IMPROVING THE LIVABILITY AND THERAPEUTIC PROPERTIES OF HOSPITAL CAMPUSES IN NORTH TEXAS BY INTEGRATING ARTFUL RAIN DESIGN AND HEAT ISLAND MITIGATION

By

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THESIS

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ABSTRACT

IMPROVING THE LIVABILITY AND THERAPEUTIC PROPERTIES OF HOSPITAL CAMPUSES IN NORTH TEXAS BY INTEGRATING ARTFUL RAIN DESIGN AND HEAT ISLAND MITIGATION

Reza Mabadi

The University of Texas at Arlington, 2021

Supervising Professors: David Hopman, Diane Allen, Jeff Fahs

Background: Since the 1980s, much research has been published discussing the restorative benefits of landscape design at healthcare facilities and the value of sustainable practices in high-performance landscape design. Many successful and expensive landscape projects have been designed and constructed on hospital sites using healing gardens or sustainable strategies.

Problem: Despite these efforts and signs of progress, such design and planning efforts have failed to thoroughly integrate restorative design principles and sustainable strategies into the landscape architecture of healthcare facilities. The case studies presented in this research illustrate this phenomenon. Currently, sustainable approaches to evidence-based research on health and well-being necessitate a reexamination and reinvention of design methods and recommendations for hospital landscapes to improve their therapeutic properties.

Purpose: The main goal of this research is to investigate strategies to improve the livability and therapeutic values of the constructed landscape of Clements University Hospital through an evidence-based approach and to examine the generalizability of this method for other hospital campuses in North Texas. The specific goal of this qualitative research is to examine and evaluate the implementation of heat island

mitigation and artful rain design strategies to enhance the therapeutic properties of a hospital site by utilizing four case studies.

Research Hypothesis: This study hypothesized that integrating sustainable strategies, such as heat island mitigation and artful rainwater design, as well as by improving views of hospital gardens by applying an evidence-based approach, can enhance the therapeutic properties and improve the livability of healthcare facilities. This study assumed that the results of the study will be generalizable and applicable to other hospital campuses in north Texas.

Methods: This empirical research examined the constructed landscape of four hospitals within the same geographical and functional contexts. The researcher used the results and scientific evidence to establish a foundation for research-informed design recommendations. The researcher collected data via both primary and secondary sources. To analyze the data, this the researcher employed content analysis, preoccupancy evaluation via a survey, and spatial-comparative analysis. To collect and analyze the data, this research aimed to establish a set of baseline performance measures. These baseline measures helped to develop a set of design and planning recommendations for hospital sites and metrics to evaluate the final landscape design of hospitals in future studies.

Conclusion: The results indicate that heat island mitigation strategies and artful rain design improve the livability of hospital campuses by disconnecting spatial continuity, increasing human comfort and safety, and planning for public gatherings and human activities. The results also suggest that improving garden views in a hospital encourages livability and increases the healing value of the site. Finally, the results reveal the extent to which improving landscape performance can increase the therapeutic value of the site. It concludes that the landscape-social and landscape-environmental metrics have different either greater or moderate therapeutic impacts and then summarize them.

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

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DEDICATION

This research is dedicated to my grandparents, Gholam Reza Mobedi and Kobra Sanjari, whose beautifully planted garden seeded the passion for nature in my soul.

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

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This project also benefited from the valuable professional advice of Mr. Jeff Fahs, director of site design at HDR, and Mr. Trey Heaton, site design practice leader at HDR, Dallas office. I am grateful to all of the UTA employees at the institutional review board office for their review and assistance with the survey, Question Pro software. Conducting this thesis would have been more difficult without support from the University Central Library. I also wish to thank those distinguished scholars and professionals who accepted my invitation for the survey and assisted my work through their insight and expertise on this subject. I would like to express my sincere gratitude to Gregory and Jolene Craig, who offered guidance, support, and mentorship throughout my internship in their design office.

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CHAPTER 1

INTRODUCTION

Background of Study

Since the 1980s, much research has been published discussing the restorative benefits of landscape design in healthcare facilities and the value of sustainable practices in high-performance landscape design. Many successful and expensive landscape projects have been designed and constructed on hospital sites using healing gardens or sustainable strategies. Despite the signs of progress, such design and planning efforts have failed to thoroughly integrate restorative design principles and sustainable strategies into the landscape architecture of healthcare facilities. The case studies presented in this research illustrate this phenomenon.

Purpose of Study

The main goal of this research is to investigate strategies to improve the livability and therapeutic values of the constructed landscape of Clements University Hospital through an evidence-based approach and to examine the generalizability of this method for other hospital campuses in north Texas. The specific goal of this qualitative study is to examine and evaluate the implementation of heat island mitigation (HIM) and artful rain design (ARD) strategies, used to enhance the therapeutic properties of a hospital site, by utilizing four case studies. The general domain of the research is limited to increasing therapeutic values, and improving livability properties of hospital landscapes by implementing sustainable strategies. The boundaries and definitions of the word *therapeutic* are complex and include various characteristics and embodied units (or design strategies). Due to the limitations, I focused exclusively on three embodied units that improve the landscape performance: artful rain design, heat island mitigation, and enhancing views from the hospital to the garden. Although many research studies have examined healing gardens and therapeutic landscapes, the lack of pre-occupancy and post-occupancy studies on the existing hospitals' landscapes is a gap that this research delves into; this will hopefully create opportunities for future studies.

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

Objectives

This study has three objectives:

1. To develop a set of recommendations to integrate therapeutic design principles and sustainable planning strategies for the landscape of healthcare facilities in north Texas.
2. To introduce and address the healing benefits of HIM strategies and ARD in the context of therapeutic landscape design.
3. To suggest practical and replicable methods and strategies for improving the livability of existing hospitals and new facilities in north Texas.

Research and Design Questions

The following research and design questions directed this study:

1. How can ARD and HIM strategies increase the livability of a hospital site?
2. What are the most important considerations in north Texas for using views of the garden in the creation of therapeutic outdoor environments in hospitals?
3. To what extent does improving the landscape performance of a hospital increase the therapeutic values of its site?

Definitions of Key Terms

Artful rain design

In 1997, McElroy and Winterbottom created the term *artful rainwater design* to refer to stormwater infrastructure for improving social and ecological values (MacElory & Winterbottom, 1997). Echols and Pannypacker (2008) defined the concept of ARD amenities as “features focused on the experience of stormwater in a way that increases the landscape's attractiveness or values” (p. xx).

Heat island effects

Urban heat island (UHI) effects are a global phenomenon attributed to the planning and design characteristics of the urban environment (Aleksandrowicz, Vuckovic, Kiesel, & Mahdavi, 2017). According to the EPA (2020), “Heat islands are urbanized areas that experience higher temperatures than

outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies" (p. xx).

Therapeutic landscape

The term *therapeutic* refers to anything that encourages wellness and healing (Batties, 2015), or anything that stimulates the senses through our experience of space via seeing, hearing, touching, smelling, or tasting; through this stimulation, some measures of healing can be reached (Wrenn, 2015). When the word *therapeutic* is defined as well-being, it reveals a difference between the exact meanings of the words *therapeutic* and *healing* (Cooper-Marcus, 2015).

