

Strengthen the review, examination, and inspection of land management and use for investment projects to build housing, urban areas, technical infrastructure, and social infrastructure in urban areas. town, housing area; Resolutely revoke and strictly handle projects that are slow to be implemented, have been allocated or leased land but are slow to put the land into use or violate land laws.

4.4. Recourses

Reasonable arrangement of capital from the City budget, including effective use of money collected from 20% and 25% residential land funds in commercial and residential housing construction investment projects. Urban area 1 to invest in building social housing for policy beneficiaries, workers and laborers in industrial zones and clusters, and student housing.

Exploit land resources to create capital for housing development, especially resettlement housing and social housing for rent according to the "Project on exploiting land resources to create capital for socio-economic development Hanoi City Council for the period 2021 - 2025 and the following years.

Mobilizing socialized capital for housing development through many forms (such as mobilizing capital from

businesses, banks, credit institutions, local development investment funds, stocks, bonds and other legal capital sources) to create a stable, long-term housing finance system and reduce dependence on the state budget.

Effectively mobilize foreign capital through international financial mobilization mechanisms such as: investment funds, real estate trust funds, joint ventures, and partnerships to implement housing investment projects; create conditions for foreign investors to participate in social housing development.

Reasonably arrange capital from the City budget, mobilize other capital sources to develop housing for policy beneficiaries, for subjects under the National Target Programs on sustainable poverty reduction, construction Building new rural areas, socio-economic development in ethnic minority and mountainous areas has been approved by the Prime Minister.

Reasonably arrange capital from the City budget, mobilize other capital sources to carry out inspection, make detailed planning, and deploy renovation and reconstruction of apartment buildings according to the Project and implementation plans. Declare the project to renovate and rebuild old apartments in the City and legal regulations./.

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Proposal for surface water drainage solutions to minimize flooding for Thai Nguyen city towards sustainable urban development

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Abstract

The article summarizes and evaluates the current situation of planning, surface drainage infrastructure and the current status of urban drainage system management in Thai Nguyen city in the context of urbanization. The research object is within the scope of urban traffic routes and urban area projects (Projects) that have been and are being implemented. Based on reference to construction standards and criteria, the article proposes a number of planning and management solutions, constructing and developing drainage systems in a sustainable and environmentally friendly manner, contributing to the sustainable urban development of Thai Nguyen city.

Key words: *Urban management for sustainable development, Thai Nguyen city drainage, Urban management, Flooding in Thai Nguyen city, Thai Nguyen city planning*

1. Introduction

In the current context of environmental degradation and global climate change, sustainable urban development has become one of the important goals for all countries in the world in the 21st century. The direction of sustainability at the scale of all urban areas and projects in Vietnam has been legalized and gradually put into practice in Vietnam. Planning, designing and organizing urban road networks towards sustainable urban traffic development is an urban planning and development trend that has appeared in recent decades and is on the rise worldwide. A sustainable urban transportation system is a transportation system with the goals of no flooding, reducing emissions, ensuring comfort and safety for users, and promoting or supporting people towards a sustainable, healthy and socially cohesive lifestyle, at the same time, ensuring current and future needs in terms of economic, social and environmental aspects.

In 2022, the Politburo and Central Committee of the Communist Party of Vietnam issued Resolution 06-NQ/TW dated January 24, 2022 on "Planning, construction, management and sustainable development of Vietnamese urban areas to 2030, vision to 2045" with 5 groups of perspectives and 6 main solutions. It is the basis for building a new, dynamic, prosperous and sustainable image for urban areas in Vietnam.

The Northern Midlands and Mountains of Vietnam is a large region with 14 provinces, 21 districts and 1 town. The policy of the Party and State is to shorten the gap between regions, therefore, urban development in the midland and mountainous regions is receiving increasing attention, especially developing the road network along urban administrative boundaries.

