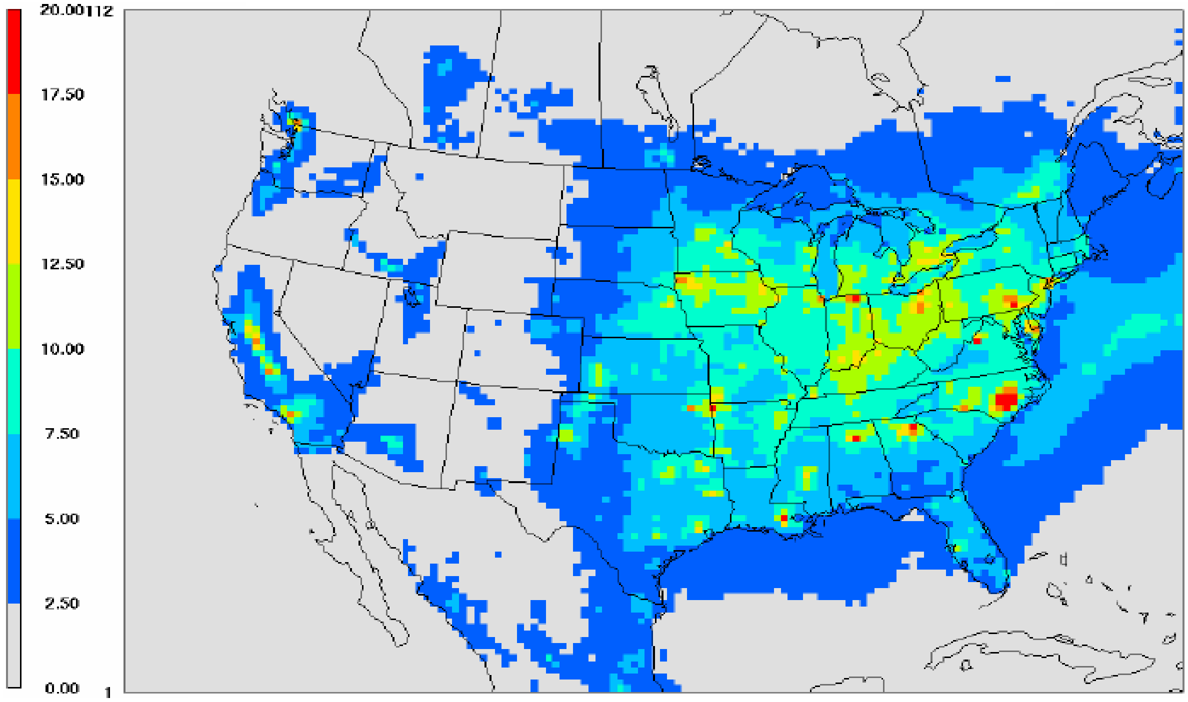


Figure L-10. Estimated 2001 annual total deposition of nitrogen (kg-N/ha) to North America and adjacent coastal ocean based on outputs from the CMAQ Air Quality Model, 36 km x 36 km grid.

That has implications for the fixed-ocean boundary condition used in the Chesapeake Bay Water Quality Sediment Transport Model. Atmospheric deposition total nitrogen loads to the coastal ocean are estimated to be about 6.63 kg/ha in the Base Case 2002 scenario (Table L-6). That correlates to 43.8 million kilograms of total nitrogen deposition to a region of the ocean that can exchange waters with the Chesapeake (Table L-6). In the case of the 2020 Maximum Feasible scenario, the nitrogen atmospheric deposition to the same region is estimated to be 29.4 million pounds, a reduction of 32 percent. If that same reduction is extrapolated to the coastal ocean, the direct atmospheric inputs to the coastal ocean would decrease to 0.14 teragram. Assuming the watershed loads discharged to the ocean and the deep upwelling pelagic loads are constant, that would give a combined watershed, direct deposition, and uncontrollable deep upwelling load of 1.95 teragrams, a decrease of 3 percent relative to the estimated current ocean boundary condition. Table L-6 lists the estimated reductions of the ocean boundary for the five key CMAQ scenarios.