Views of the garden

Theories of restorative effects in environmental psychology discuss the therapeutic impacts of natural elements (Hartig, 2004). Relevant studies have concluded that natural environments or viewing them foster stress recovery better than built spaces (Ulrich et al., 1991).

Methodology

In this empirical research, I aimed to explore one example of landscape projects in healthcare facilities through an experimental approach. I first examined the constructed landscape of four hospitals within the same geographical and functional contexts, then used the results and scientific evidence to establish a foundation for research-informed design recommendations. I also collected data via both primary and secondary sources. To analyze the data, I employed content analysis, pre-occupancy evaluation via a survey, and spatial-comparative analysis. Through an evidence-based approach to collecting and analyzing the data, I aimed to establish a set of baseline performance measures. These baseline measures helped to develop a set of design and planning recommendations for hospitals' sites and metrics to evaluate the landscape design of hospitals in future studies.

Significance

The results and conclusion of this study suggest that several design and planning strategies can specifically be measures to improve the quality of hospital campuses and enhance the value of their

landscapes. It is noteworthy that the implications of this study are applicable in both new hospitals and for improving existing hospital environments. Accordingly, design implications include the following:

1. Heat island effect mitigation strategies can improve the health and well-being of occupants and therefore improve the therapeutic properties of the site.
2. Artful rainwater design can manage the storm runoff on a site from small and average storms, in addition to creating a positive distraction for users, education, and increasing biodiversity. Therefore, ARD can heal the environmental inhabitants of the site.

Hypothesis

I hypothesized that integrating sustainable strategies, such as HIM, ARD, and improving views of hospitals' gardens via applying an evidence-based approach can enhance the therapeutic properties and improve the livability of healthcare facilities. Additionally, I assumed that the results will be generalizable and applicable to other hospital campuses in north Texas.

Limitations

Methodological Limitations:

While implementing one specific method can produce biases in findings and conclusions, this thesis applied a qualitative approach to study hospital landscapes. Although this inquiry partially used the findings of evidence-based research, it would be more beneficial to interpret the findings of other quantitative methods and use their data to support this research.

Generally, in qualitative case study methods, the number of samples is limited. During those spatial-comparative and typo-morphological analyses, studying more hospitals in north Texas would improve the representative distribution of the examined population (hospital landscapes) and increase the generalizability of the conclusion. Therefore, the literature review was expanded to include four other well-known examples of hospitals.

This qualitative methodology established criteria and standards based on the literature review to apply for site analysis. The process of generating the criteria was limited to the available literature and the

knowledge of the researcher. This could potentially be a source of bias, and other important aspects could have been ignored. To mitigate the impacts of this problem, the findings of the literature review were evaluated against the results of earlier studies.

Although many studies of therapeutic environments, healing gardens, and hospital design have been published, the lack of current research on hospital landscape design focusing on HIM and ARD practices was a major constraint during the data-collection phase. It should be acknowledged that there is a deficiency regarding ARD implementation in hospital sites, which can be an opportunity for future studies.

Although this study benefited from evidence-based published research, the data collection methods, such as site inventory and site analysis, are considered as self-reported data, which cannot be independently verified. Therefore, to remediate its negative effects on findings, a predesign questionnaire survey was disseminated among key experts such as landscape professionals and academics with therapeutic design experience and expertise.

Constraints of the Researcher

This study started in September 2020 and finished in April 2021. During this period, all hospitals in north Texas were affected by the COVID-19 pandemic. Therefore, the access to the site and especially inside the hospitals to evaluate the garden views was restricted. Additionally, due to organizational regulations of Clements University Hospital in Dallas, facility managers and site engineers were not able to participate in the survey and give feedback regarding the landscape performance of the existing site. To avoid the negative effects of these limitations on the conclusion, this research increased the number of case studies in north Texas and disseminated the survey questionnaire among healthcare architects and planners.

This study has been subjected to longitudinal effects, such as the defense due date, other school obligations, delays resulting from personal health issues of the researcher, and the winter storm in Texas. These constraints affected the available time to devote to this study. To complete this study on time, the literature review was narrowed down to site planning and the overall design of hospital landscapes, with a focus on HIE and ARD practices in north Texas.

CHAPTER 2

LITERATURE REVIEW

This chapter first investigated three major domains of research and established scholarships including therapeutic landscape, heath island effects, and artful rainwater design that partially addressed the questions of this research and assisted to establish landscape performance evaluation metrics. Then, in the last part, it discussed the precedent studies and projects that provided evidence to strengthen the argument of this research and clarify its objectives.

Therapeutic Landscape

Summary: The preceding section focused on the therapeutic landscape and briefly addressed the theoretical background, physical components, and typologies of healing gardens. First, this section defined the meaning and components of the therapeutic landscape, explained the relationships between place-making and environmental approach in healing environments. Then, it located the typology of contemporary landscape practices in healthcare facilities among the existing scholarships and, a theoretical discussion of restorative gardens was studied. Next, this section elaborated the classification of therapeutic gardens based on their specific functions, targeted populations, and design features. After that, it discussed the importance of garden views in healthcare facilities and their impacts on human well-being. Finally, this section concluded its findings as a synopsis of the existing literature, their findings, and briefly described their methodologies.

Discussion on the Meaning and Components of Therapeutic Environments

To better understand the word “therapeutic landscape”, the general definition of therapeutic landscape and, especially, a brief description of the word “therapeutic” is presented, followed by a review of the physical and non-physical elements that represent therapeutic effects that encourages wellness and healing (Batties, 2015)that stimulates the senses through our experiences such as, seeing, hearing, touching, smelling, and tasting. Thereby creating some measures of healing (Wrenn, 2015). When the word “therapeutic” is defined as well-being, that reveals a difference between the exact meanings of the words

"therapeutic" and healing" (Cooper-Marcus,2015), when an environment conducts and assists the whole process of healing or includes some levels of healing, that can be considered as the exact definition for the word "therapeutic" (Tusler, 2015; Marble, 2015; Sachs, 2015).

According to Wrenn (2015), therapeutic values of physical elements in the landscape can break down into the following parts: first, the visual quality of space and landscape, second what is perceived and seen, which a function of order and complexity is. Batties (2015) emphasized the both physical elements and non-physical properties of landscape. Batties (2015), described greenery, trees, water, and the design of the open spaces, as the physical elements. Then she defines benevolent qualities like good weather, sunlight, bird sounds, in addition to personal perception of the users of those spaces as the non-physical elements of therapeutic environments (Batties, 2015).

