Layout Exploration for Subsequent Phases of High-Quality Promotion of South-to-North Water Diversion Project in Jiangsu Province

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Abstract. The South-to-North Water Diversion Project is a significant strategic initiative aimed at resolving severe water scarcity issues in northern regions of China. Building upon the foundation of the diversion from the Yangtze River to the northern part of Jiangsu Province, the Eastern Route of the South-to-North Water Diversion Project supplements water sources to the eastern regions of the North China Plain and the Shandong Peninsula by diverting water from the lower reaches of the Yangtze River. This project, implemented in three phases, has currently completed the first phase, effectively alleviating the water supply-demand conflicts in the provinces of Jiangsu and Shandong, particularly the continuous droughts faced by the Shandong.Building upon the experiences derived from the construction and operation of the first phase, this paper considers the macroeconomic and social development plans at the national, provincial, and basin levels. It focuses on the comprehensive evaluation of proposals for the engineering layout from the Yangtze River to Hongze Lake, Hongze Lake to Luoma Lake, and Luoma Lake to Nansihu Lake within Jiangsu province. The selection of layouts caters to the dual objectives of water quantity and quality, with optimization factors favoring layouts that minimize overall impacts. This approach not only adheres to the overarching national strategy for inter-basin water diversion but also safeguards Jiangsu's reasonable rights and interests in terms of water security, water resources, and water management. It proposes a specialized water conveyance plan towards the western regions.

Keywords: South-to-North Water Diversion Project; High quality; Jiangsu Province; Engineering layout; Subsequent phases; Planning research.

1 Introduction

The Beijing-Tianjin-Hebei region stands among the most severely water-deficient areas in China, where water scarcity has become a significant bottleneck restraining high-quality economic and societal development as well as the preservation and restoration of ecological environments. The implementation of the Phase I projects of

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P. Xiang et al. (eds.), *Proceedings of the 2023 5th International Conference on Hydraulic, Civil and Construction Engineering (HCCE 2023)*, Atlantis Highlights in Engineering 26,
https://doi.org/10.2991/978-94-6463-398-6_14

both the Eastern and Central Routes of the South-to-North Water Diversion Project has partially alleviated the conflict between water supply and demand. However, with the coordinated development in the Beijing-Tianjin-Hebei region, the implementation of national strategic initiatives like the Xiong'an New Area, and the advancement of ecological civilization construction, the demand for water resources in this area is poised to increase further. During an inspection of the Jiangdu Water Conservancy Hub, President Xi Jinping emphasized that the implementation of the South-to-North Water Diversion Project by the Party and the nation aims to scientifically adjust water resources [1], fostering balanced and sustainable development between the northern and southern regions. There is an imperative need to continue propelling the construction of the Eastern Route of the South-to-North Water Diversion Project, refining both its planning and construction strategies. This is to ensure that the Eastern Route becomes a lifeline for optimizing water resource allocation, securing drinking water for the populace, revitalizing the ecological environment of rivers and lakes [2], and facilitating the flow of the northern and southern economic cycles [3-4]. The segment of the South-to-North Water Diversion Project within Jiangsu presents characteristics of intricate engineering intersections, complex systems, and an extensive network of waterways. To better accomplish the water conveyance tasks, optimize investments, conserve land, facilitate effective management, and ensure ecological safety, refining and selecting the engineering layout within the Jiangsu segment holds paramount significance. This refinement should harmonize with the *Master Planning for the Project of Diverting Water from the South to the North*, incorporating new developmental ideologies and water management strategies.

2 Current Status of the Jiangsu Segment of Phase I of the Eastern Route of the South-to-North Water Diversion Project

Expanding upon the diversion from the Yangtze River to the northern part of Jiangsu Province, Phase 1 of the Eastern Route of the South-to-North Water Diversion Project has extended northward to supply water to Shandong Province. The Eastern Route project diverts water from the mainstream of the Yangtze River near Yangzhou, Jiangsu Province, utilizing two intake gates—Sanjiangying and Gaogang—to share water resources with the East Diversion Irrigation Area of Jiangsu Province. The water transmission line, structured around reservoirs, is divided into three sections: from the Yangtze River to Hongze Lake, from Hongze Lake to Luoma Lake, and from Luoma Lake to downstream lakes [5-6].

