

## Chapter 1: Introduction

Until recently, the canals of Bangkok accommodated many social, cultural, and commercial activities, functioning as important public places for residents of Thailand's capital city. Dating from the founding of the city in 1782, the canals in Bangkok are of cultural importance to the Thai people, having originated as a means of providing security against attack, as a source of sustenance (food and water), as the focus of religious ceremonies and celebrations such as the *Loy Kratong Festival*, and as a site for recreational activities such as swimming and boating activities and competitions. The banks of the canals were also used as market places and thoroughfares, and for public gatherings. The canals were used as the city's main transportation system until the street system was introduced in 1851. Consequently, many important public institutions, such as temples and markets, are located on the canals, which served as the original means of connecting key public places in the city. The canal system has also been an important structural element that has influenced the physical pattern of settlement in Bangkok, defining the limits of development at various points in times. Some of the canals still represent boundaries of municipal districts.

Today, the role of the canal system in public life has been reduced. Dependence on the automobile has made the street system the primary means of transportation. Buildings now turn their backs to the canals and face the streets. Some canals have been converted to streets. The streets have also taken over the shopping or market functions that were once centered on the canals. The water quality and amenity of the system has also deteriorated as the waterways have become receptacles for trash and sewage. These changes have also impacted the cultural and symbolic meanings attached to the canals, eroding the perceptual structure of the city. Thus, these changes affect not only the canal areas, but the city of Bangkok as a whole.

Meanwhile the rapid growth of Bangkok in the twentieth century has placed increasing demands on the city's remaining public spaces. Population density has increased, creating a need for more public amenities. Despite its degraded state, most of the canal system retains its structural intricuity. The canals still hold symbolic

significance as part of the cultural heritage that links the Thai people to their past. There is potential to preserve the canal system and to restore its former prominence as a primary public space amenity, in order to meet the needs of the current population.

This thesis proposes to preserve the historic value and cultural symbolism of the canals, by reestablishing the canal system in Bangkok as a public space system and a connector that links important public places in Bangkok. The thesis focuses on the canal system on Rattanakosin Island, a designated historic district that has been the city center of Bangkok since its founding (Fig. 1.1). This district contains styles of architecture, landscape architecture, and urban spatial structure that are unique to the Thai culture. The two main canals on Rattanakosin Island are designated historic places not only because they date from the time of earliest settlement, but also because they hold cultural and symbolic importance for Thai citizens.

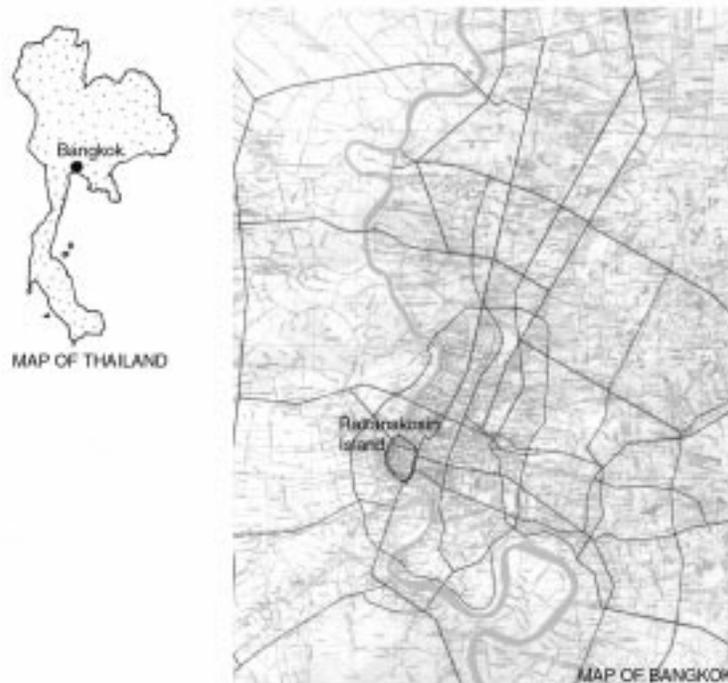


Figure 1.1: Map of Thailand showing the location of Bangkok and map of Bangkok showing the location of Rattanakosin Island.

In order to establish the historic significance of the canal system, the thesis examines its development over time, its influence on the urban settlement pattern in Bangkok, and the historic roles of the canals as settings for public life in the city. The study contrasts historic and contemporary patterns of use in order to establish the potentials and the issues associated with restoring the public space role of the canals on Rattanakosin Island. The thesis focuses on seven canal types that have the potential to accommodate a representative range of public space functions, based on current patterns of adjacent land use, scale relationship, structural condition, and edge condition. Analysis of the canal types yields guidelines for preserving and/or restoring the canals as primary public spaces. There are five specific objectives for the thesis:

- To examine the development of the canal system in Bangkok and its influence on the early settlement pattern of the city.
- To evaluate the historic and contemporary roles of the canals as public spaces and connectors of key public spaces.
- To identify the potentials and physical problems associated with preserving and reestablishing the canals as public spaces and connectors.
- To identify characteristics of the canals that support their use as public spaces by examining key representative types, based on factors such as land use, scale, structure and edge condition.
- To create guidelines related to a limited range of canal types in order to preserve the unique physical characteristics of the canals and reestablish the canal system as a primary public space system.

The theoretical basis of the thesis is derived from the theory of permanence of urban structural elements proposed by Aldo Rossi (Rossi, 1982). Urban morphological study is used to study the physical evolution of the canal system in Bangkok in relation to its changing roles over time, and its influence on urban settlement patterns in the city. Typology provides a tool to study the physical characteristics of the canals and to provide a basis for developing guidelines.

The thesis is divided into five chapters: literature review, methodology, findings, design guidelines, and conclusions. The literature review describes the theory of

permanence of urban structural elements, and the urban morphological and typological approaches. The methodology is divided into three parts: morphological or town plan analysis, typological analysis, and creation of guidelines. The findings are presented in three sections: the physical development of the canal system in Bangkok in relation to its changing functions and its influence on urban settlement patterns in the city, the potentials and issues associated with preserving and reestablishing the canals as public spaces and as connectors, and the canal types. Guidelines are presented for the key representative canal types, and for the overall canal system. An overall master plan illustrates the proposed system, and sections and plans illustrate specific guidelines related to the canal types. The conclusion summarizes the study and discusses implications for implementing the guidelines.

## Chapter 2: Literature Review

Since there is no available literature which offers a uniquely Thai perspective on the issue of continuity and change in the urban environment, the literature review has been derived from western sources. Literature relating to three main topics- the theory of permanence of urban structural elements, urban morphology, and typology- is reviewed. The theory of permanence of urban structural elements (along with the concept of typology) is used as the theoretical approach and basis for the study, and as a basis for historic preservation. Urban morphological study provides an approach to studying and understanding the physical evolution of the canal system in Bangkok in relation to its changing functions, to the changing context of the city over time, and to its influence on urban settlement patterns. Typological study provides a tool to study the canals' physical characteristics and a basis for creating guidelines for preserving and restoring key physical attributes that will enhance the proposed role of the canals as primary public spaces. This approach does not attempt to define or regulate culturally specific factors, but rather ensures that the canals will continue to accommodate expressions of local culture.

### 2.1 Permanence of Urban Structural Elements

According to Aldo Rossi, the city is a man-made object in which we can perceive differences between the past and present through the persistence of past urban physical forms and structures. This difference makes us realize the fact that “the past is being experienced now” (Rossi 1982, p. 57). This thought leads to the concept of permanence of urban structural elements as “a past that we are still experiencing” (Rossi 1982, p.59).

The concept of permanence focuses on the phenomenon of persistence. The persistence of urban artifacts can be discovered through physical signs of the past, or *monuments* (Rossi 1982). Rossi describes monuments as primary elements in the city that have significant meanings and are persistent and characteristic urban artifacts. A

monument's persistence or permanence also is a result of its capacity to constitute the city through times of transformation. Therefore, in order to understand and describe the city according to the idea of permanence, we should look beyond the permanence of physical urban elements to their present meanings or values, including the present activities that modify them.

According to Rossi, the city is described as a cultural artifact, made up of a variety of physical elements such as buildings, streets, and squares. These elements may be considered to be either “propelling” or “pathological”. *Propelling elements* have retained their physical forms and associated historical and cultural values, but have accommodated different functions over time. *Pathological elements* are considered to be unhealthy, since both physical form and function have remained unchanged. Rossi points out that the city tends to change and develop over time through a dynamic process of physical evolution that is related to development of its cultural history. In response to the changing context of the city, the physical form of monuments remaining in the city should be preserved, but they should continue to be propelling elements of city development by accepting new uses. Propelling elements maintain a degree of continuity with the past through their persistent physical form, while accepting change, a condition that is essential to a healthy city.

Carter (1973) has suggested that adaptive use is a useful strategy for preventing the destruction of existing buildings, structures, and districts that provide links to the lifestyles and history of the past. The ability to reuse existing spaces over time helps to provide users with a direct connection to the past or a sense of the past. Moreover, “recycling existing spaces provides the mechanism to allow for necessary urban growth and adaptation while still maintaining a sense of place” (Carter 1973, p. 14). In order to provide more functional values for historic buildings or other urban elements, therefore, it is necessary not only that the permanent appearances of structures be preserved, but that they accommodate new functions which fit a changing context (Schwarzer 1994).

The canals in Bangkok are important cultural artifacts. They could become propelling elements if they can accommodate new functions. This study examines the potential to preserve and reuse the canals as public spaces that meet the needs of

contemporary Bangkok. The concept of permanence, along with the application of adaptive function, can be used as a strategy for historic preservation (Schwarzer 1994 and Carter 1973).

According to the concept of permanence, the typological characteristics of urban elements can be considered as permanent conditions that exist through history. The concepts of typology and permanence are theoretical approaches that support preservation of the canals' historic value and unique physical characteristics while encouraging changes in function in response to the new context of contemporary Bangkok.

## **2.2 Urban Morphology**

### **Urban Morphological Study**

Urban morphological study is a systematic analysis of the evolution of the physical elements that structure a city. This study allows the researcher to identify important urban structural elements, and to examine how they fit together and how and why they evolved over time. This study can provide a basis for making decisions about what physical elements or attributes should be preserved or reestablished in the context of ongoing urban growth and change. According to Vance (1990), urban morphology or city form tends to change in response to the context of city development over time. Thus, urban morphological study involves examining not only the urban physical elements that structure a city, but also their evolution over the course of history.

Morphological study provides an approach to understanding the physical evolution of the canal system, which is an essential propelling element of Bangkok. It also provides an understanding of the canals' influence on urban settlement patterns in Bangkok. This analysis allows the researcher to identify the key structural elements and segments of the canal system, as well as their historic importance and value for preservation. The researcher can thus define which elements and segments hold more or less value for preservation. This understanding is helpful for informing an overall proposal for preserving the canal system.

## **Morphological Approach and Method**

A morphological approach to analyzing urban form focuses on the morphological structure of the urban environment (Whitehand 1981). It is characterized systematically by different kinds of form elements, and spatially by the association in space of these form elements resulting from historical development and functional requirements (Whitehand 1981).

According to M.R.G. Conzen, a geographer who began to study urban morphology in the late nineteenth century, there are three systematic form complexes (Whitehand 1981). They are "the *town plan* (primarily a two-dimensional cartographic representation of a town's physical layout), the *building fabric* (made of buildings and related open spaces), and the pattern of *land utilization* (detailed land use)" (Franck and Schneekloth 1994, p.297). These three analytical components, which are functionally interrelated, are essential to the explanation of urban form (Franck and Schneekloth 1994). Conzen's urban morphological study focuses on the town plan, which represents a town in two dimensions including all important characteristics of urban form that are embodied in it (Franck and Schneekloth 1994). In his study of Newcastle upon Tyne, England, he described the complete method, called an evolutionary method of plan analysis, which is the town-plan study of sequential time periods. In his *town-plan analysis* approach, he identifies three fundamental elements of the town plan that can be analyzed over time in an evolutionary fashion: the streets and their street system, the plots and their plot pattern, and the building arrangement within these patterns (Fig. 2.1) (Whitehand 1981). The evolutionary method of plan analysis provides an understanding of the physical development of urban structural elements, resulting from the city's cultural and historical development (factors that strongly influenced its morphological development), which is an objective of the morphological approach. In the study of Burgage cycle in Newcastle, Conzen also uses an evolutionary town plan analysis as a means to understand its physical development over time (Fig.2.2) (Whitehand 1981).

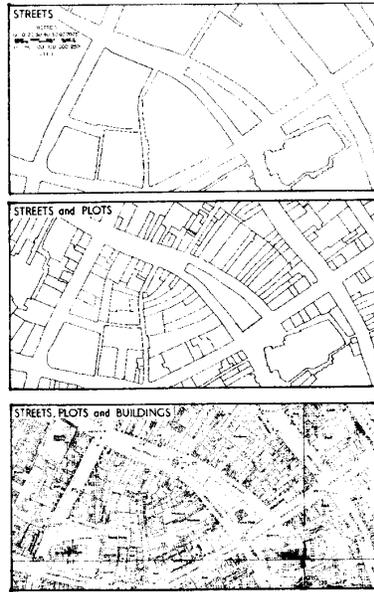


Figure 2.1: Conzen's fundamental elements of town plan (source: Whitehand 1981, p.26).

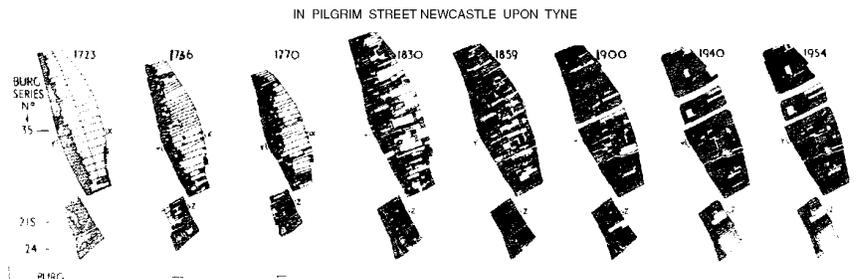


Figure 2.2: Conzen's Burgage cycle, Newcastle and its development from 1723 to 1954 (source: Whitehand 1981, p. 45).

Conzen's town plan analysis, a method of morphological analysis can be used to provide an understanding of the canals' physical development in Bangkok and their influence on urban settlement patterns, by comparison of plans showing the canal and street system in relation to the configuration of overall physical settlement and land use pattern during sequential time periods.

## 2.3 Typology

In architectural and landscape architectural study and design, typology provides a tool to study the physical characteristics of architectural and landscape architectural elements. In this study, typology is used as a tool to study the canals' physical attributes.

A clear understanding of the definitions and concepts of “type” is necessary to the discussion of typology and its uses.

### **Type and its Definitions & Concepts**

There are many definitions of type in numerous articles written by architects and theoreticians. This review begins with the definition of type described by the *Oxford English Dictionary*. “The English word *type* comes from the Greek *typos*, meaning impression or figure, with the connotation of striking or beating” explained as follows (cited by Perez-Gomez 1991, p.11).

- (1) That by which something is symbolized or figured; anything having a symbolical signification; a symbol or emblem....
- (2) A figure or picture of something; a representation, an image, or imitation.
- (3) A distinguishing mark or sign.
- (4) The general form, structure, or character distinguishing a particular group, kind, or class or beings or objects; hence, potentially a pattern or model after which something is made.
- (5) A kind, class, or order as distinguished by a particular character.
- (6) A person or thing that, reciprocally, exhibits the characteristic qualities of a class. (cited by Perez-Gomez 1991, p.12)

Type can be simply defined as a concept that explains a group of objects characterized by the same formal structure (Moneo 1978). “It is neither a spatial diagram nor the average of a serial list. It is fundamentally based on the possibility of grouping objects by certain inherent structural similarities” (Moneo 1978, p.23). The concept of type is embedded within the actions of sorting, classifying, and ordering objects into categories, which are the result of two different techniques: division (making distinctions between things), and collection (grouping similar things) (Schneekloth and Ellen 1989).

Although the concept of type is frequently used as an analytical tool for the classification of architectural work, it can be applied to other physical elements, including the products of landscape architecture. As Scheer and David have stated, “the idea of type that we are interested in is one that can be extended beyond the scale of the individual building” (1994, p.5). For example, Rob Krier has studied types of squares (1979), and Victor Caliandro has studied types of streets in America (Anderson 1978). Therefore, like the streets, typology can be applied to the study of the canals.

### **Typology and its Use**

Based on the concepts of type, typology is defined as a system of types used to classify or interpret individuals by creating relationships among type categories (Schneekloth 1989). In typological study, different approaches are characterized by theory of use; two approaches relate to the thesis.

In the first approach, typology is used as a theoretical tool to group elements that share general physical characteristics. It is also used to compare these formal characteristics. There are many criteria to classify elements into categories. For example, building types are created based on the criteria such as buildings' functions, forms, locations, styles, and/or materials (Schneekloth and Ellen 1989); street types are classified based on adjacent land use, built-form characteristics, and circulation (including pedestrian and vehicular access) (Anderson 1978). Although elements can be categorized by many criteria, the criteria for classifying elements into types within a typology should be selective. The criteria should be set in response to the purposes for which the typology is used. For example, if the purpose of building typologies used in building regulation is to insure the life, health, and safety of residents, then these building typologies are defined by material, construction methods, and potential building hazards (Schneekloth and Ellen 1989). Although the typological classification system is most commonly applied to buildings, it can be applied to other urban elements at any scale. Rob Krier has used the typological classification system to establish square types based

on the geometrical pattern of their ground plan such as rectangular squares and orthogonal squares (Fig. 2.3) (1979).

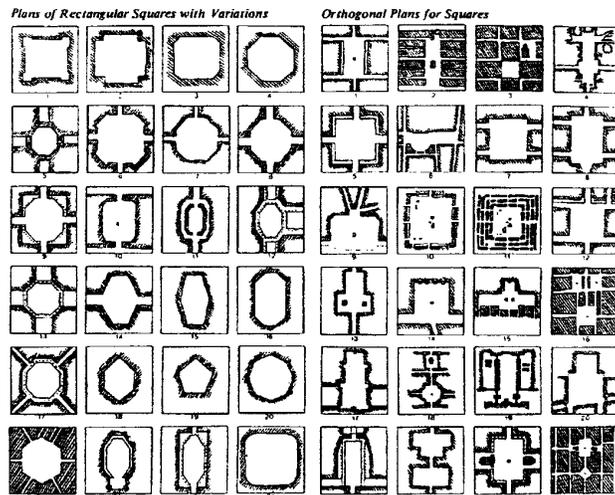


Figure 2.3: Krier's square types (source: Krier 1979, p.33).

The other example is a street typology, which has been a popular subject in urban design study. In order to evaluate the potential of American streets for human use and interpretation, Caliandro has analyzed street environments based on a classification of streets by principal land use, building density, and orientation of the buildings fronting the street (1978). The street types consist of, for instance, residential streets with low-medium-rise buildings and with medium-high-rise buildings, mixed residential and commercial streets with low-medium-rise building, and commercial streets (Caliandro 1978). Schumacher (1978) has classified streets based on user density, land-use mix, pedestrian/vehicular interaction, and configuration of street and context for the purpose of creating a good street for residential environment (Fig. 2.4). As seen in these examples, typological study provides a tool to study the physical characteristics of particular urban elements, and to classify these elements into types that respond to the purpose of their use.

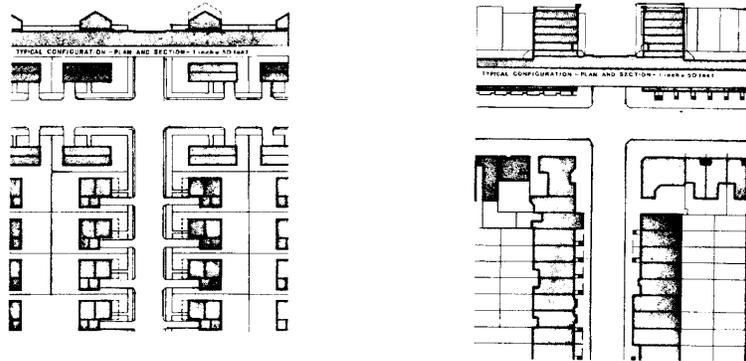


Figure 2.4: Examples of American street types from Schumacher: a low-rise, low-density, single-family, detached-house street in Queens, New York (left), and a low-rise, medium-density, multiple-family, attached-house street in Brooklyn, New York (right) (source: Schumacher 1978, p. 134).

Kostof considers rivers and canals to be streets called *waterways* or *canal streets* (1992). Kostof has identified four basic design criteria for analysis of the waterways: “the watercourse itself and its management (embankments, piers and the like); the walkways on one or two sides; the nature of the flanking buildings, especially in relation to the waterway; the bridges that constitute the crosswalks” (1992, p.218). These criteria (including the criteria for street classification) can be applied to the canal classification in the study of Rattanakosin Island. In order to create the canal types for this study, however, the criteria should be associated with supporting their role as public spaces. These criteria are, for example, current patterns of adjacent land use, structural condition, and edge condition. Thus, typological study provides an analytical tool to study the canals' physical characteristics, and to identify the canal types that have the potential to accommodate a representative range of public space functions.

The other approach concerns urban coherence, based on the belief that urban coherence can be achieved through typological consistency. In this approach, typology is used as a theoretical basis for creating guidelines. According to Rossi, type is characterized by a set of consistent structural characteristics (whether building type or public space type) that can endure despite changes in functions over time. Type is seen as permanent through history. This is the key concept that makes regulations and guidelines by typological characteristics possible; it is a valuable means of retaining

some degree of urban contextual continuity while permitting some change over time (1982).

Scheer and David have suggested that “the other advantage of using a guideline system based on typology is that it is a flexible and responsive system which respects the historical continuity of the city without embalming the architecture” (1994, p.7). Scheer and David categorized the building types along Main Street in Fairborn based mainly on site plan, building facades, and typical building elements (Fig. 2.5), and then developed guidelines in relation to these types (1994). The guidelines were created in order to point out the essential typological elements of the existing buildings, and to call for new building and restorations that respect that typology, such as the building type guidelines shown in figure 2.6 (1994).

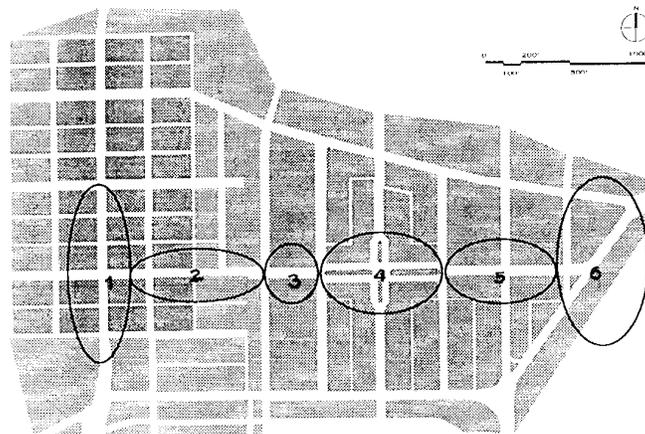
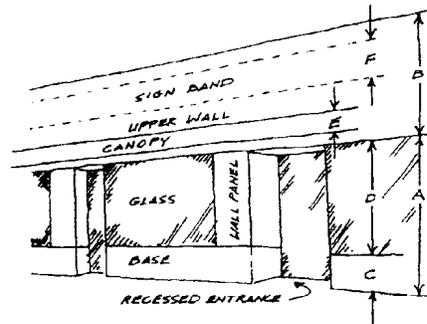


Figure 2.5: Types along Main Street: each subarea has a distinct building type associated with it such as the newer highway commercial buildings (1) and a district of 1940's commercial buildings (2) (source: Scheer and David 1994, p.8)

Typology can, therefore, be used as a practical tool available to urban designers for allowing and controlling changes in urban fabric, while still keeping the characteristics and continuity of urban form. In relation to the study, analysis of the canal types yields guidelines for preserving and restoring the key physical characteristics of the canals that enhance their proposed role as public spaces, and preserve potential for new functions to be accommodated in the future. Typological guidelines do not regulate

architectural style or other culture-specific modes of expression, rather they leave open the opportunity for local variation.