Well-known scholar Cooper-Marcus (2015), emphasizing the stress-reducing function of physical elements as an important aspect that potentially can result in a more therapeutic environment. Additionally, she states that some of those aspects, which do not have any particular connection to physical aspects of design, can directly contribute to healing and faster recovery, such as the presence of family members, social support, and so on (Cooper-Marcus, 2015). Considering the difference between therapeutic and healing, Marble (2015), argues that the therapy is not represented in any physical element, and only can be achieved through a process like using medicine, manipulation of the body, or just relaxing. While Sachs (2015) states that there are associations between physical elements of landscape and therapeutic values of space. She exemplifies that the plants are an important part of healing, but "it doesn't mean that they are intrinsically representative of healing" (Sachs, 2015). In other words, since healing is a personal perception for many people, it can be represented in many ways, such as symbols and forms, cleanliness, purity, hygiene, or renewal (Sachs, 2015).

One of the new research approaches in health care design, the movement of Evidence-Based Design (EBD), tries to focus on connecting the non-physical but measurable aspects to physical elements of space in the way to provide a more therapeutic environment (Tusler, 2015). Distinguishing the physical and non-

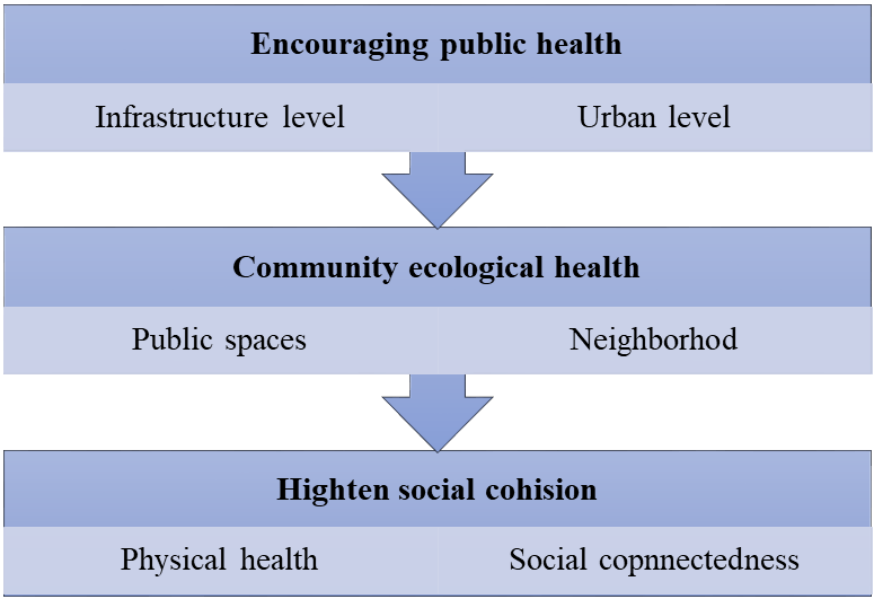
physical elements, Foote (2015), considers the whole healing-built environment, as the complete physical representation of a therapeutic environment. Consequently, he classifies the five major components of therapeutic environments as follows: holistic care, healing buildings, family care, and integration of care, and the last, a combination of wellness, nature, art, and spirituality (Foote, 2015). He emphasizes that a combination of these five components constructs the whole therapeutic environment (Foote, 2015).

The Place-Making and Environmental Approach in Therapeutic Design

Environmental approaches in a hospital's site design have gained importance in recent projects. Old-fashioned institutional policies and short-term economic considerations resulted in huge neglect of sustainability and environmental commitment to neighboring communities of hospitals. In this regard, Verderber (2010) argues that "paying attention to the local community can help to shape/reshape a hospital and a medical center's civic role." (p. 45). The implementation of such an idea can result in a considerable evolution in two dimensions. First, it elevates social cohesiveness that is connectedness among groups in society and combining it with physical health. Second, this approach will promote environmental health in surrounding communities.

Figure 1

Expected Results from Implementing Ecological Strategies in Hospital Landscape Design (Mabadi, 2017).



Throughout history and up through the modern years, hospitals have contributed to the sense of place, "Genius Loci"[1], in their communities. In modern times, the modernist urban theory of expanding residential neighborhoods out of the cities and constructing generic buildings of hospitals in suburban areas have failed to achieve any degree of "Civic Identity."

1 "*Genius loci* is the Latin for the spirit or guardian deity of a place and is a phrase that has been adopted in English and into other languages and achieved a broad degree of popularity. While spirit of place/genius loci was originally, and to some people still is, closely associated with beliefs about the sacred character of places, it has been increasingly secularized" (Designing Buildings Wiki, 2020).

Figure 2

Cook County Hospital, 1938.

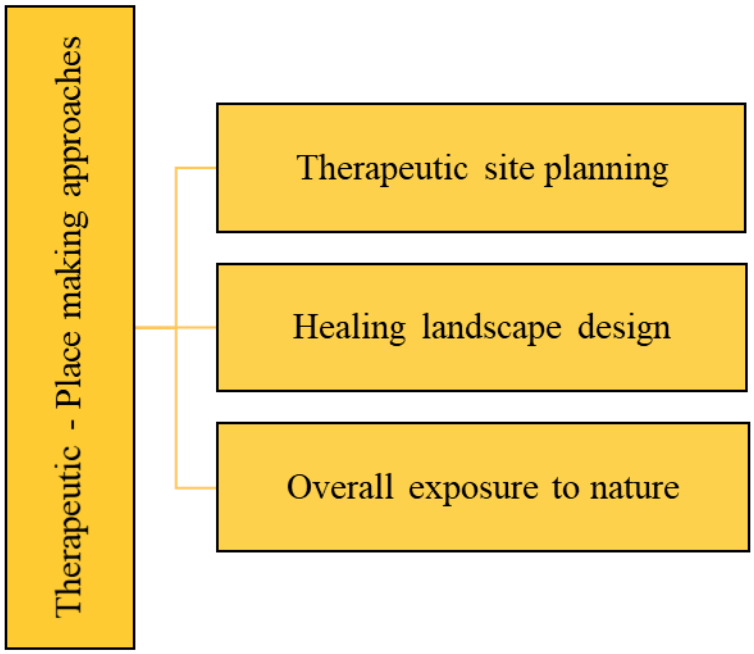
Note. Cook County Hospital, shown in 1938, made from bricks-and-mortar, was a house of big egos and surgical traumas. It was one of the world's largest hospitals that provided medical care for impoverished immigrants and African Americans but was an example of an unfriendly environment for patients, residents, and neighborhood. Source of image: Chicago Herald and Examiner.

Environmental insights into healthcare design and "sense of place" have been expressed in just a few recently constructed hospitals. Since the late 19th century, institutional rootlessness, which means the lack of connections between a facility and its socio-cultural context, has been endemic to healthcare facilities specifically in big cities in the western world (Relph, 2008). In the age of standardized franchise healthcare, a genuine design solution that considers vernacular culture, worldwide technologies, and ecological health in a holistic approach have not been sufficiently investigated and implemented. In his book, "Innovations in Hospital Architecture", Verderber (2010) discusses "three facets of genuine place-

making" or "therapeutic interventions" that include "site planning, landscape design" and bringing natural elements.

Figure 3

Holistic and Multi-scale Therapeutic Intervention Strategies in Hospital Design



Note. Adopted from Verderber (2010).

