Main points of emergency water source project planning in Xiantao City

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Abstract. Emergency water source plays a vital role of reducing risks of water supply in cities. The Chinese government has paid great attention on reserve and emergency water source. They have made clear the construction time requirements. For cities with single water source, the construction of emergency water source or standby water source should be basically completed by the end of 2020. This paper summarizes the planning content of the emergency water source project in the city, and focuses on the key points of Xiantao emergency water source function positioning. The key points includes water source function identification, economic scale calculation and determine risk duration. In the original plan, the risk duration is fifteen days, the effective storage capacity of the reservoir is proposed to be 3.5 million m³. Through systematic analysis and calculation, the risk duration is ten days, the effective storage capacity of the reservoir is 2.3 million m³. The project plan is optimized and the investment is saved. It is expected to provide a guidance for planning of standby and emergency water supply system in cities.

1. Background of The planning

Urban emergency standby water source is the most effective measure for cities to resist sudden pollution events, drought and other extreme weather. It is also the most important means for urban water supply security system to reduce water supply risk and ensure water supply security in special period. With the rapid development of the city, the risk and challenge of urban water supply security are increasing. The Chinese government has made clear the construction time requirements. For cities with single water source, the construction of emergency water source or standby water source should be basically completed by the end of 2020[1].

Xiantao City of Hubei Province is located in Jianghan Plain. The current drinking water source of the city is Hanjiang River. The raw water quality basically meets the class II water body function standard, and the annual water quality standard rate reaches 100%. However, affected by the South-to-North Water Diversion and the pollution of upstream industries, enterprises, residents and agricultural non-point sources, the water quality of Hanjiang River is in a trend of instability, seasonal water bloom and other water quality deterioration often occur, which has a great impact on the safety of urban water supply. Due to the lack of emergency water source, in the case that the water quality of Hanjiang River can not meet the requirements of drinking water source, the emergency mode can only be used to limit water supply and stop water supply.

Combined with the urban development planning, Xiantao City proposes to build an artificial reservoir in the south of the city as the emergency water source, and has the function of urban landscape. The Hanjiang River is the source of water supply for reservoirs. The water source engineering system...
is composed of water diversion (transmission) pipeline, reservoir, water intake pump station and other single projects. Among them, the raw water inlet pipe connecting the water intake (the existing water intake of the water plant) and the water transmission pipe of the reservoir are two-way water transmission pipes. During water replenishment, Hanjiang water will be transmitted to the reservoir, and in case of emergency, the reservoir water will be transmitted to the water plant by pressurizing the pump station[2].

![Figure 1. Project planning layout](image)

In the original plan, the risk duration is fifteen days, the effective storage capacity of the reservoir is proposed to be 3.5 million m$^3$. Through systematic analysis and calculation, the effective storage capacity of the reservoir is 2.3 million m$^3$. The planning conclusion was highly praised by Xiantao municipal government. They have a clear understanding of the economic scale of the project and are going through the planning approval and land permit.

2. Planning points of emergency standby water source project in Xiantao City

The key points of urban emergency standby water source planning include water source function identification, project scale, water source type and site selection, project layout and dispatching scheme, water source construction and protection.

2.1. Water source function identification

According to its main functions, the water source used in abnormal period can be divided into two types, i.e. emergency water source and standby water source. Emergency water source is a kind of water source that is built to solve the water quality safety problems such as sudden water source pollution, saltwater tide, seasonal sewage discharge, etc., to improve the safety of urban water supply and the ability to cope with water supply risks, and has the conditions of switching operation with the existing water source. Standby water source is a kind of water source constructed to solve the shortage of water source in extremely dry years, periodic cut-off and other water shortage problems, and to improve the assurance rate of urban water supply. The location of water source function depends on the risk factors.

Table 1 lists the main risk factors (not limited to) related to the safety of urban water supply, as well as the emergency measures that can be taken to ensure the basic water demand in addition to the limited time water supply measures. There are three water plants in Xiantao City can be used as standby for each other, and the water supply network in the central urban area has formed a network. Through technical and management means, the risk control of water production and transmission and distribution system is strong. Therefore, the main risks affecting the safety of urban water supply are insufficient water source and water pollution[4].

It is estimated that the long-term water demand of Xiantao City is 850000 m$^3$ per day, accounting for only 1.98% of the minimum controlled water inflow of the Hanjiang River, and the existing three water plants are all floating ship water intake. In terms of water quantity, it is reliable to be regarded as water source. Therefore, compared with the risk of water shortage, the main factor affecting the water supply
safety of Taoxian city is the risk caused by water pollution. Therefore, the function of this water source project can be positioned as emergency water source.

| Margin | Risk | Type | Emergency measure | Remarks |
|--------|------|------|-------------------|---------|
| Water shortage | Water shortage in extremely dry years | Emergency water source | Water bloom |
| | Periodic disconnection | Standby water source | |
| Source of water | Deterioration of water quality | Emergency water source, Strengthen water treatment, reduce production of water plant | |
| Water pollution | Seasonal blowdown | Emergency water source, Strengthen water treatment, reduce production of water plant | Flood period |
| | sudden water pollution | Emergency water source | |
| | Water intake facilities fault | The water plant reduces production and operation, strengthens maintenance, key equipment and main equipment are in stock. | |
| Water production | Water making facilities fault | More than two independent water systems shall be set up. When the water plant is in production reduction operation, the system not shut down is in overload operation. | |
| Equipment damage | Water conveyance facilities fault | Strengthens maintenance, key equipment and main equipment are in stock. | |
| | Power cut | Generally, more than two power incoming lines or self-contained generators are set | |
| Water Distribution System | Pipe-broken | Set up circular pipe work; strengthen maintenance force; sufficient spare parts | |

2.2. Project scale

According to the functional orientation of the project, the duration of risk period and the compression ratio of urban water use index are demonstrated. Through the analysis of water supply and demand balance, the water supply scale in emergency period is calculated. The recommended scheme is to build a new artificial reservoir and take water from Hanjiang River as the emergency water source of the city. The project investment is large and the operation cost is high. Calculating economic scale is of great significance for saving investment and operating costs.

