Analysis of the Influence of the Drainage of a Sewage Treatment Plant on the Water Environment of the Huantai Dongzhulong River

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Abstract: In this paper, according to the river conditions and combined with the fully mixed model and the one-dimensional attenuation model, the concentration of pollutants at different distances is simulated, and the one-dimensional model is used to determine the sewage discharge capacity of the sewage treatment plant into the river drain. The result shows that under the current working conditions and design conditions, the status of pollution in the downstream affected zone of the river inlet is more than the capacity of the zone. In addition, the simulation result shows that COD and Ammonia nitrogen concentration gradually decrease due to the gradual degradation of pollutants in the longitudinal migration. Therefore, the sewage discharge port of the sewage treatment plant is set under the current working conditions and the design conditions, and the total amount of COD and Ammonia nitrogen missions does not exceed its pollution holding capacity. The section of the river still has a certain potential for pollution, and the water quality of the water can meet the water quality target requirements of the corresponding water function zone, and will not affect the function of Dongzhulong River.

1. Introduction
In recent years, with the increase of urban water consumption, the discharge of wastewater has also increased, and urban sewage treatment plants have played a major role in ensuring the quality of water environment [1]. However, even if the tail water discharged from the sewage treatment plant meets the Class A standard, the concentration of pollutants in the tail water is still significantly higher than the environmental quality standard for surface water. Furthermore, the receiving river is inevitably contaminated by tail water from the sewage treatment plant [2-5].

This paper analyzes the typical pollutants of the tailwater of a sewage treatment plant in Huantai and the Dongzhulong River in the receiving river, and discusses the impact of the tailwater discharge of the sewage treatment plant on the Dongzhulong River, In order to provide a scientific basis for the environmental management of the Dongzhulong River.

2. Material method
2.1. Overview of sewage treatment plants
The sewage treatment plant is located in the Dongyue Economic Development Zone of Zibo, with a design scale of 15000m³/d. It mainly uses the physicochemical treatment process of coagulation and sedimentation for sewage treatment. At present, the sewage treatment plant operates normally, mainly dealing with sewage wastewater generated by various enterprises under the group. The sewage generated by each enterprise is pretreated by the corresponding sewage treatment station and then enters the sewage treatment plant. After the treatment reaches the standard, the tail water is discharged into Dongzhulong River.

2.2. Overview of the inlet into the river
The sewage treatment plant into the river drain is built on the left bank of Dongnilong River, about 50m south of the junction of Dongzhulong River and Yuejin River. The pipeline is connected to the drainage outlet in the plant area. The schematic diagram of the sewage treatment plant entering the river drain is shown in Figure 1.

![Figure 1. Schematic Diagram of the Sewage Treatment Plant Entering the River Drain](image.png)

3. Analysis of Influence of Drainage in River Drainage on Water Quality and Aquatic Environment of Dongzhucheng River Water Function Area

3.1. Area of research
The location of the river inlet is located in the agricultural water zone of Huantai Dongzhulong River. The impact range is from the sewage treatment plant into the river drain to the Dongzhulong River into the Xiaoqing River, with a length of about 13km.

3.2. Accounting of water pollution capacity in the affected area

3.2.1. Calculation model
The drainage water discharged from the drainage outlet is Dongzhulong River, and the water function area is the Dongzhulong River Huantai agricultural water use area. Contaminants entering the channel can be evenly mixed in the section in a short period of time, with small lateral changes, and the pollutants mainly migrate along the longitudinal direction of the river. In this study, the one-dimensional model calculation was selected to determine the pollution capacity of the interval river section. The calculation formula is as follows:

\[ C_x = C_0 \exp\left(-k \frac{x}{86400u}\right) \]
3.2.2. Pollution capacity calculation results

According to formula (1), the pollution holding capacity of the downstream affected zone of the drainage outlet is COD 383.74 t/a and ammonia nitrogen 17.49 t/a. Under the current working conditions of the sewage treatment plant, the pollutant discharge COD reached 204.4 t/a, the ammonia nitrogen emission reached 10.22 t/a, and the COD and ammonia nitrogen emissions under the design conditions were 219 t/a and 10.95 t/a, respectively. According to the survey and the information obtained, a thermal power company and a paper industry tail water tailwater also merged into the Dongzhulong River Huantai agricultural water use area. According to the sewage discharge scale and the effluent water quality standards of the two enterprises, the COD and ammonia nitrogen emissions of the Thermoelectric Co., Ltd. were calculated to be 34.93 t/a, 1.75 t/a; the COD emission of the Paper Co., Ltd. was 43.8 t/a. The ammonia nitrogen emission was 2.19 t/a. Therefore, considering the data of the discharge volume of each drainage outlet, under the current working conditions of the sewage treatment plant, the current total amount of COD and ammonia nitrogen in the section of the river section is 283.13 t/a, 14.16 t/a, respectively. The potentials are COD 100.61 t/a and ammonia nitrogen 3.33 t/a. Under the design conditions of the sewage treatment plant, the total amount of COD and ammonia nitrogen in the section of the river is 297.73 t/a, 14.89 t/a, respectively. The pollution potential is COD 86.01 t/a and ammonia nitrogen 2.60 t/a. The specific calculation results of the pollution receiving capacity in the range of influence downstream of the drainage outlet are shown in Table 1.

