POINT SOURCE WASTE LOAD ALLOCATION FOR THE TOWN OF RED RIVER

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The Federal Clean Water Act requires that every municipality must at least provide secondary treatment of its wastewater before discharging it to a surface watercourse. The application of secondary treatment is usually sufficient to improve the water quality of the receiving stream. In high mountain headwater streams like the Red River, however, advanced wastewater treatment, often called tertiary treatment, must be provided to ensure that violations of water quality do not occur.

When the water quality standards cannot be met by secondary treatment, the state must develop a point source waste load allocation (WLA) for the municipal discharge. The allocation will specify the quantity of a pollutant that may be discharged during a period of time. The purpose of waste load allocation is to preserve and enhance the water quality of the receiving stream and to protect its designated uses.

The process of developing a waste load allocation for the town of Red River began with a consideration of the water quality standards of the Red River. A water quality standard consists of two principal elements:

1. A "designated use" (such as high quality coldwater fishery).
2. "Numeric or narrative criteria" sufficient to preserve the designated use. We should keep in mind that the designated use is the most important element of the water quality standard.

The designated uses of the upper Red River are given in figure 1. The most vulnerable of these, and hence the most critical, is high quality coldwater fishery. The numeric criteria or "standards", as they are usually called, are shown in figure 2. All of these numeric standards are necessary to protect the designated use, high quality coldwater fishery. A point source waste load allocation may be calculated for any water contaminant that could potentially impair a designated use.

STREAM SEGMENT	DESIGNATED USES
The Red River from its confluence with the Rio Grande upstream to a point 1-1/2 miles above the bridge at the Red River Fish Hatchery.	Coldwater Fishery Fish Culture Livestock and Wildlife Watering Secondary Contact Recreation
The Red River from a point 1-1/2 miles above the bridge at the Red River Fish Hatchery upstream to its headwaters, including all tributaries thereto.	Domestic Water Supply Fish Culture High Quality Coldwater Fishery Irrigation Livestock and Wildlife Watering Secondary Contact Recreation

Fig. 1. Stream Segments and Designated Uses

The intent of the numeric standards for inorganic nitrogen and phosphorus is to control the growth of algae and other aquatic plants in order to preserve the aesthetic and ecologic qualities that originally provided the basis for designating the stream as a high quality coldwater fishery. Excessive accumulations of biomass and changes in the kinds of algae can lead to the deterioration of the quality of the fishery habitat.

PARAMETER	HOW APPLIED	STANDARD	UNITS
	Shall...		
Un-ionized Ammonia	Not exceed	.02	mg/l
Conductivity	Be less than	400	µmho
Dissolved Oxygen	Be greater than	6.0	mg/l
Total Inorganic Nitrogen	Be less than	1.0	mg/l
pH	Be within range	6.6 to 8.8	--
Temperature	Be less than	20	°C
Total Chlorine Residual	Be less than	.002	mg/l
Total Organic Carbon	Be less than	7	mg/l
Total Phosphorus	Be less than	0.1	mg/l
Turbidity	Be less than	25	ftu
Fecal Coliform Bacteria	Be less than	100/100	cells/ml*

*Based on monthly log mean

Fig. 2. Numeric Standards

One or both of these plant nutrients are often in short supply in aquatic environments. The nutrient in short supply will limit algal growth, providing that all other growth requirements are being met. This phenomenon is known as the limiting nutrient concept.

Control of the limiting nutrient only can result in a significant reduction in cost of constructing and, in particular, operating advanced wastewater treatment systems while ensuring that designated uses are protected. Recognizing the economic importance of this, the Water Quality Control Commission adopted a provision to the water quality standards (1) that allows for the control of the limiting nutrient only. Therefore, waste load allocations will be developed for nitrogen or phosphorus, but not both.

To provide a current data base, the bureau conducted a yearlong stream and effluent sampling program on the Red River above and below the town (figure 3). The purposes of the study were to:

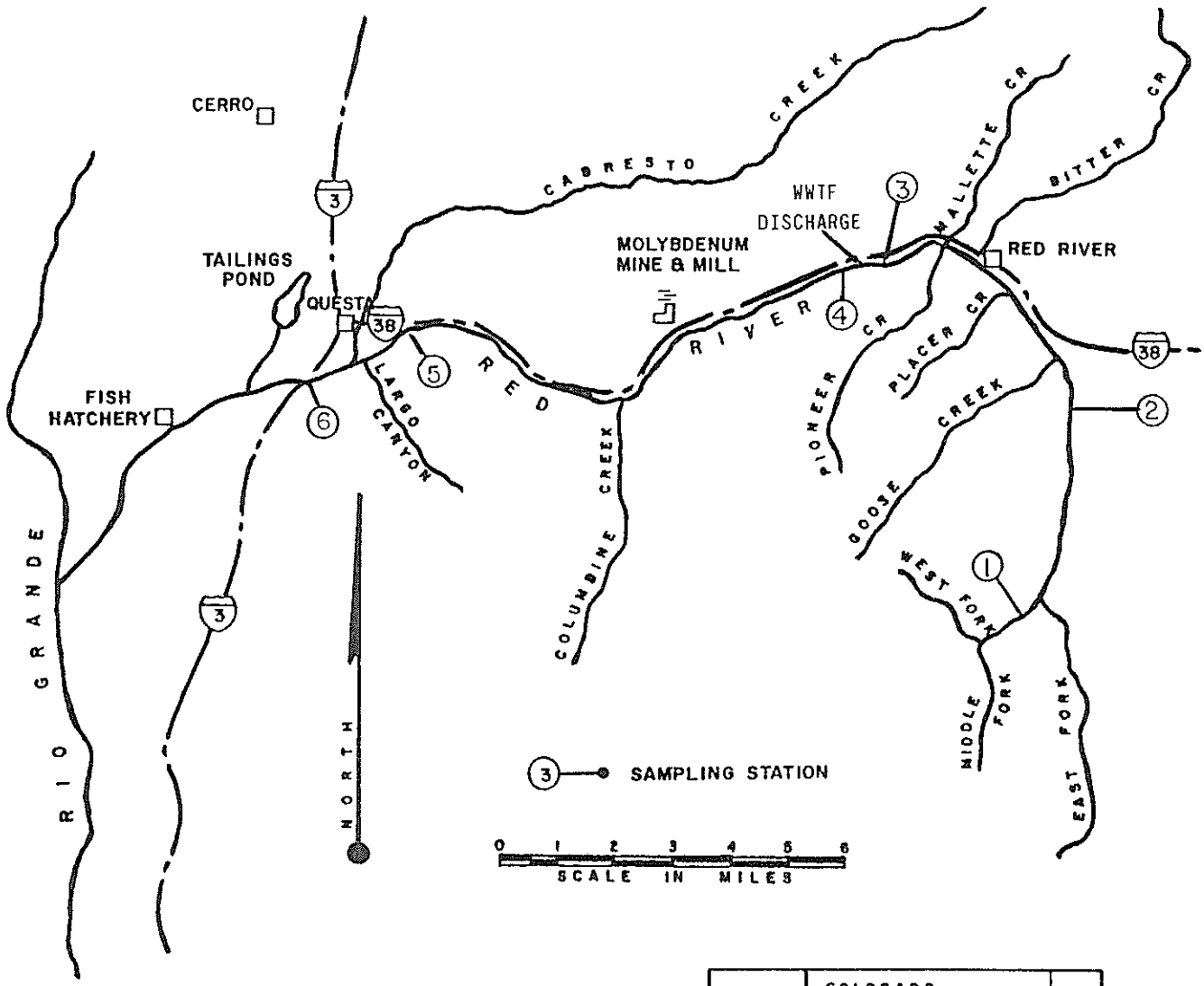
1. Determine which stream standards were being violated (if any).
2. Characterize the natural background (or ambient) quality of the river
3. Determine the limiting nutrient
4. Quantify the nonpoint source loading to the river

The results of the study were as follows:

A series of 11 algal assay tests demonstrated that the Red River is a phosphorus-limited aquatic environment. Consequently, the river is exempt from the total inorganic nitrogen standard and a waste load allocation is not required for that constituent.

The stream standard for total phosphorus was exceeded on 15 of 21 sampling dates at the station below the treatment works. No other violations of stream standards were observed at this station.

The mean and range of total phosphorus concentrations observed at several Red River stations during winter low flows is shown in table 1. The natural quality of the river is represented at Station HRG-21, six miles above the town. The average P concentration here is 0.006 mg/liter. Cultural nonpoint sources in and above the town of Red River add phosphorus sufficient to raise the river concentration to 0.022 mg/liter, increasing it 3.67 times.



LEGEND

STATION	STORET NUMBER
1	HRG21
2	HRG22
3	HRG23.1
4	HRG23.3
5	HRG24
6	HRG25

Fig. 3. Location Map

TABLE 1
Total Phosphorus Concentrations in the Red River
During Winter Low Flow 1979-1981
(mg/liter--November through March)

STATION	NO. OF SAMPLES	MEAN	MINIMUM	MAXIMUM
HRG-21 (Middle Fork)	11	.006	.001	.01
HRG-22 (Two miles above town)	13	.021	.001	.059
HRG-23.1 (Above lift station)	10	.022	.009	.042
HRG-23.3 (Below WWTF)	13	.154	.03	.37

Effluent flow from Red River's new wastewater treatment works will vary seasonally. Critical low streamflow varies monthly. These data are shown in table 2.

Early on in Red River's WLA process, the bureau recognized that plant operating costs could be substantially reduced while ensuring that designated uses were protected if seasonal variations of flow were considered. Accordingly, monthly phosphorus limitations were developed that take into account monthly low streamflow and seasonal variations in wastewater flow.