The emergency water supply shall at least meet the basic domestic and production water demand in the risk period, and its water quantity shall be determined according to the city scale, nature, water supply risk faced and water use characteristics. For single water source cities:

\[ Q = q \times (1-k) \times t \]

Q—Emergency water volume (m³/d);
q—Urban average daily water consumption (m³/d);
$t$ — Duration (d);
$k$—Water compression ratio in risk period (%)

It can be seen that the function orientation and risk duration $D$ of water source are particularly important for calculating the economic scale of reservoir.

### 2.3. Water source type and site selection

According to the actual situation of Xiantao City, the type of water source and the site of water source should be optimized according to local conditions. The construction of urban emergency standby water source shall select groundwater or surface water such as rivers, lakes and reservoirs as the standby water source in combination with the local water resources. When there is no stable natural water source, artificial regulation and storage project can be built. The scheme of constructing artificial reservoir is selected for Xiantao emergency water source project.

Xiantao City is located in the hinterland of Jianghan Plain, with many surface waters. However, in the urban area of Xiantao City, except for a few water sources that can meet the requirements of water quality and quantity, such as the Yangtze River 30 kilometers away and the Dongjing River 20 kilometers away, most of the rivers in the city are poor five kinds of water bodies, most of the suburbs are dry lands or fishing ponds, lack of large-scale lakes and reservoirs, and the groundwater quality is greatly affected by the surface runoff. Therefore, apart from the Han River, there are few natural water sources to choose from.

Through scheme comparison and selection, the water quality and quantity of Dongjing River are lack of stability and reliability, and are far away from the central urban area, so it is not suitable to be used as emergency water source. In the long-term emergency period of Xiantao City, the water supply is 230000 m$^3$/d, and the water volume is large, so it is necessary to set up well groups to meet the water intake requirements. The distribution area of well group is wide, the protection requirement of water source is high, and the daily maintenance management is inconvenient. Therefore, groundwater is not suitable for centralized emergency water supply, but only for decentralized emergency water supply.

### 2.4. Project layout and dispatching scheme

It mainly includes the composition of urban water supply system in emergency period, the composition of emergency water supply transmission system and water supply dispatching scheme[3].

### 2.5. Water source construction and protection.

Through the comparison of technology and economy, the construction scheme of water source area is optimized, and according to the national and local laws and regulations, the protection requirements of water source area are put forward, and the corresponding engineering and technical scheme is recommended.

### 3. Determine risk duration

Risk period refers to the duration of water quality safety problems such as sudden water source pollution, saltwater tide and seasonal pollution, which is an important basis for determining the scale of emergency water source. The risk of water supply in different cities is different, and the duration of the risk is also very different. As for the duration of risk period, there are no existing standards or norms in China. It can only be inferred from existing cases and general knowledge.

Urban drainage: generally, it is only conducted in summer, and the duration of continuous rainfall is generally several days. For southern cities, the duration is relatively long. The duration of Urban Drainage Impact on water quality can be 5-15 days.

There are two reasons for the deterioration of water quality: on the one hand, eutrophication, algae exceeding the standard and so on cause the gradual deterioration or sudden deterioration of water quality (such as water bloom), so that the emergency measures such as strengthening water treatment process (such as increasing dosage, etc.) or reducing production load are not necessarily effective; on the other hand, some pollutants are discharged into water source, resulting in long water quality Pollution. For
Hanjiang River, the risk of water quality deterioration mainly comes from seasonal bloom, which lasts for 1-2 months and 15-20 days at peak.

The short-term sudden water source pollution incident generally refers to the incident that the pollutant enters the river and causes water pollution. The pollution group will move downstream with the water flow, so the impact time on the water supply is relatively short, such as the nitrobenzene pollution incident in Songhua River, the cadmium pollution incident in Beijiang River of Guangdong Province, etc. The impact of such incidents on the urban water supply is generally 5-10 days.

Based on the above analysis, according to the possible impact of water source risk on the economy and society of Xiantao City and the local disaster bearing capacity, the planning critical risk duration should be no less than 10 days. When the economic construction conditions permit, it can be further improved. According to the critical risk duration of 10 days, the total water demand is 1.98 million m³ (long term). Considering 15% water supply margin, the critical water supply in emergency period is 2.3 million m³ (long term). The comprehensive compression ratio is about 33%. If the expected emergency time is more than 10 days in the actual emergency process, the emergency period can be extended by increasing the compression ratio of water supply (such as further compression of industrial production water, water supply in different periods)[3].

4. Conclusion
The core content of emergency standby water source planning includes: selecting water source, reasonably determining water supply scale, scientifically formulating project construction plan and starting implementation according to the construction requirements of different water source types, and finally constructing urban emergency standby water source management system to provide effective support and guarantee for urban water supply safety. This paper introduces the key points of urban emergency water source project planning. Based on the functional analysis of the urban emergency water source project, the risk duration is calculated and the economic scale of the urban emergency water source is reasonably determined, which is conducive to optimizing the project plan and saving investment. It can be used as a reference for similar projects.

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