Typology of Landscapes in Contemporary Hospitals

There are many distinct types of grounds and outdoor spaces at modern medical facilities, but only a few of them have been designed as "healing gardens". However, during the last decade of the 20th century, and the first decade of the 21st century the number of healing gardens has considerably increased. The increase in awareness of healthcare designers and hospital administrators, clients, and patients caused this proliferation of therapeutic gardens in hospital landscapes (Winterbottom & Wagenfeld, 2015). The landscapes of contemporary hospitals are classified according to their physical and functional characteristics including size, main functions, design elements, and the location of these gardens on the hospital site. Clare Cooper Marcuse has extensively described typologies of landscape in healthcare

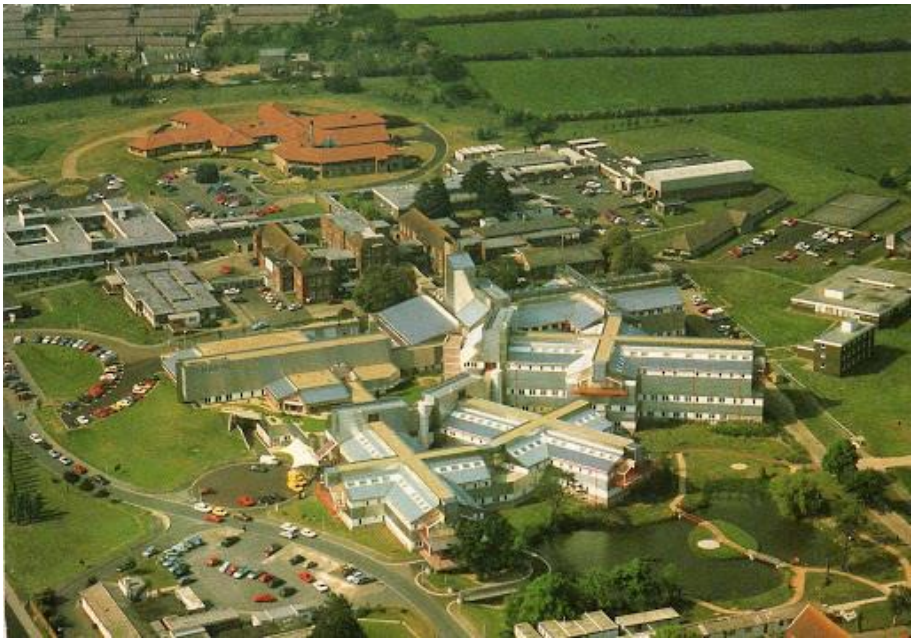
facilities (Cooper Marcus & Barens, 1999; Cooper Marcus & Sachs, 2013), which constitute the following classification of hospital landscapes.

Landscaped Grounds

Landscaped grounds include extensive designed and built landscapes between buildings also called "park", "campus" or "hub of the hospital complex". For example; the gardens of St. Mary Hospital, Newport, U.K, include a lake, a looped path, and a broad range of spaces for outdoor activities. In addition to a dedication to environmental sustainability, the department of Healing Arts is independent in St. Mary Hospital that provides recovery from illness and improvements in health and promotes well-being by displaying artwork in public areas of the hospital. The "art walks" connect the outdoor and indoor spaces of the Main Hospital and North Hospital within a sequence of modern and classic sculptures and artifacts (Isle of Wight NHS Trust, 2015).

Figure 4

The Ground of St. Mary Hospital



Note. Image retrieved from woottonbridgeiow.org.uk.

Landscape Setback Landscape setback, this type of space provides a buffer and separation between the building and public urban spaces. Generally, lawns and trees are planted in this area that is located in front of the main entrance of the hospital. The Charing Cross Hospital in London, U.K is an example of the use of a setback landscape. The clear and direct pedestrian space separates the hospital from the traffic of the city. The design elements include sculptures, seating, water features, and car parking. The healing environment of the hospital includes some spiritual and religious facilities, such as a Chapel, a Prayer room for Muslims, and a sanctuary space (Imperial College Healthcare NHS Trust, 2015).

Figure 5

The Landscape Setback of The Charing Cross Hospital in London

Note. Image source: www.charingcrosshospitalnurses.org.uk

The Front PorchThe front porch can be situated at the main entrance like the porch of single-family houses. The main elements of this design include: a porch roof, a turnabout for automobile pick up, seating, and other urban furniture. In Suburban Hospital of Glendale Adventist Medical Center (GAMC), Los Angeles, CA, the combination of pedestrian and vehicular access has shaped a confusing and challenging space. GAMC provides a wide variety of rehabilitation services while the site of the hospital has not been adapted for outdoor rehab activities and spiritual care (Adventist Health, 2014).

Figure 6

The Front Porch of Suburban Hospital of Glendale Adventist Medical Center Provided Space for Rehabilitation Services and a Safe Pedestrian Path

Note. Image source: ©2021 Hollywood Locations

Entry GardenEntry garden, this green area usually includes a small and beautiful garden, it is also close to the main hospital entrance and will be specially designed for use. The entry garden of St. Thomas' Hospital is an attractive and often live park-like space in an urban setting of central London. The garden was built when the hospital was reconstructed in the 1960s and has been designed in abstract modernist style. The constructivist sculptor "Naum Gabo" (1890-1977) created the central feature of the garden which constituted a revolving fountain and abstract monuments (Gardenvisit, 2015).

Figure 7.

Revolving Torsion Fountain, at St Thomas Hospital Entry Garden, with Big Ben on the Other side of the Thames in the Background.

Note. Image source: Flicker.com.

Courtyard Gardens

Courtyard gardens are enclosed open spaces, which are in the "core" of a building or complex. This space usually is designed on the main axis of a hospital and constitutes a restaurant or cafeteria on at least one side. In The Linnaeus Physik Garden at the Santa Rosa, California community Hospital, the courtyard provides opportunities for sitting, socializing, and relaxing (The Center for Health Design, 1995).

Figure 8

The Contemporary Design of the Courtyard Garden at Guy's Hospital in London.

Note. Image source: Guy's Hospital, London.

Plaza Gardens

Plaza gardens are usually a hard-surfaced furnished outdoor space, including trees, shrubs, and flowers. But despite these soft elements, it is not considered a green space. For example, the Alta Bates Medical Center of Herrick Campus in Berkeley California offers a seating plaza, which is constructed of hardscapes, steel, and glass. Therefore, the extensive use of these materials does not evocate any sense of healing space (Cooper Marcus & Barnes, 1999).

Figure 9

The Healing Garden at Cedars-Sinai Medical Center.

Note. Source of image: www.hlblighting.com.

Roof Gardens and Roof Terraces

Roof gardens and roof terraces have some differences when present in a hospital landscape. A roof garden is built on the top of a medical building to be used by people. This space provides several views in different directions or can be viewed from more elevated parts of the hospital. But when the roof terraces are located on the side of the buildings, they are designed in linear forms with hardscape elements and some limited garden plants. In St. Mary Hospital, San Francisco, California, space which is called "Promenade" is an excellent example of a roof terrace. It offers very clear views from different parts of the hospital building and grounds. The design elements are seating clusters, trees, and plants that make a bio-habitat for birds and beneficial insects that provide pleasing views for patients (Mike Moores & Ellerbe Becket, Inc, 2009).

