TOTAL MAXIMUM DAILY LOADS
FOR
RIDENOUR LAKE, WEST VIRGINIA

Introduction

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. By following the TMDL process, states can establish water quality-based controls to reduce pollution from both point and nonpoint sources and to restore and maintain the quality of their water resources (USEPA, 1991).

The West Virginia Division of Environmental Protection (WVDEP) has determined that the use designation of Ridenour Lake for aquatic life has been impaired by nutrients, siltation, aluminum, and iron and the human health designation has been impaired by iron . The United States Environmental Protection Agency (USEPA) conducted this study to analyze the loadings to the lake and to establish TMDLs that will restore and maintain the quality of Ridenour Lake for the uses designated by West Virginia.

The report (including the attached technical report), also provides a description of the waterbody and associated pollution sources, provides a summary of water quality monitoring data, and describes the analytical approach used to develop the TMDL. This report specifically addresses each of the elements of a TMDL, including the following:

1. The TMDLs are designed to implement applicable water quality standards.
2. The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3. The TMDLs consider the impacts of background pollutant contributions.
4. The TMDLs consider critical environmental conditions.
5. The TMDLs consider seasonal environmental variations.
6. The TMDLs include a margin of safety.
7. The TMDLs has been subject to public participation.
8. There is reasonable assurance that the TMDLs can be met.

II. Background

The Ridenour Lake watershed is located within the Lower Kanawha River hydrologic cataloging unit (05050008), as shown in Figure 2.1. The land area of the watershed is approximately 613 hectares (1,560 acres) contained solely within Kanawha County. Runoff from the watershed flows into Ridenour Lake from Blakes Creek. Water discharged from the lake continues in Blakes Creek to Armour Creek and then to the Kanawha River, (Please note, historically Armour Creek was also known as tributary of Blake Creek or as part of Blake Creek, but for the purpose of this report should be known as Armour Creek). The primary purpose of the impoundment is for flood control (WVDNR, 1983). The lake is also used for recreational activities such as fishing and picnicking. Private boats and boat motors are prohibited on the lake. The lake's watershed is primarily rural, and the main land uses are forest and hay/pasture.

Ridenour Lake is a 10.9-hectare (27-acre the lake area reported here is slightly different from that from the land use map, 10.4 ha) impoundment located in the city of Nitro's Ridenour Park in Kanawha County, West Virginia, 1 mile east of Nitro and 16 miles west of Charleston, West Virginia (WVDNR, 1983). The impoundment structure for Ridenour Lake is owned by the city of Nitro and was completed in 1970. The lake was filled in 1971 and opened for fishing in 1972.

WVDEP listed Ridenour Lake on the 1998 303(d) list for not meeting its designated uses. The waterbody is given a high priority for TMDL development. The lake (designated code WV_K(L)-30-A-(1)) was listed for nutrients, siltation, iron, and aluminum (WVDEP, 1998). The impairments, from the West Virginia Primary Waterbody List, are presented in Table 2.1.

The water quality uses that are impaired are aquatic life (impaired by nutrients, siltation, aluminum, and iron) and human health (impaired by iron). The primary source column provides the "general source descriptions, if confirmed" (WVDEP, 1998). WVDEP assumed that the lake impairments are due to a variety of sources including domestic sewage, construction activity, agriculture, and urban runoff.

West Virginia classifies a waterbody as impaired for the listed pollutants based on the following considerations:

- Nutrients: West Virginia typically uses a trophic state index when considering lakes for listing due to nutrient impairment. Lakes with a total phosphorus or chlorophyll *a* trophic state index greater than or equal to 65 or with summer algal blooms or excessive vegetation were considered to be impacted by nutrients (WVDEP, 1998).

- Siltation: West Virginia considers lakes to be impaired by siltation if sediments are visually observed to accumulate to a depth approaching the lake normal pool elevation.

- Metals: Observed data violate specific aluminum and iron criteria at a frequency greater than 10%.

The development of TMDLs for Lake Ridenour includes a review of the potential causes of impairment and the establishment of the TMDL loading capacity, load allocation, wasteload allocation, and margin of safety.