#### GENERAL

This type of commercial building was very commonly constructed in the era from 1940 to 1960. It is usually built of brick or glazed block, and one of its main features is the continuous canopy.

#### SITE PLAN

Buildings are always placed along the front property line - this is referred to as the "set-to" line. Projections such as the canopy and signs may protrude up to 36" into the public right-of-way if they are located more than ten feet above the sidewalk.

Parking, when available on-site, is located at the rear of the building. For this reason, rear facades need to be maintained and kept clean and free of obvious trash. Some businesses may have second entrances on the back, but the main entrance should be on Main Street.

The sidewalk extends from the facade to the curb. Planting may occur in planting wells, but the sidewalk is too narrow in this area for continuous planting strips.

#### OVERALL FORM

Buildings in this type are a simple, single story box with a horizontal roof line. Modifications to the roof line should maintain the overall horizontal line. Several stores are usually contained in one building, with a continuous canopy across the entire front. Facades are in a single plane, that is, they are usually flat, except for recesses at the entrance (see below) and the canopy.

#### WINDOWS

A glass storefront should occupy the entire height between the base and the canopy (see diagram). Different stores within the same building should use similarly sized and shaped windows and doors and where there is a pattern already established in an existing building, it should be followed.

Window glass is usually held in a thin metal frame, but may also be butt-jointed. Large panes of glass predominate. Note the large amount of glass compared to the narrow base and wall panels. Glass panels are large relative to the storefront so that goods on display can be clearly seen. A merchant should provide interesting displays for the storefront or a clear view into the business rather than blocking windows with signs or the backs of cases. This makes it more interesting for people walking by. Lighting should be provided to illuminate displays and to avoid windows becoming dark rectangles.

#### ENTRANCES

All doors should be fully glazed, of either the metal frame or solid glass type. Single or double doors may be used. Entrances should be recessed a few feet from the facade, so that doors may open out without opening into the sidewalk right of way.

#### CANOPY

Since the canopy is such a strong defining element of the type, great care should be taken not to cover it up or remove it. For buildings without a canopy, one can be added. It should be continuous across the entire width of the facade and protrude about 36" out from the facade. Awnings are not necessary or recommended in this type.

#### SIGNS

Signs should be placed within the sign band shown in the diagram. Locate the sign so that it is centered over the windows, or otherwise lined up with elements of the facade. Signs may be either flush against the wall or may be mounted perpendicular to the wall face. Signs should be lighted by external sources, not internally.

The size of the sign is important.

Figure 2.6: Example of guidelines for a single type (source: Scheer and David 1994, p. 10).

## **Chapter 3: Methodology**

There are three main stages involved in examining the potential of the canal system to be reestablished as a primary public space system and as a connector linking the main public spaces on Rattanakosin Island. Morphological analysis provides an analytical method to examine the development of the canal system in Bangkok and its influence on the settlement pattern of the city. This facilitates the identification of key segments of the canal system that hold more or less value for preservation and reveals the potentials and physical problems associated with preserving and reestablishing the canals as public spaces and connectors. Typological analysis provides a tool to identify the physical characteristics that support use of the canals as public spaces, by examining key representative types. The last stage is the creation of guidelines related to a limited range of canal types in order to preserve the unique physical characteristics of the canals and to reestablish their as public space functions.

### **3.1 Morphological Analysis**

To examine the physical evolution of the canal system in Bangkok in relation to its roles and its influence in the early settlement pattern, an evolutionary plan analysis is used as an analytical method of morphological study. Plans showing the canal and street system in relation to the configuration of overall physical settlement and land use pattern in Bangkok are necessary for this stage of analysis. Three sequential time periods are examined. These are related to Bangkok's cultural and historical development, factors that strongly influenced the city's morphological development, and that of the canal system. The periods include early Bangkok (1782 - 1851), a period of westernization (1851-1925) and the contemporary period (1925 - present). Published documentation on the evolution of the canal system and the historic and contemporary roles of the canals supplements the plan analysis.

The product of this analysis stage is a description of the physical development of the canal system in relation to its historic and contemporary roles, with a focus on its role

as primary public space and its impacts on other urban elements in Bangkok. Key segments of the canal system of historic importance or value for preservation are identified. In addition, the morphological analysis reveals potentials and physical problems associated with preserving the canals and reestablishing their roles as public spaces and connectors.

### 3.2 Typological Analysis

Typological analysis is an analytical method used to study the physical characteristics of the canals and to identify types that have the potential to accommodate contemporary public space functions. The primary goal is to reestablish the canal system as a public space system and as a connector linking the main public spaces on Rattanakosin Island. Five main criteria are used to classify the canal in response to this goal.

The first criterion is *structural condition*. There are two structural conditions: an intersection condition and a corridor condition (Fig. 3.1). Each of these conditions has a particular impact on the canals' physical attributes and functions: flood devices with water gates and raised walls at their edges are found at the intersections between primary canals and the Chao Phraya River. The use of these canals for transportation and amenity purposes is inhibited by the water gates and walls. A corridor condition on the other hand, usually permits boating (depending on overhead structures) and passive recreational activities (also depending on building setback distance).

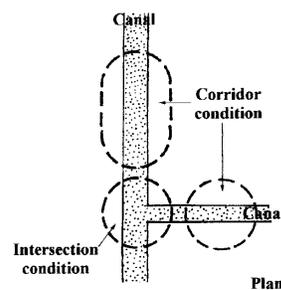


Figure 3.1: Diagram showing structural condition.

The second criterion is *canal width*, together with *presence of overhead structure* (Fig. 3.2). This criterion affects the potential of the canal to function as a continuous connecting element. If the canal is not wide enough for a boat to pass or is covered by a structure such as a road, the use of the canal as a waterway will be limited. On the other hand, if the canal is wide enough and has a curved or raised bridge with adequate clearance, there will be potential for boating along the canal. To promote the use of the canals as public spaces, minimum canal widths and bridge heights should be maintained. In the study area, the narrowest canal is 6 meters wide, which is wide enough for boating. Since all canals on Rattanakosin Island are all of adequate width, the presence of overhead structures becomes the limiting factor for boating use. In addition, the canal width (together with the height of flanking buildings) can affect the scale of the canal-corridor space, and therefore the perceptual quality of the space.

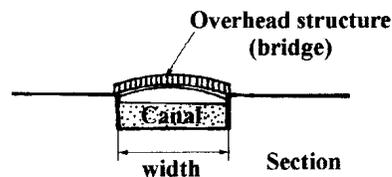


Figure 3.2: Diagram showing canal width together with overhead structure.

The next criterion is *edge condition*, which includes the orientation of buildings lining the canal as well as the building height (Fig. 3.3). The orientation (front or back) of buildings implies a functional relationship between the buildings and the canal. The primary activities in a building fronting the canal will be focused on the waterway. Conversely, buildings fronting the street tend to relegate service functions to the canal side. As mentioned above, building height together with canal width affects the scale relationship of the canal corridor.

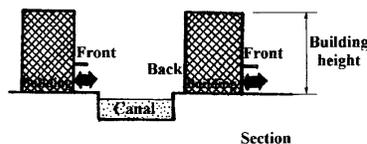


Figure 3.3: Diagram showing edge condition including orientation of buildings and building height.

*Building setback distance* (Fig. 3.4) including circulation pattern (pedestrian and vehicular) is also an important criterion, because it can affect accessibility to the canal as well as potential for linking places along the canals by pedestrian and vehicular ways. Building setback distance also affects the usable space along the canals. If the setback area is at least 4 meters wide, it is possible to use the canal as both a connector and a public place. On the other hand, if it is narrower than 4 meters, it can be used only for connecting purposes. If there is no setback distance, it cannot be used as either a walkway or a road. Consequently, building setback distance can affect the proposed role of the canals as public spaces and as connectors of key public spaces on Rattanakosin Island.

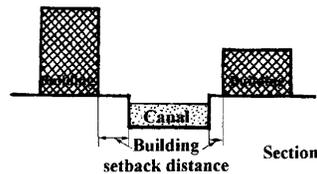


Figure 3.4: Diagram showing building setback distance.

The last criterion is *adjacent land use* (Fig. 3.5). Adjacent land use can strongly influence the physical characteristics and functions of the canals. It influences possible user groups and activities, which could affect the potential to reestablish the canals as public spaces. For example, the canals could be used as amenity space for passive recreational activities in residential areas. In some case such as temples, the land use not only supports the use of the canals as public spaces, but also encourages cultural attachments to the canals. Adjacent land use also affects building setback distance. Institutional areas for example, usually have wider setbacks than commercial and residential areas in order to create an institutional scale.

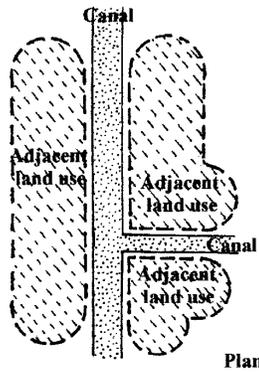


Figure 3.5: Diagram showing adjacent land use.

These five criteria are used for classifying the canals. Each canal type has distinct physical attributes that affect potentials for preserving or reestablishing public space functions.

### 3.3 Creation of Guidelines

The guidelines are created in relation to a limited range of canal types, to preserve the key physical characteristics that will enhance the proposed role of the canals as public spaces or as connectors of key public spaces on Rattanakosin Island. The study includes an overall master plan illustrating the proposed system, together with detailed guidelines and drawings showing improvements to the canal as public spaces.

In order to reestablish the canals as public space corridors, it is necessary to clarify what makes a good public space, especially in Bangkok. The principles described below are principles for creating a good street, but they can be applied to a pedestrian way or a canal. They focus on improving the physical characteristics of a public space and address the comfort, safety, and quality of space.

Like a street, a pedestrian path or a canal needs to be physically comfortable and safe (Jacobs 1993, Jacobs 1961, and Francis 1987). Comfort involves adequate shading from hot sun and extreme temperatures, and solar access on cold days. In Bangkok, the climate ranges from tepid to torrid. Adequate shading is preferable, which is achieved

by planting trees along a street or walkway. A wide walkway that makes it easy and comfortable to walk is desirable; the exact width of the walkway depends on the number of expected pedestrians as well as its importance as a primary or secondary path. Providing adequate and comfortable seating space is also important. People's need to feel safe on a street is another concern. One of the most important principles for creating a sense of safety is providing light, which increases visibility within a space. Jacobs (1961) also suggests that allowing visual surveillance is another way to increase a sense of safety. Visual surveillance can be created by a concentration of activities along the canal. The orientation (front or back) of buildings fronting the canal thus can influence the degree of surveillance.

Other considerations include continuity, intimacy, and ecological quality (Cullen 1961, and Francis 1987). Since a main function of a canal, street, or walkway is linking places together, physical continuity as well as visual continuity within the individual space and the overall system is important. Intimacy refers to a sense of enclosure resulting from the scale relationship between the street or canal width and building height along the street or canal. The scale relationship of 1: 1 is a desirable proportion, which makes space comfortable (Ashihara 1981). The proposed scale relationship should also respond to existing conditions. Ecological quality refers to the presence of natural systems in the urban context. Providing natural elements including vegetation contributes to clean air, noise reduction, and visual relief, thus increasing urban environmental quality. Vegetation and plant materials are also important elements that enhance the visual quality of an urban environment. Water quality is another important concern related to the canals. Clean water is desirable and enhances the use of the canals as amenities.

These principles suggest that good public spaces along the canals in Bangkok would offer wide walkways with shaded areas and seating spaces for comfortable pedestrian use, and provide visual surveillance and enough light for safety. Trees along the canals and high water quality are recommended in order to improve the environmental quality of public spaces along the canals. A continuous public space system is also important, given the objective that the canals function as connectors.

## **Chapter 4: Findings**

### **4.1 The Evolution of the Canal System in Bangkok and its Influence on the Settlement Pattern of the City**

There are three main periods in the development of the canal system in Bangkok, which can be classified in relation to the physical evolution of the city. According to Fine Arts Dept. and Siam Cement Foundation (1996) and Synchron Group Co., Ltd. (1995), they are the early Bangkok (1782 - 1851), westernization (1851 - 1925), and contemporary periods (1925 - present). This analysis examines the relationship of the canal system to other important urban elements including palaces, temples, markets, residential areas, and streets. It also identifies the key structural elements or segments of the system that hold more or less historic importance and value for preservation.

#### **1. Early Bangkok (King Rama I - King Rama III or 1782 - 1851)**

In 1782, King Rama I (1782 - 1810), the founder of the Chakri Dynasty, established a new capital city of Thailand on the eastern side of the Chao Phraya River, and named it “Krung Rattanakosin” or “Bangkok”.

Prior to 1782, the eastern bank consisted of two parts divided by a moat and a defensive wall (Fig. 4.1). The area within the moat and wall consisted of the ancient temples and Chinese community; outside the moat and wall were residential and agricultural areas. In order to expand the new capital city to the north, east and south in 1783, an outer city moat called the City Moat Canal was built parallel to the original one, which was renamed the Former City Moat Canal (Fig. 4.2). Like the Former City Moat Canal, the City Moat Canal was dug mainly for defensive purposes. This strategic factor determined the location of both canals, which were built at the boundary of the urban area. It also affected other critical characteristics such as the width and depth of the canals. The City Moat Canal for example, was more than twenty meters wide.

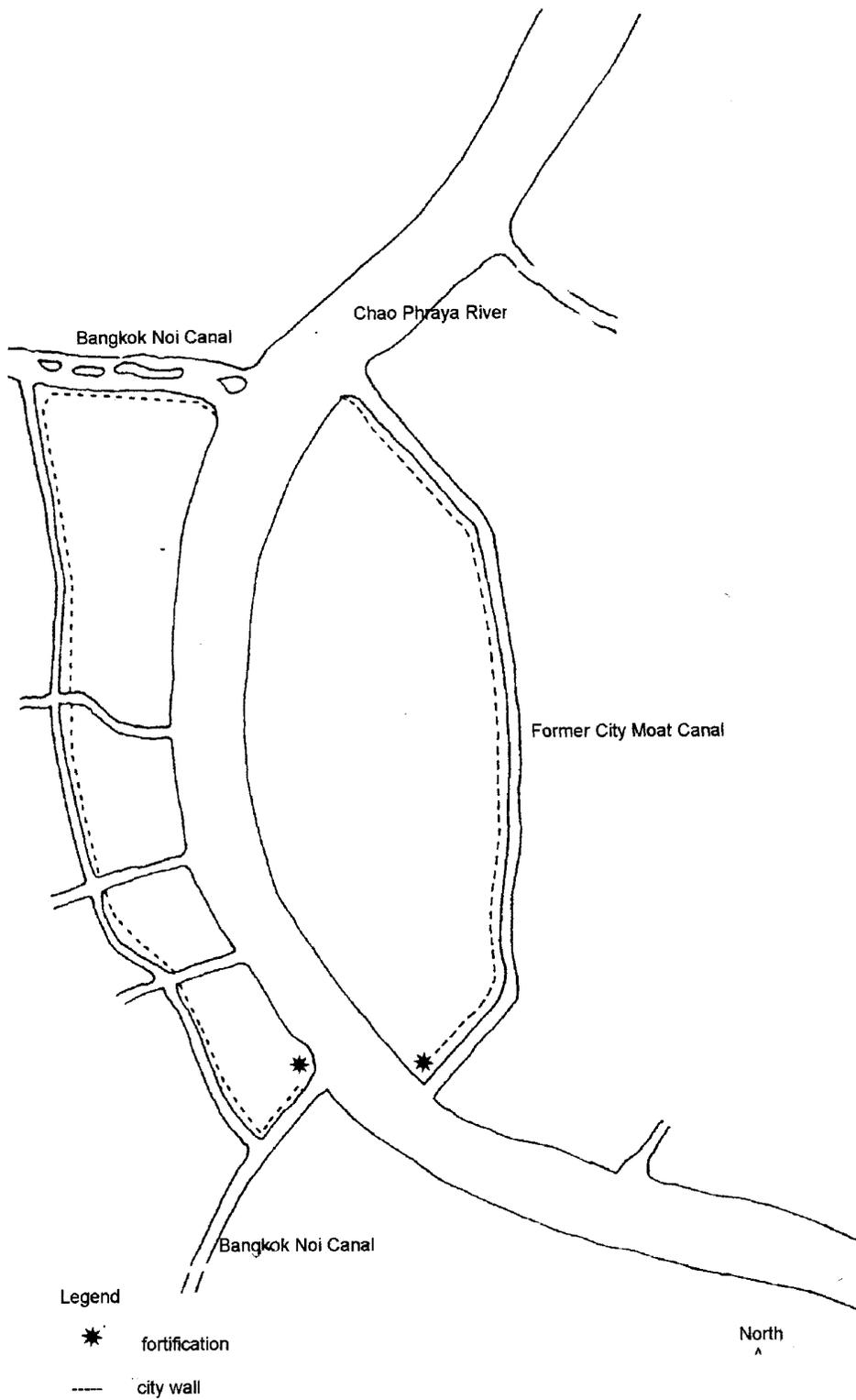


Figure 4.1: Eastern bank of the Chao Phraya River prior to 1782 (source: Chulalongkorn University 1991, p. 17).

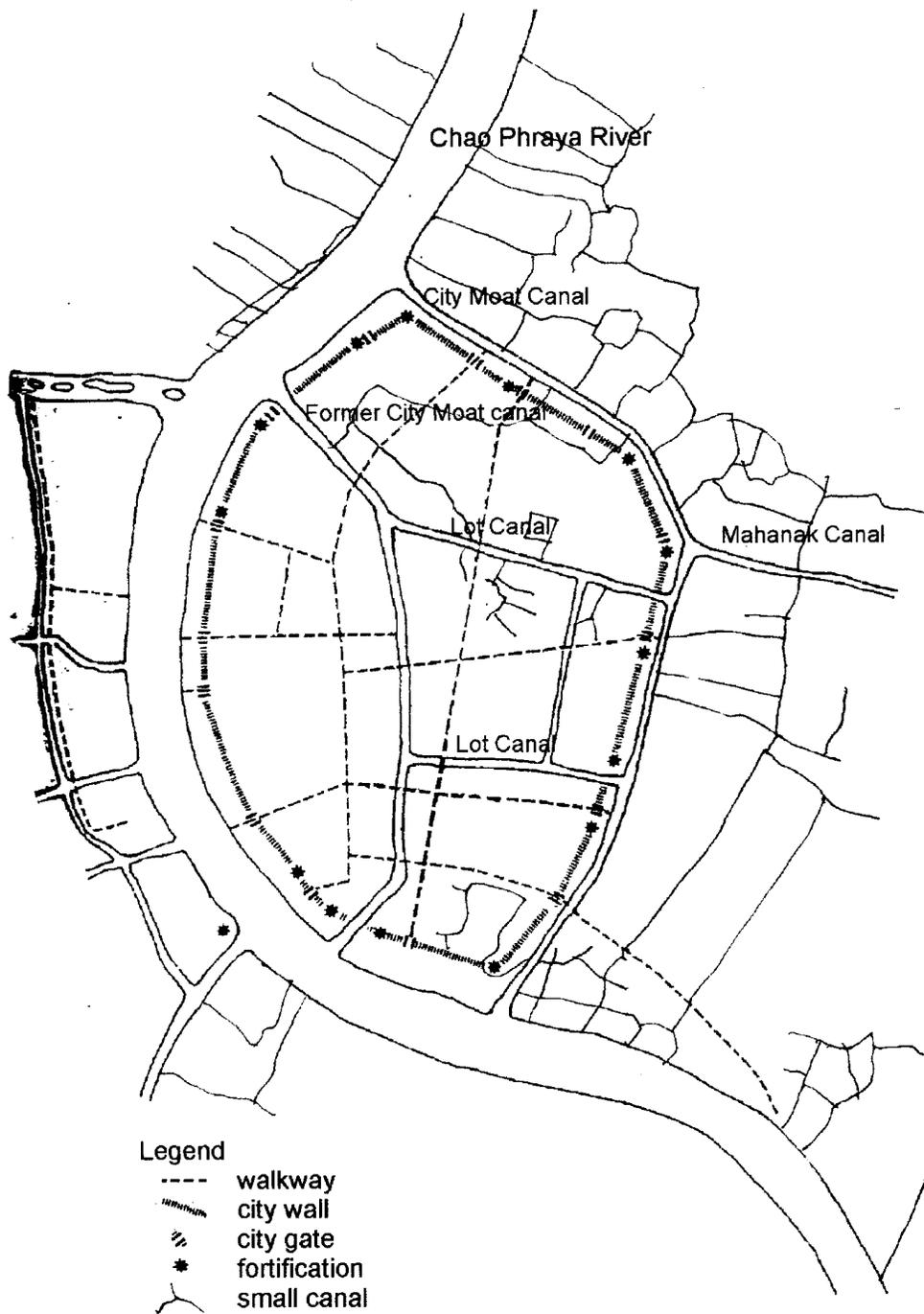


Figure 4.2: Canal and street system in the early Bangkok phase, 1782 – 1851 (source: Chulalongkorn University 1991).

A new city wall and fortifications were also constructed along the City Moat Canal. Moreover, two small canals known as Lot Canals were dug between the Former City Moat Canal and the City Moat Canal for the purpose of connecting the main canals and adjusting the water levels.<sup>1</sup> Since Bangkok is located on a flood plain area, the canal system was also used as an efficient drainage system for flood control. This required canals for collecting as well as draining water. The other canal built in this period was the Mahanak Canal, which ran perpendicularly from the City Moat Canal toward the countryside east of Bangkok. Figure 4.2 shows the development of the canal system in this phase.

The construction of the new capital city was completed in 1785. By this time the canals had come to be used as a planning tool to define the boundaries of land-use zones. According to urban land-use planning policy in the reign of King Rama I, the city was divided into three parts by the canals: inner Bangkok, outer Bangkok, and the area outside the city wall. Inner Bangkok was the city center and institutional area within the Former City Moat Canal. It consisted of the Grand Palace at the center, temples such as Wat Salak and Wat Pho, a main public square called Sanam Laung, institutional buildings such as the Royal Court of Justice, and residences of Thai royalty. Outer Bangkok was the residential area between the Former City Moat Canal and the City Moat Canal or the city wall. This district was subdivided into three smaller areas by the Lot Canals. It housed residences of court officials, low ranking officials, general residents, and foreigners such as Malay and Vietnamese people. Outside the City Moat Canal, beyond Rattanakosin Island, was a vast plain with groves of trees. The Chinese community lived in the southern part of the plain near the Chao Phraya River. During the reigns of King Rama II and King Rama III (1824 - 1851), physical changes continued to be implemented in response to the land-use zoning policies of King Rama I's regime.