Figure 10

Healing Garden at the Roof and Traces of Cedar Sinai Hospital.

Note. Image source: © 2021 Cedars-Sinai.

Meditation gardens

Meditation gardens are specially intended for meditation practices, which most of the time are very quiet and enclosed areas. The meditation gardens include a short path, a few seats, and creative water features that provide soothing sounds. The garden in El Camino Hospital Mountain View, in California, is enclosed by buildings and trees. A concrete pathway, a green canopy, and non-native plants provide a quiet milieu that is separated from the hospital for the practice of "Mindfulness" for stress reduction and relaxation art (El Camino Hospital, 2015; Mindfulness Programs, 2015).

Figure 11

The Zen garden in the Suburban Hospital of Glendale Adventist Medical Center

Note. Image source: ©2021 Hollywood Locations.

Viewing gardens

Viewing gardens are those enclosed small gardens that can be entered but the main function is to be viewed through windows.

Borrowed landscape and natural trails

Borrowed landscape and natural trails, according to many recent studies, view out onto gardens and natural landscapes which reduce a considerable amount of stress for hospital patients and staff and positive distraction for people outside of the hospital. In Scottsdale Memorial Hospital North, in Phoenix Arizona, the design provides a wonderful view of a shallow valley, an active trail, and the University of Arizona Campus (The American Society of Landscape Architects [ASLA], 2012).

Figure 12

A Path for the senses at Horatio's Garden, Salisbury

Note. Image Credit: HORATIO'S GARDEN.

Figure 13

Horatio's Woodland Garden at the Scottish National Spinal Injuries Unit, Glasgow

Note. Image source: Horatio's Garden, Glasgow.

Atrium Garden

Atrium garden is an indoor garden that may be heated or air-conditioned. This is usually located in the central part of a building or complex, particularly designed for both very hot and very cold regions. In Royal Alexandra Hospital in Edmonton, Alberta in Canada, the glass-roofed atriums provide daylight and resemble outdoor space (Vlieg, 2015).

Healing Gardens

Healing gardens see 2.1.4, 2.1.5, & 2.1.6.

Discussion on the Theory of the Restorative Gardens

Since ancient times, the sun, moon, earth, and water of gardens have shaped human psychological states of mind and physical health. Historically, when society acknowledged the role of nature on human feelings and the experience of space, gardens became therapeutic environments (Gerlach-Spriggs, Kaufman, & Warner, 2004). At the beginning of the 20th century, the effects of specialization and medical approach to patients made hospital environments more like an office or laboratory. Physicians extensively practiced occupational therapy in mental hospitals and asylums in the United States of America during the 19 century. But in the latter decades of the 20th century, there were significant innovations that made a solid foundation for the establishment of healing gardens. While during this period urban and acute-care hospitals witnessed a huge loss of gardens (Rosenberg, 1995; Stevens, 1999), the horticultural therapy expanded the dimensions and typologies of healing environments of hospitals (Watson & Burlingame, 1960; Schlensinger & Holzman, 1970; Davis, 1944).

The term “healing” is broad and implies the process of well-being in general. Cooper Marcus and Barnes (1999) have described it in two ways; “First, is achieving a degree of relief from physical symptoms or awareness of those symptoms…, The second form of that healing can take, is that of stress reduction and increase levels of comfort for an individual dealing with the emotionally and physically trying experiences of a medical setting” (p.3). According to them, several mechanisms make a garden, restorative, or healing. The most well-known characteristics are aesthetically natural properties (Cooper Marcus & Barens, 1999).

But the design approach that promotes social activities and engaging people in exercise, meditating alone, talking to each other, and wandering in nature have significant potential to enhance the therapeutic impacts of the landscape beyond existing gardens. Therefore, a healing garden encompasses all preceding subcategory typologies. Gerlach-Spriggs, Kaufman, & Warner (2004), argue that: restorative gardens are not an alternative mode of therapy, and they cannot replace any medical interventions. They argued that the function of hospital gardens is an enhancement to a medical procedure, and they essentially contribute to the sense of well-being (Gerlach-Spriggs, Kaufman, & Warner, 2004).

The cultural influences impact our perception and response to the healing power of nature (Unruh, 1997; Osler, 1998). As Osler (1998), states: "The spirituality of gardens has spanned the world in time and in geography. The mystical quality that a garden throws off is as powerful as the scent of flowers" (p.16). The restorative environment has a more specific aspect of individual psychology that is beyond cultural values and social norms (Kaplan & Kaplan, 1989). The highly technological societies and the stressful routine activities cause, as they are called, "direct attention" and fatigue. Therefore, they suggest that experiences in natural environments will facilitate recovery from these ever-increasing stresses (Kaplan & Kaplan, 1989).

In their book, the restorative experience is described as the psychological impacts of gardens that "invigorate" and refresh the man and therefore have healing power (Kaplan & Kaplan, 1989). One of the common sources of stress in human life is illness or hospitalization. The psychological impacts of stress can result in changing blood pressure, influence heart rate, muscle tension, and mental concentration (Ulrich, 1993). The psychological studies showed that exposure to nature or at least some natural elements reduces stress quickly.

In a stressful situation, our brain and body have either "biophilic"[2] or "biophobic" responses to space. For example, in health-related conditions and space, our first decision to stay or skip space is critical,

2 **Biophilism** is a belief that animals have rights which human beings should respect.

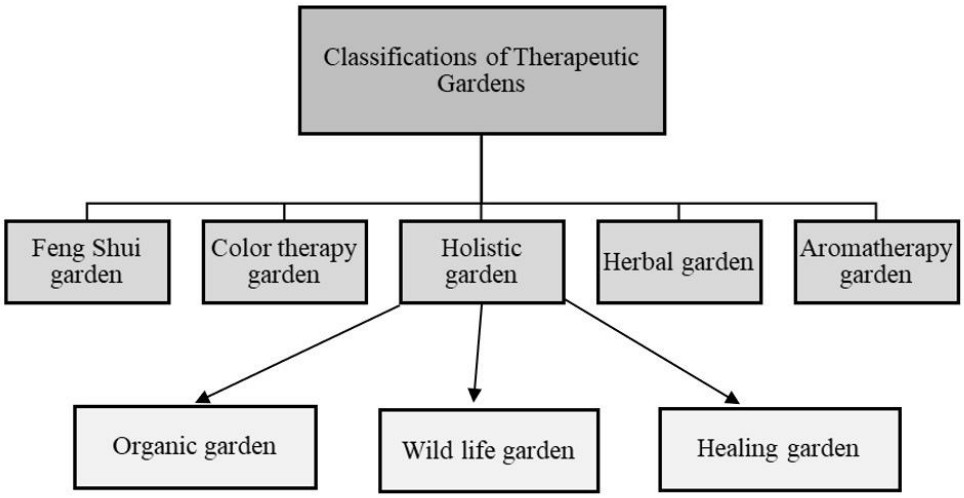
while after that, our second response or our brain-body adaptation has greater importance for a longer period. Their findings suggest that the historical-emotional background of an individual determines the choices which are made to settle in a landscape and reside in nature. (Orians & Heerwagen, 1992). In Levis (1996), many examples of many human-made environments have been studied to prove the beneficial impacts of nature on constructed space (Lewis, 1996).

