5.2 Air Resources

5.2.1 Introduction

Potential changes in reservoir operations policy may result in changes in the quantity, timing, and location of hydropower generation. Decreases in hydropower generation could result in increased requirements on the thermal generation of electrical power. Increased thermal generation would result in increased fossil-fuel combustion and therefore more emissions of air pollutants. The opposite is true if hydropower generation is increased.

This section analyzes the changes in air pollutant emissions created by each policy alternative being evaluated for the ROS. The air resources analysis addressed potential changes on attainment of the National Ambient Air Quality Standards (NAAQS), Hazardous Air Pollutant (HAP) emissions, and air-quality-related values (AQRVs).

The timing of hydropower changes is important because of the seasonal nature of air pollution problems. The period of concern for ozone is April 1 to October 31 in much of the TVA region. Emissions of volatile organic compounds and nitrogen oxides (NO_x) usually create the most ozone during summer, which is also the season of most concern for fine particles, regional haze, and acidic deposition. The atmosphere is more chemically active in summer. Thus, increasing emissions during summer could result in more adverse air quality consequences than during the rest of the year.

5.2.2 Assessment Methodology and Results

TVA has a variety of methods for generating electricity. Reductions or seasonal shifts in hydropower generation can be replaced by nuclear, coal, or natural gas generation—or even by purchased power from other utilities, especially at times of peak demands. This analysis of air quality impacts required assumptions about which power generation sources would replace reductions or shifts in hydropower generation and which generation sources would be operated less if hydropower generation increased.

The steps in the methodology were as follows:

- Determine the increase or decrease in the monthly and annual hydropower generation for the alternative being considered as compared to the Base Case.
- Determine the likely generation, by fuel type (nuclear, coal, or gas) that would be affected by a change in hydropower generation (either substituting for or being displaced by), and calculate any associated change in air emissions. TVA used a computer code entitled PROSYM (see Appendix C-3) to make these calculations for both monthly and annual periods.
- Provide detailed results for pertinent emissions.

- Compare increases/decreases in emissions with Base Case emissions and present a percentage change.
- Discuss timing of monthly emissions increases/decreases and the effect on air quality.

The analysis of increases/decreases for annual emissions of each pollutant, based on the methodology described above is presented in Table 5.2-01. This shows the annual changes in emissions for each alternative and the percentage of TVA emissions that the increase represents for the maximum increase alternative.

The annual results shown in Table 5.2-01 and Figure 5.2-01 do not, however, adequately describe impacts on regional air quality resources. Using NO_x emissions as an example, Table 5.2-02 and Figure 5.2-02 show the seasonal pattern of NO_x emissions increases and decreases. For Figure 5.2-02, season is defined climatologically as winter being December, January, and February, for example. The seasonal differences for the other emissions are similar. The larger variation in emissions changes by season for the policy alternatives is masked by the annual emissions changes. The evaluations of each alternative examined both annual and seasonal changes.

Table 5.2-01 Summary of Annual Emission Increases/Decreases by Policy Alternative (Based on PROSYM Model Outputs for 2005) (in tons per year)

Alternative	Increase/ Decrease in Non-Hydro Generation (MW hours)	Sulfur Dioxide	Nitrogen Oxide	Particulate Matter	Mercury
Reservoir Recreation A	-89,310	-1,408	-447	-39	-.0028
Reservoir Recreation B	248,370	689	-7	18	.0007
Summer Hydropower	157,850	2,354	690	63	.0053
Equalized Summer/ Winter Flood Risk	906,350	4,172	1,163	113	.0080
Commercial Navigation	-90,930	-26	-109	-1	-.0006
Tailwater Recreation[1]	248,370	689	-7	18	.0007
Tailwater Habitat	298,810	-14,211	-4,700	-386	-.0362
Preferred [2]	Similar to Reservoir Recreation Alternative A				
Maximum Percentage Increase	0.52%	0.89%	0.58%	0.89%	0.49%

[1] Identical to Reservoir Recreation Alternative B, no separate PROSYM run was made for the Tailwater Recreation Alternative.

[2] The Preferred Alternative was assumed to be similar to the results of Reservoir Recreation Alternative A; no separate PROSYM run was made for the Preferred Alternative.