To evaluate the relationship between the sources, their loading characteristics, and the resulting conditions in the lake, a combination of analytical tools were used. Assessments of the nonpoint source loading into the lake were developed for Turkey Run Lake watershed using the Generalized Watershed Loading Function (GWLF) computer program. GWLF provided estimates of nutrients and sediments transported to the lake for individual land use categories. The lake was evaluated using the BATHTUB water quality simulation computer model to estimate the concentrations of nutrients and chlorophyll *a*. The lake was segmented into four cells to represent characteristics of the system. The results of the watershed and reservoir models were compared with observed water quality data, literature values, previous studies, and reservoir conditions to evaluate the models' performance.

TMDLs are composed of the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. A representative hydrologic simulation year was used for testing and development of the TMDL by averaging the hydrology from daily rainfall records for the period from 1978 to 1997. The resulting allocation for the four listed pollutants includes a 7 percent reduction of nutrients (expressed as total phosphorus) and a 35 percent reduction of sediment load. The aluminum and iron loads are believed to occur from their natural presence in clay sediments. The aluminum and iron TMDLs are set consistent with the sediment loading for the sediment TMDL.

The loads are described as average annual load reductions, which is typically appropriate for reservoirs and impoundments. The margin of safety has been addressed through a series of conservative assumptions in the development of the TMDL analysis. The load reductions can be achieved through a combination of land use and restoration practices such as erosion and sediment control practices, forest management, and stream restoration.

III. Discussion of Regulatory Conditions

EPA developed these TMDLs consistent with statutory and regulatory requirements and EPA policy and guidance. The Ridenour Lake TMDLs address the following eight regulatory requirements.

1. The TMDLs are designed to implement applicable water quality standards.

These TMDLs ensure that Ridenour Lake will meet applicable water quality criteria for nutrients and sediment, thus ensuring that the water supports its designated use. West Virginia has only narrative criteria related to nutrients, sediment, aluminum, and iron..

The state water quality standards include water use categories, antidegradation criteria, numeric criteria, and narrative descriptions of conditions in waters of the state.

The relevant water use categories for Ridenour Lake include the following:

> Propagation and Maintenance of Fish and Other Aquatic Life (Category B-1)
> Water Contact Recreation (Category C)
> Drinking Water and consumption of fish (Class A)

No special exceptions or use designations are identified for Ridenour Lake.

1.1 Nutrients

No numeric criteria are available in the West Virginia water quality standards relevant to the 303(d) listing of this waterbody for nutrient impairment. The relevant narrative description of condition includes the following:

> §46-1.3 Conditions Not Allowable in State Waters.
> 3.2 No sewage, industrial wastes or other wastes present in any of the water of the State shall cause therein or materially contribute to any of the following conditions thereof:
> a. Distinctly visible floating or settleable solids, suspended solids, scum, foam or oily slicks;
> b. Deposits or sludge banks on the bottom;
> ...
> i. Any other condition ... which adversely alters the integrity of the waters of the State including wetlands; no significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems shall be allowed. (Title 46, Series 1, Requirements Governing Water Quality Standards, 1999)

WVDEP identifies lakes as impaired due to nutrients on the state's 303(d) list

> "...if summer total phosphorus or chlorophyll *a* levels in surface waters resulted in a trophic state index value of $ 65 (highly eutrophic) or summer algal blooms or excessive aquatic vegetation were noted." (WVDEP, 1998).

The concept of trophic states was developed by Einar Naumann to characterize the condition of lakes (Naumann 1919). The principle behind trophic states is that physical and chemical factors control the production of algae which in turn affects the biological structure of the lake. The amount of algal production plays an important role in lake conditions such as color, visible light penetration, dissolved oxygen concentrations, and odor. Common trophic state classifications include oligotrophic (low production, low nitrogen and phosphorus, oxygenated hypolimnion), mesotrophic (moderate production, moderate nitrogen and phosphorus), and eutrophic (high production, high nitrogen and phosphorus, anoxic hypolimnion).