Table L-6. Atmospheric deposition loads of nitrogen (kg per hectare) to the coastal water area shown in Figure L-11 for key scenarios

Scenario	Dry deposition	Wet deposition	Total deposition
Base 2002 Scenario	3.32	3.31	6.63
2010 Scenario	2.59	2.68	5.27
2020 Scenario	2.26	2.49	4.75
2020 Maximum Feasible	2.10	2.35	4.45
2030 Scenario	2.13	2.40	4.53

To determine CMAQ estimates of atmospheric deposition to the coastal ocean region affecting nitrogen loads through the ocean boundary EPA assigned boundaries as shown in Figure L-11 that correspond to the proximate region of the coastal ocean exchanging waters with the Chesapeake Bay. The boundary is adjacent to the shore, and is inside, or west, of the Gulf Stream. To account for the prevailing north to south current along the coast, the coastal ocean boundary includes more of the coastal waters north of the Chesapeake Bay mouth.

Estimated atmospheric deposition loads to the coastal waters are listed in Table L- 7 for key scenarios. The loads to the coastal ocean in kilograms per hectare for the CMAQ Base 2002 scenario are shown in Figure L-12. Table L-8 lists the relative reduction of atmospheric deposition of nitrogen in coastal waters versus the Base Calibration scenario.