Among the major cities in the North, Thai Nguyen city is the central city of the Northern Midlands and Mountains region. Established in 1962 and developed into an industrial city, after many adjustments and transformations to suit socio-economic development, it is the 10th most populous city in the country now with an area of 23,874.36 hectares and a population of approximately 400,000 people, acting as a provincial city and urban area Type I (Decision No. 1645/QD-TTg dated September 1, 2010 of the Prime Minister). Thai Nguyen city is currently the political, economic, cultural, educational, scientific - technical, medical, tourism and service center of Thai Nguyen province and the Northern Midlands and Mountains. In the inter-regional transportation system, Thai Nguyen city acts as a traffic hub with 4 national highways passing through National Highway 3, National Highway 17, National Highway 37, National Highway 1B; 1 Hanoi - Thai Nguyen expressway; The Thai Nguyen - Bac Kan expressway is also the gateway to the Northeastern provinces such as Cao Bang, Bac Kan, Ha Giang, Tuyen Quang, and Lang Son.

The general planning for Thai Nguyen city construction until 2035 has been approved and adjusted by the Prime Minister in Decision No. 1989/QD-TTg dated November 26, 2021 with the general goal to develop Thai Nguyen as a sustainable, modern city, the political, economic, cultural, educational, medical, tourism and service center of Thai Nguyen province & the Northern Midlands and Mountains region; is a development pole of Hanoi Capital region. At the same time, Thai Nguyen city has an important position in security and defense, is a gateway city, and plays an important connecting role between the Hanoi Capital Region and the Northern Midlands and Mountains Region. In that context, concretizing the strategies and development orientations of the Country, Region, Province and Thai Nguyen City in investing in urban road networks towards sustainable and modern

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urban development, intelligence is an inevitable trend.

Thai Nguyen city has made strong development steps, many urban infrastructure projects and strategically important roads have been built. The system of social utility infrastructure has been invested in on a large scale and safely, all of which have changed the appearance of the city, including urban traffic.

However, in recent years, the population of Thai Nguyen city has continuously increased rapidly. In addition, the city has to receive a large number of immigrants as labor force and students studying at universities and colleges in the area each year, so there has been a situation where the transportation system cannot meet travel needs, traffic volume has increased rapidly, the road network is overloaded, and environmental pollution has occurred on some routes.

Roads are degraded and surface water flooding has not been resolved. Besides, the pace of urbanization is rapid, while ponds and lakes that collect water are increasingly shrinking, the drainage infrastructure system is not synchronized and there is still a situation where people litter trash and construction materials into the sewer, encroaching on the sewer surface for business purposes...causing flooding in the city, especially when heavy rain occurs. Some solutions have been proposed, but they are still fragmentary or narrow in scope, without forming a comprehensive, sustainable, long-term system. The traffic and environmental problems that Thai Nguyen city is facing in the current context of urban development require solutions suitable to the trend of sustainable urban development.

2. Current status of surface water drainage infrastructure

2.1. Planning adjustments and impacts on surface water drainage infrastructure

Detailed planning projects are approved with criteria according to a sustainable model to create complete, synchronous urban areas, in accordance with the overall city planning. The projects are initially planned and built very well, but during the implementation of the later stages, the investor adjusted the planning and transferred the component projects to secondary investors. These projects then built more floors, increased construction density, increased land use coefficient, and changed land use purposes, leading to the completely broken planning structure of the project. Increased concrete rate and reduced tree-water ratio will reduce the surface water permeability of the soil and reduce the drainage capacity of basins in urban areas.

Some projects are delayed in implementation, leading to suspended planning. In addition to wasting land and socio-economic resources, they also seriously affect the environment. The project is abandoned, the drainage points as ponds and lakes in the project land are leveled while the infrastructure has not been deployed synchronously (traffic, drainage...). There is no receiving body for surface water discharging, leading to local flooding in the heart of the city. Some projects so far have not been or are slowly being implemented, such as: Planning for the Western administrative area; Eastern administrative region; Some residential areas in Tuc Duyen, Tan Lap, Quyet Thang wards, etc.^[14]



Figure 1. The first rain of the season turns many roads in Thai Nguyen city into streams and rivers[12]

The sudden increase in population leads to increased traffic density, putting pressure on the technical infrastructure system, including the surface water drainage system. Emissions from vehicles can pollute surface water sources. Toxic substances in exhaust fumes can fall into storm water and flow into sewer systems, reducing water quality and causing environmental problems. Garbage and solid waste from vehicles and users can clog the drainage system. When drainage flow is not guaranteed, local flooding on the roads of Thai Nguyen city is unavoidable.

2.2. Problems encountered during the use of surface drainage infrastructure

In projects, due to the investment mechanism, the construction of drainage infrastructure systems has not been synchronized.