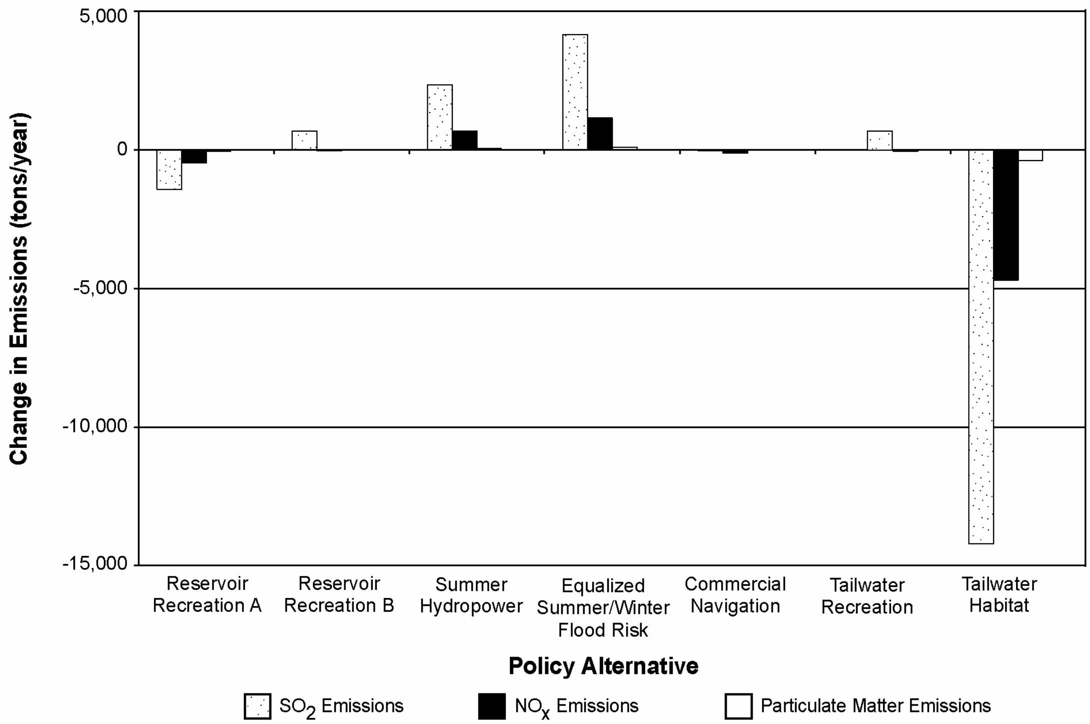
Table 5.2-02 Increases/Decreases of Nitrogen Oxides Emissions by Policy Alternative (in tons)

Alternative	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year	Comparison to Base Case (%)
Base Case	25,670	22,744	20,940	22,357	7,784	7,746	8,620	8,862	6,918	22,105	22,759	25,194	201,698	100%
Reservoir Recreation A	66	-315	-100	-49	-64	172	112	284	-254	-362	-55	117	-447	-0.22
Reservoir Recreation B	28	-499	-256	-101	-245	120	138	390	228	170	148	-128	-7	-0.00
Summer Hydropower	6	-320	-232	69	-121	-380	-188	-74	305	503	567	555	690	0.34
Equalized Summer/Winter Flood Risk	101	-622	-246	-416	-228	238	125	265	791	424	389	338	1163	0.58
Commercial Navigation	2	-61	-35	-32	-108	18	-1	-18	23	8	72	25	-109	-0.05
Tailwater Recreation[1]	28	-499	-256	-101	-245	120	138	390	228	170	148	-128	-7	-0.00
Tailwater Habitat	-644	-1075	-802	-712	-472	-2	98	201	546	-438	-919	-482	-4700	-2.33
Preferred[2]	Similar to Reservoir Recreation Alternative A													

[1] The Tailwater Recreation Alternative was assumed to be similar to the results of Reservoir Recreation Alternative B; no separate PROSYM run was made for the Tailwater Recreation Alternative.