As a result of these policies, the canals became important structural elements that influenced early land-use patterns in Bangkok. Moreover, in the early Bangkok phase (1782 - 1851), the canals were built not only for defense purposes, but also to serve as

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<sup>1</sup> The name "Lot Canal" is derived from its physical characteristics, which are straight and narrow like a straw. "Lot" is the Thai word for "straw".

main transportation and communication routes (Chulalongkorn University 1994). Because of their easy construction, waterways had been the traditional transportation routes for Thai people prior to 1782 (Bunnag, Duangporn and Suwattana 1982). People built their houses along the rivers or canals (including floating houses), using them as sources of water for agriculture, drinking, cooking, cleaning, and as sources of food such as fish, crab, and shrimp. Population density in Bangkok at this time was low, and all residential settlements were located along the Chao Phraya River and the canals in linear communities (Chulalongkorn University 1994). In addition to the residential areas, there were other important public functions located along the river and canals. For instance, palaces such as the Tha Tian Palace located on the Chao Phraya River, served as both royal residences and governmental offices. Temples such as Wat Theptidaram and Wat Ratchanaddaram on Lot Canals, were religious, social, cultural, and educational centers for the Thai people. The rivers and canals were the elements that connected houses, temples, and other public spaces (Fig. 4.3).

The canals also functioned as essential commercial routes for the transport of all domestic commodities, especially agricultural products (Bunnag, et al. 1982). Floating markets developed (Fig. 4.4), especially at the intersections of the canals and the river. In response to these functions, the canals needed to be wide, deep and continuous. Although floating markets were more popular than ground markets because waterways were the primary transport corridors, usually ground markets developed near the waterways (Chulalongkorn University 1991).

Figure 4.3 shows the influence of the canal system on other physical elements and settlement patterns. It shows that a number of religious and cultural centers such as palaces and temples had been built on the canals. Many cultural activities associated with these institutions occurred along the canals as well. These included the Loy Kratong Festival, in which people pay respect to the God of River, and the Sakkawa Festival, in which people sail boats and sing songs. The canals had to be wide enough to serve these cultural activities. In addition to the cultural significance attached to the water, the canals were also used for general recreational activities such as swimming and

traveling by boat (Chulalongkorn University 1994), since the water quality was generally good.

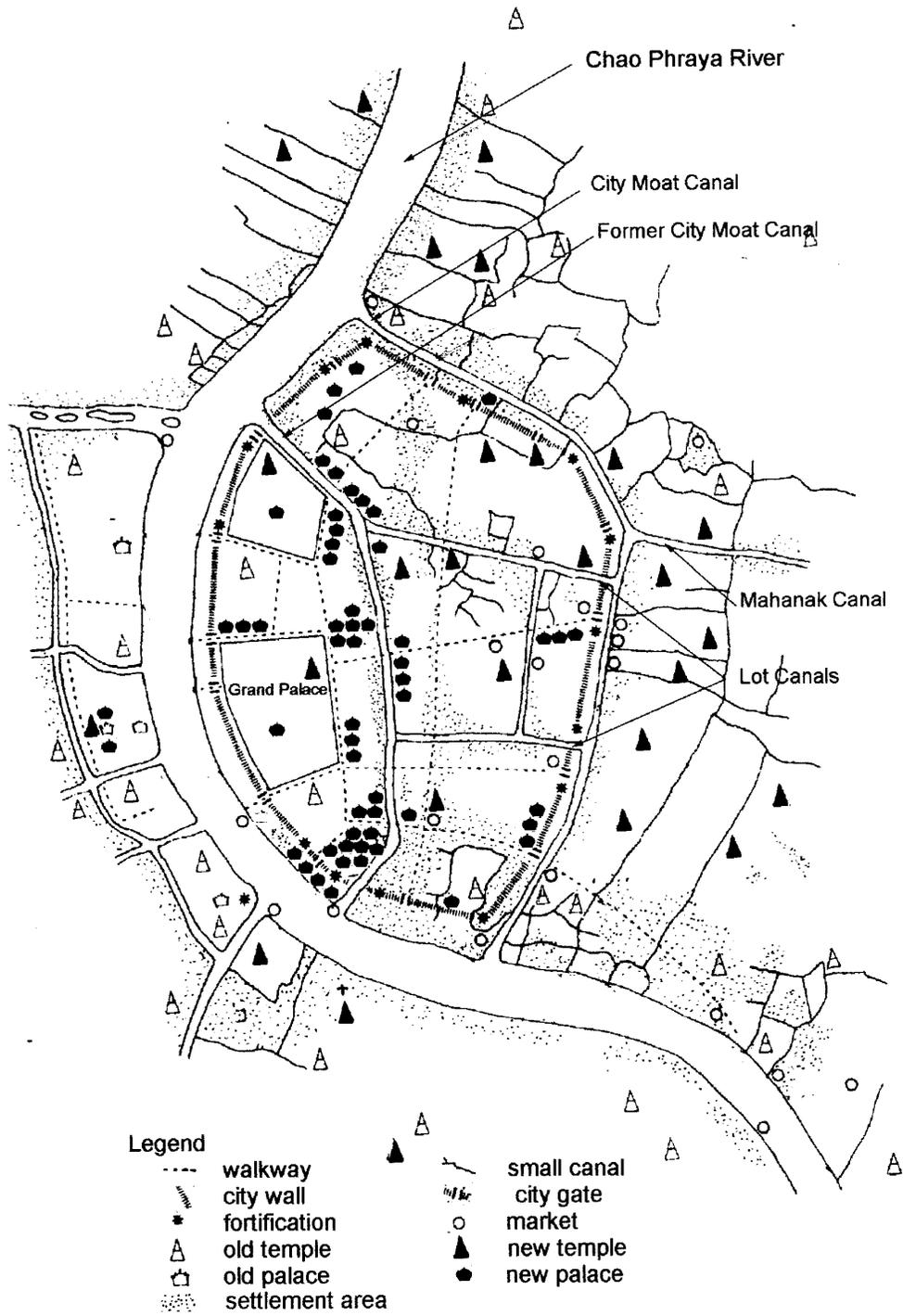


Figure 4.3: The influence of the canal system on settlement patterns in the early Bangkok phase, 1782 – 1851 (source: Chulalongkorn University 1991).

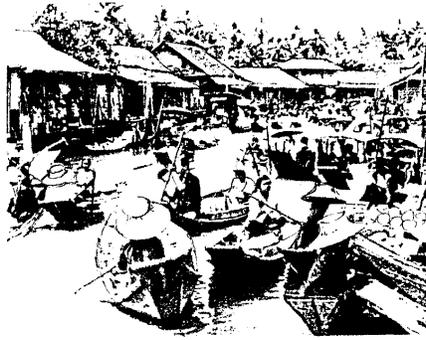


Figure 4.4: The use of the canals for commercial purposes or floating markets (source: Bunnag, et al. 1982, p. 213).

As mentioned above, the canals were the main mode of transportation in this period (1782 - 1851), so there were no roads built during this time. There were only walkways with earth or brick surfaces to connect the inner and outer sections of the city (Fig. 4.3). The wooden bridges that crossed the canals could be lifted when boats passed by (Chulalongkorn University 1991).

## **2. Westernization Period (King Rama IV - King Rama VI or 1851 - 1925)**

In the reign of King Rama IV (1851 - 1925) under the influence of western countries, especially those in Europe, Thailand implemented a modernization policy. The major change in Bangkok was a shift from primarily water-based transport to land-based transport. However, the canals remained more popular than the new streets for some time, because they represented a traditional means of transportation, which was efficient and appropriate to Thai society.

As a result of a population increase in Bangkok, along with a new open-door foreign policy (resulting in an increasing number of countries having diplomatic and commercial relations with Thailand), King Rama IV began to lay the foundation for further city expansion. In 1851 the Padung Krung Kasem Canal was dug on the east, parallel to the City Moat Canal, to expand the boundary of the capital city toward the east and the southeast (Fig. 4.6). A wall was not built along the new canal because conflicts with neighboring countries were now settled diplomatically. Fortifications were built only at intervals along the new canal. This open-door policy also resulted in a slight difference in the canals' function. After the Bowring Treaty with England was signed in

1855, the need to dig canals for defensive purposes was superceded by economic concerns (Bunnag, et al. 1982). However, the canals remained highly useful for transportation. The free trade clauses in the Bowring Treaty enabled increasing numbers of countries, especially western countries, to develop commercial relations with Thailand. Consequently, the Thai economic system changed from producing for domestic use, to overproducing for both domestic use and export. The use of the canals for commercial purposes thus became more important not only for domestic commerce, but also for international commerce. Because of the economic prosperity, the number of foreigners, especially from western countries, was increasing. Thus, the construction of new canals in the era of King Rama IV (and King Rama V) continued in response to the demands of a growing population.

The street construction that began in King Rama IV's period also resulted in construction of one and two-story buildings in the European style for commercial and residential purposes. Bangkok, then, had gradually changed from an old walled city to a modern city.

During King Rama V's reign, from 1868 - 1910, which corresponded to the Industrial Revolution in Europe, roads and railways became viable alternative means of transportation. With new construction materials such as cast iron and cement, Bangkok changed considerably in its features. The many new roads and railways included the Ratchadamnoen Avenue built to connect the Grand Palace with Suan Dusit Palace located on the outskirts of Bangkok. Some new roads were built next to and parallel to the Former City Moat Canal, City Moat Canal and Padung Krung Kasem Canal (Chulalongkorn University 1991). The canals were the primary structural elements that influenced the pattern of streets. Although roads had become important for transportation and communication, King Rama V realized the importance of the role of the canal system as the main route of transportation. In 1870, before developing the road system, King Rama V implemented a policy to develop the canal system and improve its quality (Bunnag, et al. 1982). This policy was used to develop the physical and environmental quality of the canals, and to maximize their usefulness as public spaces. No littering was allowed on canals, and canal-traffic regulations were established. As a

result, Bangkok became known as “Eastern Venice” (Chulalongkorn University 1982). Furthermore, the bridges built in this period were constructed in order to permit the use of both roads and canals as means of transportation (Fig. 4.5). New canals such as Prempracha, Prapa and Sathon, were built during this era on the outskirts of Bangkok for both transportation and the expansion of the city to the north, east and south.

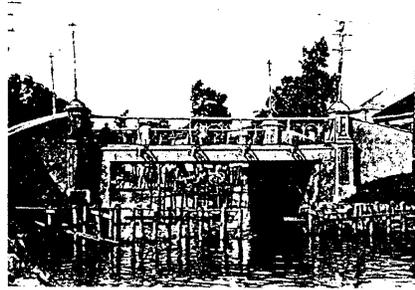


Figure 4.5: The raised bridge on the Lot Canal built in King Rama V’s period allows the use of streets and canals as means of transportation (source: Bunnag, et al. 1982, p. 228).

Since King Rama VI’s reign (1910 - 1925), the importance of the canals has diminished. No new canal has been built since this time, while the number of roads and bridges in Bangkok has increased. The first bridge across the Chao Phraya River, Rama VI Bridge, was built in this era, and gradually streets became the main mode of transportation in Bangkok (Chulalongkorn University 1991). The number of people using cars or rickshaws increased rapidly during King Rama VI’s period. Within two years, the number of cars increased from 251 in King Rama V’s reign to 622 in 1911 in King Rama VI’s reign, a 147.81 % increase (Bunnag, et al. 1982). Consequently, several existing canals were filled and transformed into roads. Figure 4.6 shows the development of the canals in the westernization phase (1851 - 1925).

During the westernization period, the canals had a strong influence on the street patterns in Bangkok; roads were built along the main canals and on filled canals (Fig. 4.6). In this reign, many palaces in the capital area, especially on Rattanakosin Island, were also converted to governmental offices and temples, and some of them were destroyed. Although construction of temples along roads began at this time, some new temples continued to be built along the canals. Until 1910, King Rama VI’s policy was

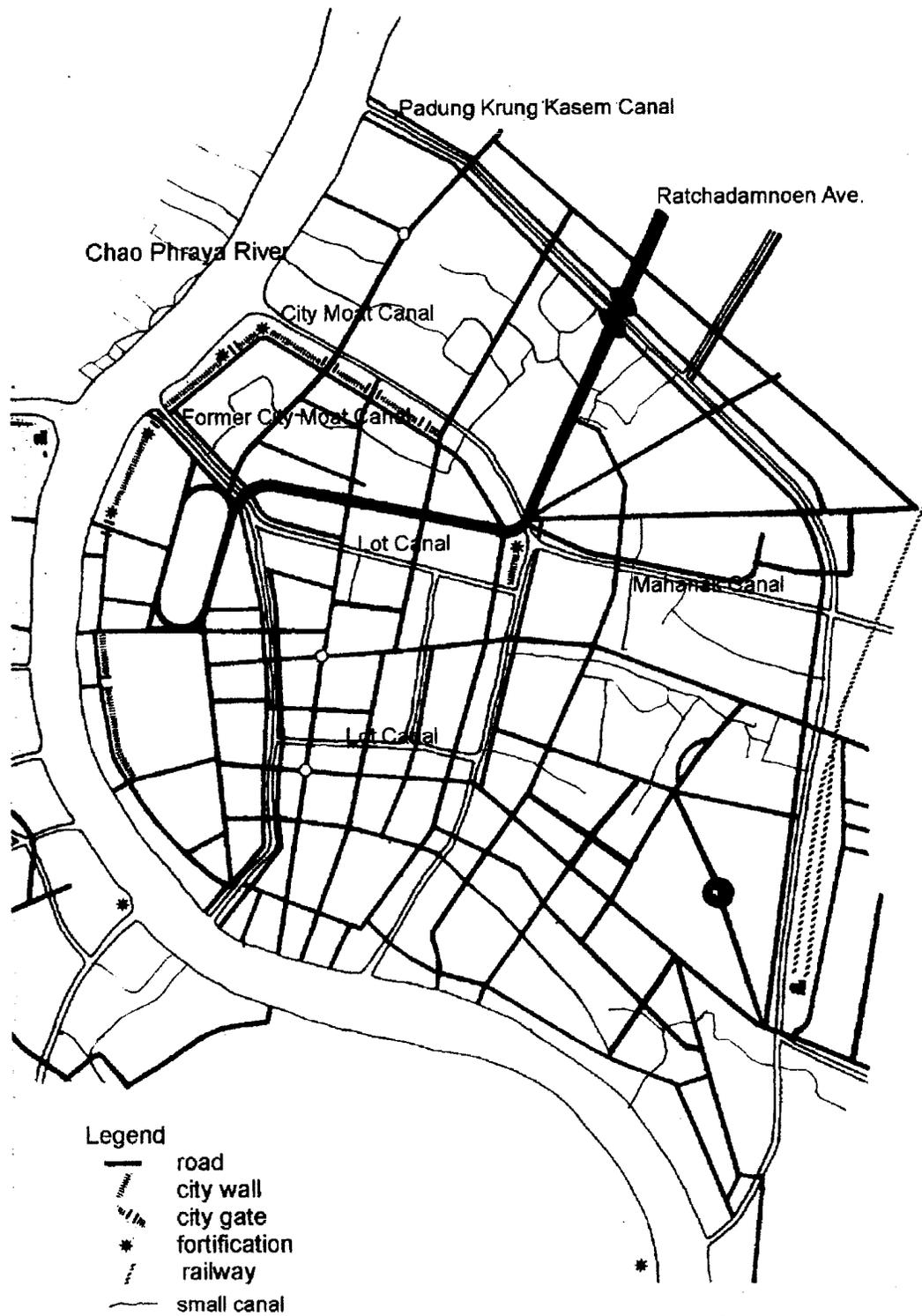


Figure 4.6: Canal and street system in the westernization phase, 1851 – 1925 (source: Chulalongkorn University 1991).

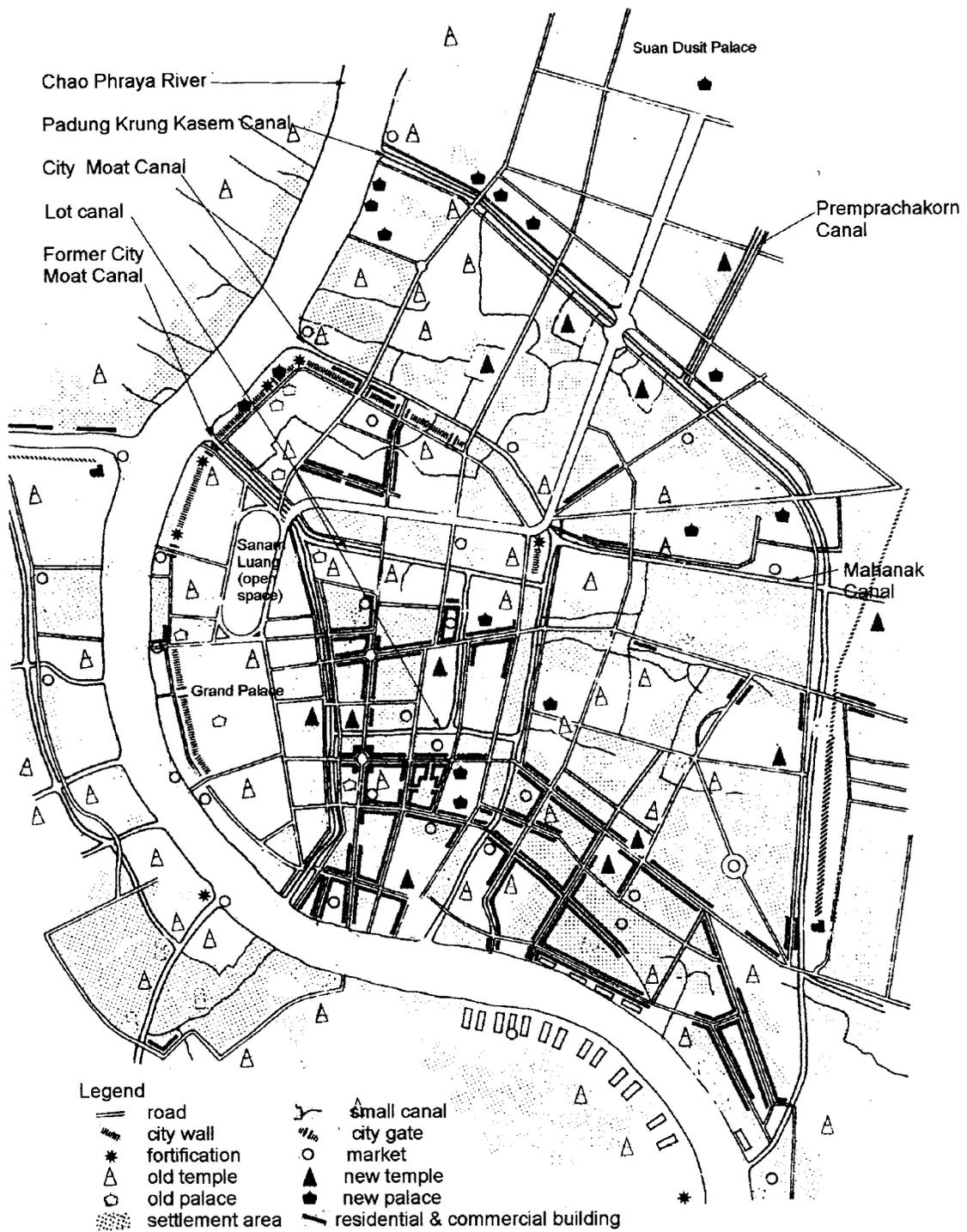


Figure 4.7: The influence of the canal system on settlement patterns in the westernization phase, 1851 – 1925 (source: Chulalongkorn University 1991).

to build schools as educational centers and stop building temples for this purpose (Chulalongkorn University 1991). Figure 4.7 shows that the number of residential and commercial settlements along the roads increased as streets developed, especially in the reign of King Rama VI, and new markets began to move from the water (the floating market, for example) to the land. During this transitional period, the canals' role as a main mode of transportation as well as an influence on settlement patterns was reduced. Figure 4.7 shows the influence of the canal system on other physical elements and settlement patterns in Bangkok during the period from 1852 - 1925.

### **3. Contemporary Condition (King Rama VII - King Rama IX or 1925 - the present time)**

Under the influence of new transportation technologies and an increasing dependence on the automobile, the street system has replaced the canals. There has been no canal construction since 1910, the period of King Rama VI (Chulalongkorn University 1991). Instead, the number of canals has decreased as the city has developed, and conversely, the number of roads has increased. Some of the canals were filled and replaced by roads, and some were covered by bridges, which impeded boat transportation. For example, Phra Pin Klao Bridge was built across the Chao Phraya River and covered the north section of the Former City Moat Canal in the period of King Rama IX. By 1934, only the essential canals, the Former City Moat Canal, City Moat Canal, and Lot Canals remained (Chulalongkorn University 1994 and Bunnag, et al. 1982). Figure 4.8 shows the existing canals that remain today.

As a result of a 1961 economic development policy associated with high construction technology, Bangkok has developed rapidly, resulting in many changes in the physical appearance of the city. A significant increase in population, especially after 1957, is one of the important changes. Between 1957 and 1981, the population increased from 1,908,059 to 5,331,402. The current population is 5,604,772 (Bunnag, et al. 1982, and Statistics Division 1999). High population density has become a problem, in that every area of Bangkok, including areas along the canals, is very densely occupied.

In addition, a significantly increasing population also results in a demand for more public

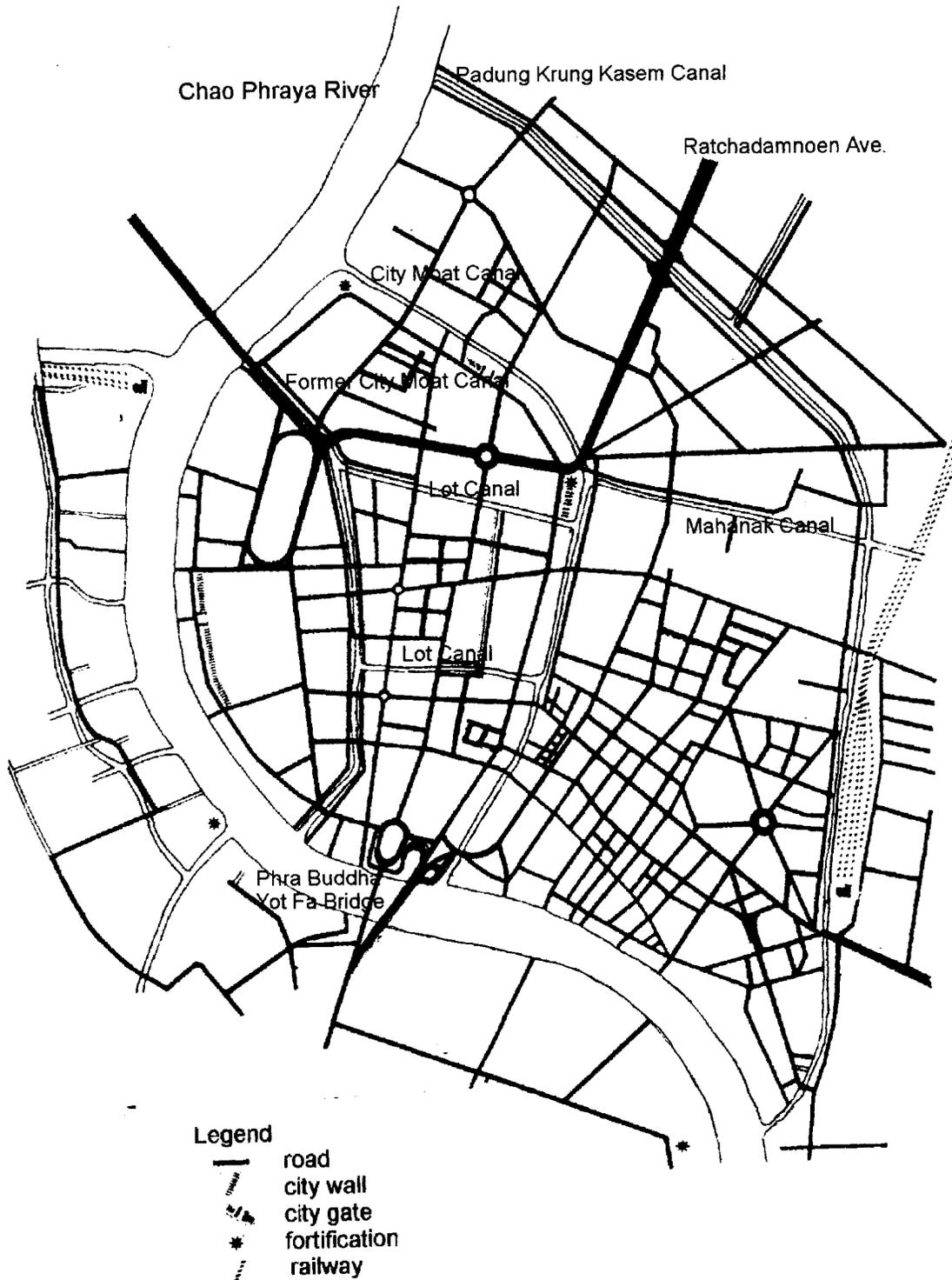


Figure 4.8: Existing canal and street system in the contemporary phase, 1925 – present (source: Chulalongkorn University 1991).