Management work has not been paid attention to, lack of synchronous coordination between functional branches and urban authorities, sanctions are not strict for construction violations, and people's awareness of law observance is still low.

- Over the past 4 years, many projects have not been completed synchronously, such as: Xuong Rong Lake urban area project; Thai Nguyen city drainage project of Drainage and Urban Infrastructure Development Limited Company; Residential Area Project No. 5, Phan Dinh Phung Ward; Bac Son - Song Hong Housing Area Project; Parking lot project at Dan overpass intersection; Residential area projects No. 3 and 4 in Dong Quang ward, etc.

- The outlet at the end of Xuong Rong lake was constructed in the wrong location, the current sluice area is only two-thirds the area of the approved design; Not long after the drainage system was put into use, it had to stop operating from August 2019 due to the fire and explosion of electric cabinets; The connection of newly constructed sewers to the old sewer line is not suitable in terms of sewer bottom elevation, leading to untimely drainage, such as at the gate of Thai Nguyen Central Hospital, the gate of Thai Nguyen Pedagogical University, and the gate of Thai Nguyen City Police Department, etc.

- In many places, the drainage system is encroached on the sewer surface, such as: Minh Cau street, Dong Danh stream (section from Bong Toi bridge to Cau river), Lang Danh stream (section from Dan overpass to Mo Bach stream), stream Cactus (the section from behind the International Hospital to Dong Danh stream), Mo Bach



Figure 2. Construction work above the drainage sluice gates on both sides of the road (New bus station, Tan Lap and Tan Thinh wards)[12]

stream (the section from Mo Bach bridge to Cau river), etc.. In particular, some locations of underground sewer systems, box culverts and open ditches are encroached, such as: Next to Luong Trang Co., Ltd. on Bac Kan street, next to the Department of Agriculture and Rural Development on Luong Ngoc Quyen street, the underground box culvert system has narrowed flow; Square underground sewers in group 11 of Dong Quang ward, group 11 of Phan Dinh Phung ward were completely encroached by construction; On the section of Xuong Rong stream near Viet Bac Mining Chemical Joint Stock Company and the section near Phan Dinh Phung street, a row of 2-storey houses on the stream with a length of about over 100m was built by Dan Chu Glass Cooperative.

According to the Director of Thai Nguyen Department of Construction, it is due to the rapid pace of urbanization in the inner city, while the main drainage system has not responded appropriately. The current rainwater drainage system is basically too old and cannot meet drainage needs when there is heavy rain.

The area of lakes and ponds, green land, cultivated land, and public land has been reduced and filled; Besides, the beds of streams, streams, and ditches are encroached, with a case of building 2-storey houses on the stream surface or building stone embankments, planting trees narrow and change the flow direction. In particular, sidewalks on roads are also "concreted" with waterproof construction materials, leading to the flow of rainwater not being blocked.

Residential and urban area projects are implemented inconsistently and do not meet the schedule. Projects next to the previous construction have higher ground elevations, therefore, the adjacent residential areas or adjacent projects slow implemented are flooded.

The road surface is cracked and locally degraded. Drains are clogged with sludge, manhole covers are broken or stolen, drains become places for littering.

Currently, the drainage system of Thai Nguyen city is divided into 4 catchments, including: Dong Danh Stream; Lang Danh stream; Xuong Rong 2 stream and Cong Ngu ditch - take on the role of drainage for central wards and some main roads. However, because the sewer system, drainage manholes, open ditches and the downstream part of underground sewers are not regularly dredged, they obstruct the flow when it rains heavily.

Periodic maintenance and dredging of sewers, clearing of ditches and streams is not regular and is not guaranteed according to procedures. Low awareness in community, the

discharge of solid waste from construction, production, and daily life into the storm water drainage system causes filling of the water intake, causing stagnation and blocking the flow. The proportion of land serving the drainage system has not been paid enough attention to meet urban development, the investment efficiency of some projects is still slow, and the feasibility is low... [12].

The increase in urban population leads to increased vehicles and traffic volume, putting pressure on the transportation infrastructure system, including the surface water drainage system.

Residents of Thai Nguyen city are suffering from environmental pollution affecting their health and quality of life. Ondeedly flooded streets, there are low-lying spots that flood from 0.5 meters to more than 1 meter during the rainy season, making it impossible for people and vehicles to move. Therefore, traffic participants have to choose many shortcuts and bypasses, causing local traffic congestion, especially during rush hours. In addition, many residential areas suffered from localized flooding that flooded into houses, disrupting people's lives [6].