The planning for the Phase 1 project from the Yangtze River to the Hongze Lake section involves diverting 500 m^3/s from the Yangtze River, with an intake into Hongze Lake at 450 m^3/s. Capitalizing on the Li Canal and two water conveyance routes via the Sanyang River and Tong River, water is pumped at 400 m^3/s from Jiangdu Station and 100 m^3/s from Baoying Station into the Li Canal. Continuing north along the Li Canal to Dashanzi, the route intersects the Northern Jiangsu Irrigation Main Canal in Huaian Hub. From Huaiyin Station, 300 m^3/s is drawn into

Hongze Lake. Simultaneously, another route proceeds westward through the Jinbao Channel and Sanhe River, drawing 150 m^3/s from Jiangba Station into Hongze Lake.

In the Phase 1 project from Hongze Lake to Luoma Lake, the planned extraction from Hongze Lake stands at 350 m^3/s, with an inflow into Luoma Lake at 275 m^3/s. This phase utilizes a dual-line water conveyance system via the Zhongyun Canal and the Xuhong River. Within this system, the Zhongyun Canal conveys water at rates ranging from 230 to 175 m^3/s, drawing water from the Zaohe Station into Luoma Lake. Meanwhile, the Xuhong River conveys water at rates between 120 to 100 m^3/s, drawing water from the Pizhou Station and merging with the Fangting River towards the east into the Zhongyun Canal [7].

Moving to the Phase 1 project from Luoma Lake to Nansihu Lake, the planned extraction from Luoma Lake is set at 250 m^3/s, with an inflow into downstream lakes at 200 m^3/s. This phase adopts a dual-line water conveyance system via the Bulao River and the Hanzhuang Canal, with both lines conveying water at a scale of 125 m^3/s each. The construction in the Bulao River section includes renovations and new constructions of the three-tire pump stations (Liushan, Jietai, and Linjiaba). Simultaneously, in the Hanzhuang Canal section, the construction involves the establishment of the three-tire pump stations (Taierzhuang, Wannianzha, and Hanzhuang) [2,8].

3 Scope and Scale of Water Supply in the Eastern Route of the South-to-North Water Diversion Project

The Eastern Route of the South-to-North Water Diversion Project spans four major river basins: the Yangtze River, the Huaihe River, the Yellow River, and the Haihe River. It primarily caters to urban and rural domestic water needs and facilitates industrial water supply. It also addresses considerations for agricultural irrigation, ecological replenishment for Baiyangdian Lake, and remediation of over-extracted groundwater sources. The project's water supply scope encompasses two municipalities directly under the central government—Beijing and Tianjin—along with 178 counties (districts, cities), including Xiong'an New Area, within 28 prefecture-level cities in four provinces: Anhui, Jiangsu, Shandong, and Hebei [9].

In the subsequent phases of the Eastern Route of the South-to-North Water Diversion Project, the planned water conveyance scale for each segment is delineated as follows: 870 m^3/s extracted from the river (with an additional 370 m^3/s in future phases), 530m^3/s inflow into downstream lakes (with an additional 330 m^3/s in future phases), and 340 m^3/s crossing the Yellow River (with an additional 290 m^3/s in future phases). Over multiple years, the average annual water extraction quantities stand at 14.913 billion m^3 from the river, 9.072 billion m^3 inflow into downstream lakes, and 5.783 billion m^3 crossing the Yellow River. The net additional supply averaged over multiple years from the mouth gates of each mainline in the subsequent phases of the Eastern Route amounts to 5.354 billion m^3 annually.

4 Characteristics of the Eastern Route of the South-to-North Water Diversion Project in Jiangsu Province

The characteristics of the Eastern Route of the South-to-North Water Diversion Project in Jiangsu Province, building upon the foundation of the diversion from the Yangtze River to the northern part of Jiangsu Province, involve an expanded scale and northward extension. The project utilizes the Grand Canal and its parallel waterways as the main water conveyance routes. Water is incrementally lifted at various stages along the route towards the north, ultimately connecting to the reservoirs of Hongze Lake, Luoma Lake, and Nansi Lake, which function as water storage facilities. The project exhibits the following distinct characteristics:

4.1 The South-to-North Water Diversion Project is an elevation upon the foundation of the diversion from the Yangtze River to the northern part of Jiangsu Province, rather than an independent engineering system.