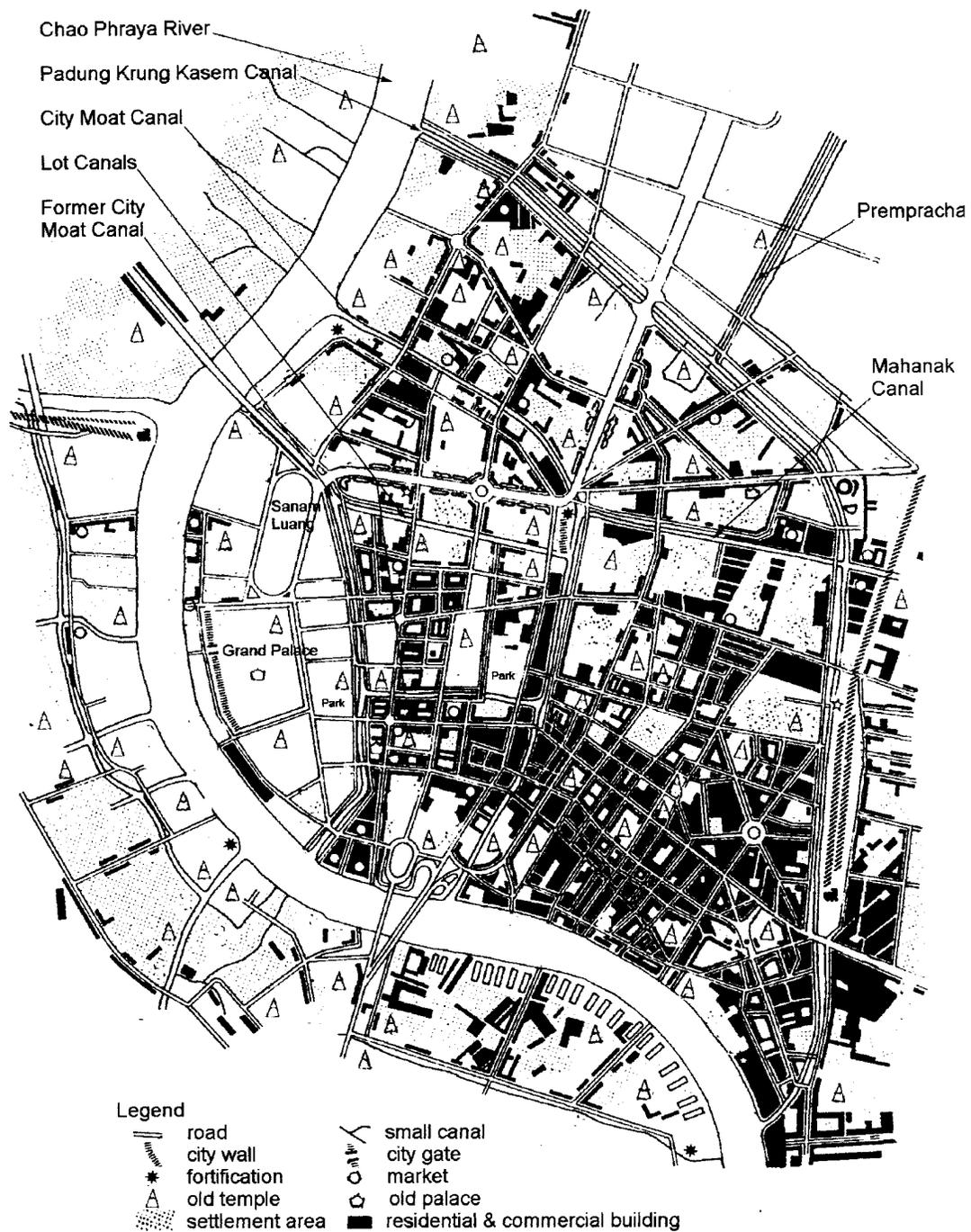


Figure 4.9: The influence of the canal system on settlement patterns in the contemporary phase, 1925 – present (source: Chulalongkorn University 1991).

spaces in Bangkok. Consequently, some historic palaces and institutional areas located on the canals have been converted to public spaces or urban parks, such as the Saranrom Royal Garden, which used to be a palace and Rommaneenart Park, which used to be a jail. Currently, the temples and grounds of former institutional buildings comprise the main public spaces on Rattanakosin Island. Due to the high population density, canals such as the City Moat Canal are also used as sewers, resulting in poor quality water and increasingly shallow canal depths (Bunnag, et al. 1982). This discourages boating and recreational use.

Streets have taken over the role of the canals as both primary public spaces and connectors linking important places in Bangkok. They have also become the most important functional and structural elements influencing contemporary settlement patterns in Bangkok. Bangkok has expanded away from the central Rattanakosin District, along main roads on the eastern bank. The new residential settlements are no longer along the canals, but rather along the roads (Figure 4.9) due to changes in focus from the canal system to the street system (Chulalongkorn University 1994).

The morphological analysis establishes that Bangkok's canals are primary structural elements, as defined by Rossi. They have retained the integrity of their physical form over time, and have accumulated cultural meaning, becoming part of the "collective memory" of the local populace. They are also "propelling" elements, since their functions have changed over time, in response to a changing context. The morphological analysis also suggests that the canal system on Rattanakosin Island has held functional value and historic importance, which are worthy of preservation. The Former City Moat Canal and City Moat Canal are original primary canals that were built for defensive purposes. These were designated historic places in *Historic Monuments and Objects, and National Museum Act 1962*, which restricts the conversion of canals to roads and prohibits new development or encroaching structures on the public right-of-way along the canals. The maximum building height along the canals is also limited to sixteen meters (4 stories). Because of their historic importance, the fortifications, city gates and city walls that still remain on these canals are preserved as historic places (Fig. 4.10a and b). Other key historic places located along the canals include a number of

temples, which still hold religious, social, and cultural significance for Thai citizens (Fig. 4.10a and c).

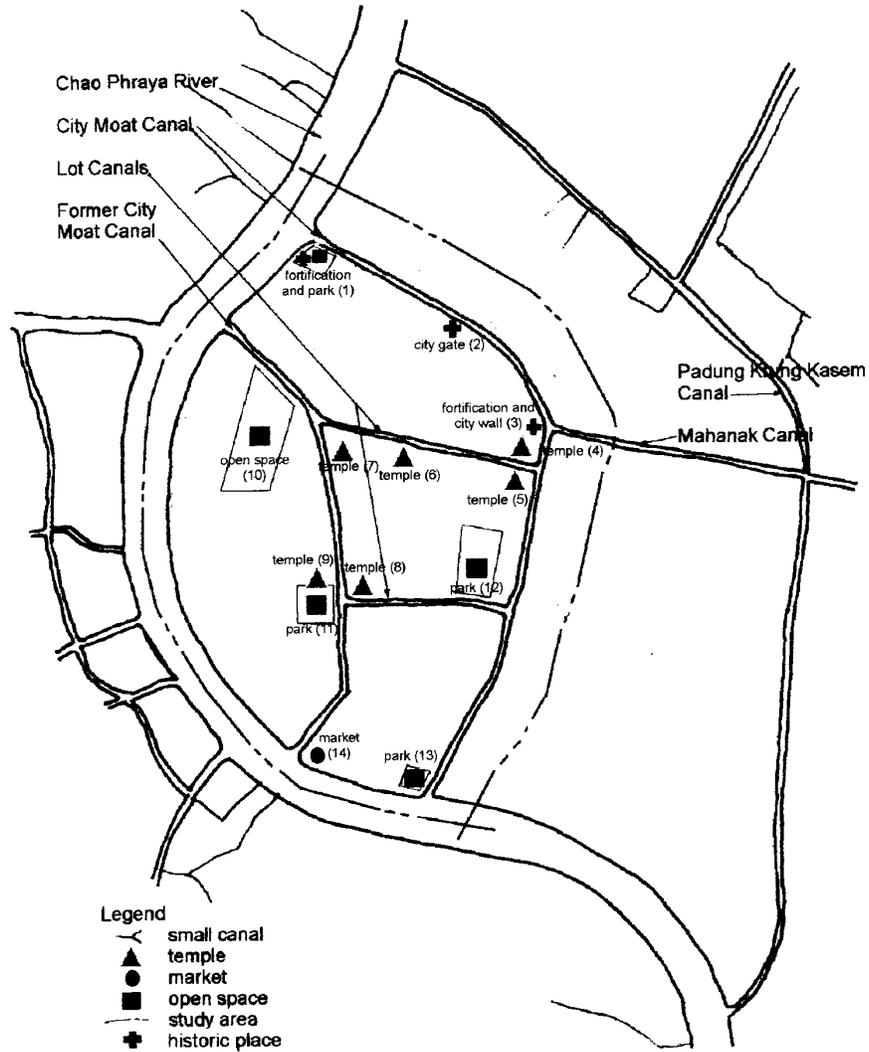
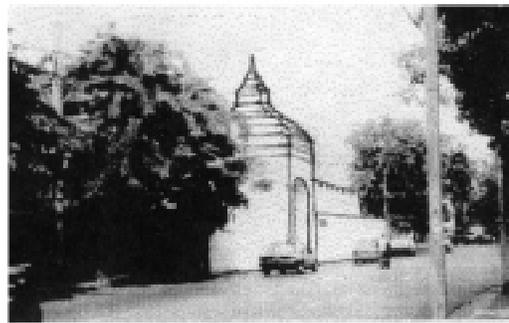


Figure 4.10a: Map showing key public spaces on the canals on Rattanakosin Island in the present time.



(1). The fortification and the park behind.



(2). The city gate.

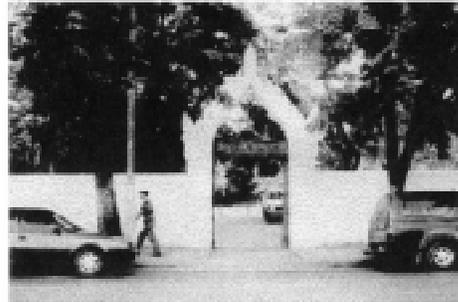


(3) The fortification and the city wall.

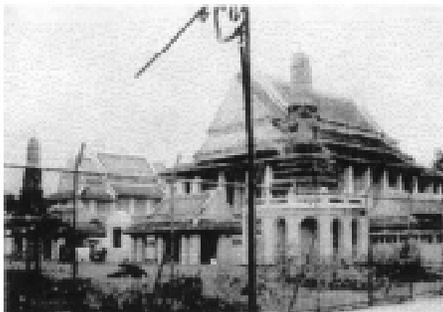
Figure 4.10b: Existing fortifications, city gate, and city wall on the canal on Rattanakosin Island.



(4). Ratchanadaram Temple



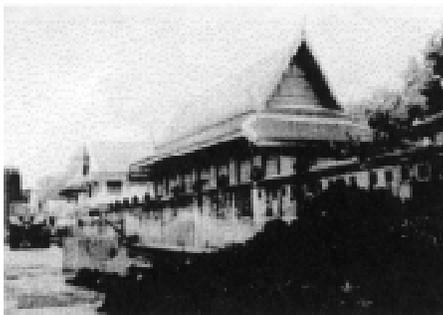
(7). Ratchabopit Temple



(5) (Buranasirinayaram Temple



(8). Mahannaparam Temple



(6). Thepthidaram Temple

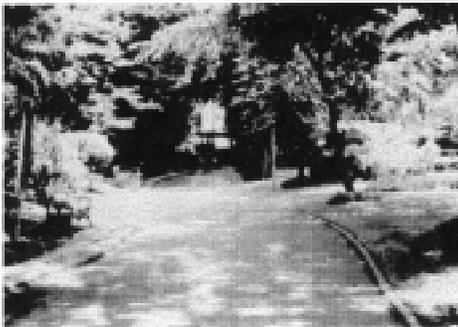


(9). Ratchapradit Temple

Figure 4.10c: Existing temples on the canals on Rattanakosin Island.



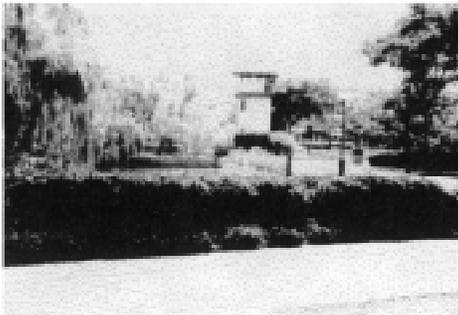
(10). Sanam Luang public square



(11). Saranrom Royal Garden park



(13). Park under Phra Buddha Yot Fa Bridge



(12). Rommaneernart park



(14). Pak Klong market

Figure 4.10d: Existing parks and market on the canals on Rattanakosin Island.

Other remaining key public spaces along the canals are squares, parks, and markets (Fig. 4.10a and d). Although they have less historic importance than the fortifications, city gates and walls, and temples, they are important due to their function

as public spaces. The main public square called “Sanam Luang” has been the site for various religious, recreational, and political activities and festivals since the early Bangkok period. It is an important civic open space that still functions and should be preserved. All key public spaces on the canals are shown in Figure 4.10.

## 4.2 Potentials and Issues associated with Preserving and Reestablishing the Canals as Public Spaces and as Connectors of Key Public Spaces

There are both potentials and issues associated with the objective of preserving the canal system and reestablishing it as a primary public space system and as a connector linking key public spaces on Rattanakosin Island.

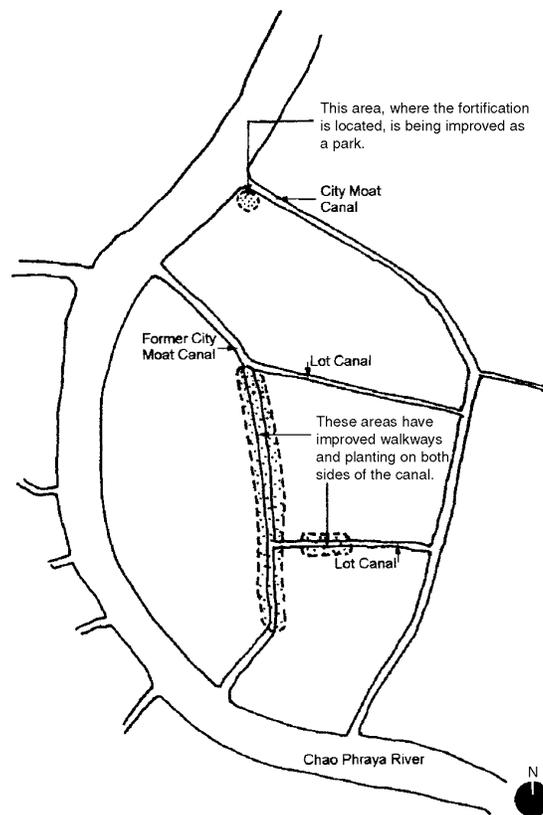


Figure 4.11: Map showing improved areas along the canals on Rattanakosin Island.

Although the original functions of the canals are no longer viable, there have been attempts to preserve and redevelop Bangkok's canals, especially on Rattanakosin Island. Such projects include cleaning the water by operating a public water treatment system along all remaining canals, and developing walkways and planting along the Former City Moat Canal, and the section of the Lot Canal (Fig. 4.1 1). There has also been a proposal by Office of Environmental Policy and Planning to develop additional walkways along all remaining canals. Moreover, there have been attempts to provide more public spaces on Rattanakosin Island for a better quality of life by proposing to redevelop some historic areas as parks. These include the existing fortifications along the City Moat Canal. The park at the fortification located on the north of the City Moat Canal is being implemented (Fig. 4.11). These public projects also enhance the proposed role of the canal system as a public space system.

Due to high population densities, there is increased demand for public space in Bangkok. The Former City Moat Canal, which has a wide setback area, is already used as a site for passive recreational activities, especially for sitting. This demand could be met by improving and redeveloping the remaining canal frontages on Rattanakosin Island as public spaces to serve local residents. As a result of a high dependence on automobiles, congestion on the street system in Bangkok is currently an important problem that results in other problems such as noise and air pollution. Many people are turning back to the canal system as alternative means of transportation. On Rattanakosin Island, the northern part of the City Moat Canal is still used for transportation purposes (Fig. 4.12). Associated with their original roles as the primary transportation routes, the



Figure 4.12: The use of the City Moat Canal for transportation purposes.

canals still provide an address for some important public spaces, including a civic center with a public square (Fig. 4.16, p. 46). There is potential to reuse the canals as connectors of key public spaces on Rattanakosin Island.

Since the canals are important historic places, they also attract many domestic and foreign visitors, especially the Former City Moat and the City Moat canal, which are the locations of fortifications, city walls, city gates, and temples. These public spaces are important permanent structures that record Bangkok's cultural history. Therefore, these two canals also have potential to be developed as tourist destinations. The Lot Canals connecting these two attractions should also be reestablished as connecting corridors, in order to create a continuous interpretive system. The proposed role of the canal system as a tourist destination also responds to the 1998 - 1999 tourism campaign, "Amazing Thailand", which was introduced to boost the economy of Thailand, one of many countries facing an economic crisis. During this campaign, the Former City Moat Canal became a popular attraction, and boating on this canal was sometimes permitted. Moreover, the legislation preserving historic monuments along the canals, such as temples and fortifications, supports their functions as tourist destinations and is helpful for historic interpretation.

Nevertheless, there are four main physical problems affecting the use of the canals as public spaces and connectors. The first problem is poor water quality. Some existing canals, including the City Moat Canal and Lot canals, function as sewers because of an inefficient water treatment system. The canals cannot serve as sites for recreational activities as they did in previous times. The water pollution is, however, being addressed by a new public water treatment system.

The second problem is the shallow depth of the canals resulting from litter deposited by residents living along the canals. This affects the use of the canals as connectors, making boating difficult and uncomfortable. However, this problem is being resolved by a government dredging project.

The third problem is lack of setback area along the canals. In some places, canal banks or setback areas are illegally occupied by encroaching structures. Therefore, some areas along the canals have no building setbacks, which interrupts the continuity of

walkways and reduces opportunities to use the canal banks for public spaces and recreational areas. The problem of encroaching structures occurs mainly along the Lot Canals and the City Moat canal. Since properties on the west bank of the Former City Moat Canal are in an institutional area, the public right-of-way along this canal is clearly defined and rigorously controlled.

The last problem results from overhead structures. The heights of overhead structures, such as streets and bridges, can impact the function of the canals as waterways. As seen on Rattanakosin Island, some streets and bridges are not high enough for boats to pass below. This factor limits the role of the canal system as a connector. The north section of the Former City Moat Canal is covered by a bridge and parking lot (Fig. 4.13); the south section of the City Moat Canal is covered by many iron bridges that house commercial enterprises (Fig. 4.14); and the Lot Canals are crossed by streets and bridges with minimal clearances (Fig. 4.15). These structures interrupt the continuity of the waterways, and prohibit the use of the canals for boat transportation in these areas.



Figure 4.13: The north section of the Former City Moat Canal is covered by the bridge and parking lot.



Figure 4.14: The south section of the City Moat Canal is covered by several iron bridges for commercial purposes.

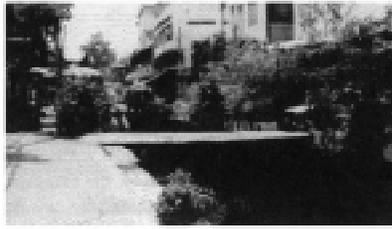


Figure 4.15: The Lot Canals are crossed by straight bridges.

In conclusion, the canals of Rattanakosin Island are important historic places, especially the Former City Moat Canal, the oldest canal. They also are essential functional and structural elements that hold symbolic values for Thai residents. Although only two of them, the Former City Moat Canal and the City Moat Canal, are designated historic places, the others can be considered historic places as well due to the values embodied in them. All canals in this area thus have historic importance and retain valuable symbolic significance that links the Thai people to their past, which are worthy for preservation.

Unlike the Lot Canals, the Former City Moat Canal and City Moat Canal have potential to be redeveloped for boating. Except for the north area of the Former City Moat Canal and the south area of the City Moat Canal (Fig. 4.16), the bridges crossing over these canals are high enough for boats to pass below. However, in order to reestablish a continuous canal system on Rattanakosin Island, the Lot Canals are necessary as links between the two primary canals. Although the Lot Canals have limitations for boat access, they can be used to restore pedestrian connections. However, the use of the canals as walkways and public spaces requires minimum building setbacks. Due to this criterion, the Former City Moat Canal seems to have more potential to be reestablished as a public space because of its wide setback area. Ultimately, in order to recreate the canal system as a public space system on Rattanakosin Island, the Former City Moat Canal and the City Moat Canal should be redeveloped as primary routes, and the Lot Canals should be reestablished as secondary ones. Figure 4.16 shows potentials for redeveloping the canal system as a public space system and a connector of key public spaces.