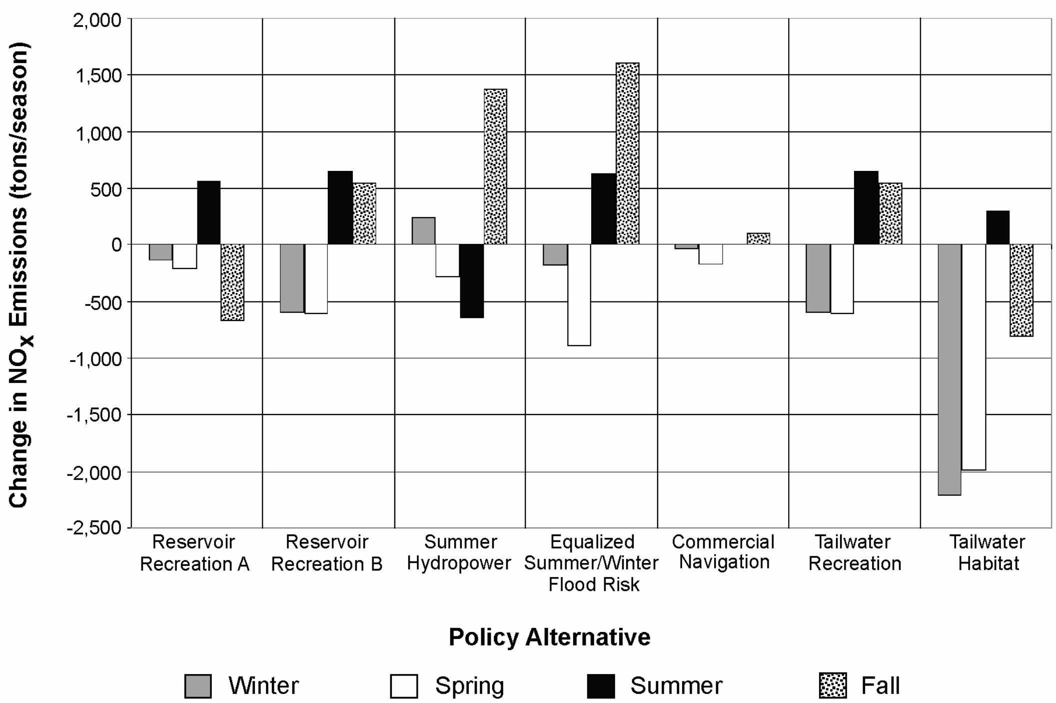
[2] The Preferred Alternative was assumed to be similar to the results of Reservoir Recreation Alternative A; no separate PROSYM run was made for the Preferred Alternative. The trends in hydropower generation would be similar to those under Reservoir Recreation Alternative A but with less hydropower generation shifted away from summer months. As a result, the summer increases would be similar to or less than the numbers provided for Reservoir Recreation Alternative A. Unlike Reservoir Recreation A, fall emissions would increase relative to the Base Case.

Source: TVA PROSYM model runs for 2005.



Source: TVA (based on PROSYM model results).

Figure 5.2-01 Comparison of Air Pollutant Emissions by Policy Alternative



Source: TVA (based on PROSYM model results).

Figure 5.2-02 Comparison of NOx Emissions by Policy Alternative by Season

Increases in emissions were generally assumed to result in a negative impact, and decreases were assumed to result in a positive impact. The year 2005 PROSYM computer program outputs were used for comparison because 2005 is the first full year of assumed implementation of alternatives.

5.2.3 Base Case

Under the existing reservoir operations policy, increases or decreases in air emissions occur due to annual variation of rainfall. These variations would continue to occur under the Base Case.

5.2.4 Reservoir Recreation Alternative A

For Reservoir Recreation Alternative A, the total annual hydropower generation on average would be slightly higher than the hydropower generation expected under the Base Case (see Section 5.23, Power). The amount of hydropower generation, however, would be reduced in summer and increased in the other seasons. In response to this shift in hydropower generation, other peaking generation resources, such as coal, combustion turbines, Raccoon Mountain Pumped Storage, and purchased power, would be dispatched to replace it. In addition, hydropower generation shifted to off-peak in other seasons would likely displace some coal generation.

Due to slightly higher total annual hydropower generation, Reservoir Recreation Alternative A would result in a reduction in annual emissions, with slight reductions in all pollutant emissions because of the shift of hydropower from summer. Reservoir Recreation Alternative A would result in an increase in summer emissions of all pollutants and decreases in the other seasons. Since the summer season is when ozone non-attainment and potential $PM_{2.5}$ non-attainment episodes could occur, Reservoir Recreation Alternative A could result in a potentially negative impact on NAAQS attainment.

Reservoir Recreation Alternative A would result in a slight decrease in mercury emissions, 5.6 pounds per year, although there would be a seasonal increase in the summer. Reservoir Recreation Alternative A would result in a very slight decrease in HAP emissions.