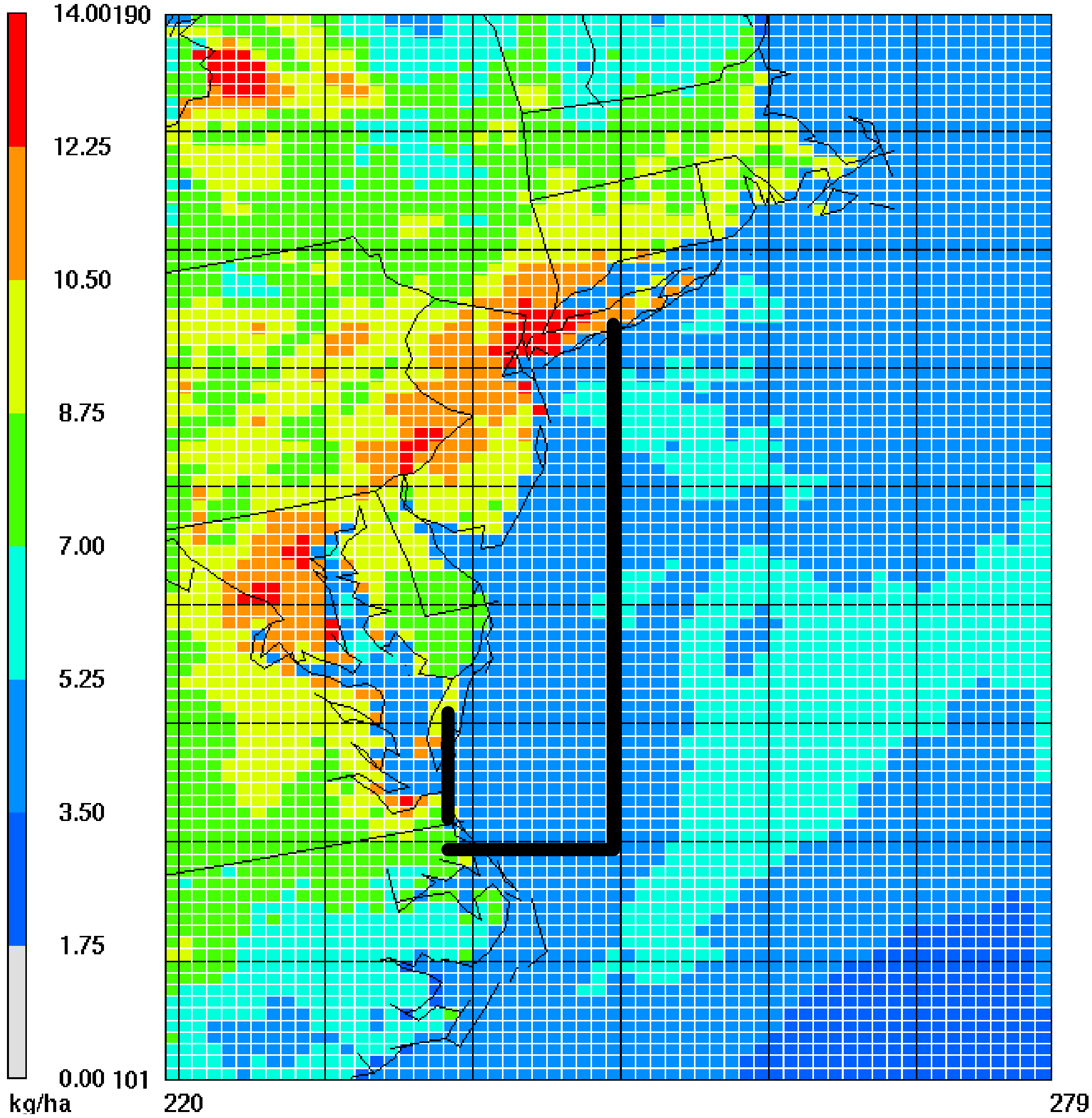


Figure L-11. Boundaries of the coastal ocean region used to adjust the ocean boundary conditions in the Chesapeake Bay WQSTM.

Table L-7. Total atmospheric deposition loads of nitrogen (millions of kg) to coastal waters for key scenarios

Scenario	Dry deposition	Wet deposition	Total deposition
Base 2002 Scenario	21.90	21.89	43.80
2010 Scenario	17.12	17.71	34.82
2020 Scenario	14.94	16.45	31.39
2020 Maximum Feasible	13.87	15.50	29.37
2030 Scenario	14.06	15.88	29.95