Since the 1950s, Jiangsu Province has embarked on planning and constructing critical infrastructure such as the Jiangdu Station, the Huai-Shu New River, and the rehabilitation of the Grand Canal. Over more than 60 years of concerted development efforts, a relatively comprehensive system for the Jiangsu Water Diversion Project has been established. This system facilitates mutual water exchanges and support between the Yangtze River, the Huai River, the Shu River, the Yi River, and the Si River. It achieves unified water resource allocation, enabling the distribution of Yangtze River water to every county, city, and district in northern Jiangsu, yielding tremendous benefits. Phase I of the South-to-North Water Diversion Project builds upon this existing groundwork in Jiangsu, renewing and transforming three pumping stations, constructing eleven new pumping stations, and expanding some water conveyance channels. This phase primarily constitutes isolated projects interlinked with the diversion from the Yangtze River to the northern part of Jiangsu Province, lacking the formation of an independent engineering system [10].

4.2 The Jiangsu segment of the South-to-North Water Diversion Project system serves not only as a water diversion system out of the province but also fulfills various comprehensive public functions along its route, including flood control, drainage, irrigation, and navigation.

Initiated in the 1950s, the diversion system from the Yangtze River to the northern part of Jiangsu Province originated from existing flood control and drainage infrastructure, evolving into a comprehensive water supply and drainage system across basins, incorporating irrigation, drainage, navigation, ecology, salinization control, and marshland development. It covers seven cities and fifty counties (districts) of northern Jiangsu, spanning over 63,000 square kilometers, irrigating more than 45 million mu (approximately 3 million hectares) of farmland, and serving nearly 40 million people. Key reservoirs such as Hongze Lake, Luoma Lake, and downstream lakes serve as both

water storage reservoirs and crucial flood regulators for the Huai River, the Shu River, the Yi River, and the Si River regions. They are integral components of the flood control system. Moreover, the Grand Canal and the Xuhong River not only function as water conveyance mainlines but also contribute to the drainage system and serve as major waterways. Around 70% of the pumping stations are tasked with drainage responsibilities. Crucial nodes such as Jiangdu, Huai'an, Erhe, Suqian, and Zaohe act as pivotal hubs for joint flood control, drainage, and water supply operations in northern Jiangsu. Cooperative coordination among these nodes is essential to ensure safety and maximize efficiency, enabling the full realization of benefits [11].

4.3 The subsequent phases of the Eastern Route of the South-to-North Water Diversion Project within Jiangsu province do not entail additional water supply to the region, with the primary objective of ensuring water supply to areas outside the province.

Phase I of the South-to-North Water Diversion Project in Jiangsu involves a supply area encompassing six cities—Yangzhou, Yancheng, Xuzhou, Huai'an, Suqian, and Lianyungang—and 33 counties (districts), covering a total area of approximately 31,300 square kilometers with around 28 million mu (approximately 1.87 million hectares) of arable land. Through comprehensive analysis under the principle of "prioritizing water conservation, achieving spatial equilibrium, comprehensive system governance, and dual efforts," it has been determined that by maximizing the existing potential of the current infrastructure and rational utilization of water resources from the Huai River, the Shu River, the Yi River, and the Si River, the Phase I of the project can meet the water supply demands of the designated South-to-North Water Diversion supply area by 2035. Therefore, there is no planned increase in the volume of new water supply within Jiangsu in the subsequent phases of the South-to-North Water Diversion Project. Instead, the primary focus of these later phases within Jiangsu is to ensure water supply to areas outside the province [12].