The Carlson Trophic State Index (TSI) (Carlson 1977) was developed to estimate the algal production and determine trophic state based upon chlorophyll pigments, secchi depth, and total phosphorus. The TSI is a logarithmic scale that ranges from approximately 0 to 100. The three index variables chlorophyll pigments (CHL), Secchi depth (SD), and total phosphorus (TP) use regression equations to estimate the index value and algal production. These three index variables are interrelated and should produce the same index value for a given combination of variables values. The regression equations used to calculate the TSI are shown in equations 1.1 to 1.3.

$$TSI(SD) = 60 - 14.41 \ln (SD) \quad (1.1)$$
$$TSI(CHL) = 9.81 \ln (CHL) + 30.6 \quad (1.2)$$
$$TSI (TP) = 14.42 \ln (TP) + 4.15 \quad (1.3)$$

The trophic state can be related to the trophic state index and lakes conditions as shown in Table 1.

Table 1 Trophic state, trophic state index and lakes conditions

TSI	**Trophic State**	**Attributes**	**Aquatic Life**
< 30	Oligotrophic	Clear water, low production, oxygenated hypolimnion.	Trout possible in deep lakes.
30-50	Mesotrophic	Moderately clear water, possible anoxia in summer.	Warm Water Fishery
50-70	Eutrophic	Low transparency, anoxic hypolimnion in summer.	Warm Water Fishery
>70	Hypereutrophic	Dense algae and macrophytes, noticeable odor, fish kills possible.	

Review of the available water quality monitoring information from 1993 to 1996 and 1998 indicates the likely source of impairment is periodic nuisance algal blooms. Based on monitoring (15 samples), observed chlorophyll *a*, an indicator of algae, is periodically elevated during the growing season, ranging from <1 ug/l to 57.3 ug/l, with a mean of 15.3 ug/l (Table 5.1 of the attached report). The observed trophic state indices are 60.6 for total phosphorus and 57.3 for chlorophyll *a*. Neither exceed the listing threshold of 65.

In the absence of a relevant numeric criterion, a numeric endpoint is selected consistent with the use description and the narrative condition. Based on the evaluation of the lake monitoring and modeling analysis and evaluation of the nitrogen-phosphorus ratio (see section 5.2 of the attached report), phosphorus was determined to be the limiting nutrient for the reservoir. The trophic state index and the mean chlorophyll *a* concentration were considered as potential endpoints. The trophic state index threshold of 65 is currently not exceeded in Ridenour Lake. Chlorophyll *a* concentration is a measure of algal productivity and is directly correlated to the trophic state of the reservoir. A chlorophyll *a* threshold ranging from 15 to 33 ug/l was considered acceptable based on review of trophic state ranges (Carlson and Simpson, 1996). Since Ridenour Lake is well below the trophic state index limit, the lower end (15 ug/l) of the chlorophyll *a* threshold was selected. The selection of the limit for Ridenour Lake is consistent with the reservoir characteristics and the use designation.

1.2 Sediment

Ridenour Lake is listed as impaired due to siltation on the 303(d) list. Siltation is the excessive accumulation of sediment in the reservoir. The accumulation of sediment can impair the water uses of Fish and Other Aquatic Life and Recreation. The excessive accumulation of sediment can adversely affect aquatic life by creating thick mud deposits, filling habitat, and increasing turbidity. The excessive accumulation of sediment impairs recreational use by reducing access and degrading the aesthetic character of the lake.

The state has no numeric criteria related to the impairment of siltation in lakes. The relevant narrative description of conditions specifies the following:

> §46-1-3.3.2 No sewage, industrial wastes or other wastes present in any of the water of the State shall cause therein or materially contribute to any of the following conditions thereof:
> ...
> c. Deposits or sludge banks on the bottom.
> ...
> i. Any other condition ... which adversely alters the integrity of the waters of the State including wetlands; no significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems shall be allowed. (Title 46, Series 1, Requirements Governing Water Quality Standards)

In the absence of numeric criteria for lake siltation in West Virginia, a numeric limit is selected for the development of Ridenour Lake siltation TMDL. This numeric limit is selected to be protective of the lake uses and serves as a target for identifying achievement of water quality standards associated with the lake listing. The selection of this numeric limit was based on several considerations:

- The selected endpoint, expressed as a long-term sedimentation rate for Ridenour Lake, is consistent with the causes of the Lake Ridenour listing. Excessive siltation is reported by the state as the main cause of the lake impairment.