3. Management of surface water drainage system

According to Decision No. 07/2021/QD-UBND of Thai Nguyen Provincial People's Committee dated January 22, 2021 on promulgating regulations on management of drainage and wastewater treatment activities in Thai Nguyen province [5], in Article 04, Chapter 02: The Provincial People's Committee delegates to the People's Committees of districts, cities and towns (hereinafter referred to as district-level People's Committees) to be the owners of drainage systems in the locality. The table is managed by me. The owner of the authorized drainage system is Thai Nguyen City People's Committee; The Department of Construction is assigned to preside over monitoring and urging the implementation of appraisal of construction planning projects under the approval authority of the Provincial People's Committee; The Department of Transport presides over and advises on the construction of vertical ditches and horizontal drainage systems in urban areas on national and provincial highways; The Department of Natural Resources and Environment monitors and manages activities related to drainage and wastewater treatment in Thai Nguyen province; Drainage units: Thai Nguyen City Drainage and Wastewater Treatment Project Management Board is responsible for managing projects related to drainage and wastewater treatment in Thai Nguyen City; Thai Nguyen Urban Infrastructure Development and Drainage Company is assigned to manage and operate the drainage system in Thai Nguyen city; Water treatment plants...

Thai Nguyen City has implemented many measures to improve drainage and wastewater management systems, to minimize the risk of water pollution and flooding. Decision 07/2021/QD-UBND Thai Nguyen has established new regulations for the management of drainage and water treatment activities in the combined drainage system. This counter light effort force belong to main permission land direction in job elevate High matter quantity muscle department Summer floor and tell guard lip school. In addition, studies and reports have evaluated urban wastewater management activities in Vietnam, providing valuable information for developing more effective solutions. However, there are still challenges that need to be addressed, such as improving infrastructure to cope with heavy rains that cause flooding, especially in the context of

climate change and rapid urban development...

4. Propose Criteria for managing surface water drainage infrastructure systems according to sustainable trends

It is possible to propose 09 drainage infrastructure system management tasks according to the trend of sustainable urban development on the basis of ensuring that it meets current and future needs for economic and social aspects and environment refer to the list of construction criteria according to Circular 01/2018/TT-BXD [7], Refer to the Sustainable Drainage System (SUDS) model proposed by the UK Construction Association (CIRIA)[2] and comply with Resolution 06-NQ/TW dated January 24, 2022 on "Planning, construction, management and sustainable urban development in Vietnam to 2030, vision to 2045" with 5 groups of perspectives and 6 main solution tasks [8]:

- Focusing on project planning and implementation. Review the appraisal and approval work in accordance with procedures and standards.

- Synchronizing the drainage infrastructure system on the basis of reducing the use of construction materials, using recycled materials, materials that are easy to manufacture, materials that are created with little energy consumption.

- Smart drainage systems allow for the control of flooding and pollution, using efficient, sustainable technologies that can adapt to extreme weather events.

- Protecting ecology, public green areas, and water surface.

- Minimizing waste and environmental pollution.
- Using public transport and bicycles, limit large vehicles.
- Measures to combat climate change.
- Connecting surrounding utilities, infrastructure and services.
- Enhancing community participation.

5. Solutions for managing surface water drainage infrastructure systems according to sustainable urban development trends

The drainage infrastructure system is an important factor in building and developing sustainable urban areas, improving the quality of life of people in urban areas.

The scope of the study is Thai Nguyen city, based on the current and ongoing situation. Proposed appropriate directions for development in the immediate period are: Manage and continue to develop and complete with adjustments the use of the drainage infrastructure system according to the approved planning; Promote the application of scientific and technical advances and new technologies in the design, construction, exploitation and maintenance of drainage infrastructure in a sustainable and environmentally friendly manner.

5.1. Propose some solutions for planning and improving the urban surface drainage infrastructure system

* Planning solutions:

Re-planning the drainage infrastructure system in Thai Nguyen city in the direction of infrastructure reconstruction with priority order: Main

drainage sewer line, branch drainage sewer line combined with dredging of sewers, rivers and streams, upgrading and renovate outlet, build retention basin according to planning. Orient drainage according to the shortest distance. Construction, exploitation and maintenance of drainage infrastructure systems in a sustainable and environmentally friendly manner combined with increasing the area of green trees contributes to greening the urban landscape and increasing the soil permeability coefficient.