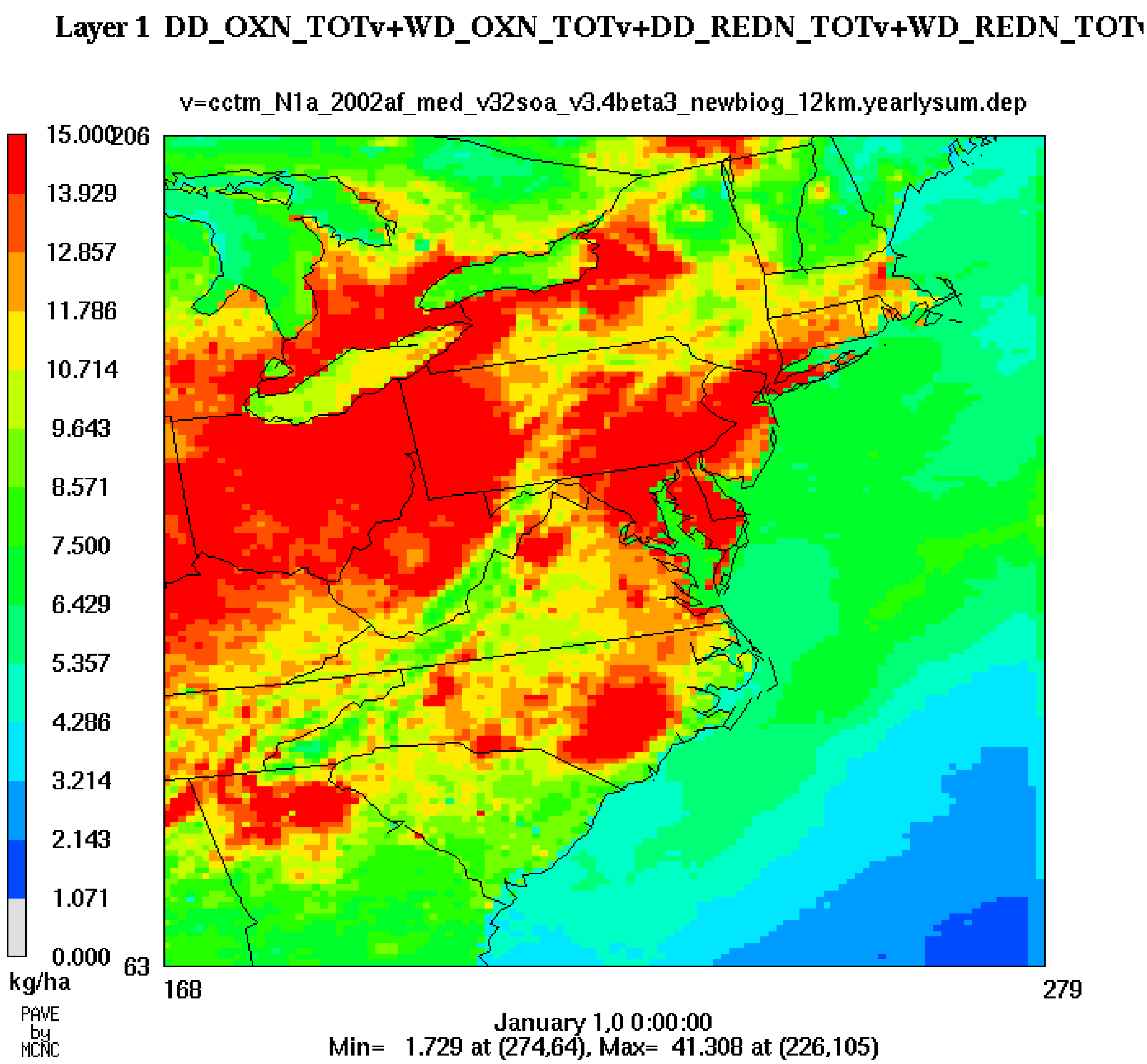


Figure L-12. Nitrogen atmospheric deposition loads (kg/ha) to the coastal ocean region for the Base 2002 scenario.

Table L-8. Adjustment of the ocean boundary load for all nitrogen species for key CMAQ Model scenarios' deposition to coastal waters adjacent to the Chesapeake Bay mouth

Scenario	% Reduction of ocean boundary
Base 2002 Scenario	0%
2010 Scenario	2.1%
2020 Scenario	2.9%
2020 Maximum Feasible	3.5%
2030 Scenario	3.3%

Adjustment of Ocean Boundary Concentrations in the WQSTM from Reductions in Atmospheric Deposition to Coastal Waters and Internal Bay Load Changes

Ocean boundary concentrations of the Bay Water Quality and Sediment Transport Model state-variables are set based on monthly observations at the Bay mouth water quality monitoring stations. The exchange of materials at the Bay mouth/ocean boundary follows the two layer flows of the estuary. Net outflow occurs predominantly at the upper and southern boundaries with the ebb tides, while net inflow occurs predominantly at the lower and northern boundaries. The ocean boundary values govern the inflowing flux of ocean nutrients and sediment to the Bay. Specifically, adjustments are made to the ocean boundary conditions to adjust for changes in loads in the Chesapeake and for changes in atmospheric deposition.

Adjustment of Nutrient Boundary Conditions Due to Load Reductions in the Chesapeake

Previous versions of the Bay Water Quality Model (8k grid version) found that a 90 percent reduction in nitrogen load from the watershed produced a 10 percent reduction in inflowing nitrogen concentration at the Bay mouth. Likewise, a 90 percent phosphorus load reduction produced a 5 percent reduction in inflowing phosphorus.

Accordingly, for each load reduction scenario, the percent reduction (or increase) of total nitrogen and total phosphorus loads in the entire Bay versus the Base Calibration scenario is calculated

TN reduction = 100 × (TN Base Calibration scenario – TN scenario) / TN Base Calibration scenario

TP reduction = 100 × (TP Base Calibration scenario – TP scenario) / TP Base Calibration scenario

EPA further calculates the following factors:

TN Factor = 1 – 0.1 × TN reduction/90

TP Factor = 1 – 0.05 × TP reduction/90

EPA then uses the TN factor and TP factor to multiply the Base Calibration ocean boundary concentrations of all the nitrogen and phosphorus nutrient species in each boundary cell, with the only exception of the cells in the southern boundary, because the southern Bay cells have predominantly outflows. No adjustments are made to ocean boundary sediment because it responds do different dynamics, and the source of the ocean input is primarily from courser particles entrained in the southbound long-shore current.