- The long-term annual siltation rate should not be excessive and should allow for a reasonable life span of the lake before deposits become evident at normal pool elevations or create barrier to recreational uses. For small impoundments such as Ridenour Lake, and in the absence of the design specifications of the lake, a minimum 40-year life span is selected as a target and is used in derivation of siltation rate limit for this TMDL.

- Siltation does not occur uniformly over the entire lake bottom. Selected locations within the lake experience high siltation rates compared to other locations within the lake. The selected locations are the areas most likely to create barrier for recreational uses. Specifically for Ridenour Lake, characterized by a small area (10.9 hectares) and a shallow depth (2.4 meters mean depth), the high siltation locations are assumed to correspond to 26,000 cubic meters (less than 10% of the lake volume).

Based on the above considerations regarding the life span of the impoundment and the siltation volume (or critical volume), a long-term average annual siltation rate limit of 0.25 cm was calculated and established as the numeric criteria for this siltation TMDL.

1.3 Metals

Ridenour Lake is on the 303(d) list as impaired due to elevated iron and aluminum. The West Virginia water quality standards establish numeric criteria for chronic and acute levels of metals. The currently applicable numeric criteria for waters designated as category B-1 are presented in Table 2.

Table 2. Numeric criteria for metals

Averaging Period	Iron - measured as total (mg/l)	Aluminum - measured as total (ug/l)
Acute	--	750
Chronic	1.5	__[a]

[a] These criteria may change as a result of EPA's review of the 1998 West Virginia Water Quality Standards Triennial Review. These TMDLs may need to be reviewed following these water quality standards revision to determine if water quality standards can still be met.

Review of the water quality data and discussion with WVDEP led to the conclusion that the soils in the Ridenour Lake watershed are naturally rich in metals. The increased metals concentration in the lake and tributary are related to the inputs of sediment and associated metals. The following information was reviewed:

- Existing water quality monitoring information
- Inventory of potential sources of aluminum and iron and watersheds
- Regional geology and soil aluminum and iron content

The review revealed that concentration was not significantly elevated in the lake or tributary when compared with other undeveloped watersheds.

The inventory of potential sources failed to identify any activities, current or historical, that are likely sources of elevated metals. No existing or past records of mining activities were identified. However, evaluation of USGS report *Isopleth Maps of Titanium, Aluminum, and Associated Elements in Stream Sediments of West Virginia* indicates that elevated metals concentrations occur in stream sediments in the Lower Kanawha River cataloging unit (USGS, 1994). These enriched sediments occur naturally in areas with aluminous host rocks. Analysis of the sediment-associated aluminum distribution in the vicinity of Ridenour Lake watershed show significantly higher concentrations than the median values.

For naturally occurring pollutants, WV Water Quality Standards provide in §46-1-7.7.2, which states

> c. Exceptions: Numeric water quality standards shall not apply: ...
>
> D. Where lesser quality is due to natural conditions. In such cases the naturally occurring values shall be the applicable criteria.

Based on the above exception for naturally occurring pollutants, EPA established the TMDL for aluminum and iron using the managed sediment loading condition (defined under the sediment TMDL) as the relevant criteria.

2. The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.

A) Wasteload Allocation

No point sources were identified within the drainage area of the listed water after review of several databases from WVDEP and EPA . Therefore the wasteload allocation is set to zero.

B) Load Allocation

2.1 Nutrients

Nonpoint sources of pollutants within the watershed can generally be associated with the different types of land uses and land activities within the watershed. For example, sediment loadings can originate from silvicultural activities and road construction. Expansion of residential and commercial/industrial areas can also cause an increase in storm water flows and sediment loads through soil erosion and sediment transport. In addition, the erosion rate can potentially increase phosphorus loads since phosphorus is readily adsorbed onto soil particles. For nutrient enrichment, animal waste handling, manure and fertilizer application, and septic systems are the key potential sources.
The primary land uses within Ridenour Lake watershed is forest with minor components of agriculture and urban/industrial/commercial land uses.