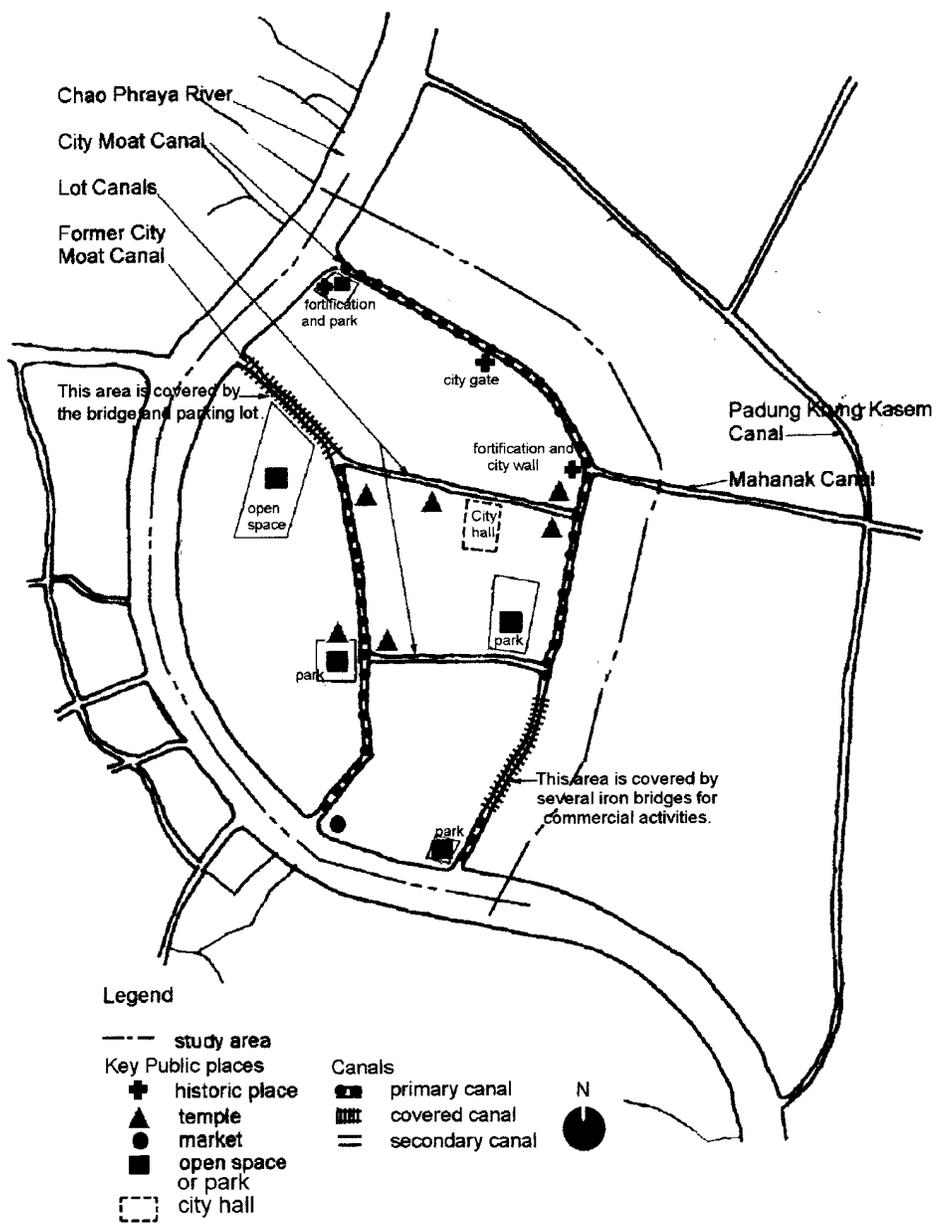


Figure 4.16: Map showing potential to preserve and reestablish the canals as public spaces and connectors of key public spaces on Rattanakosin Island.

Based on the theory of permanence of urban structural elements, the canals on Rattanakosin Island represent propelling elements because they can accommodate new functions. The canals are important cultural artifacts that hold cultural and symbolic meanings for Thai citizens, and their physical structures have endured over the course of

history. Although the canals' original functions as defensive installations, as primary modes of transportation, and as sites for commercial activities have been supplanted, they have been able to accommodate new functions over time in response to the ongoing development of the city. They have always accommodated public space functions, and continue to do so, particularly activities associated with the temples and other public institutions, and to adopt new ones such as tourism and historic interpretation. In response to the new context of contemporary Bangkok, the canals have potential to retain their current function as flood control devices and to accommodate new functions as passive public spaces and connectors linking key public spaces on Rattanakosin Island, serving local residents, and as tourist destinations that reflect Bangkok's cultural history through the existing physical structures of historic places along the canals. This proposal would ensure that the canals become propelling elements in Bangkok. There is a need to preserve the structural characteristics of the canals that support public space functions. These characteristics can be identified through typological analysis.

### **4.3 Canal Types**

Typology is used as a tool to group elements that share general physical characteristics and as a basis for creating guidelines. In this study, the typological analysis focuses on the canals on Rattanakosin Island, which include the Former City Moat Canal, City Moat Canal, and Lot Canals (Fig. 4.17). However, in some areas the canals are covered by structures such as a parking lot and bridge on the Former City Moat Canal (Fig. 4.13 and 4.17), and several iron bridges used for commercial purposes on the City Moat Canal (Fig. 4.14 and 4.17). The physical characteristics of the canals in these two areas are obscured, and are difficult to see by direct observation. Therefore, these two areas are not included in the study area.

On Rattanakosin Island, there are seven main canal types (Appendix A) that have potential to accommodate a range of public space functions, based on five main criteria: structural condition, canal width, edge condition, building setback distance, and adjacent

land use. Analysis of these types reveals the implications for preserving and reestablishing the canals as primary public spaces.

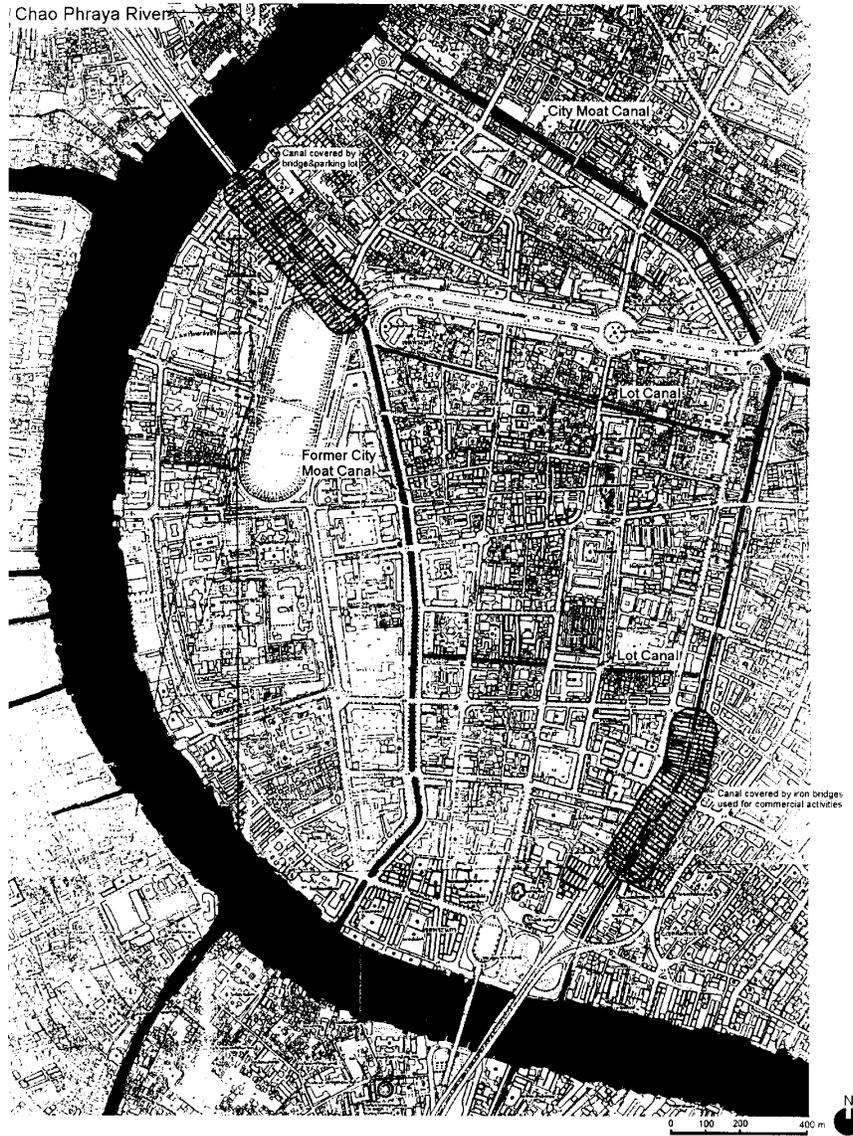


Figure 4.17: Map showing the study area.

Based on structural condition, the seven main canal types can be divided into two main groups, intersection condition and corridor condition. Intersection condition consists of types A and B, and corridor condition includes types C, D, E, F and G (Fig. 4.18a and b). Each type with the implications is described below.

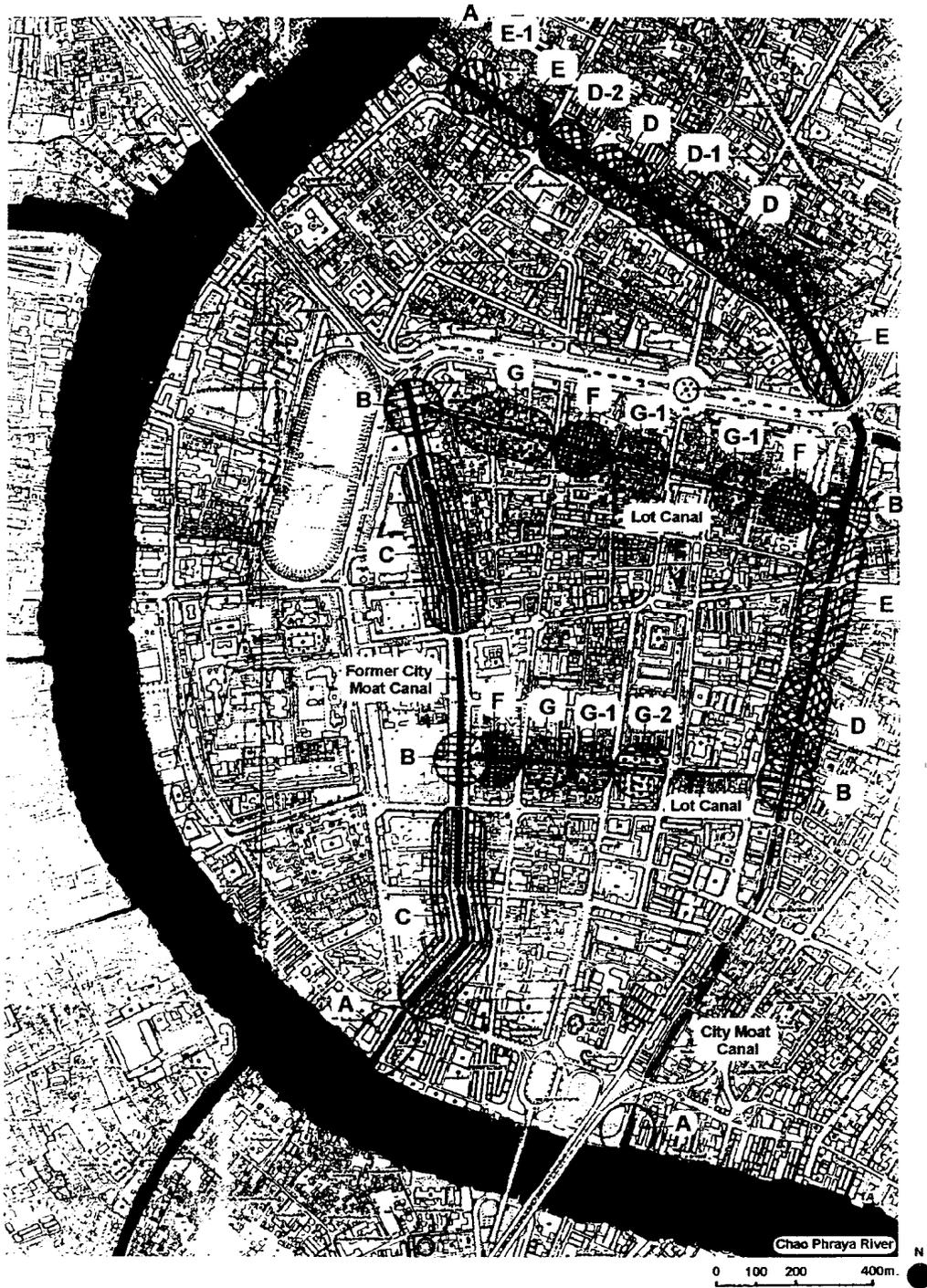


Figure 4.18a: Map showing the locations of the seven canal types.

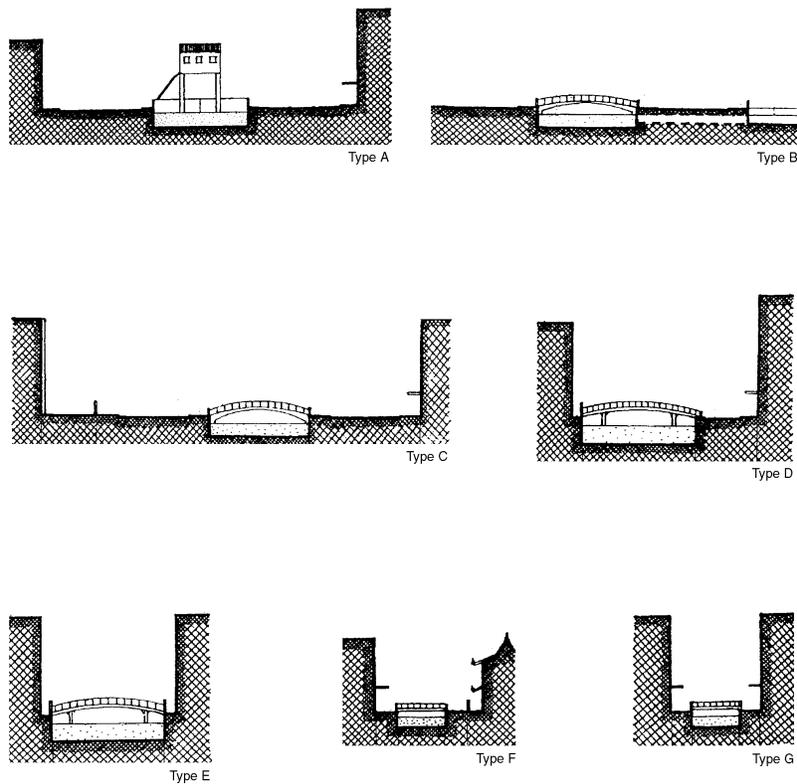


Figure 4.18b: Sections showing the seven canal types.

### 1. Type A

Type A is the area where the canal meets the Chao Phraya River. It is an intersection condition. Key physical characteristics related to the use of this canal type as a flood control device are a raised wall at the canal edge and a water gate (lock). Although building setback distance varies in relation to adjacent land use, there are setback areas used as walkways and roads at both sides of the canal. These key physical attributes are shown in a section of type A (Fig. 4.19).

#### *Implications*

Type A cannot be used as a connector by boats because of the water gates, but it can be used as a walkway corridor. Raised walls at the canal edge also separate the canal from ground level and limit the use of the canal as a public place for recreational activities such as sitting and sightseeing.

Type A

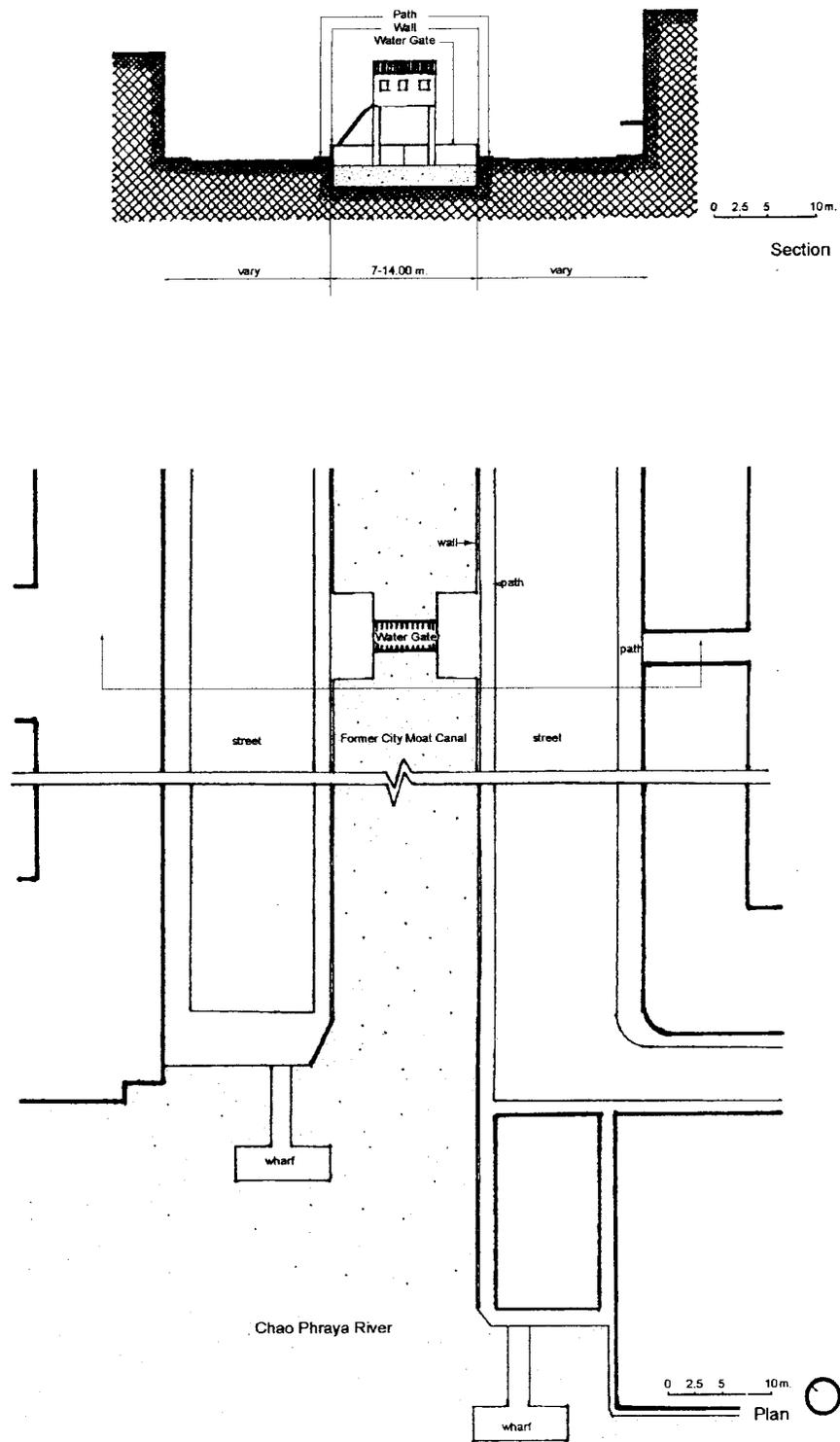


Figure 4.19: Section and plan of type A.

## **2. Type B**

Type B is the other intersection condition (Fig. 4.20). It is the meeting place between the primary (the Former City Moat and City Moat Canal) and the secondary canals (the Lot Canals). The widths of the primary canals vary from 12 - 20 meters, and the widths of the secondary canals are 6.5 - 8 meters, which are wide enough for boating. For this type, at (or next to) the meeting area the secondary canal is usually covered by the street running parallel to the main canal. For the Former City Moat Canal and City Moat Canal, the bridges crossing the canals are curved bridges, which are high enough for boats to pass under.

### ***Implications***

Due to the canal width and the overhead structure of type B, there is potential to reuse the main canal as a waterway, but for the secondary canal, which is crossed by a street, a walkway is the only appropriate means of transportation. As an intersection condition, this type draws more traffic, a factor that should be considered when redeveloping the canal as a connector.

Type B

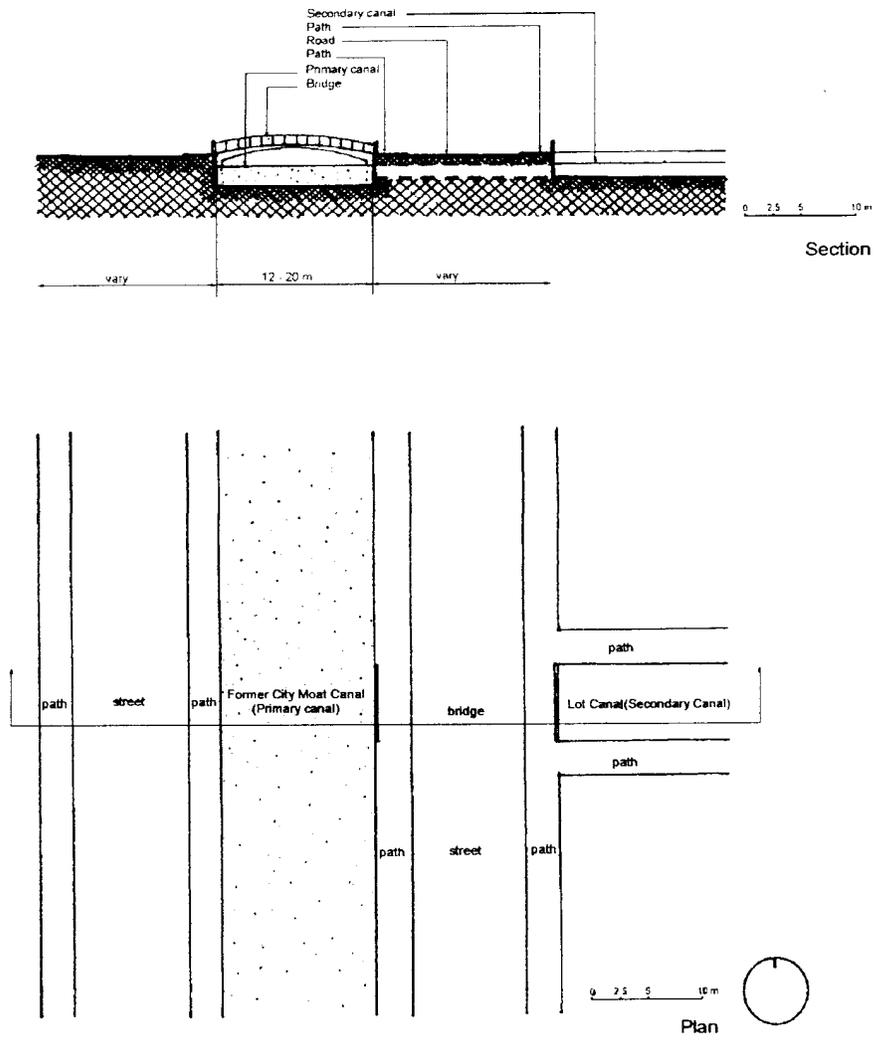


Figure 4.20: Section and plan of type B.

### **3. Type C**

Type C is typically found on the Former City Moat Canal. It is a corridor condition. The canal width is 14 meters, and the bridges crossing the canal are curved or raised. On one side there are institutional buildings 2 - 4 stories high, and on the other side is a mix of commercial and residential buildings 2 - 4 stories high. For the commercial and residential buildings, the first floor is usually used for commercial activities, and the upper floors are used for residences. Buildings on both sides face the canals. At the setback area, the canal is enclosed by a street with walkways at each side; the width of each street with walkways is approximately 16 meters. Figure 4.21 shows the common physical characteristics of this type.

#### ***Implications***

Due to the canal width and the curved bridges, there is potential to reuse this canal type as a waterway. There are also streets and walkways on both sides of the canal, which strongly support the use of the canal corridor as a connector. Moreover, there is enough setback distance for this canal type to be redeveloped as a public place. Because of the adjacent land use for governmental offices and commercial buildings, many activities that require a public space happen in this area, for instance, having lunch areas for office workers and shaded areas for pedestrians or shoppers.