Classification of Therapeutic Gardens: Design Principles and Elements

Increasing interest in holistic medicine throughout the modern world made people return to complementary therapies such as those illustrated in figure 8, (Caplan, 1992). The healing gardens are considered both mentally and physically sensory environments. These gardens can be designed to respond to the needs of a narrowly targeted population or they can provide a very broad range of sensory experiences. Also, the design elements and material in addition to the scale of those gardens are major determinants of a healing gardens' typology. According to Rawlings (1998); "Touch, sight, sound, smell, and taste can all be designed for, and each has a significant role to play in maintaining health" (p.12). The basic human senses are significant factors that shape our perception of healing environments like gardens, therefore healing gardens also can be classified according to those senses (Rawlings, 1998) as illustrated in Figure 9. Classification of therapeutic gardens.

Figure 14

Classification of Therapeutic Gardens According to Their Restorative Approaches, and Design Elements



Note. Based on Rawlings (1998).

Classification of Therapeutic Gardens by Specific Functions and Targeted User Group

Another way to classify therapeutic landscapes is based on the places where those gardens are built such as hospitals, hospices, clinics, nursing homes, and continuing care retirement communities. These gardens are designed for a targeted population, often with specific purposes including educational activities and physical exercises, or may provide a very special kind of treatment for patients. Several scientific methods are used to design more efficient healing spaces which recently have become common in the healthcare industry such as evidence-based design (EBD)[3] (The Center for Health Design, 2015), and Lean[4] (Lean Construction Institute, 2015). The American Society of Landscape Architects [ASLA], classified

3 "**Evidence-Based Design** (EBD) is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes" (The Center for Health Design, 2015).

4 "**Lean Design and Construction** is a production management-based approach to project delivery -- a new way to design and build capital facilities. Lean production management has caused a revolution in manufacturing design, supply and assembly." (Lean Construction Institute , 2015)

healing gardens based on the treatment of a specific disease. This classification includes two major categories for Adults and Children (The American Society of Landscape Architects [ASLA], 2015) as illustrated in Figure 10. Classification of healing gardens according to the targeted population of patients.

Figure 15

Classification of Healing Gardens According to the Targeted Population of Patients

Adult	Children
Alzheimer's and Dementia	ADD/ADHD
Asthma & Respiratory Disorders	Autism Spectrum Disorders
Cognition	Cognition
Depression	Depression
General Health	General Health
Heart Health	Nature Deficit Disorder
Hospital Recovery	Obesity
Obesity	
Post-Traumatic Stress Disorder (PTSD)	
Stress, and Stroke	
Type II Diabetes	
Well-Being	

Note. (ASLA, 2015).

Garden Views, and Well-Being

Theories of restorative effects in environmental psychology discuss the therapeutic impacts of natural elements (Hartig, 2004). Those studies conclude that natural environments foster stress recovery better than built spaces (Ulrich, et al., 1991). Analytical research by Grinde (1996) examines the different and effective aspects of plants' presence on stress reduction (Grinde, 1996). Based on the attention restoration theory (ART), environments that create a potential for effortless attention and natural elements that offer aesthetic stimuli improve mental capacity and are more restorative (Kaplan & Kaplan, 1989).

Psychological and emotional influences of the visual presence of plants and flowers on student's subconscious were described by Liu, Kim, and Mattson in 2007. They argued that the presence of plants, even in the background, can influence the unconscious mechanism of the brain (Liu, Kim, & Mattson, 2003). There are increasing numbers of empirical studies on outdoor environments and health; for example, in 2004, the Health Council of the Netherlands studied the impacts of nature on the social, psychological, and physical well-being of people and found that there is a positive correlation between proximity to nature and health indicators (Health Council of the Netherlands, 2019).

Additionally, many other studies have concluded that exposure to natural elements reduces stress and improves concentration (Taylor, Kuo, & Sullivan, 2001). According to them, those health benefits are connected to a series of various forms of exposure to nature, including wilderness, community parks, gardens, and residential landscapes. Based on a study by Kim and Mattson (2002), nature can improve wellbeing in the following ways: by providing fresh air, reducing air pollution, adjusting humidity, and ensuring pleasant views (Kim & Mattson, 2002).

Many studies have proposed that reduced stress is one of the psychological benefits of landscapes in healthcare facilities. Both Verderber (1986) and Ulrich (1984) have demonstrated that improvements in pain levels and recovery speed are achieved by viewing gardens (Verderber, 1986; Ulrich, 1984). According to the conclusion of Velarde et al (2007) and Grinde (2009), "nature appears to have qualities useful for stress relief, mental restoration, and improved mood simply by being consciously or unconsciously pleasing to the eye" (Velarde, Fry, & Tveit, 2007; Grinde & Patil, 2009).

Louv (2008) presented evidence from studies that confirm the therapeutic impacts of viewing nature in indoor environments (Louv, 2008). The theory of the healing effects of visual contact with greenery is supported by both the empirical data and theoretical studies (Park & Mattson, 2009; Mabadi, 2017). According to recent studies, the psychological benefits of indoor greenery and experiencing nature are also mediated by cultural factors (Bringslimark, Hartig, & Patil, 2009; Hartig, 2003).

Grinde and Patil (2009) hypothesized that "the positive effects of having the view from the window may be related more to the perceived openness than to any particularities of vista" (Grinde & Patil, 2009), while other studies by Velarde et al (2007) also confirmed that a view of green landscaped areas has positive mental effects (Velarde, Fry, & Tveit, 2007). Additionally, the potentially different responses based on gender toward the presence of plants and natural elements have been investigated (Verderber, 1986). As those studies conclude, females are more susceptible to showing interest and paying attention to plants compared to males (Pergams & Zaradic, 2006; United States Department of Labor, 2019).

Synopsis of the Recent Studies and Methodologies of Therapeutic Environments

In the late decades of the 20th century, two studies by Ulrich that examined the views to nature or natural scenes concluded that the outdoor visual environments have positive impacts on patients and have a significant advantage on brick and mortar walls (Ulrich, 1983; Ulrich, 1984). Likewise, in 1984, Kaplan implemented a theoretical analysis and suggested that the natural settings in cities have strong restorative effects. In 1989, Olds published the results of his research that focused on the healing influences of nature.

The results implied that the outdoor spaces with natural elements have strong healing characteristics. This survey research concluded that both the indoor and outdoor natural environments can influence the healing perception of people (Olds, 1989). During the early 1990s, Francis and Cooper-Marcus conducted two qualitative formative research studies to explore: first, the healing elements of nature and, second, to understand the environmental conditions and spaces, which could provide refuge during stress and depression. The results of the first study summarized that most of the participants preferred specific degrees of privacy in public spaces with dominant natural elements, such as plants, water features, and benevolent meteorological conditions (Francis & Cooper-Marcus, 1991).