5 Layout for Subsequent Phases of the Eastern Route of the South-to-North Water Diversion Project in Jiangsu Province

5.1 Principles for Project Layout

Phase I of the Eastern Route of the South-to-North Water Diversion Project in Jiangsu Province extensively utilized existing water conservancy projects. Most of the water conveyance mainlines and associated hub projects serve multiple purposes, such as water supply, flood control, navigation, and ecological preservation. Considering various factors covering economic, land utilization, and management aspects, the layout of subsequent phases should aim to maximize the utilization of existing river and lake systems and other water conservancy projects. This ensures meeting the required scale of water conveyance while also addressing the needs for flood control, drainage,

ecological preservation, and navigation [2, 3]. The primary principles guiding the layout study for these subsequent phases include:

1. The project layout heavily hinges on pre-existing river channels, lakes, and associated water systems (like hydraulic structures). This strategy aims to optimize investments and efficiently manage land and spatial resources [4, 5].
2. Designing the layout entails considering current functionalities and future demands encompassing water supply, flood control, navigation, and ecological preservation. Balancing standards for water supply, flood control, and drainage while accommodating navigation needs is crucial. Safeguard measures should be proposed in areas where it is challenging to address all these requirements simultaneously [6].
3. Prioritizing land conservation, environmental protection, and sustainable ecological practices is integral to the layout. Reasonable optimization of design plans aims to minimize additional land use and avoid ecologically sensitive areas.
4. Determining conveyance levels considers terrain, hydrogeological conditions, and current water usage patterns. This approach aims to minimize disruption to existing flood control, drainage, water supply, and navigation functions. It facilitates the utilization of existing supporting infrastructure to supply water to users. In cases where changes in water conveyance or storage conditions affect the environment, appropriate measures or compensations should be undertaken.
5. The project layout should fully consider the principle of integration with Phase I infrastructure. Under the premise of technical feasibility and economic rationality, the project layout should strive to seamlessly integrate with Phase I facilities, ensuring it does not impede the operation of Phase I or compromise the safety of surrounding structures.

5.2 Project Layout

In Jiangsu, with its well-developed water systems and dense river networks, the strategic determination of water conveyance routes is particularly crucial to maximize the benefits of the subsequent phases of the project. Based on the current project status and the distinctive features of the projects within Jiangsu, two comparative options have been proposed: a dual-line water conveyance scheme and a single-line water conveyance scheme. These options revolve around the reservoirs at Hongze Lake, Luoma Lake, and downstream lakes, segmented into three sections. The detailed delineation of the water conveyance routes in these sections is as follows:

Section from the Yangtze River to Hongze Lake.

In the subsequent project planning, an additional intake of 370 m^3/s from the Yangtze River and an inflow of 360 m^3/s into Hongze Lake are proposed. There are two available water conveyance routes for the subsequent project: the Sanyang River-Tong River route and the Yunxi River route.

Single-line plan: The proposed approach for the increased capacity involves a single-line water conveyance through the Yunxi River channel. Starting from Jiajiang and passing through Liaojiagou, a new pumping station, Guangling Station (370 m^3/s),

would draw water into Shaobo Lake. From there, at the Gaoyou Control Line, a new Gaoyou Station would pump water into Gaoyou Lake. Continuing along the Jingou Diversion Section, the water would be pumped into Xin Sanhe from the new station, Jinhu Second Station. Then, through a newly built Hongze Second Station, water would be pumped into Hongze Lake.

Doube-line plan: This plan proposes the utilization of both the Yunxi River channel and the Sanyang River-Tong River channel for increased capacity. The Sanyang River and Tong River would contribute an additional intake of 100 m^3/s to Baoying Station. Water would be conveyed from Baoying Station through the Jinbao Waterway to Jinhu Station. Simultaneously, the Yunxi River channel, similar to the single-line plan, would convey water at a capacity of 270 m^3/s. At the Jinhu Cascade, this flow would merge with the Yundong water conveyance line, and together, they would carry the water through Sanhe to the Hongze Cascade. From the Hongze Cascade, an additional intake of 360 m^3/s would be directed into Hongze Lake.

Section from Hongze Lake to Luoma Lake.

In the subsequent project planning, an additional discharge of 350 m^3/s from Hongze Lake and an inflow of 345 m^3/s into Luoma Lake are proposed. There are two available water conveyance routes for the subsequent project: the Luonan Middle Canal water conveyance route and the Xuhong River water conveyance route.

Single-line plan: The entire additional capacity in the subsequent plan would be transported solely through the Xuhong River. It would pass through the Sihong Cascade, the Suining Cascade, and the Pizhou Cascade, drawing water into Fangting River via the Middle Canal to enter Luoma Lake or be diverted north. The Luonan Middle Canal would maintain its original scale from the first phase.