Reviewing and re-planning the city's main drainage points. Renovate degraded areas, encroach on areas and misuse, apply high technology in investment work.

Overcoming the situation of "suspended planning" and "suspended projects" in Thai Nguyen city, implementing procedures for revoking investment policy approvals, investment policy decisions, and investment certificates; for projects that do not meet the prescribed conditions. Do not seek profit or group benefits from planning funding.

* Investment solutions and renovation of surface water drainage infrastructure system:

Proactively responding to natural disasters and prevent floods and storms, develop plans to prevent and fight floods and storms with the motto of effective application to limit floods and storms occurring in the city.

Proposing immediate and long-term solutions. Accordingly, in the immediate future, focus on directing and immediately clearing the flow; assign officers to be on duty during storms in locations where flooding frequently occurs; Direct wards and communes to strengthen inspection and clear water flow; Handle cases of leveling and encroachment that obstruct the flow. At the same time, it is proposed to arrange reserve capital to focus on investing in immediately handling some flooded areas on the streets: Hoang Van Thu, Luong Ngoc Quyen, Quang Trung, etc., ... In the long term, specialized agencies will be assigned to do research and planning to solve the problem of flooding throughout the city; direct wards and communes to continue checking the drainage system and handle encroachments that obstruct the flow. Require investors of residential areas in the area to complete technical infrastructure systems, especially residential area drainage systems, to connect to the city's general system.

Table 1. Evaluation of sustainable drainage technical solutions for urban construction sites [11]

Đặc điểm khu đất xây dựng trong đô thị	Loại công trình SUDS	Vỉa hè, bãi đỗ xe, quảng trường thảm nước	Mương lục thảm	Vườn thu nước mưa, hồ điều hòa	Kính thảm dẫn	Bìa ngầm chứa nước
Khu vực trung, thấp						
Mực nước ngầm ≤ 3m						
Độ dốc địa hình ≤ 2%						
Đất có độ tham kém						
Đất bị ô nhiễm						
Có công trình hạ tầng ngầm phức tạp						
Không gian bị giới hạn						
Đóng chảy mặt cát nguy cơ ô nhiễm						
Ghi chú:						
Điều kiện đánh giá		Áp dụng phù hợp	Áp dụng hạn chế	Không nên áp dụng		



Figure 3a. New approach to urban design and planning (Green infrastructure) [3]

Investing in additional smart technology for the drainage infrastructure system when renovating.

* Some new approaches in urban design and planning [3]:

- Building green infrastructure to reduce surface runoff, increase water permeability, store water, promote evaporation, minimize the heat island effect, and create green corridors in the area.

- Using green ecosystems to reduce the load on the drainage system.

- Retaining rainwater: Flow slowly, retain water, increase water infiltration into the ground. Good for localized heavy rain in a short period of time.

- Multi-level surface water treatment: planting trees on roofs, local water retention ponds, large-scale water storage areas.

- Urban drainage: Arrange green landscapes for current drainage canals, streams, ponds and flood control works.

- Opening canals for small-scale water storage, parks with water storage function.

- Permeable concrete (water permeable concrete): is a durable material, absorbs little solar heat and has 50% fewer surface cracks than regular concrete. Honeycomb hollow concrete has a continuous open pore structure that allows water to flow through the surface and be filtered into the

ground. Permeable concrete can be applied to tennis courts, parking lots, sidewalks, gardens, riverside slopes, and riverbank sidewalks (Commonly used in major cities in the UK, USA, Mexico, Japan, etc.)[13].

5.2. Managing the construction and development of surface water drainage infrastructure systems in a sustainable and environmentally friendly manner

Managing construction work in compliance with the planning after adjustment, avoiding repeating mistakes during previous implementation. Comply with the goal of "Rebuilding infrastructure".

Establishing management regulations and build drainage infrastructure systems according to sustainable urban development trends. Complete guiding documents and criteria for sustainable drainage [16].

Increasing the use of technology in management. Applying technology (technology 4.0, IoT...) [7], [9] to manage and operate the drainage infrastructure system in the most optimal (smartest) way but in accordance with immediate accessibility and potential. Upgradeability during use.