### Table 1. Calculation results of pollution capacity in the downstream affected zone of the drainage outlet

| Water quality target | Pollution capacity | Pollution status | Pollution potential |
|----------------------|-------------------|-----------------|--------------------|
| COD (mg/L) | Ammonia nitrogen (mg/L) | COD (t/a) | Ammonia nitrogen (t/a) | COD (t/a) | Ammonia nitrogen (t/a) |
| Current working conditions | 40 | 2 | 383.74 | 17.49 | 283.13 | 14.16 | 100.61 | 3.33 |
| Design condition | 40 | 2 | 383.74 | 17.49 | 297.73 | 14.89 | 86.01 | 2.60 |

3.3. Analysis of the impact on water functional areas

3.3.1. Analysis of the impact on water pollution capacity

The current total amount of COD and ammonia nitrogen in the section of the river is 283.13 t/a and 14.16 t/a, respectively. It can be seen that when the upstream water meets the water quality target of the water function zone, under the current working conditions of the sewage treatment plant, the total COD and ammonia nitrogen emissions of the sewage treatment plant do not exceed the capacity of the sewage treatment, and the section of the river still remains. Has a certain potential for pollution.

If the sewage treatment plant is under the design conditions, that is, the tail water discharge is 15000 t/d, the COD concentration is 40 mg/L, and the ammonia nitrogen concentration is 2 mg/L, the corresponding COD and ammonia nitrogen emissions increase, respectively 219 t/a, 10.95 t/a. Under this condition, the total amount of COD and ammonia nitrogen in the river section is 297.73 t/a and 14.89 t/a, respectively. Compared with the sewage capacity, it is found that COD and ammonia nitrogen emissions are still within the range of regional pollution capacity.

Table 2 Statistical Table of Pollution Receiving in the Influence Zone of the Downstream of the
Drainage Port under Different Forecast Conditions

| project                | Water quality target | Pollution capacity | Pollutant discharge | Pollution potential |
|------------------------|----------------------|--------------------|---------------------|---------------------|
|                        | COD (mg/L)           | Ammonia nitrogen (mg/L) | COD (t/a) | Ammonia nitrogen (t/a) | COD (t/a) | Ammonia nitrogen (t/a) |
| Current working conditions | 40                   | 2                  | 383.74             | 17.49               | 204.4     | 10.22             | 100.61 | 3.33 |
| Design condition       | 219                  |                    |                    |                     |           |                   | 86.01  | 2.60 |

a Only sewage treatment plant pollutant emissions.
b Calculated by taking into account the amount of sewage discharged by a certain thermal power company and a certain paper industry.

In summary, when the upstream water meets the water quality target of the water function zone, regardless of the sewage treatment plant under the current working conditions or under the design conditions, the total COD and ammonia nitrogen emissions of the sewage treatment plant are not exceeded. The range of regional pollution capacity has a certain potential for pollution of COD and ammonia nitrogen.

3.3.2. Impact on water quality

The water inlet of the river is located in the agricultural water area of Dongzhulong River Huantai, and the water quality management target of the water function area is the V standard of surface water environmental quality. In the case that the upstream water meets the water quality target of the water function zone, under the current working conditions of the sewage treatment plant, since the upper limit of the COD emission concentration is equivalent to the COD concentration in the upstream water of the river section, the discharge of the sewage is The COD concentration in the river section is less affected. At the same time, as the pollutants gradually degrade with the longitudinal migration of the river, the COD concentration and the ammonia nitrogen concentration also gradually decrease. In short, when the upstream water meets the water quality target of the water function zone, under the current working conditions of the sewage treatment plant, the COD and ammonia nitrogen concentrations are still within the water quality management target range of the water function zone, and the water quality still meets the surface water environmental quality class V standard.

4. Conclusion

When the upstream water meets the water quality target of the water function area, the sewage treatment plant operates normally. When the sewage reaches the standard discharge, the water quality of the water area is affected by the discharge of the sewage water, but it can still meet the water quality target requirements of the water function area. It will not change the function of the water function zone. The COD and ammonia nitrogen emissions do not exceed the water-staining capacity of the affected area, and have little impact on the river water quality and ecological environment.

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