Reservoir Recreation Alternative A would result in an increase in nitrogen oxide, sulfur dioxide, and particulate matter emissions during summer. The alternative could result in a slight increase in acidic deposition and decrease in visibility in the Class I areas.

5.2.5 Reservoir Recreation Alternative B

The effect on hydropower generation under Reservoir Recreation Alternative B would be similar to Reservoir Recreation Alternative A, although more adverse. The total annual hydropower generation would be somewhat lower than the hydropower generation expected under the Base Case. The timing of the generation would shift from summer peak to other seasons similar to, although to a greater extent than, Reservoir Recreation Alternative A. TVA's response to this shift in hydropower generation would also be similar to Reservoir Recreation Alternative A.

Due to losses in annual hydropower, Reservoir Recreation Alternative B would result in slight increases in all NAAQS emissions (except nitrogen oxides) on an annual basis, similar to Reservoir Recreation Alternative A. On a seasonal basis, these increases would be disproportionately higher in summer and fall, as shown in Figure 5.2-02. Reservoir Recreation Alternative B would add 1.6 percent to TVA's nitrogen oxide summer emissions and similar percentages to the other emissions. Thus, this alternative could result in a negative impact on attainment of NAAQS.

Reservoir Recreation Alternative B could create an increase in mercury emissions of about 0.04 percent per year, or about 1.4 pounds.

Reservoir Recreation Alternative B would result in increases in summertime emissions of sulfur dioxide and nitrogen oxides, with air quality effects similar to those discussed for Reservoir Recreation Alternative A.

5.2.6 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, hydropower generation would increase during the summer and winter peak demand periods and decrease in fall, relative to the Base Case. The total annual hydropower generation on average would be somewhat lower.

Because the Summer Hydropower Alternative would supply increased hydropower during summer, it would substantially decrease summer emissions of NAAQS emissions. Reduced hydropower generation in late September would increase emissions in fall. The Summer Hydropower Alternative might positively affect NAAQS attainment.

The Summer Hydropower Alternative could result in an increase in emissions of mercury of 10.6 pounds per year, or about a 0.33-percent increase from emissions under the Base Case.

The Summer Hydropower Alternative could, in general, benefit AQRVs in Class I areas because of its reduced emissions in summer.

5.2.7 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative would result in the most adverse effect on total annual hydropower generation, producing almost 5 percent less on an average annual basis. In addition, hydropower generation would shift relative to the Base Case, decreasing in summer and fall and increasing during winter. As in Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and to a greater extent, the Tailwater Recreation Alternative, other higher cost peaking generation units would need to be run to replace the shifted hydropower generation in summer and fall; and hydropower generation would likely displace coal generation in other seasons.

Due to the impacts on hydropower generation, the Equalized Summer/Winter Flood Risk Alternative would result in the largest increase in both annual and seasonal emissions of NAAQS pollutants. Annual emissions increases would be twice as large as under any other alternative, with increases of nearly 1 percent for sulfur dioxide and particulate matter, and nearly 0.5 percent for nitrogen oxide and mercury. The seasonal increases occur in summer and fall.

The Equalized Summer/Winter Flood Risk Alternative could result in an increase in mercury emissions of about 16 pounds annually, or about 0.49 percent of the Base Case emissions.

The Equalized Summer/Winter Flood Risk Alternative could also produce the highest negative impact on AQRVs, not only because of the higher annual total emissions but also because of their imbalance toward summer and fall.

5.2.8 Commercial Navigation Alternative

The Commercial Navigation Alternative would result in an increase in hydropower generation and thus a slight reduction in coal-fired emissions. This reduction is slightly skewed toward winter and spring, with fall emissions increasing slightly.

The Commercial Navigation Alternative could result in a slight decrease in mercury emissions.

The Commercial Navigation Alternative would result in a potential reduction in annual emissions and only a slight increase in fall.

5.2.9 Tailwater Recreation Alternative

The Tailwater Recreation Alternative could result in a slight increase in annual emissions similar to those under Reservoir Recreation Alternative B. The PROSYM results shown in the tables are identical to those under Reservoir Recreation Alternative B because the effects of the hydropower operation would be very similar to that of Reservoir Recreation B. However, a disproportionate amount of this increase would occur in summer and fall.

The Tailwater Recreation Alternative could lead to an increase in mercury emissions of approximately 1.4 pounds annually.