Minimizing the number of large vehicles causing negative impacts on the drainage infrastructure system underground on the road.

Well managing the care, maintenance and planting of new landscape trees for roads and landscape areas in the city.



Figure 3b. New approach in urban design and planning [13]. (Permeable concrete)



Figure 4. Goals and benefits in the SUDS management model (4a); SUD solutions with different models (4b) [1]

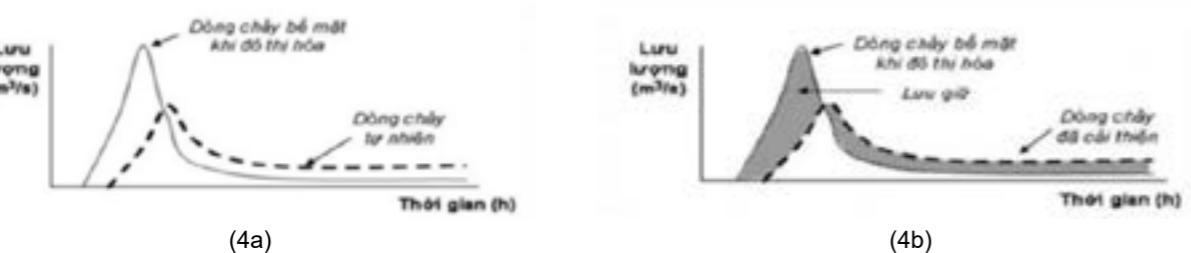


Figure 5. Graph depicting surface flow during urbanization with natural surface (5a); depicting the amount of surface water retained and returned to its natural state (5b) thanks to the application of sustainable drainage solutions [13]

Strengthening human resources for management, inspection, and handling of violations.

- Fostering and improving the quality of management human resources. Strengthen the role and management human resources of the State and relevant agencies in implementing the drainage infrastructure development strategy according to sustainable urban development. Convey the message to managers, businesses and resident communities, improve Awareness - Responsibility - Skills of all people, considering it a central issue of city development.

Strictly managing sidewalk space, green parks, and urban public land. Promote inspection, inspection and handling of violations, eliminate encroachment on public spaces for trading, business and organization of violating activities that affect drainage infrastructure.

* Applying the Sustainable Drainage System Management Model (Sustainable Drainage System - SUDS)

This is a management model proposed by the UK Construction Association (CIRIA) [2] with the idea of sustainable development integrated into the planning and design process of drainage systems. This means that the impacts of the drainage system do not change the flow at the source, do not transfer risks from one place to another. Urban areas use and optimize natural drainage according to surface flows; reduce the speed and flow through a system of water storage works (natural and artificial) to help prevent flooding, replenish groundwater, and utilize rainwater for urban purposes such as treatment for reuse for urban water supply, firefighting water, watering plants, washing streets...

Rainwater is moved from one state to another to extend the flow time to bring the urban flow path back closer to the



Figure 6. Water-permeable tree roots (6a); Water-permeable channels (6b) [10]

natural flow path (Figure 5a).

Management and circulation techniques aim to limit the active surface of water to facilitate water infiltration into the soil or limit peak discharge into the network through containment measures (Figure 5b).

Applying the management solution "Water-absorbing tree stumps and permeation canals and ditches" for main routes of Thai Nguyen city such as (Quang Trung street, Bac Son street, Viet Bac street, Hoang Van Thu street, Hoang Van Thu street, etc. Minh Cau...): Drainage relies on a strip of land designed with filter materials and improved vegetation to remove pollution and reduce surface runoff.

6. Conclusion:

Researching the current state of surface water drainage infrastructure of the transportation network and projects

that have been and are being implemented when put into use in Thai Nguyen city is the basis for proposing measures to manage construction and develop the system. Thai Nguyen city's drainage infrastructure system follows the trend of sustainable urban development. On basis of the inadequacies in planning adjustment, the process of using and managing transportation system drainage infrastructure in projects that have been and are being implemented, there are proposals for renovation, new construction and appropriate management for projects and routes in Thai Nguyen City. From the perspective of planning solutions, renovation planning and management of surface water drainage infrastructure systems in a sustainable manner, the proposed solutions for Thai Nguyen city need to be researched, perfected and advanced. applied, if successful, can be applied to other cities in Vietnam./.

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