Doube-line plan: Utilizing the existing potential of the Luonan Middle Canal, the subsequent project proposes a dual-line water conveyance system using both the Luonan Middle Canal and the Xuhong River. In this plan, the Luonan Middle Canal would introduce an additional intake of 100 m^3/s, drawing water from the Siyang Cascade, the Liulaogou Cascade, and the Zaohe Cascade to enter Luoma Lake. Simultaneously, the Xuhong River would introduce an additional intake of 250 m^3/s, drawing water respectively from the Sihong Cascade, the Suining Cascade, and the Pizhou Cascade into Fangting River via the Middle Canal to enter Luoma Lake or be diverted north.

Section from Luoma Lake to downstream lakes.

In the subsequent project planning, an additional discharge of 340 m^3/s from Luoma Lake and an inflow of 330 m^3/s into Luoma Lake are proposed. There are two available water conveyance routes for the subsequent project: the Bulao River water conveyance route and the Hanzhuang Canal water conveyance route.

Single-line plan: All additional water conveyance in the subsequent plan would proceed through the Luobei Middle Canal and the Hanzhuang Canal. The water would be drawn through the three-tier pump stations (Taierzhuang, Wannianzha, and Hanzhuang) and pumped via the old canal into downstream lakes.

Doube-line plan: By fully utilizing the existing potential of the Bulao River, the subsequent plan suggests that after the additional water exits Luoma Lake, it would be conveyed northward along the Luobei Middle Canal. One route would follow the Bulao River (additional 75 m³/s) westward, passing through the three-tier pump stations (Liushan, Jietai, and Linjiaba) to enter downstream lakes. The other route would follow the Luobei Middle Canal and Hanzhuang Canal (additional 265 m³/s) northward, passing through three-tier pump stations (Taierzhuang, Wannianzha, and Hanzhuang) via the old canal into downstream lakes. Conceptual Layout for the Subsequent Phases of the South-to-North Water Diversion Project in Jiangsu Province as follows Figure 1.

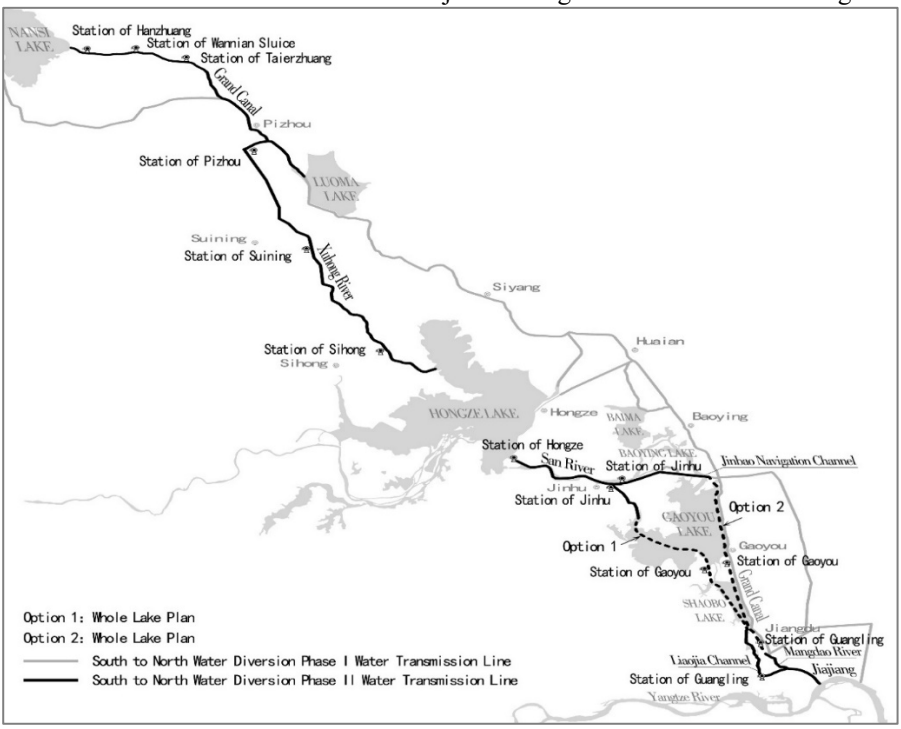

Fig. 1. Conceptual Layout for the Subsequent Phases of the South-to-North Water Diversion Project in Jiangsu Province