The Tailwater Recreation Alternative could result in a moderate annual increase in pollutants. The seasonal nature of the potential increases, mostly in summer, could increase the degree of negative impacts.

5.2.10 Tailwater Habitat Alternative

The effect on hydropower generation under the Tailwater Habitat Alternative would be similar to Reservoir Recreation Alternative B, although more adverse. The total annual hydropower generation would be somewhat lower, and the timing would shift from summer peak to other seasons similar to, although to a greater extent than, Reservoir Recreation Alternative B.

The Tailwater Habitat Alternative would result in an annual decrease of NAAQS emissions. This decrease is the consequence of displacing more coal generation than any other alternative. The Tailwater Habitat Alternative would shift the greatest amount of hydropower generation away from May through September, the period when coal and gas plant emissions are most costly. TVA's response to this shift in hydropower generation would be to reduce coal generation during the May through September period to avoid costly emissions and replace it with combustion turbines, pumped storage, or purchased power. The hydropower that is shifted out of the summer period would likely also displace coal generation. This alternative would, however, result in increased summer emissions due to greater combustion turbine generation during that time.

The Tailwater Habitat Alternative would result in a substantial decrease (72.4 pounds per year) in mercury emissions.

The Tailwater Habitat Alternative could negatively affect AQRVs in the Class I areas because its increase in emissions would occur in summer.

5.2.11 Preferred Alternative

For the Preferred Alternative, the total annual hydropower generation is expected to be slightly less than the Base Case. Hydropower would be slightly reduced in summer and fall, and increased in other seasons. In response to this shift in hydropower generation, other peaking generation resources, such as coal, combustion turbines, Raccoon Mountain Pumped Storage, and purchased power, would be dispatched to replace it. In addition, hydropower generation shifted to off-peak in other seasons would likely displace some coal generation.

The Preferred Alternative would result in a slight increase in summer emissions of all pollutants and decreases during the other seasons. Because ozone non-attainment and potential $PM_{2.5}$ non-attainment episodes are greatest in summer, the Preferred Alternative could result in a potentially negative impact on NAAQS attainment.

The Preferred Alternative would result in a slight increase in nitrogen oxide, sulfur dioxide, and particulate matter emissions during summer. The alternative could result in a slight increase in acidic deposition and a decrease in visibility in the Class I areas, compared to the Base Case.

The Preferred Alternative could result in a slight change in mercury and HAP emissions, as compared to the Base Case.

5.2.12 Summary of Impacts

The air quality resources of the TVA region could be negatively affected by decreases in hydropower generation due to changes in operations (Table 5.2-03). The Equalized Summer/Winter Flood Risk Alternative could result in the largest negative impact. Reservoir Recreation Alternative B, the Summer Hydropower Alternative, and the Tailwater Recreation Alternative would result in small annual impacts when compared to the Equalized Summer/Winter Flood Risk Alternative. The summer seasonal impacts of the Preferred Alternative, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would be negative. However, Reservoir Recreation Alternative A, the Commercial Navigation Alternative, and the Tailwater Habitat Alternative would tend to result in positive impacts on an annual basis. The Commercial Navigation Alternative would be relatively neutral concerning overall impacts on air quality resources. The Preferred Alternative would result in no change to slightly adverse air quality impacts on an annual basis.

Table 5.2-03 Summary of Impacts on Air Resources by Policy Alternative

Alternative	Description of Impacts
Base Case	Under the existing reservoir operations policy, increases or decreases in air pollutant emissions would not occur.
Reservoir Recreation A	Seasonal Adverse in summer, otherwise beneficial Annual Slightly beneficial
Reservoir Recreation B	Seasonal Adverse in summer and fall, otherwise beneficial Annual Slightly adverse
Summer Hydropower	Seasonal Adverse in fall and winter, otherwise beneficial Annual Slightly adverse
Equalized Summer/ Winter Flood Risk	Seasonal Adverse in summer and fall, otherwise beneficial Annual Slightly adverse
Commercial Navigation	Seasonal Minimal change, but slightly adverse in fall and beneficial in spring Annual No change
Tailwater Recreation	Seasonal Adverse in summer and fall, otherwise beneficial Annual Slightly adverse
Tailwater Habitat	Seasonal Adverse in summer, otherwise beneficial Annual Beneficial
Preferred	Seasonal Slightly adverse in summer, otherwise beneficial Annual No change to slightly adverse