Type C

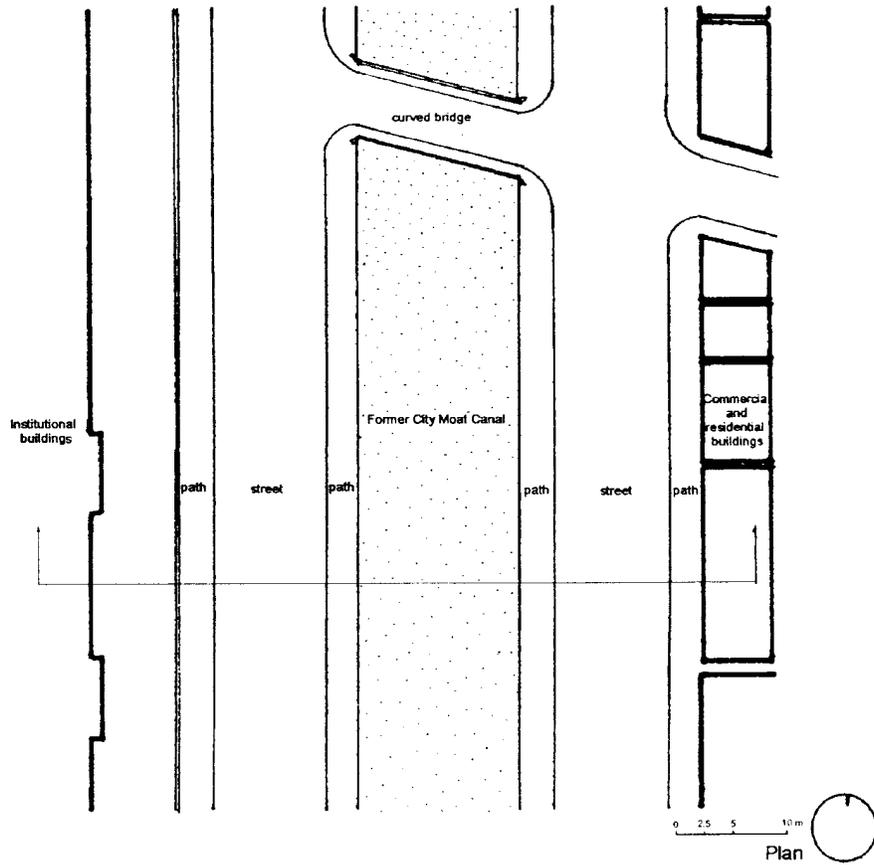
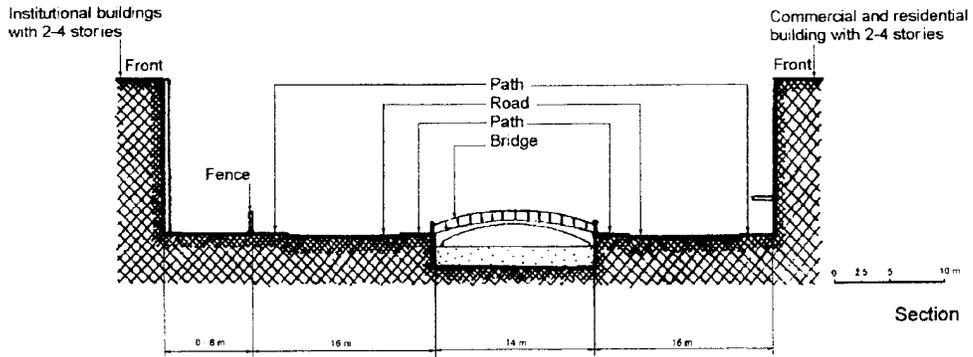


Figure 4.21: Section and plan of type C.

#### **4. Type D**

Type D is a corridor condition found along the City Moat Canal. The canal width of this type varies from 12 to 20 meters, and its overhead structures are curved or raised bridges. There is no setback area on one side, where there are 2 - 4 story commercial and residential buildings with backs facing the canal. On the other side, there is an 8 - 10 meter setback distance and 2 - 5 story residential buildings with fronts facing the canal. The setback area is used as a road with walkways on both sides. There are two areas, D-1 and D-2 (Fig. 4.18a), which are slightly different from type D, but they can still be considered as type D. In the area D-1, there is a 2-meter setback area left without encroaching structures on the commercial and residential side. For area D-2, the only difference is the height of 7 story apartment buildings on the residential side. Figure 4.22 shows the physical attributes of type D.

#### ***Implications***

From the physical characteristics of type D, there is potential to redevelop the canal as a transportation route both on water and on land. On the residential side, it is suitable for some recreational activities.

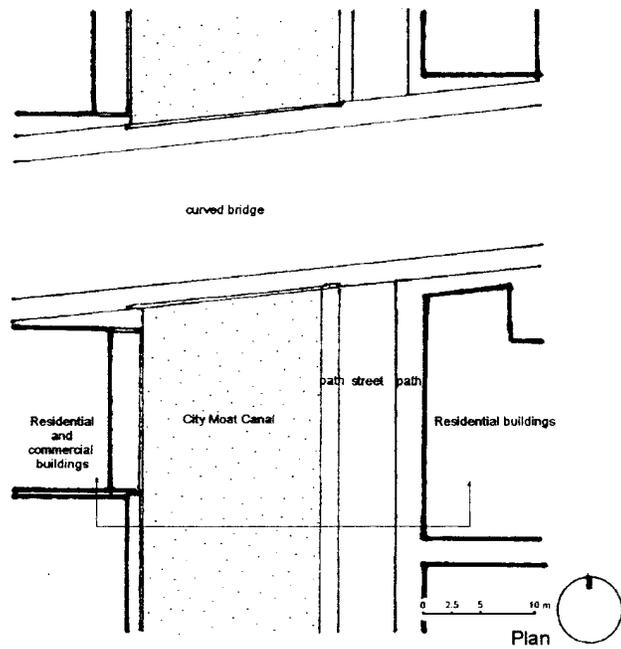
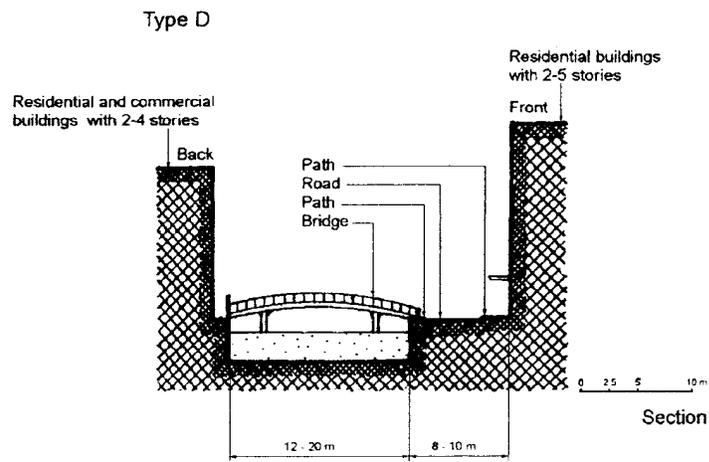


Figure 4.22: Section and plan of type D.

## **5. Type E**

Type E is another type of a corridor condition (Fig. 4.23). This canal type is found on the City Moat Canal, where the canal is 12-20 meters wide with curved or raised bridges crossing over. There is no building setback distance on either side for this type. The buildings along both sides are commercial and residential buildings with backs facing the canal and with 2 - 4 story height. However, in the area E-1 (Fig. 4.18a), the adjacent land uses on both sides of the canal are institutional.

### ***Implications***

The lack of setback area on either side of the canal is a constraint for redeveloping the canal as a public place, and also as a pedestrian connector. However boat travel is possible.

Type E

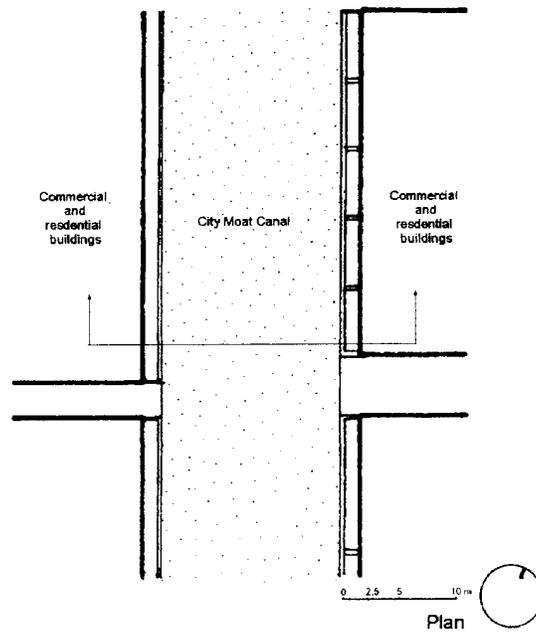
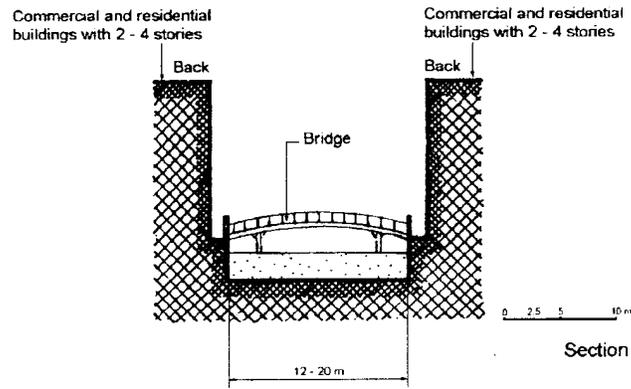


Figure 4.23: Section and plan of type E.

## **6. Type F**

Type F is typically found on the Lot Canals, which have straight bridges crossing over. The canal is 6.5-8 meters in width. On one side, there are 2-3 story residential buildings with 3-meter setback distance, and on the opposite side, a temple with a 3-4 meter setback distance. The setback areas on both sides are used as walkways. The common physical characteristics of this type are shown in figure 4.24.

### ***Implications***

As a result of overhead structures, this canal type cannot be used for transportation, but its setback distance allows the canal corridor to be used as a connector or walkway. On the residential side, the canal can provide amenities for residential use; on the other side, the temple with its courtyard garden is a main public space for religious, social, cultural, recreational, and educational activities. There is potential to reestablish this canal type not only as a connector, but also as a public place.

Type F

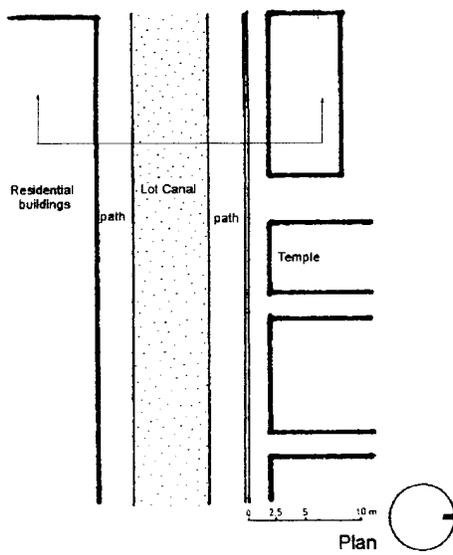
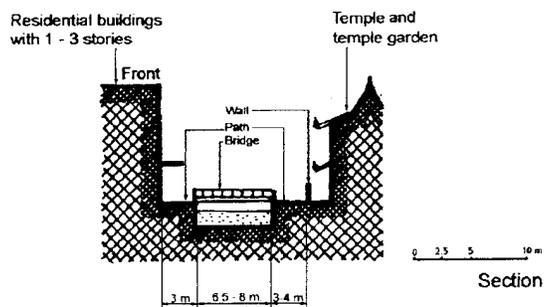


Figure 4.24: Section and plan of type F.

## **7. Type G**

Type G is a corridor condition typically found on the Lot Canals (Fig. 4.25). These canals are 6.5-8 meters wide, and have straight bridges crossing over. The adjacent land uses on both sides are residential buildings 2-4 stories high, which have their fronts facing the canal. Building setback distance is 2-3 meters (or 10 meters in some areas) on both sides of the canal. The setback areas on both sides are used as walkways. Streets are also found in the 10-meter setback areas. In the area G-1 (Fig. 4.18a), there is a mix of fronts and backs of buildings facing the canals and encroaching structures occupying the public setback area, especially where the buildings' backs face the canal. In the other area, G-2 (Fig. 4.18a), the only difference is the adjacent land uses on both sides, which are used for commercial and residential buildings.

### ***Implications***

Although this canal type cannot be used as a waterway due to overhead structures, its building setback distances allow use as connectors or walkways (and streets in some areas). The canals are essential amenities for the residential areas, and their banks have potential for passive recreational activities that support residential use.

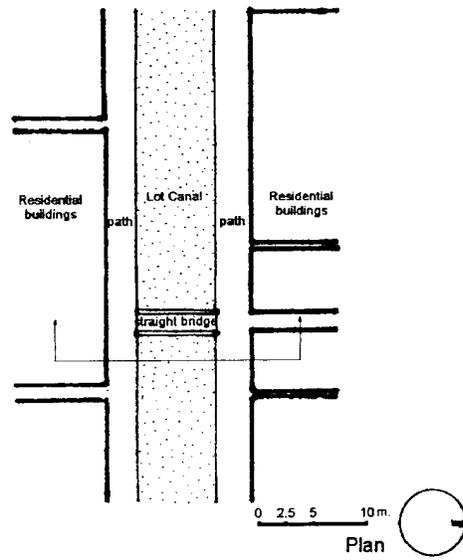
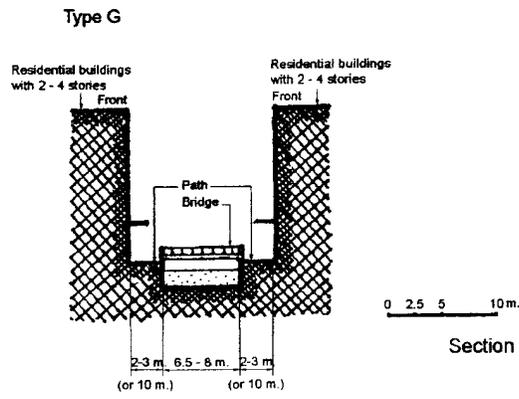


Figure 4.25: Section and plan of type G.

## Chapter 5: The Guidelines

This chapter provides guidelines for preserving the unique physical characteristics of Bangkok's canals and reestablishing them as public spaces and connectors of key public spaces on Rattanakosin Island. There are guidelines for an overall system and for seven types of canals within the system. Typologically-based guidelines are proposed in order to regulate structural characteristics, such as building setback distances, canal widths, and overhead structures, that will preserve the potentials of the canals to accommodate a range of public space activities, in response to current and future needs. Preserving these structural characteristics will provide continuity with the past. Typological guidelines do not regulate in favor of a specific function or architectural/ landscape architectural character. Instead they attempt to ensure the integrity of the canal system, while providing opportunity for cultural expressions and changing functions.

### **Guidelines for the overall canal system**

The proposed canal system includes the Former City Moat Canal, the City Moat Canal, and two Lot Canals as shown in figures 5.1 and 5.2a. It does not include the north section of the Former City Moat Canal, which is covered by a parking lot, or the south section of the City Moat Canal, which is covered by a number of iron bridges. The Former City Moat Canal is proposed as a primary canal, with boat access and walkways and streets on both sides. Due to its wide setback area, this canal can also serve as a public space. The City Moat Canal is the other primary canal, which allows only boat access (Fig. 5.2b). The two Lot Canals are secondary canals, which cannot be used as waterways because of overhead structures or straight bridges. There are proposed walkways on both sides of these canals (Fig. 5.2c). Figures 5.1 and 5.2a-d show the canal system as a public space system and connector linking the key public spaces on Rattanakosin Island.

While all of the canals are connected, currently the system is not continuous for any one means of transportation. However, there are walkways on all but one segment,

the City Moat Canal. Therefore, a walkway is proposed as the most suitable option for a continuous connection (Fig. 5.2c). This can be achieved by providing a new cantilevered walkway on one side of the City Moat Canal, where the existing canal is 12 - 20 meters wide.

### Conceptual Diagram

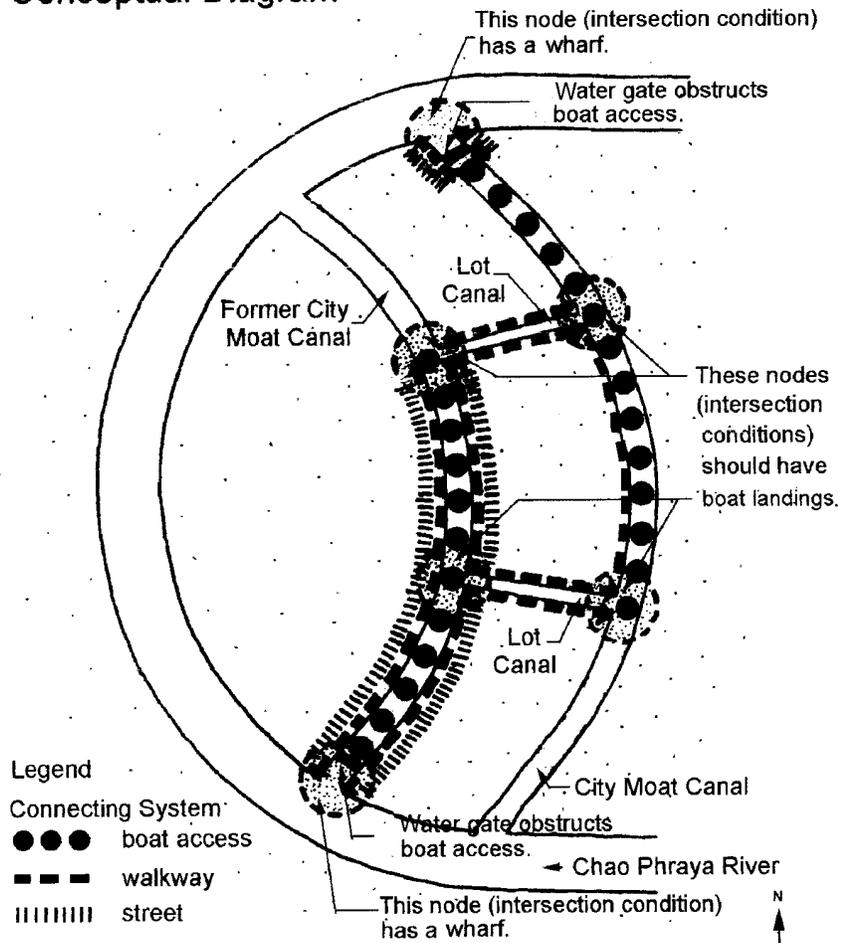


Figure 5.1: Conceptual plan illustrating the proposed system.

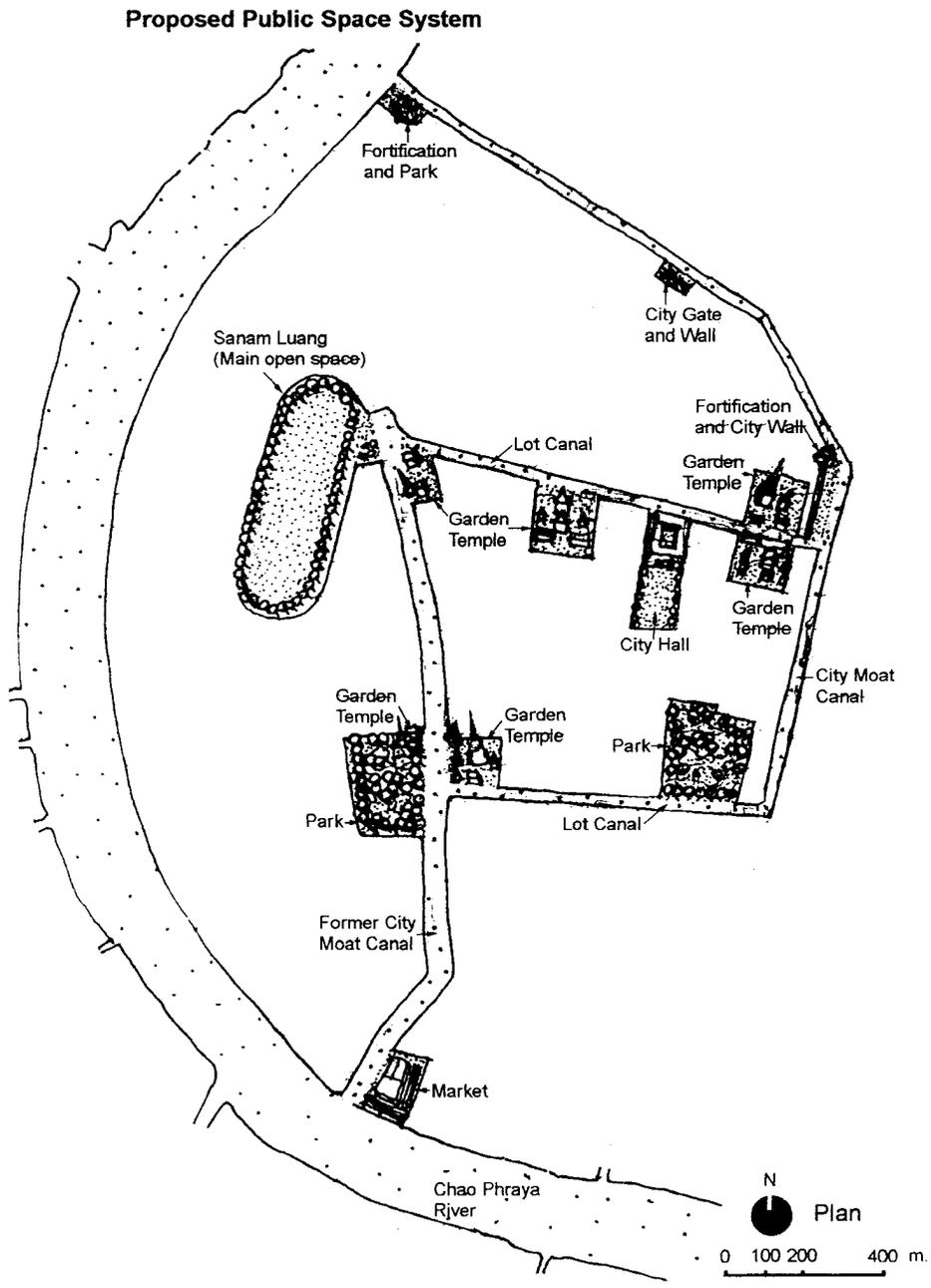


Figure 5.2a: Master plan illustrating the proposed public space system.