TABLE 2
Seasonal Variation of Effluent and Streamflow at the Outfall of the Red River Treatment Works

MONTH	CUBIC FEET PER SECOND 7Q10*	EFFLUENT
January	6.1	0.60
February	5.9	0.60
March	5.9	0.60
April	8.4	0.15
May	16.3	0.15
June	18.0	0.75
July	12.3	0.75
August	11.3	0.75
September	10.7	0.15
October	9.4	0.15
November	5.6	0.60
December	5.6	0.60

*7 consecutive-10 year recurring low flow

Un-ionized or undisassociated ammonia is potentially highly toxic to trout. However, the concentration of un-ionized ammonia that results from a given concentration of total ammonia varies greatly as a function of pH and temperature. The relationship is illustrated in figure 4. We used this relation together with stream and effluent flow variation to develop effluent limitations for un-ionized ammonia while not requiring unnecessarily stringent ammonia removal.

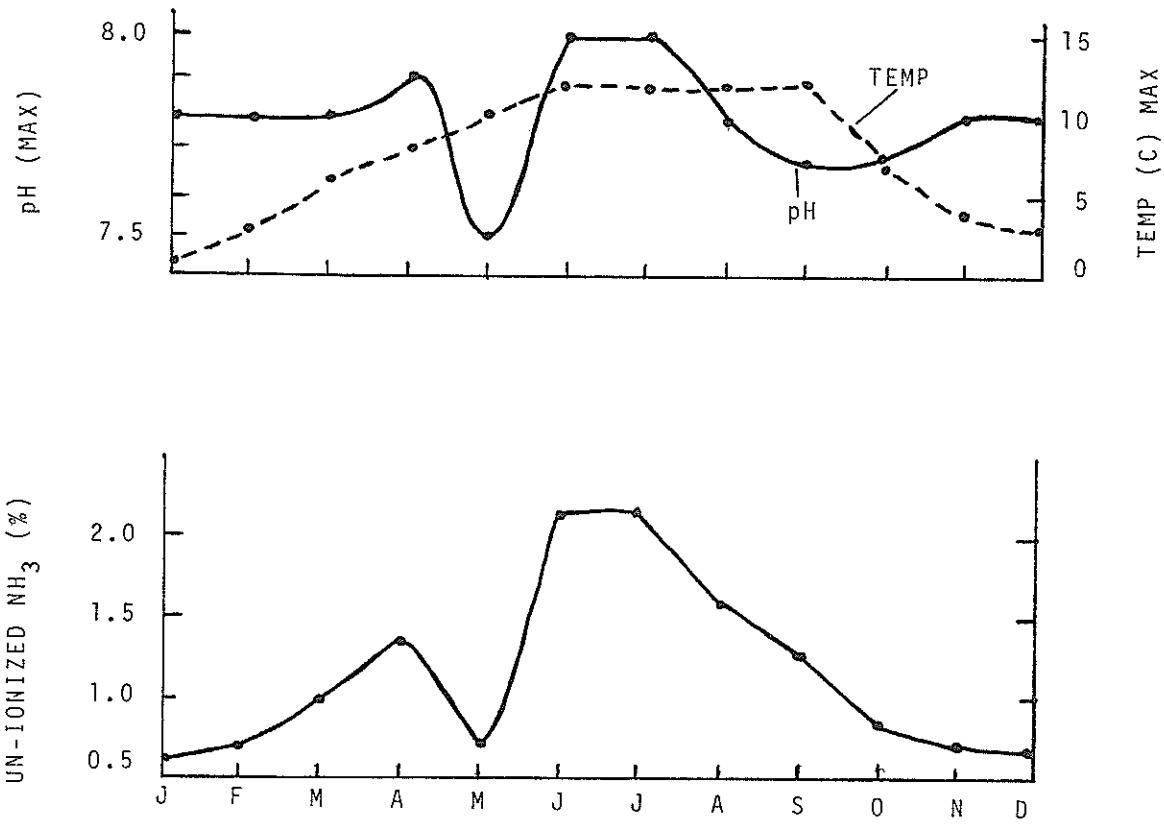


Fig. 4. Relation of Temperature and pH to Un-ionized Ammonia

The savings in costs of operation to the town of Red River that will result from wastewater treatment requirements for phosphorus and ammonia developed on a seasonal schedule was estimated at more than $200,000 per year. This is a substantial savings to a town of some 5,000 people.

The monthly waste load allocations for phosphorus and ammonia are summarized in table 3. These allocations were recommended to the U.S. Environmental Protection Agency for inclusion as effluent limitations in the town's NPDES permit.

TABLE 3
Final Effluent Limitations for the Red River

MONTH	TOTAL PHOSPHORUS	TOTAL AMMONIA
January	1.0	30
February	1.0	30
March	1.0	20
April	1.0	20
May	7.5	30
June	1.7	20
July	1.2	14
August	1.2	18
September	5.0	30
October	4.0	30
November	1.0	30
December	1.0	30

REFERENCES

1. New Mexico Water Quality Control Commission 1981. Water Quality Standards for Interstate and Intrastate Streams of New Mexico. Santa Fe, New Mexico. 40 pp.