In the same way, the second study suggested that the majority of the respondents selected natural settings to deal with stress conditions (Francis & Cooper-Marcus, 1992). Following the landmark research studies, which were conducted by Ulrich during the late 1980s, many studies during the early years of the 21st century, (Pretty, 2004; Pretty, Peacock, Sellens, & Griffin, 2005; Ward Thompson, 2011), investigated

the contributions of natural elements to mental and physical health and focused on the recurring themes between landscape features and health. Advocating the restorative impacts of nature on humans, their studies classified three significant ways for human-nature involvement as follows: first, visual connection to natural settings; second, presence in natural settings; third, green exercise.

In 2001, two different studies by Kaplan (2001) and Kuo, Bacaicoa, & Sullivian (2001) demonstrated that viewing natural settings in residential spaces improves human satisfaction with neighborhoods and also strengthens the functional effectiveness, in addition to overall wellbeing. These studies, (Kuo, Bacaicoa, & Sullivian, 2001; Kaplan, 2001), confirmed the results of the previous qualitative research that was conducted by Collins (1975) and had shown that spaces without windows are not preferred by people.

Since 1984, the experimental research by Ulrich that a "view through a window may influence recovery" was considered a classic study, and developed by many researchers as well. For example; in 2008, Pati, Harvey, and Barach investigated the correlation between the stress level of nurses and exposure to nature via the windows of hospitals. Their research implied views away from nurses' stations, to natural settings can increase alertness and reduce their stress (Pati, Harvey, & Barach, 2008).

Regarding the health benefits of exposure to nature, Stigsdotter, et al., (2010), conducted research based on "the Danish National Representative Survey," which indicated that proximity to green areas improves health and wellbeing in specific ways. Similarly, improving mood and the stress-reducing benefits of being present in nature have been demonstrated by several research studies (Cooper-Marcus & Barnes, 1995; Whitehouse, et al., 2001; Ulrich, 1993). Historically, real presence in nature is assumed to have a therapeutic influence on humans. Accordingly, active exposure to nature, including all types of activities in natural settings, and sport in green areas were concluded to have positive impacts as well as increase positivity and effectiveness (Kaplan, 2001; Pretty, 2004).

Jiang (2015) classified the research on a person's nature engagement. According to her study, there are three major categories based on the degrees of human involvement with nature as follows: the first is

positive exposure, including windows at home, workplace and patients rooms, and picturesque painting in health care environments (Jiang, 2015). The second is moderate engagement that includes indoor plants in workplaces and hospitals, roadside planting, nearby nature in residential areas, gardens at the workplace, and finally healing gardens (Jiang, 2015).

The third, active engagement includes horticultural therapy, and green exercises (Jiang, 2015). The recent environmental-psychological literature is classified into two schools or approaches: the first focuses on the attention-restoration hypothesis, and the second concerns "biophilia" and the restorative effects of the living system. In 1989, Rachel and Stephen Kaplan published the results of their studies that were conducted for twenty years. They founded their research hypothesis on Attention Restoration Theory (ART) and suggested that being present in nature, or looking at natural settings improves people's concentration.

In their book "The Experience of Nature" they explained how different natural settings can deliver satisfaction to humans and how people understand various natural settings, from the wilderness to backyard gardens (Kaplan & Kaplan, 1989). The results of their studies were proven by the later research. For example, (Berman, Jonides, & Kaplan, 2008) explored the cognition of human interaction with nature and concluded that nature can increase memory, reduce depression, and have positive effects on people's moods.

Faber Taylor, Kuo, & Sullivan (2001) conducted an evidence-based study and reported that viewing natural settings can heighten self-discipline in girls in urban environments. Wells & Evans hypothesized that rural children are less stressed because of their presence in more natural environments (Wells & Evans, 2003). Another study by Cimprich suggested the natural and "biophilic" environments can improve attention in women who suffered from breast cancer (Cimprich, 2007).

Berman et al. (2008) classified Attention Restoration Theory (ART) into two separate components, namely, involuntary attention and directed attention. When a cognitive- control process directs our attention, it results in some restorative status and recovery mood in people (Berman, Jonides, & Kaplan, 2008); this needs efforts and concentration on positive feelings or images. Kaplan (2001) inferred that

when fascination with the system is examined, for example by natural settings, the direction attention effects gain their maximum positive impacts.

Recently, the attention-restoration theory has been enhanced in fields of urban study as well as landscape architecture. For example, recent studies of urban parks, cities, and green infrastructures proved the healing properties of those environments and their advantages over densely constructed spaces and hardscapes. Laumann, Gorling, & Stormark (2001) conducted two separate sets of studies and developed a rating scale that measures restorative elements of environments. Furthermore, they concluded that "environments with natural elements generally scored higher than city environments on all measures."

Additionally, Herzog et al., (2003) assessed the restorative components of nature and confirmed the results of Laumann, Gorling, & Stormark (2001). Scopelliti and Giuliani (2004) have shown the different healing potentials of natural or man-made environments in various stages of people's lifespans. The latest ART studies concentrate on urban settings and the importance of small green areas. The results of those research studies confirm the significance of restorative impacts of urban pocket parks on their surroundings communities (Scopelliti & Giuliani, 2004).

For instance, (Nordha, Alalouch, & Hartig, 2011) studied small urban parks from Scandinavian cities, examined their potential restorative impacts, and provided guidance for designing healing-pocket parks. Just a few studies have considered the socio-cultural components of urban environments, which can influence our perception of healing, For example, Wilkie and Starridou (2009) argued that a "person with an urban preference perceived both nature and urban environments equal in restoration potentials; this may explain circumstances when environmental choice appears inconsistence to cognitive restoration goals."

Considering the importance of local conditions and therefore emphasizing the perceived image of health and restoration in every individual's mind, they demand the application of more quantitative or mixed methods to analyze the urban parks (Wilkie & Stavridou, 2013). In 2013, Irvine et al. highlighted the divergences between perceived image real reasons for visiting urban parks, as they stated "Derived effects highlighted relaxation, positive emotions…," as well as "spiritual well-being."