Adjustment of Nutrient Boundary Conditions from Atmospheric Deposition Load Reductions in the Coastal Shelf

If a load reduction scenario involves reducing nitrogen load from the atmosphere, a further adjustment in the boundary conditions is done. A reduction of nitrogen atmospheric deposition on the coastal ocean adjacent to the Chesapeake Bay causes reductions of nitrogen concentrations in the shelf waters and thereby, reduction to inputs of nitrogen to the Bay.

For example, with the 2020 Clean-Air scenario, the reduction of atmospheric deposition of nitrogen versus the Base Calibration scenario in the shelf waters is 0.029 (Table L-8). In that case, the ocean boundary TN factor is further reduced by the third term on the right-hand side of the following equation:

$$\text{TN Factor} = 1 - 0.1 \times \text{TN reduction}/90 - 0.029 \times 26/32$$

In the above formula, the 0.029 is multiplied with a ratio of 26 to 32. That is based on the average salinity at the boundary to be 26 ppt, and the average salinity of shelf waters to be 32 ppt. The ratio of 26 to 32 represents the ratio of the incoming ocean water over the sum of the incoming water and the freshwater going out the boundary (i.e., the mixing water at the boundary).

Allocation of Atmospheric Deposition of Nitrogen to Tidal Waters

In determining the allowable loading from air deposition, EPA separated the nitrogen deposition into two discreet parcels: (1) deposition occurring on the land and non-tidal waters which is subsequently transported to the Bay, also called indirect deposition; and (2) atmospheric deposition occurring directly onto the Bay's tidal surface waters also called direct deposition (Figure L-13).

The deposition on the land becomes part of the allocated load to the jurisdictions because the air deposition on the land becomes mixed with the nitrogen loadings from the land based sources and, therefore, becomes indistinguishable from land based sources. Furthermore, once the nitrogen is deposited on the land, it would be managed and controlled along with other sources of nitrogen that are present on that parcel of land. That is also called the referenced allocation as Clean Air Act mandates nationwide reductions, as estimated in the CMAQ 2020 scenario, are required to reduce the air deposition to the watershed and are assumed to be in place as the Bay watershed jurisdictions finalize and implement their Watershed Implementation Plans to reduce nitrogen loads further with land-based Best Management Practices (BMPs). In contrast, the nitrogen deposition directly to the Bay's tidal surface waters is a direct loading with no land-based management controls and, therefore, needs to be linked directly back to the air sources and air controls as EPA's allocation of atmospheric nitrogen deposition.