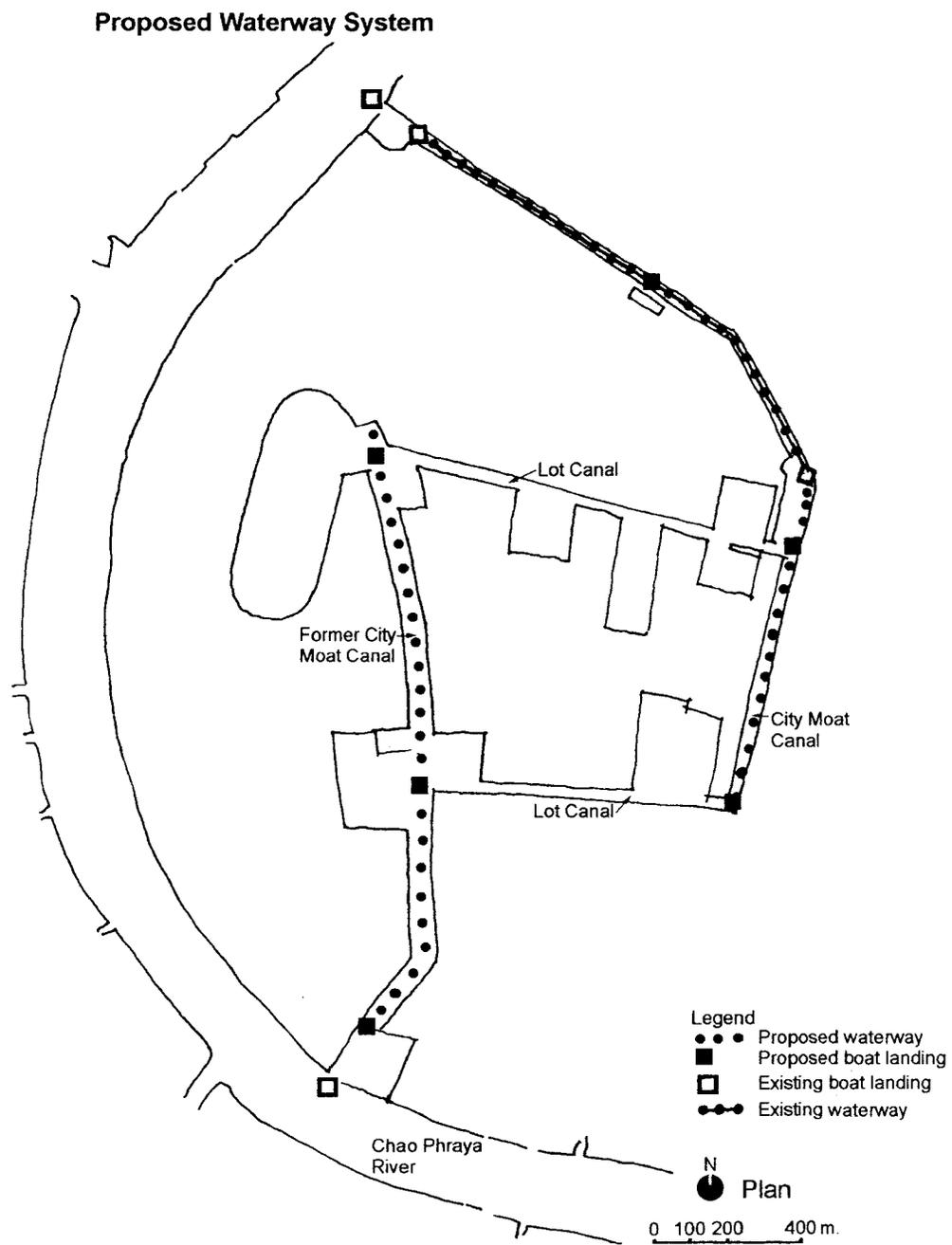


Figure 5.2b: Master plan illustrating the proposed waterway system.

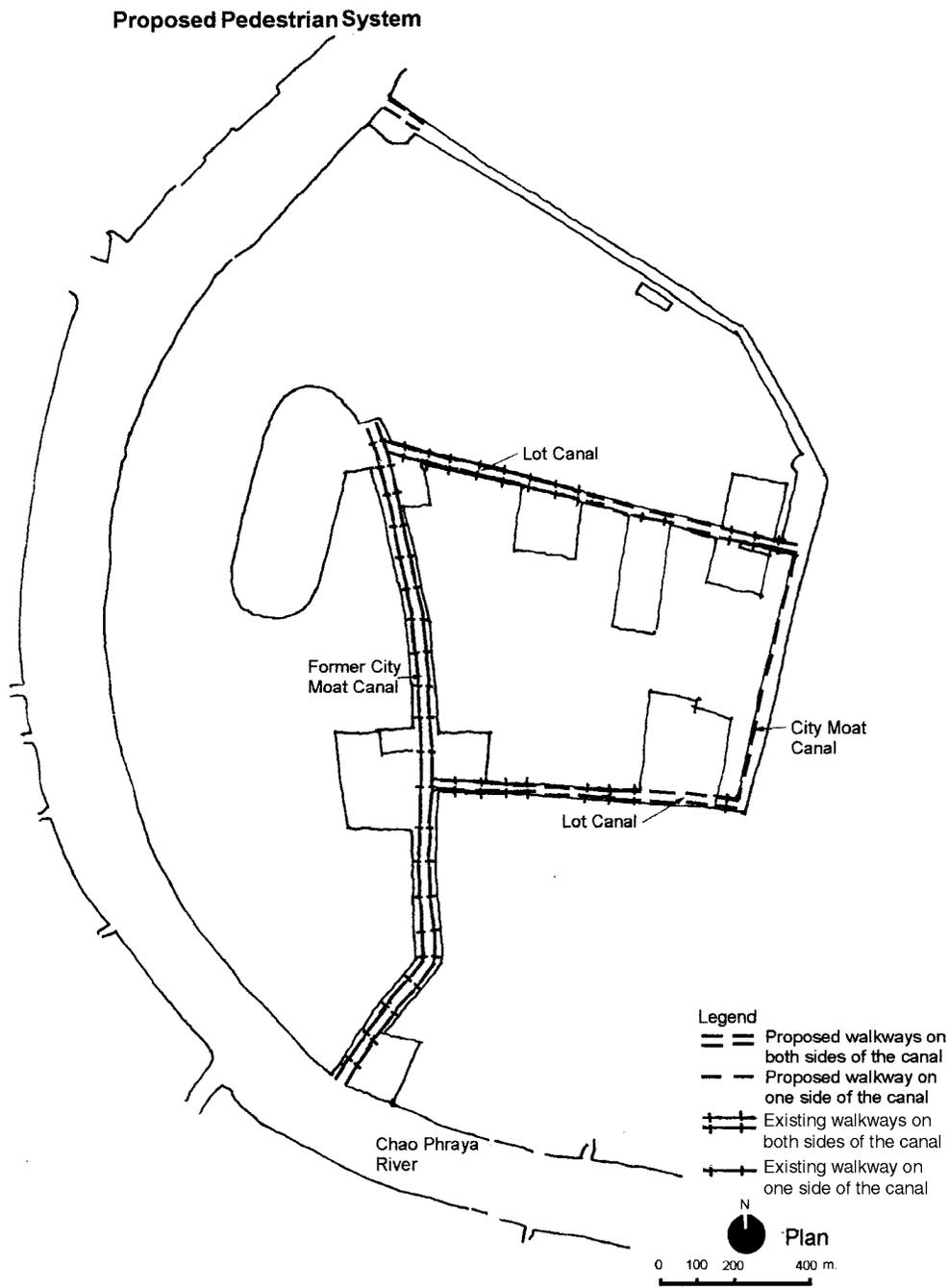


Figure 5.2c: Master plan illustrating the proposed pedestrian system.

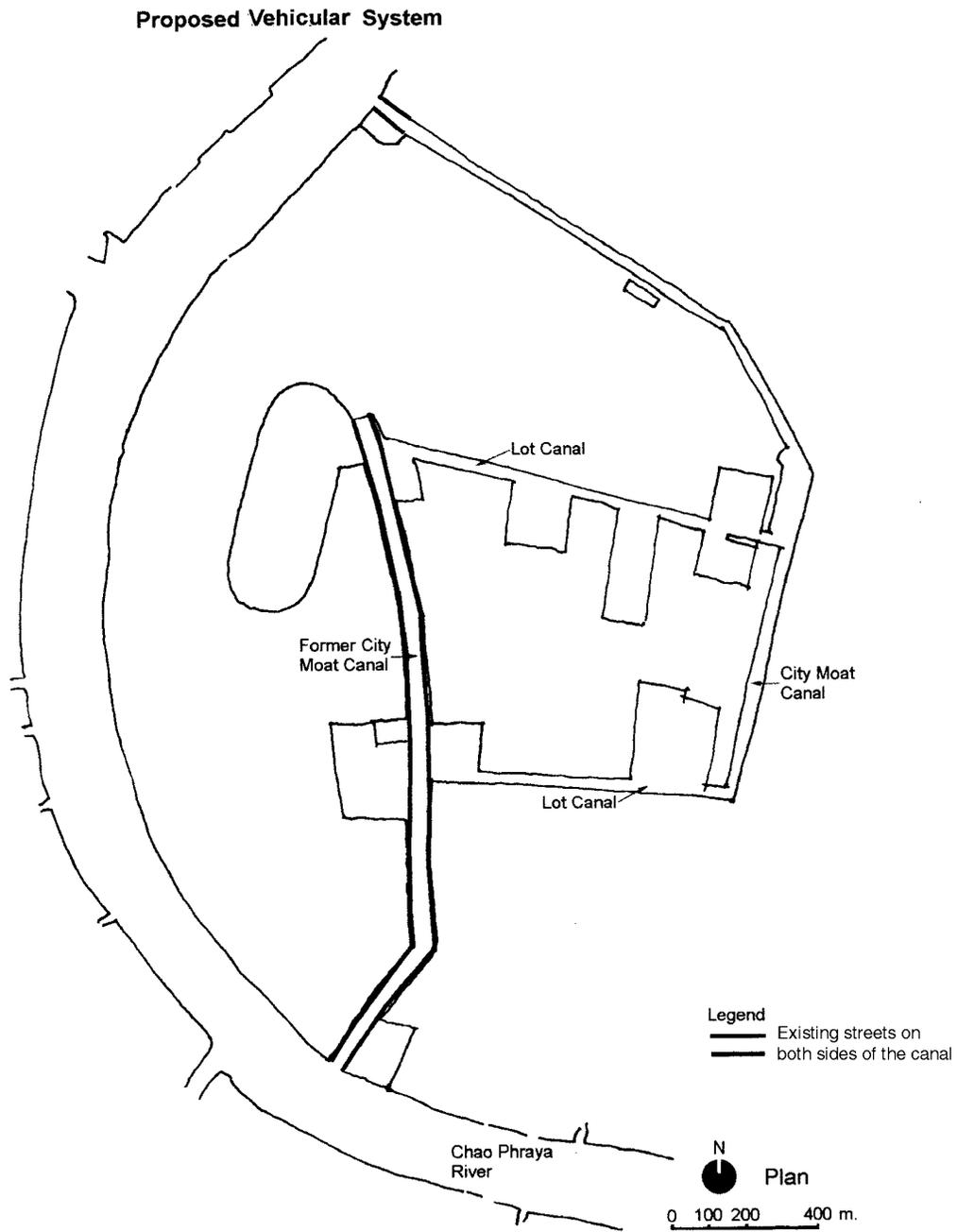


Figure 5.2d: Master plan illustrating the existing vehicular system.

There are specific guidelines for particular segments of the system. These specific guidelines refer to the seven canal types. The drawings in these guidelines are for illustrative purposes only, so the arrangement of proposed elements, such as trees, lights, and other furniture, could be varied according to site specific conditions.

### **Guidelines for Type A Canal**

Type A is an intersection condition between primary canals and the Chao Phraya River. Due to their importance for flood control, the raised walls at the canal edges and the water gate should be preserved. The water gate, however, obstructs the use of the canal by boats. Therefore, the setback areas on both sides of the canal should be retained for use as walkways and streets leading to the wharves at the intersection of the canal and the river. The walkway along the canal in this segment should be a minimum of 4 meters wide. Proposed streets should be at least 6 meters wide (or two lanes). Planting of shade trees along walkways and streets is recommended. Lighting is also important to provide good visibility as well as a sense of safety. Figure 5.3 illustrates the guidelines for developing this canal type.

Type A: Guidelines

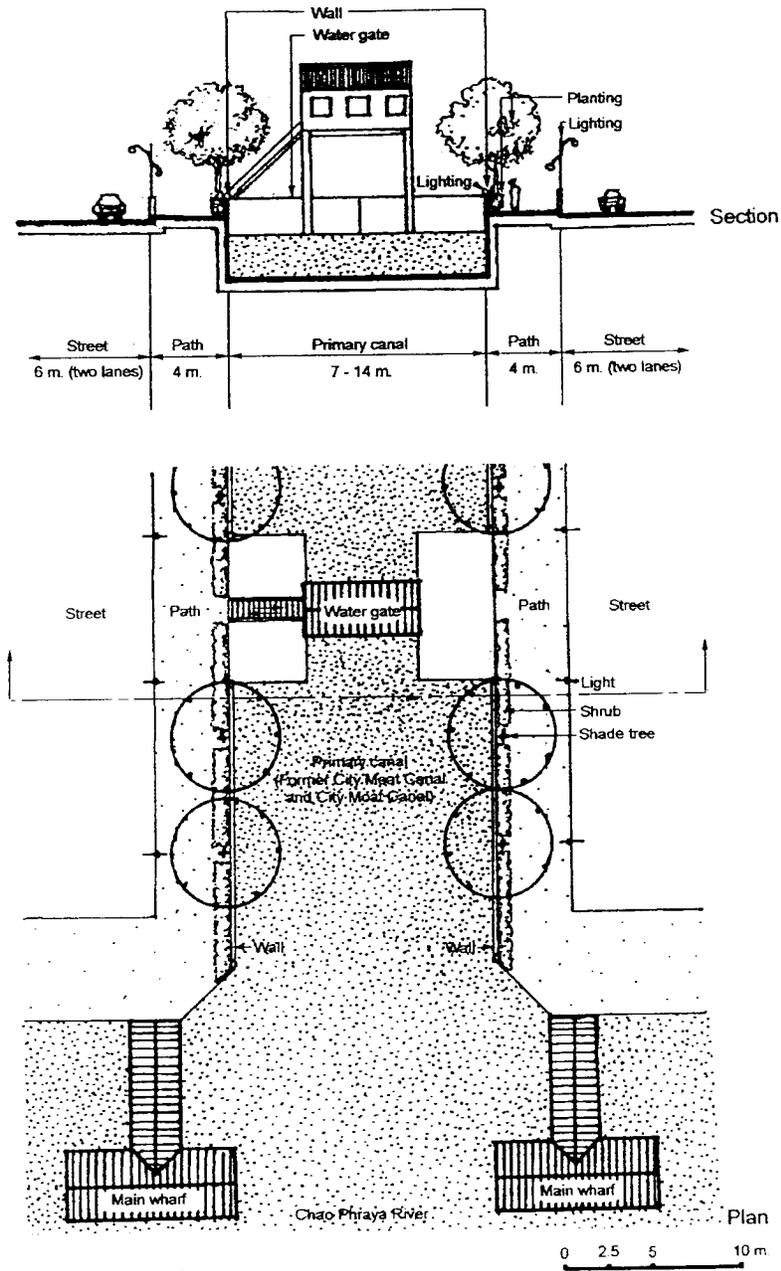


Figure 5.3: Section and plan illustrating proposed guidelines for type A.

## Guidelines for Type B Canal

Type B is the other intersection condition between a primary canal and a secondary canal. This canal type is considered a node, which is a meeting area of different modes of transportation, especially boats (on the primary canals) and pedestrians (along the secondary canals). Therefore, walkways are proposed along the secondary canals that lead to the proposed boat landings on the primary canals (Fig. 5.4). Paths along the primary canal, where a boat landing is located, should be a minimum of 4 meters wide. However, where possible a path wider than 4 meters is desirable to provide a gathering place for people. Planting and lighting are also recommended as explained in type A.

Type B: Guidelines

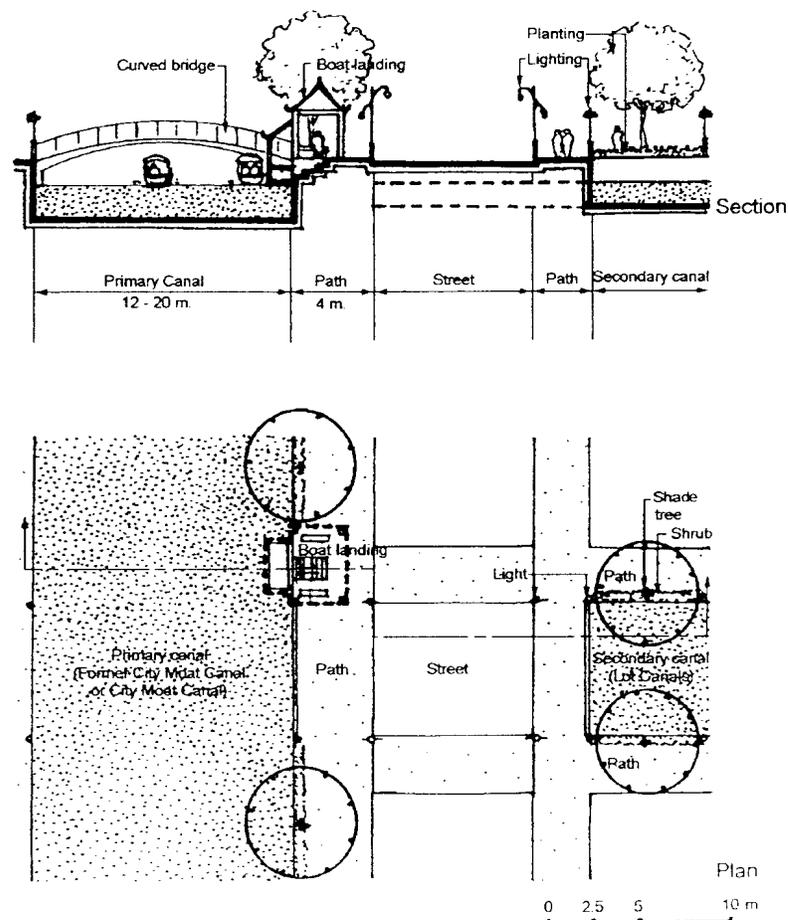


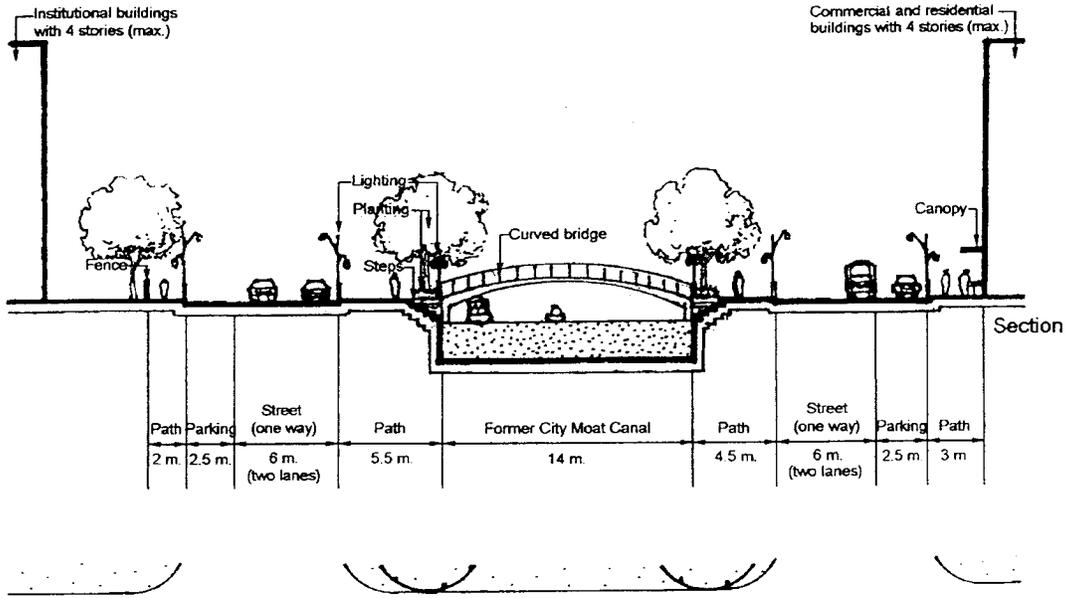
Figure 5.4: Section and plan illustrating proposed guidelines for type B.

### **Guidelines for Type C Canal**

Type C is a corridor condition found on the Former City Moat Canal, which is proposed to be the primary route of the system, with boat access and walkways as well as streets on both sides of the canal. The current width of the canal and the curved bridges should be retained to allow boat access. Due to the 16-meter building setback distance and the adjacent institutional and commercial land uses, the parallel and temporary parking spaces should be retained to support the use of this area. However, the width of the streets should be reduced to permit widening of the pedestrian right of way. A street of 8.5 meters width is proposed on each side of the canal instead of the existing 11-12 meter wide street. This street will accommodate two one-way lanes (6 m), and one parking lane (2.5 m). Walkways of 4.5 – 5.5 meters width (Fig. 5.5) are also recommended on both sides of the canals. These walkways can be used not only as connectors, but also as public spaces to support the activities of adjacent land uses. For example, there is a need for public spaces to support the lunch time activities of office workers, and places for shoppers to sit and rest. Thus, not only are shade trees and lights along the canal and walkways desirable, but also street furniture such as benches, tables; and seats should be provided. The steps along the canal can also serve as a seating area and as a place for the Loy Kratong Festival. Alongside buildings, walkways are also recommended. A 3 meter wide walkway is recommended on the commercial side to accommodate commercial activities. On the institutional side, a 2 meter wide walkway is suggested.

Along the Former City Moat Canal, there is an existing regulation that limits the height of buildings to 16 meters (or 4 stories). Figure 5.5 illustrates the guidelines for redeveloping this canal type as a connector and a public space.

Type C: Guidelines



Curved bridge

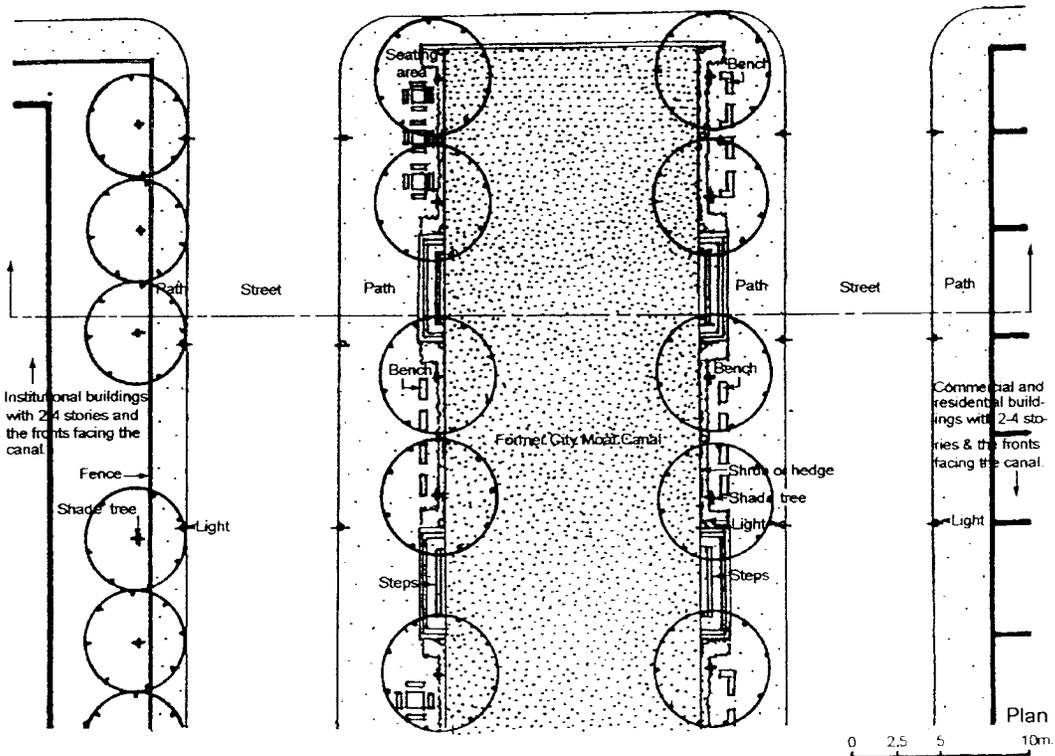


Figure 5.5: Section and plan illustrating proposed guidelines for type C.