In order to fulfill the subsequent water transmission missions, the single-line plan proposes the construction of ten cascade pump stations, including Guangling Station and Gaoyou Station, within Jiangsu province. The plan involves the implementation of channel extraction from the Shaobo Lake, Gaoyou Lake, Hongze Lake, and the Xuhong River mouth, alongside dredging operations at the diversion section of the Jingou in the West Pianhong, the Sanhe River, the Fangting River (from Liujidihan to the Middle Canal), the Luobei Middle Canal (from Dawang Temple to the provincial border), and the Hanzhuang Canal. Additionally, expansion of the Xuhong River and excavation of river channels will necessitate a total of 220.02 million cubic meters of earthworks while requiring 4.01 million cubic meters of fill. This undertaking entails permanent

land acquisition of 59,000 mu and temporary land acquisition of 188,000 mu, with a comprehensive project investment totaling 80.61 billion yuan.

In contrast, the double-line plan proposes the construction of 18 cascade pump stations, including Guangling Station, Baoying Station, and Gaoyou Station, within Jiangsu province. This plan involves executing channel extraction from Shaobo Lake, Gaoyou Lake, Hongze Lake, and the mouths of the Xuhong River and Chengzi River. Dredging operations will occur at the diversion sections of the Jingou in the West Pianhong, the Sanhe River, Chengzi River, Luonan Middle Canal (from Siyang Station to Pihong River Station), the Fangting River (from Liujidihan to the Middle Canal mouth), the Luobei Middle Canal (from Dawang Temple to the provincial border), and the Hanzhuang Canal. Furthermore, expansions of the Sanyang River, Tong River, and Jinbao Channel, alongside the Xuhong River, will take place. Risk mitigation efforts will be implemented in the Luonan Middle Canal and Bulao River sections. This comprehensive undertaking requires a cumulative excavation of 209.11 million cubic meters and a filling of 6.65 million cubic meters. It entails a permanent land acquisition of 58,000 mu and a temporary land acquisition of 186,000 mu, with a total project investment racking up 89.11 billion yuan. Summary of Project Investments for Different Plans as follows Table 1.

Table 1. Summary of Project Investments for Different Plans

Section	Single-line Plan				Double-line Plan			
	From Yangtze River to Hongze Lake	From Hongze Lake to Luoma Lake	From Luoma Lake to downstream lakes	Total	From Yangtze River to Hongze Lake	From Hongze Lake to Luoma Lake	From Luoma Lake to downstream lakes	Total
Excavation (10,000 cubic meters)	10805	8552	2645	22002	12294	7179	1438	20911
Filling (10,000 cubic meters)	13	378	9.51	401	342	313	9.51	665
Permanent Land Acquisition (10,000 mu)	1.331	3.65	0.9	5.9	1.544	3.38	0.92	5.8
Temporary Land Occupation (10,000 mu)	6.639	8.84	3.36	18.8	7.72	8.51	2.37	18.6
Project Investment (billion yuan)	37.9	30.69	12.02	80.61	44.5	33.03	11.58	89.11

5.3 Comparison of Plans for Water Conveyance Routes

The subsequent project for the Eastern Route of the South-to-North Water Diversion Project in Jiangsu Province utilizes existing rivers and lakes to supply water to areas outside the province without increasing the water supply within the province. Critical considerations for the selection of subsequent project routes include coordinating the timing of water supply both within and outside the province, harmonizing flood control and drainage with water supply schedules, aligning existing functions of rivers and lakes with water supply for shipping, aquaculture, and ecological preservation, and effectively managing water pollution under the conditions of water transfer within Jiangsu's river network. Table 2 demonstrates further details on the project quantities, investments, and advantages and disadvantages of each proposed plan.