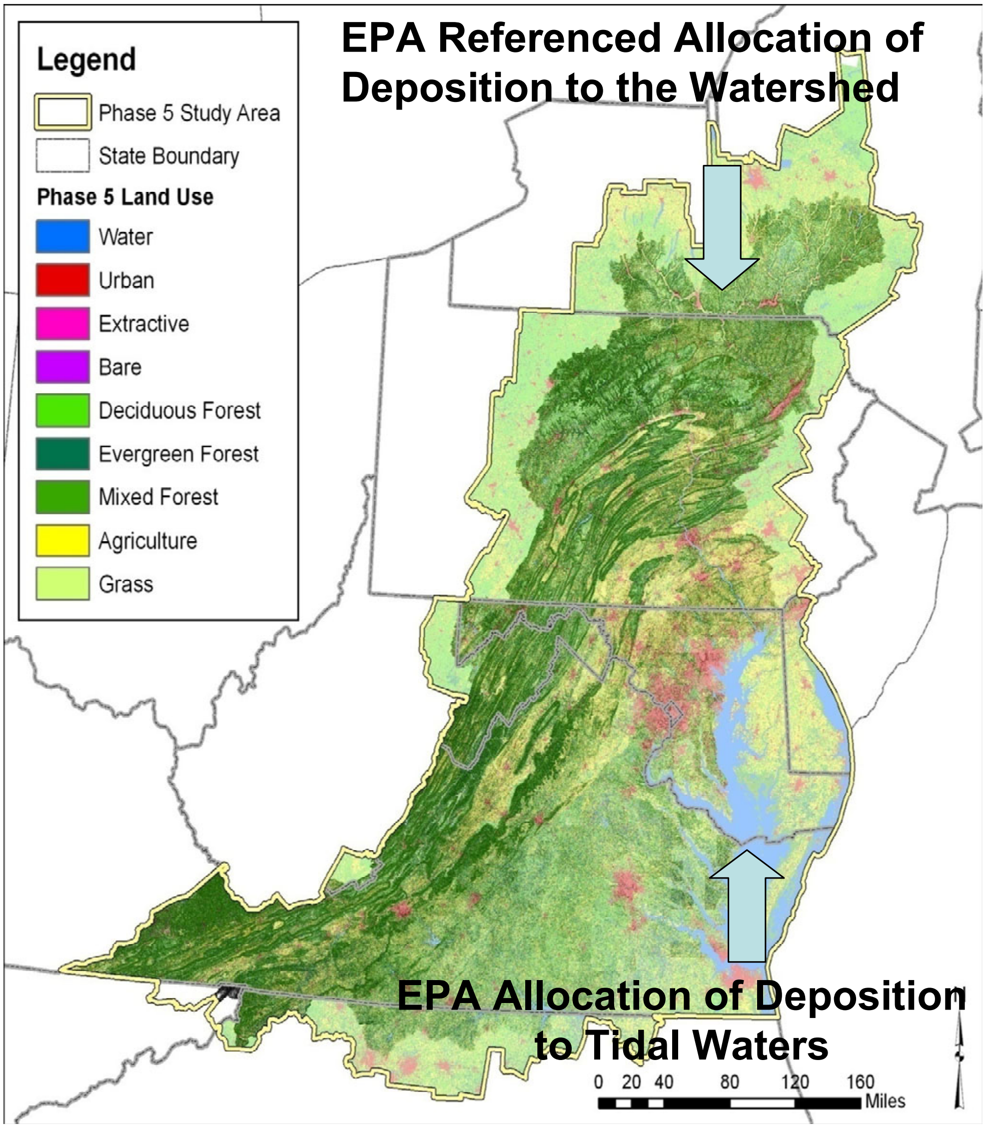


Figure L-13. EPA's reference allocation of nitrogen atmospheric deposition to the Bay watershed and the allocation of nitrogen atmospheric deposition direct to Bay's tidal surface waters.

EPA included an explicit basinwide nitrogen allocation, which was determined to be 15.7 million pounds of atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters. Activities associated with implementation of federal Clean Air Act regulations by EPA and the jurisdictions through 2020 will ensure achievement of this allocation. This nitrogen atmospheric deposition allocation is already accounted for within the jurisdiction and major river basin nitrogen allocations. Any additional nitrogen reductions realized through more stringent air pollution controls at the jurisdictional level, beyond federal requirements to meet air quality standards, may be credited to the individual jurisdictions through future revisions to the jurisdictions' Watershed Implementation Plans, 2-year milestones, and the Chesapeake Bay TMDL tracking and accounting framework.

In determining the amount of air controls to be used as a basis for the air allocation, EPA relied on current laws and regulations under the Clean Air Act. These requirements, together with national air modeling analysis, provided the resulting allocated load to air from direct deposition to the tidal waters of the Bay and its tidal tributaries.

The air allocation scenario represents emission reductions due to regulations implemented through the Clean Air Act authority to meet National Ambient Air Quality Standards for criteria pollutants in 2020. The air allocation scenario includes:

- The CAMR.
- The BART used for reducing regional haze, and the off-road diesel and heavy duty diesel regulations.
- On-Road mobile sources: For On-Road Light Duty Mobile Sources this includes Tier 2 vehicle emissions standards and the Gasoline Sulfur Program, which affects SUVs pickups, and vans, which are now subject to same national emission standards as cars.
- On-Road Heavy Duty Diesel Rule – Tier 4: New emission standards on diesel engines starting with the 2010 model year for NOx, plus some diesel engine retrofits.
- Clean Air Non-Road Diesel Rule: Off-road diesel engine vehicle rule, commercial marine diesels, and locomotive diesels (phased in by 2014) require controls on new engines.
- EGUs: CAIR second phase in place (in coordination with earlier NOx SIP call).
- Non-EGUs: Solid Waste Rules (Hospital and Medical Waste Incinerator Regulations).