Nutrient loading capacity was evaluated based on simulated chlorophyll *a* and estimates of the Trophic State Index (TSI) for phosphorus and chlorophyll *a*. Several loading reduction scenarios were simulated and summarized in Table 3.

Table3 describes the derivation of the required load reduction for nutrients and presents the selected level of control that meets the TMDL endpoint of 15 ug/l chlorophyll *a*.

Table 3 Analysis of loading reduction scenarios for Ridenour Lake

Scenario	**TP**	**TSI(TP)**	**Chlorophyll *a***	**TSI(CHL)**
Observed value	50	60.6	15.3	57.3
Baseline	59	59.0	15.7	57.6
5% nutrient reduction	56	62.2	15.2	57.3
10% nutrient reduction	53	61.4	14.6	56.9
15% nutrient reduction	50	60.6	14.0	56.5
20% nutrient reduction	47	59.7	13.4	56.0

A 7% reduction in nutrient loading meets the targeted endpoint of 15 ug/l chlorophyll *a* and also is significantly below a TSI of 65.

The 1999 bathymetry data was used to setup the lake model under existing conditions. The designated use of the lake was specified using the as-built volumetric conditions. The original bathymetric data was not available to determine the as-built conditions of the lake. The allocation scenarios were simulated using the 1980 bathymetry data to approximate the as-built conditions.

Based on the evaluation of the lake monitoring and modeling analysis and evaluation of the nitrogen-phosphorus ratio (see section 5.2 of the attached report), phosphorus is determined to be the limiting nutrient for the reservoir. Table 4 summarizes the existing loading, the loading capacity, the projected load reductions, and the load allocation for the nutrient TMDL.

Table 4. Ridenour Lake nutrient TMDL (in kilograms per year)

Source	Existing Loading Total Phosphorus (kg)	Estimated Percent Reduction	Load Allocation (kg)	Comments
Forest	124.9	13.5	108.0	
Agriculture	10.3	12	9.0	
Urban	3.6	0	3.6	
Construction	2.9	25	2.2	
Groundwater	38.6	0	38.6	
Septic Systems	2.6	80	0.5	
Total Existing Load	**182.9**	**3 Load Allocation**	**161.9**	
Loading Reduction	**12.5 (7%)**	**Waste Load Allocation**	**0.0**	**No point sources**
		Margin of Safety	**8.5**	**5% of Loading Capacity**[a]
TMDL = Loading Capacity = 170.4				

2.2 Sediment

The sediment allocation was based on the long-term average siltation rate as an endpoint and a numeric limit of 0.25 cm per year. Table 5 provides the computed mean siltation rate of the lake for three different conditions: (1) existing condition; (2) predevelopment condition (assuming the watershed is totally forested); and (3) a loading scenario that meet the numeric limit of 0.25 cm per year as the long-term average siltation rate. The table also compares the life span of the lake under these 3 conditions.

Table 6 summarizes the sediment load allocation scheme corresponding to an overall reduction of 35% and extending the useful life of the lake from 26 to 40 years.

Table 5. Siltation Analysis of Ridenour Lake

	Existing Conditions	Predevelopment Conditions	Loading Scenario
Mean annual load (kg)	385,887	161,673	250,820
Siltation rate (cm)	0.38	0.16	0.25
Fill time (years)[a]	26	62	40
Loading scenario for 40 year time span corresponds to a 35% load reduction (see Table 8.4)			

[a]Based on a siltation volume of 26,000 m^3

Table 6. Ridenour Lake sediment TMDL (in metric tons per year)