Table 2. Comprehensive Comparison of Plans for Water Conveyance Routes

Conveyance plan	Project	Project Quantity	Plan Comparison	
			Advantages	Disadvantages
Single-line Plan	Excavation (10,000 cubic meters)	22002	1. Centralized water delivery with relatively economical investment, simplified operational management, fewer water users and pollution outlets along the route, high guarantees for water quantity and quality, and minimal impact on regional flood control, drainage, irrigation, and navigation; 2. Economical investment and relatively simple management.	1. Inadequate utilization of the existing water conveyance capacities of the Chengzi River, Luonan Middle Canal, and Bulao River and large-scale excavation required for the Xuhong River, Luobei Canal, and Huanzhuang Canal; 2. Large-scale excavation for Luobei Canal and Huanzhuang Canal accelerates flood discharge, intensifying flood control pressure on Luoma Lake. However, this can potentially be resolved by controlling discharge at the Huanzhuang Hub.
	Filling (10,000 cubic meters)	401		
	Permanent Land Acquisition (10,000 mu)	5.9		
	Temporary Land Occupation (10,000 mu)	18.8		
	Project Investment (billion yuan)	80.61		
Double-line Plan	Excavation (10,000 cubic meters)	20911	1. Maximum utilization of existing river and lake conveyance capacities and relatively smaller channel excavation scale; 2. Slightly reduced permanent and temporary land occupation compared to the single line plan.	1. Dispersion in station construction leads to significant investment in building infrastructure, resulting in complex operational scheduling and management; 2. The Luonan Middle Canal and Bulao River pass through the Suqian and Xuzhou urban areas, while the Sanyang River and Tong River traverse the Liduhe area. Numerous industrial and agricultural water intake and drainage outlets along these areas result in poor water supply stability during the irrigation peak in June. This significantly affects navigation on the Grand Canal, posing a higher risk of water pollution [13].
	Filling (10,000 cubic meters)	665		
	Permanent Land Acquisition (10,000 mu)	5.8		
	Temporary Land Occupation (10,000 mu)	18.6		
	Project Investment (billion yuan)	89.11		

Table 1 reveals that the double-line plan's engineering investment from the Yangtze River to the Luoma Lake section is higher than that of the single-line plan [14]. The

investment in the section from Luoma Lake to downstream lakes is slightly higher for the double-line plan than the single-line plan. Simultaneously, the northern Jiangsu section of the Grand Canal serves as a crucial inland waterway connecting the north and south of China, a primary flood control and drainage channel in the Huai River, Yi River, Huai River, and Si River, and an irrigation water source for the grain depot in northern Jiangsu [15]. This region features dense urban and industrial layouts, numerous inlet and outlet ports, prominent conflicts between water diversion and shipping, relatively high pollution risks, and poor stability in supplying water during irrigation peak periods. The water diversion line from the west to the river mouth and the Xuhong River water transmission line exhibit comparatively lower levels of industrialization, fewer user households for water diversion, and focus primarily on subsequent projects for domestic and industrial water supply. There are high requirements for water quality assurance and water supply guarantee rates, ensuring prolonged and consistent water supply [16-17]. In prioritizing the achievement of water supply objectives while minimizing comprehensive impacts on regional flood control, drainage, and shipping, the recommended approach within Jiangsu Province for the subsequent phases of the South-to-North Water Diversion Project is the single-line plan.

6 Conclusion

The South-to-North Water Diversion Project stands as a significant strategic initiative in establishing the overall water resources allocation pattern of "Three Diverged Routes, Four Interconnected Rivers, South-North Redistribution, and East-West Mutual Assistance" in China [6,18]. This paper, while analyzing the necessity of the subsequent phases of the Eastern Route of the South-to-North Water Diversion Project and the engineering characteristics within Jiangsu Province, conducts a comprehensive comparison of water transmission routes in Jiangsu Province based on economic and technical aspects, considering the *Master Planning for the Project of Diverting Water from the South to the North*, the *Planning of Subsequent Phases of the Eastern Route of the South-to-North Water Diversion Project*, and opinions from local governments along the route [19]. The proposed recommendation [4,20], aiming for the realization of water supply goals while minimizing comprehensive impacts, serves as a guiding basis for the smooth construction and implementation of the subsequent phases of the Eastern Route of the South-to-North Water Diversion Project. Furthermore, it provides valuable insights and experiences for the planning and design of watershed water diversion projects[21-25].

Acknowledgment

This research was supported by the Jiangsu Province Water Conservancy Science and Technology Project: Study on the Relationship between the Subsequent Phases of the Eastern Route of the South-to-North Water Diversion and Water Security in Northern Jiangsu (Project No.: 2021001).

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