### **Guidelines for Type D Canal**

Type D is a corridor condition on the City Moat Canal, which is proposed as a primary connecting route, especially for boats. Therefore, the existing canal width and curved bridges should be preserved. Currently, there also is 8-10 meter setback area on one side of the canal, which is used as a residential area. This setback area should be redeveloped as a walkway as well as a public space for passive recreational activities for the residents. Planting, lighting, seating, steps, and other furniture should be provided to improve the pedestrian environment. Although this building setback distance is wide enough to allow vehicular access, there is no need for a street in this residential area, since it would be discontinuous, and therefore inefficient as a connector. However, the proposed walkway and public space should allow for occasional use as a service road. There is no setback on the other side of the canal, where there are commercial and residential buildings. These buildings should have back gardens, allowing for use of the canal as an amenity. It is also possible to have a back door or an exit to the canal to benefit from the canal's function as a mode of transportation.

The buildings on the west side of the canal in this segment are on Rattanakosin Island, where the maximum height is 16 meters (or 4 stories). On the east of this canal type, there is currently no building height limit, however, the highest buildings here are 5 stories in height. Since this canal type has a wide setback area (8 m), it would be possible to allow a maximum height of 6 stories for future development without affecting the existing scale of the canal corridor. Figure 5.6 illustrates the guidelines related to this canal type.

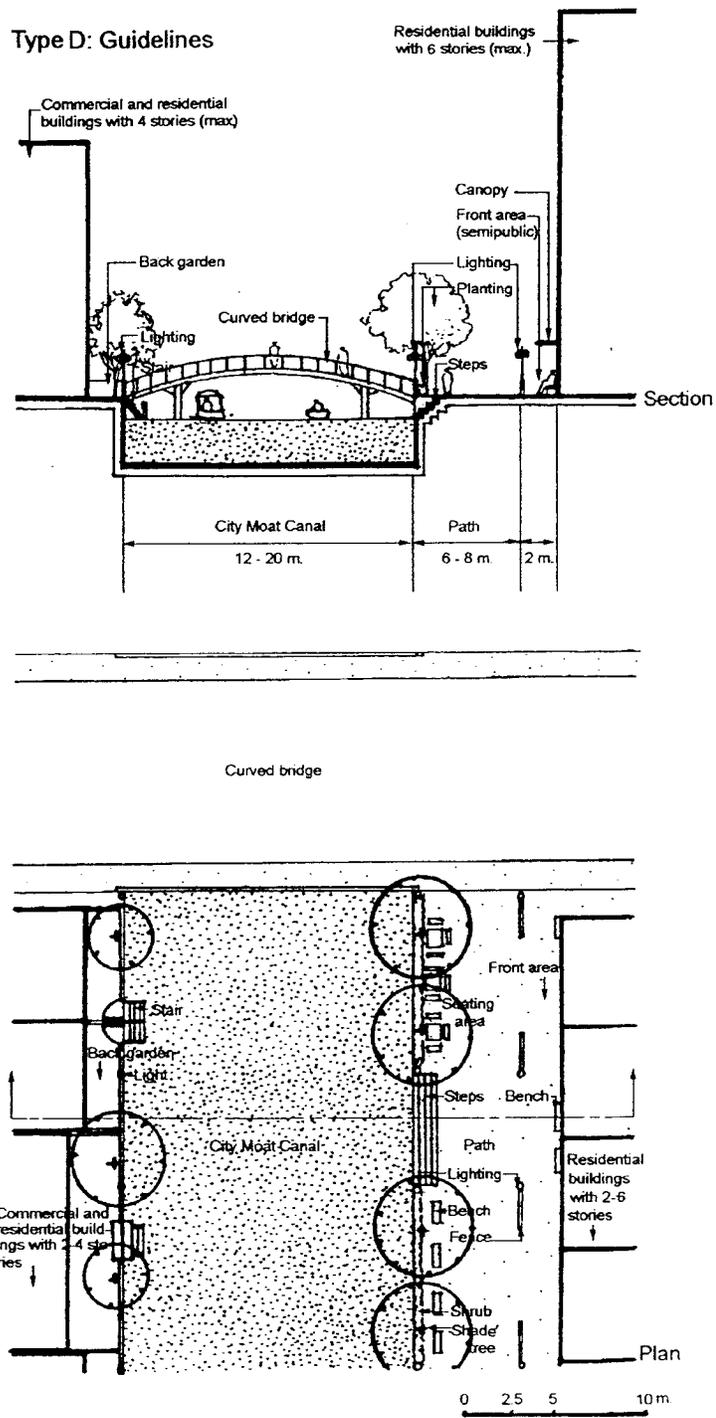


Figure 5.6: Section and plan illustrating proposed guidelines for type D.

### **Guidelines for Type E Canal**

Type E is a corridor condition on the City Moat Canal. Since there is no building setback distance on either side of the canal, this segment allows only boat access. Consequently, the canal width and curved bridges are key physical characteristics that should be preserved. Commercial and residential buildings with backs facing the canal on both sides can benefit from this relationship by developing back gardens and using the canal as an amenity, as well as by having an exit to the canal and using it as a means of transportation.

As for type D, building height on the west side of this segment is limited to 16 meters (or 4 stories), and buildings on the other side have no height limit. However, maximum 4 story buildings are proposed in order to preserve the existing scale relationship, since there is no building setback distance on either side of the canal. Figure 5.7 illustrates the proposed guidelines related to type E.

### Type E: Guidelines

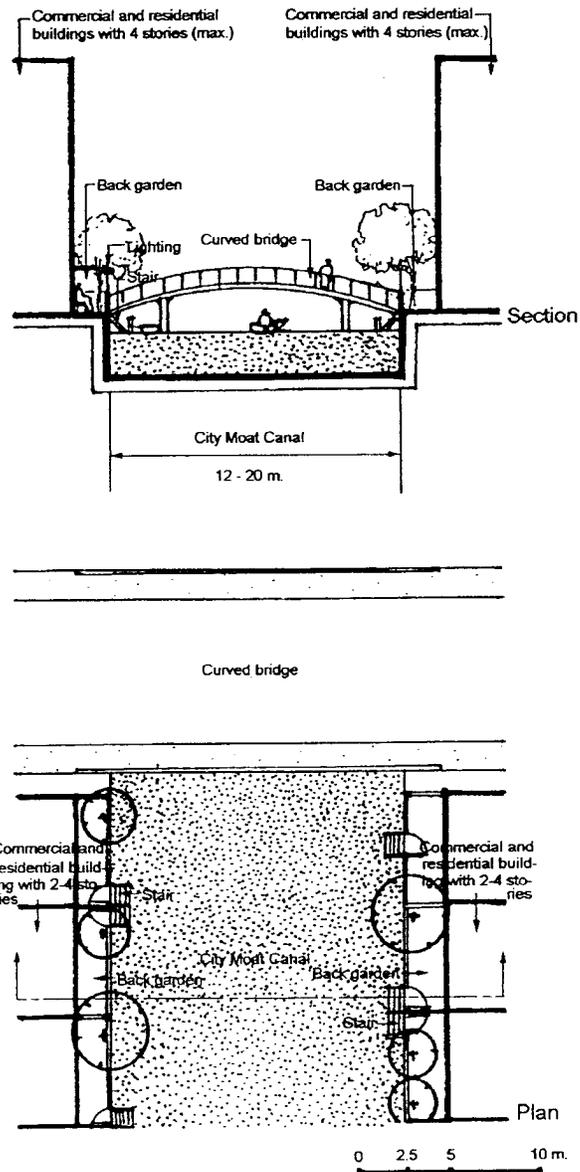


Figure 5.7: Section and plan illustrating proposed guidelines for type E.

### **Guidelines for Type F Canal**

Type F is a corridor condition on the Lot Canals, which have streets or straight bridges crossing over them. Although these canals cannot be reused as waterways, they can be used as amenities for adjacent residential areas and as public spaces. The setback areas on both sides (3 meters on the residential side and 3-4 meters on the temple side) should be preserved for walkways, which will be the primary connectors along the Lot Canals. The adjacent temple garden is a key public space; the temple should be preserved. The setback area on this side should also serve as a public space related to temple activities. Therefore, a 4-meter building setback distance is desirable. As for previous types, planting, lighting, steps and other furniture are also recommended.

Although the existing maximum height of residential buildings in this segment is 3 stories, due to the maximum restriction on building height on Rattanakosin Island, it is possible and permissible to have 4-story buildings in this area. Guidelines for preserving and redeveloping the physical characteristics of this canal type are shown in figure 5.8.

Type F: Guidelines

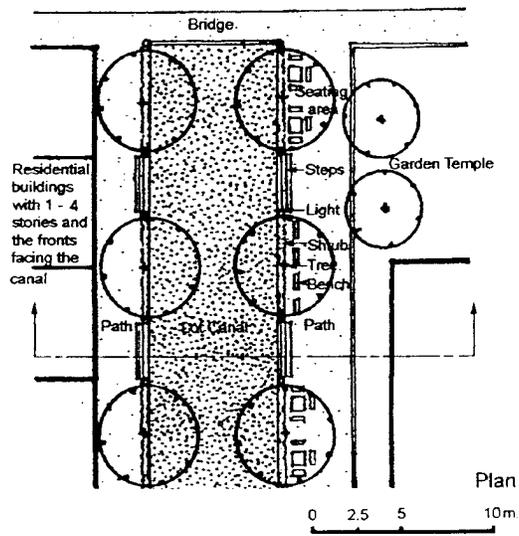
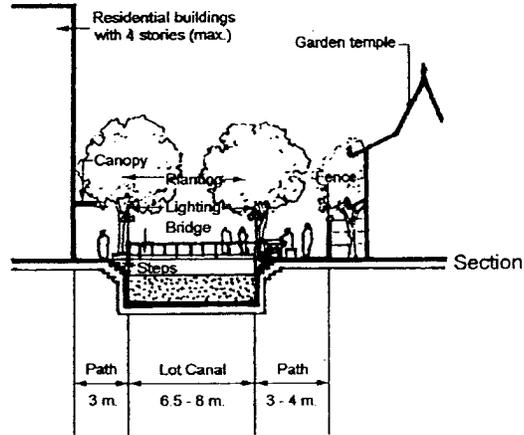


Figure 5.8: Section and plan illustrating proposed guidelines for type F.

### **Guidelines for Type G Canal**

Type G is the other corridor condition found on the Lot Canals, which cannot serve boat transportation. Therefore, preservation of building setback distances for walkways is essential. Consistent with existing conditions, 3 meter wide walkways are proposed on both sides of the canal. As for previous types, light, shade trees, and shrubs along the canal and walkways are recommended in order to provide a safer, more comfortable, and beautiful environment. Steps from the walkways to the canal are also proposed to provide a closer relationship between users and the canal, or to be used as a seating area. In some areas, there is 10-meter building setback distance on both sides of the canal, making it possible to provide a wider walkway, which is more desirable. This setback area is also wide enough for a vehicular access. The proposed vehicular access is a secondary street or alley, which should serve only residents in that area. Due to the adjacent residential land uses on both sides of the canal, it can also have amenity value. The height limit on these buildings is 4 stories (or 16 m) as in other areas of Rattanakosin Island. Figure 5.9 illustrates the guidelines related to this canal type.

### Type G: Guidelines

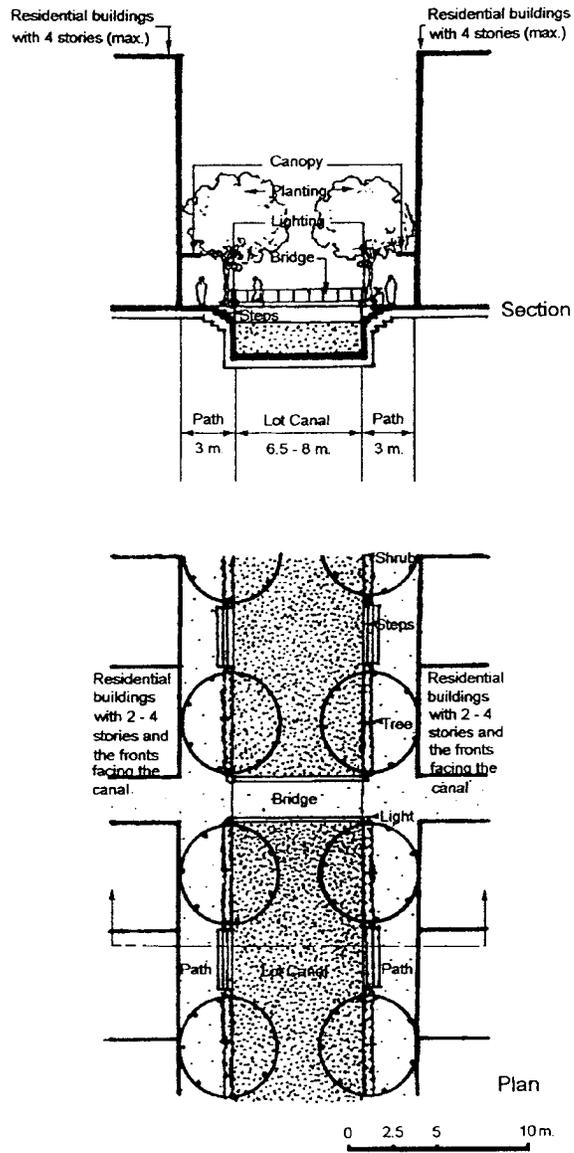


Figure 5.9: Section and plan illustrating proposed guidelines for type G.

The guidelines related to the seven canal types do not cover the entire area of the proposed system (4.18a). There are several anomalous areas including key public spaces (Fig. 5.10) that do not fit into any of the seven canal types. Each of these areas will require specific design guidelines that respond to public space objectives for the overall system, and to site-specific characteristics. All of these key public spaces, especially on the Former City Moat Canal and the City Moat Canal, are recommended to have boat landings, to support the use of the canals by boats.

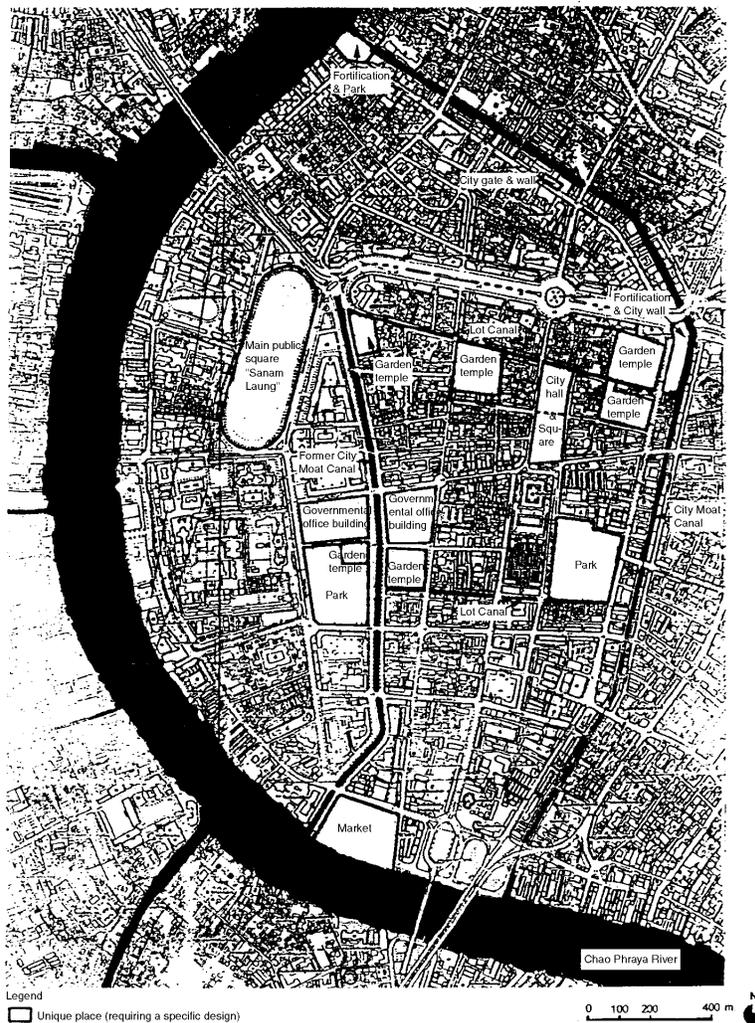


Figure 5.10: Map showing anomalous areas.

In order to reestablish the role of the canals as amenity spaces, high water quality will be necessary. Fortunately, a public water treatment system has already been implemented. The water level of the canals on Rattanakosin Island is controlled by the locks (or water gates) and pumps located at the areas where the canals meet the Chao Phraya River (type A). Water levels are high enough to allow the canal to function for boating.

## Chapter 6: Conclusions

The concluding chapter summarizes the study and describes its importance, discusses implications for implementation, and indicates further areas for study.

The canal system in Bangkok has been the subject of earlier studies, which were generally descriptive explaining their historic importance and functions of the canals. Some of them studied the influence of the canals on settlement patterns in Bangkok, similar to this study. However, this study is limited to the canal corridors and also focuses on key physical characteristics of the canals that have potential to accommodate public space functions. It yields guidelines for preserving and redeveloping the canal system as a public space system. Therefore, it provides a basis for further action in order to accomplish the larger goal of revitalizing the canal system, especially on Rattanakosin Island. Action might include: improving environmental qualities (especially water quality, being implemented by public water treatment system), developing continuous connecting systems (including waterways, walkways, and streets), and restoring key public spaces along the canals (such as temples, fortifications, markets, and parks). Revitalizing the canals, which have retained cultural and symbolic significance for the Thai people, also enhances the unique character of Bangkok and provides identity to its residents.

The study begins with a morphological analysis tracing the evolution of the canal system. It establishes that the canals in Bangkok are primary structural elements according to Aldo Rossi's definition. They have retained the integrity of their physical form over time, and have accumulated cultural meaning. Therefore, they have become part of the "collective memory" of local residents.

The discussion of historic and contemporary roles of the canals establishes that the canals have accommodated the new functions over time, in response to a changing urban context. Therefore, they are propelling elements according to the concept of permanence. Although the canals' functions have changed over time, they have always accommodated public space functions. There is potential for the canals to retain their current functions and to adopt new functions.

According to Rossi's concept of permanence, the canals could continue to be propelling elements in the present time, if they can accommodate new functions. The results from the morphological analysis suggest that there is potential to reestablish the canals as more passive public spaces, connectors of key public spaces on Rattanakosin Island, and as tourist destinations and interpretive routes. Since the canals are propelling elements, their certain structural characteristics that support public space functions should be preserved. Although there are physical problems such as poor water quality, shallow depths, and encroaching structures, these can be resolved by improved management. The presence of overhead structures with minimal clearance is the primary problem that obstructs the use of the canals, especially the Lot Canals, as waterways.

Typological analysis identifies certain characteristics of the canals that support their use as public spaces. It yields seven canal types that have potential to accommodate a range of public space functions, based on structural condition, canal width, presence of overhead structures, building setback distance, edge condition, and adjacent land use. Each canal type yields guidelines for preserving and reestablishing key physical characteristics that will enhance proposed roles of the canals as public spaces and as connectors of key public spaces.

The overall proposed system consists of the Former City Moat Canal (excluding its north section), the city Moat Canal (excluding its south section), and the Lot Canals. The guidelines for the seven canal types are created in order to preserve their unique characteristics and reestablish the canal system as a public space system. The guidelines attempt to preserve the potentials of the canals to accommodate a range of public space activities, in response to current and future needs. These potentials are essential to providing continuity to the city. The guidelines do not regulate functions of the canals or buildings, or detailed architectural/landscape architectural style, but they attempt to ensure the integrity of the canals' physical forms. Therefore, the guidelines allow changing functions of the canals and cultural expression. This also ensures that the canals continue to be propelling elements, which are essential to a healthy city according to Rossi's concept of permanence.

The guidelines can be implemented through regulations, consistent with planning policies that aims to preserve historic places and monuments on Rattanakosin Island and to provide more public spaces, especially on sites where historic monuments or objects are located. However, in implementing the guidelines, the issues of ownership patterns and encroachments are important concerns. In some areas, canal banks are illegally occupied by encroaching structures, which interrupt the continuity of the walkways that border the canals. Therefore, the canal public rights of way should be clearly defined and rigorously controlled, especially in residential areas.

There is also a need for a proactive stance in envisioning potentials of the public space system. These potentials include: re-opening closed portions of the canals, regaining canal public rights of way by removing encroaching structures, linking streets and canals into a cohesive pedestrian system, and considering alternative means of providing access where necessary, for example, cantilevering walkways from the edge of canal where structures encroach. Moreover, since environmental quality, especially water quality, is essential to making the canals public space amenities, there is a need for environmental education programs and more rigorous regulation, such as fines, to discourage littering and other forms of pollution. Better environmental quality can also be enhanced by management and design such as providing enough bins as furniture along the canals.

In order to redevelop the canal system as a public space system, further study should examine the potential of the covered canals to be reestablished as public spaces, which would make the proposed canal system on Rattanakosin Island more cohesive. A broader study, encompassing streets as well as canals would provide a more cohesive and efficient overall pedestrian system. Moreover, in order to identify culturally specific environmental patterns that should be preserved, more detailed study should be undertaken. This type of study could focus on factors such as relationship of streets to canals, relationship of temples and their gardens to the canals, and spatial organization of temples, which are specific conditions that are characteristic of Thai culture.

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## Appendix A

Table 1: The seven canal types on Rattanakosin Island

		C R I T E R I A										
		Structural condition	Canal width (m) (&overhead structure)		Edge condition				Building setback distance (m)		Adjacent land use**	
					Front/Back *		Build. height (story)					
			Main canal	Minor canal	Side 1	Side 2	Side 1	Side 2	Side 1	Side 2	Side 1	Side 2
				1	2	1	2	1	2	1	2	
<b>C A N A L  T Y P E</b>	A	Intersection	7-14 Water gate									
	B	Intersection	12-20 Curved bridges	6.5-8 Straight bridges								
	C	Corridor	14 Curved bridges		F	F	2-4	2-4	16	16	I	CR
	D	Corridor	12-20 Curved bridges		B	F	2-4	2-5	0	8-10	CR	R
	E	Corridor	12-20 Curved bridges		B	B	2-4	2-4	0	0	CR	CR
	F	Corridor		6.5-8 Straight bridges	F	F	1-3		3	3-4	R	T
	G	Corridor		6.5-8 Straight bridges	F	F	2-4	2-4	2-3 or 10	2-3 or 10	R	R

\* F = Front, and B = Back orientation of adjacent buildings

\*\* I = Institutional buildings, CR = Commercial and residential buildings,

R = Residential buildings, and T = Temples

## **Vita**

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