Source	Existing Loading Sediment (metric tons)	Percent Reduction	Load Allocation (metric tons)	Comments
Forest	358.5	38.2%	221.6	
Agriculture	18.2	10%	16.4	
Construction	7.0	50%	3.5	
Urban	2.1		2.1	
Groundwater	-			
Septic Systems	-			
Total Existing Load	**385.8**	**3 Load Allocation**	**243.6**	
Load Reduction	**134.4 (35%)**	**Waste Load Allocation**	**0**	**No point sources**
		Margin of Safety	**7.5**	**3% of Loading Capacity**
TMDL = Loading Capacity = 251.1				

2.3 Metals

Analysis of the Ridenour Lake watershed did not identify any point or nonpoint sources of metals. Evaluation of USGS report *Isopleth Maps of Titanium, Aluminum, and Associated Elements in Stream Sediments of West Virginia* indicates that elevated metal concentrations occur in stream sediments in Ridenour Lake watershed (USGS, 1994). Metal concentration in sediment collected from Lake Ridenour bottom deposits range from low values to 12.5 g/kg for aluminum and 20.3 g/kg for iron (Table 5.3 of the attached report). Assuming that sediment deposited on the lake bottom is less enriched than the soil of origin, an enrichment ratio of 1.5 was assumed as the ratio of metal content in soil to that in lake sediment (see section 7.3 of the attached report). Aluminum and iron TMDL allocations are shown in Table 8 and Table 9. Table 7 summarizes the computation of loading capacity and a load reduction scenario. An explicit 10% margin of safety is considered.

Table 7. Derivation of loading capacity for aluminum and iron assumed to be naturally occurring

Metal	Sediment Concentration (mg/kg)	Sediment Load Allocation (kg/yr)	Enrichment Ratio	Metal Loading Capacity (kg/yr)	Load Allocation (kg/yr)
Aluminum	12,500	243,600	1.5	4,568	4,568
Iron	20,300	243,600	1.5	7,418	7,418

Table 8. Ridenour Lake aluminum TMDL (in kilograms per year)

Source	Existing Loading Total Aluminum	Percent Reduction	Load Allocation (kg)	Comments
Naturally Occurring (soil)	---	---	4,568	
Total Existing Load	**---**	**3 Load Allocation**	**4,568**	
Load Allocation	**---**	**Waste Load Allocation**	**0**	**No point sources**
		Explicit Margin of Safety	**0**	
TMDL = Loading Capacity = 4,568				

Table 9. Ridenour Lake iron TMDL (in kilograms per year)

Source	Existing Loading Total Iron (kg)	Percent Reduction	Load Allocation (kg)	Comments
Naturally Occurring (soil)	---	---	7,418	
Total Existing Load	**---**	**3 Load Allocation**	**7,418**	
Load Reduction	**---**	**Waste Load Allocation**	**0**	**No point sources**
		Explicit Margin of Safety	**0**	
TMDL = Loading Capacity = 7,418				

3. The TMDLs consider the impacts of background pollutant contributions.

Background Conditions for Nutrients

The TMDL load allocation should include, when possible as a separate allocation, the natural background loading of the pollutant. In this analysis natural background is included as an allocation to groundwater or baseflow loadings, and the forest loadings. Note that the forest category also includes some loads due to forestry activities, which are in addition to the naturally occurring runoff and erosion from forested areas. The monitoring data were insufficient to separate natural forest loadings from other forest sources.

Background Conditions for Sediment

The TMDL load allocation should include, when possible as a separate allocation, the natural background loading of the pollutant. For sediment natural background is included as an allocation to the forest loadings. Note that the forest category also includes some loads due to forestry activities, which are in addition to the naturally occurring runoff and erosion from forested areas. The monitoring data were insufficient to separate natural forest loadings from other forest sources.

Background Conditions for Metals

The TMDL load allocation should include, when possible as a separate allocation, the natural background loading of the pollutant. Metals naturally occur in the existing sediments in the watershed and no other contributing sources were identified. All metals loadings defined in the TMDL are considered background under the TMDL. If additional sources are defined in the future, through reconnaissance and monitoring, a revision to the TMDL could establish separate LAs or WLAs as appropriate.