The controls described above were modeled using the national air models (CMAQ) and the amount of deposition direct to the Chesapeake Bay's tidal surface waters was determined. On the basis of the air allocation scenario as described above, the nitrogen deposition direct to tidal surface waters is 15.7 million pounds per year. Therefore, the air allocation for the Chesapeake Bay TMDL is 15.7 million pounds per year of nitrogen.

EPA anticipates that the loading cap of 15.7 million pounds of atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters will be achieved through implementation of federal Clean Air Act regulations by EPA and the states through 2020. Projected reductions in atmospheric deposition loads to the surrounding watershed over this same period are already accounted for within the individual jurisdiction and major river basin nitrogen load allocations. Any additional nitrogen reductions realized through more stringent air pollution controls at the jurisdiction level, beyond minimum federal requirements, as for example in ammonia deposition reductions, may be credited to the individual jurisdictions through future revisions to the jurisdictions' Watershed Implementation Plans, 2-year milestones and the Bay TMDL tracking and accounting framework.

Crediting the States with Additional Air Controls

As mentioned above, it is possible, that individual or statewide air emission reductions, beyond those used to derive the air deposition allocation may be achieved by a state. In this case, for the purpose of evaluating the 2-year milestone progress, the state can be credited with the reductions that would result for its portion of the Chesapeake Bay watershed. EPA will use the following steps to determine, with the state, the amount of nitrogen credit to apply to air emission controls that go beyond the air allocation scenario described above.

1) Determine whether the emission source for which the state is seeking credit already assessed credit for reductions in the State's State Implementation Plan (SIP) for achieving the State's air quality standards)

All of the Chesapeake Bay Watershed states are in nonattainment of current air quality standards. When new air quality standards for ozone are complete in July 2011, the gap between current air quality conditions and air quality standard achievement is expected to grow. Since the Chesapeake Bay Program tracks the SIP management actions in an ongoing series of scenarios designed to track expanded SIP implementation in the watershed and credit these additional air reductions in the two-year milestones, the inclusion of air emissions reductions that are already captured in the SIP will double count the reduction. Examples of air reductions that are not in the SIPs are reductions in any ammonia emissions and reductions in NOx emissions that are not needed for air quality standard achievement.

2) Determine whether the emission reduction is a state-wide emission or point source

Currently only a state-wide source emission reduction can be applied in the Phase I Watershed Implementation Plans. As modeling capacity to handle air to water trading develops, the capability to handle the specificity of latitude and longitude of point source emissions that are being reduced will be applied in the Chesapeake models.

3) Determine if the emission controls will impact NOx and/or NH_3 emission

There are situations in some air management actions where, for example, a NOx point source emission is reduced, which in turn reduces the ammonia slip emissions (ammonia slip occurs with NOx control technologies). States might be provided additional credit if both are reduced.

4) Determine the annual average emission reduction

Estimates are needed of the emission reduction on an annual average basis, and whether the emission reduction occurs year round or is seasonal. Estimates of current emissions, which serve as a baseline for the reduction, are also needed.

It should be noted that the reduction in nitrogen loads to the Bay can be orders of magnitude less than the actual reduction in air emissions. Operationally, the emission reductions could be discounted by the following:

1. Discounting the mass of NO_2 measured in air programs to the "as N" units used in water programs and in the WIP
2. Discounting for what is deposited within the State from the emissions reduced based on a CMAQ State and sector analysis (also, the reduced deposition in other States will be calculated if operationally possible)
3. Discounting for estimated attenuation from the land
4. Discounting for estimated attenuation in the rivers.

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