4. The TMDLs consider critical environmental conditions.

Critical Conditions For Nutrients

The critical conditions for the nutrient TMDL are selected to evaluate the type of impairment (eutrophication) and the type of waterbody (reservoir). Protection of the lake condition requires the control of long term loadings and accumulation of phosphorus. The lake condition is evaluated based on chlorophyll *a* concentrations in response to long-term annual loading of nutrients (phosphorus).

Critical Conditions for Sediment

The critical conditions for the sediment TMDL are selected to evaluate the type of impairment (siltation) and the type of waterbody (reservoir). Protection of the lake condition requires the control of long term loadings and accumulation of sediment. The lake condition is evaluated based on mean siltation rates, in selected locations, in response to long-term annual loading and trapping of sediments in the reservoir.

Critical Conditions for Metals

The critical conditions for the metals TMDL are selected consistent with the delivery mechanism of the metals and the type of waterbody (reservoir). The metals loads are expected to be delivered with fine grained, naturally occurring sediment. Variability in the fined grained sediment load is expected to occur due to natural fluctuations in the hydrology. Periodic elevated concentrations of iron and aluminum are expected to occur due to the high concentration of metals in local sediments. The TMDL sets a site specific criteria under the sediment loading conditions defined by the sediment TMDL. This will result in controlling long term loadings and accumulation of sediment and associated metals. The lake condition is evaluated based on annual metals loading associated with reduced sediment loading, under the sediment load allocation.

5. The TMDLs consider seasonal environmental variations.

Seasonality for Nutrients

The nutrient analysis considered seasonality in the loading through the simulation of monthly watershed loadings based on historic precipitation records. The evaluation of nutrient impacts in the reservoir was considered for the average annual conditions representing the response to long term, cumulative nutrient loading. The TMDL and load allocation are presented as annual average loading consistent with the type of impairment (eutrophication) and waterbody type (reservoir). Reduction of the average annual load is expected to result in achievement of water quality standards.

Seasonality for Sediment

The sediment analysis considered seasonality in the loading through the simulation of monthly watershed loadings based on historic precipitation records. The evaluation of sediment impacts in the reservoir was considered for the average annual conditions representing the response to long term, cumulative siltation. The TMDL and load allocation are presented as annual average loading consistent with the type of impairment (siltation) and waterbody type (reservoir). Reduction of the average annual load is expected to result in achievement of water quality standards.

Seasonality for Metals

The sediment analysis considered seasonality in the loading through the simulation of monthly watershed loadings based on historic precipitation records. The TMDL and load allocation are presented as annual average loading consistent with the available information, the transport mechanism (metals associated with sediment) and waterbody type (reservoir).

6. The TMDLs include a margin of safety.

Margin of Safety for Nutrients

The MOS one of the required elements of a TMDL. There are two basic methods for incorporating the MOS (USEPA 1991):

Implicitly incorporate the MOS using conservative model assumptions to develop allocations.
Explicitly specify a portion of the total TMDL as the MOS; use the remainder for allocations.

The margin of safety for this TMDL was expressed as an explicit number, calculated as a percentage of the total loading capacity. A 5 percent margin of safety was selected to reflect the uncertainty in the modeling analysis and the selection of the TMDL endpoint. Other implicit conservative assumptions provide an additional margin of safety. Specific conservative assumptions include:

The loadings calculated by the nonpoint source model (GWLF) were derived using conservative assumptions in the selection of nutrient potency factors. The use of conservative assumptions in developing the loading model results in relatively highly loads and slightly larger required load reductions.

Margin of Safety for Sediment

The margin of safety for this TMDL was expressed as an explicit number, calculated as a percentage of the total loading capacity. A 3 percent margin of safety was selected to reflect the uncertainty in the modeling analysis and the selection of the TMDL endpoint. Other implicit conservative assumptions provide an additional margin of safety. Specific conservative assumptions include:

- The endpoint for the reservoir is defined based on a 40 year lifespan for a selected volume of the lake.

- The loadings calculated by the nonpoint source model (GWLF) were derived using conservative assumptions in the selection of soil erosion factors. The use of conservative assumptions in developing the loading model results in relatively highly loads and slightly larger required load reductions.

Margin of Safety for Metals

The margin of safety for this TMDL was expressed as an implicit conservative assumption in the analysis. Therefore all specific conservative assumptions made in the development of the sediment TMDL apply to the metals TMDL as well. In addition, other conservative assumptions associated with the metals TMDL include:

- Fine sediment particles have larger surface areas for adsoption and contain higher levels of metals' coarser particles. The trap efficiency for fine sediment, with associated metals, is likely to be lower than the total sediment trap efficiency identified for the sediment TMDL. This results in relatively less accumulation of metals in the reservoir than identified under the selected TMDL.

7. The TMDLs has been subject to public participation.

EPA published and requested comments on the proposed TMDLs on July 1, 1999 in the Charleston Gazette , which has statewide distribution. In addition, a press release was sent to most of the newspapers in West Virginia. The public comment period closed on August 16, 1999, and EPA did not receive comments from any individual or organization for the Turkey Run Lake TMDL.

8. There is reasonable assurance that the TMDLs can be met.

Management Practices

There are number of best management practices that can be adopted to minimize the nutrient, sediment and metals loadings in accordance with the identified TMDLs and load reduction targets.

Nutrient

The nutrient TMDL identifies load allocations and reductions from forested land, agricultural operations, urban, transition/ barren areas, construction areas, and septic systems. Some of the management practices that can be used to achieve the identified load reductions include:

Current regulations of the WV Dept of Health require correction of all straight pipes and failed septic systems, and it is recommended in the TMDL allocation that all such sources be brought into compliance. Because it is difficult to obtain accurate numbers for these sources during development of a TMDL, ground proofing may be needed as part of the implementation..

Forestry management: forestry practices including preharvest planning, streamside area management and buffers, road construction/reconstruction/management, timber harvest management, site preparation, erosion and sediment control, and forest regeneration. Wildlife and water fowl control can also be used to manage nutrient loads.

Agricultural management: Agricultural management practices can reduce sediment and associated nutrient loads. Typical practices include conservation tillage, terraces, crop rotations, and stream buffers. A nutrient management plan can be adopted for individual farms. The plan addresses the methods to utilize manure nutrient and to apply manure and fertilizers at agronomic rates. Fencing or alternative water supplies can assist in reducing the time where livestock are in or near streams.

Urban areas: Sediment and associated nutrient loads can be reduced through management of new developments, site planning, pollution prevention, and stormwater management.

Maintenance and inspection of septic systems: By properly maintaining septic systems, the failure rate and associated nutrients loadings could be greatly reduced.

Sediment

The sediment TMDL identifies load allocations and reductions from forest land, agricultural operations, and construction areas. Some of the management practices that can be used to achieve the identified load reductions include:

Forestry management: forestry practices including preharvest planning, streamside area management and buffers, road construction/reconstruction/management, timber harvest management, site preparation, erosion and sediment control, and forest regeneration.

Agricultural management: Agricultural management practices can reduce erosion and sediment delivery. Typical practices include conservation tillage, terraces, crop rotations, and stream buffers. Fencing or alternative water supplies can assist in reducing the time when livestock are in or near streams. Trampling of stream corridors can increase erosion and turbidity.

Construction: Sediment loads can be reduced through management of new developments, erosion and sediment control practices, site planning, and stormwater management.

Metals

Sediment is the dominant, and only apparent source, of the listed metals in the Turkey Run watershed. Control of the listed metals in the watershed can only be achieved by reducing the disturbance of sediment in the watershed and thereby reducing erosion and transport of sediment to the lake.

The West Virginia Division of Environmental Protection-Office of Water Resources, as the lead agency for West Virginia's nonpoint source program, coordinates with other cooperating state agencies to address nonpoint source impacts, develop and implement best management practices reducing pollutant loads for agricultural, silvicultural, oil and gas, abandoned mines and construction activities. Activities in the various categories include education, technical assistance, financial assistance, research, regulatory and enforcement. WV DEP, through the Nonpoint Management Program, has been successful in initiating the land use controls and BMP's for controlling NPS pollution and protecting the designated uses of the states waterbodies.