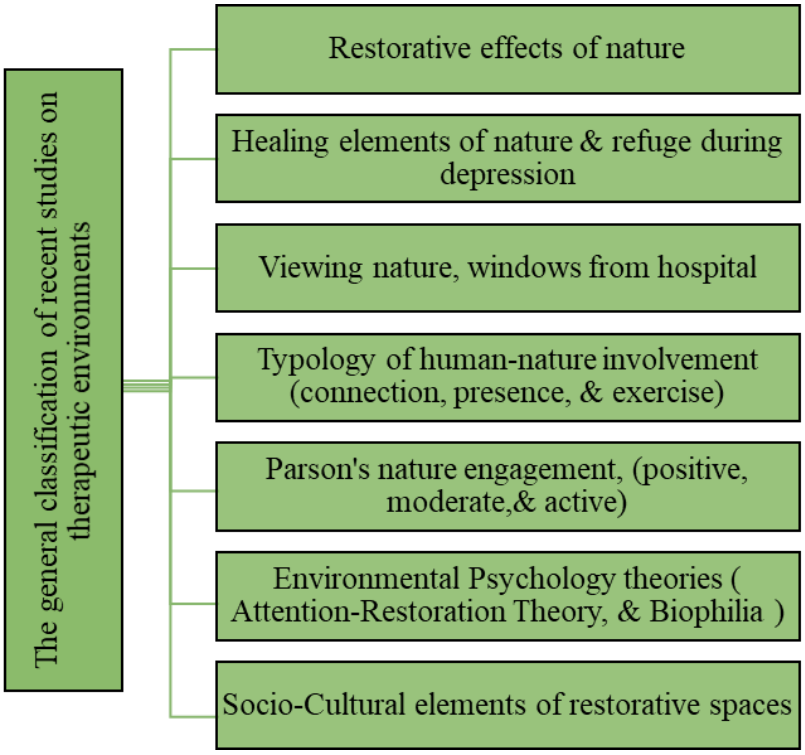
A new study classified the components of "Biophilic Architecture" as follows: first, the naturalistic dimension, second; the wholeness of the site; third geometric coherency (Caperna & Serafini, 2015). Describing the "biophilic design" and its connection to producing healthy urban settings, Caperna & Tracada (2012) emphasized the sociological and psychological potentials of sustainable urban design to encourage life and unburden the human cognitive system. Likewise, other studies demonstrate the medical benefits of biophilic gardens at Children's Hospital Boston (Franklin, 2012).

The efforts for understanding the restorative impacts of biophilic design are not limited to urban scale or outdoor environments. For instance, Park & Mattson (2009) suggested that "patients in hospital rooms with plants and flowers had significantly more positive physiologic responses, and also conveyed positive impressions of hospital employees caring for patients" (Park & Mattson, 2009).

One of the innovative approaches in the therapeutic landscape design is a strategy based on aesthetic-affective theory. According to Grahn, Ivarsson, Stigsdotter, & Bengtsson (2014), the restorative properties of an environment, such as landscape can be influenced by the visual elements of that environment. Based on the aesthetic-affective theory, Ulrich et al. (1991) mentioned two separate biological responses to natural stressors; "restoration responses following stressful activities," and "attention approach responses… that favored wellbeing" to describe human stress recovery during exposure to natural settings and cities.

Table 1

The General Classification of the Recent Studies on Therapeutic Environments is Based on 3.5.4



Note. (Mabadi, 2017).

Table 2

Recent Studies on Therapeutic Environments and Methods

	Authors	Focus	Method
1	Ulrich (1983), Ulrich (1984),	The views to nature or natural scenes,	survey, EBD
2	Kaplan (1984), Kaplan & Kaplan, 1989, Herzog et al., (2003)	Restorative effects of natural settings	theoretical analysis
3	Olds (1989)	Healing influences of nature	survey
4	Francis & Cooper-Marcus, 1991, 1992	The healing elements of nature and, environmental conditions	qualitative formative research
5	Pretty(2004), Pretty, Peacock, Sellens, & Griffin, (2005), Ward Thompson, (2011)	Natural elements to mental and physical health	qualitative and quantitative

6	Pati, Harvey, & Barach (2008)	Health benefits of exposure to nature	survey
7	Stigsdotter, et al., (2010)	Nature has a therapeutic influence on humans	Survey and quantitative
8	Kaplan (2001), Kuo, Bacaicoa, & Sullivian (2001)	Human satisfaction, neighborhoods & overall wellbeing.	qualitative
9	Collins (1975)	View through a window may influence recovery	quantitative
10	Wells & Evans (2003), Cimprich (2007), Franklin, (2012), Park & Mattson (2009)	Biophilic" environments and attention restoration	qualitative
11	Jiang (2015)	Person's nature engagement	Literature review
12	Berman, Jonides, & Kaplan (2008), Nordha, Alalouch, & Hartig (2011), Irvine et al,(2013), Berman et al. (2008)	Attention-restoration theory and public parks	Survey, quantitative
13	Scopelliti and Giuliani (2004)	Healing potentials of natural or man-made environments in various stages of people	Content analysis, quantitative
14	Grahn, Ivarsson, Stigsdotter, & Bengtsson (2014)	Aesthetic-affective theory	Survey, qualitative

Heat Island Effects

Summary: The following section first focused on heat island effects and their environmental contributors at both urban and site levels. Then, using available studies, this section specifically explained the problem of heat island effects in the urban context of Dallas, Texas. Next, this section described two critical aspects of heat island effects include: health impacts and cooling intensity. Finally, it investigated the existing literature and previous environmental remediation projects to summarize mitigation strategies with an especial concentration on natural solutions and landscape architecture.

Environmental Contributors to Heat Island Effects

Urban heat island (UHI) effects are a global phenomenon that is attributed to the planning and design characteristics of the urban environment (Aleksandrowicz, Vuckovic, Kiesel, & Mahdavi, 2017). In 2015, a study by Debbage and Shepherd indicated that in many U.S. urban developments, regardless of urban density and the degree of sprawl, spatial contiguity is a significant factor that determines the extent

of the heat island effects of cities. In their study, they analyzed the tree canopy, urban heat island intensities, and spatial continuations of the 50 most populous metropolitan statistical areas (MSAs) based on the 2010 U.S. census (Debbage & Shepherd, 2015). They devised a methodology to evaluate UHI intensities and quantify urban morphology. Their study posits that spatial continuity is a critical contributor to UHI effects. According to them, uninterrupted and contiguous urban footprints are more influential than shape complexity, polycentrism, and urban sprawl (Debbage & Shepherd, 2015).

Debbage and Shepherd (2015) argued that "policies have to comprehensively address the entire urban system and not simply focus on the UHI effects in isolation" (p.192). In this regard, they used an example to support their proposal for a holistic approach involving a network of more than 20 densely vegetated urban plazas that would diminish the high-intensity urban development in the historic downtown district of Savannah, Georgia (Debbage & Shepherd, 2015). Their study concluded that, first, the previously unknown factor contributing to the UHI, the spatial continuity, should be considered in future strategies for UHI mitigation. Secondly, remediation of UHI intensity in cities is a complex process; therefore, any planning and design solutions should be tailored to specific sites and urban conditions.

Urban vegetation is a critical factor in UHI remediation. A lack of vegetation and tree canopies results in increasing surface temperatures, solar energy interception, and increased heat exchange (Wang & Hashem, 2016). Akbari and Wanga (2016) examined the correlations between tree size, empty spaces, and outdoor comfort through environmental simulation research. According to Mirzaei and Haghighat (2010), trees can positively affect the urban environment via shading and blocking the solar radiation, leaf transpiration, and blocking of the wind. As Wang and Akbari (2016) have argued, larger tree crowns improve tree leaves and increase transpiration, thereby reducing wind intensity and creating more shaded areas. Their study suggested that tree planting patterns and high tree size in urban streets, such as crown size can mitigate average SVF5 in cities and reduce Ta6 considerably.

5 SVF: Sky view factor is the fraction of sky area when look up to the sky.
6 Ta: indicates one day air temperature.

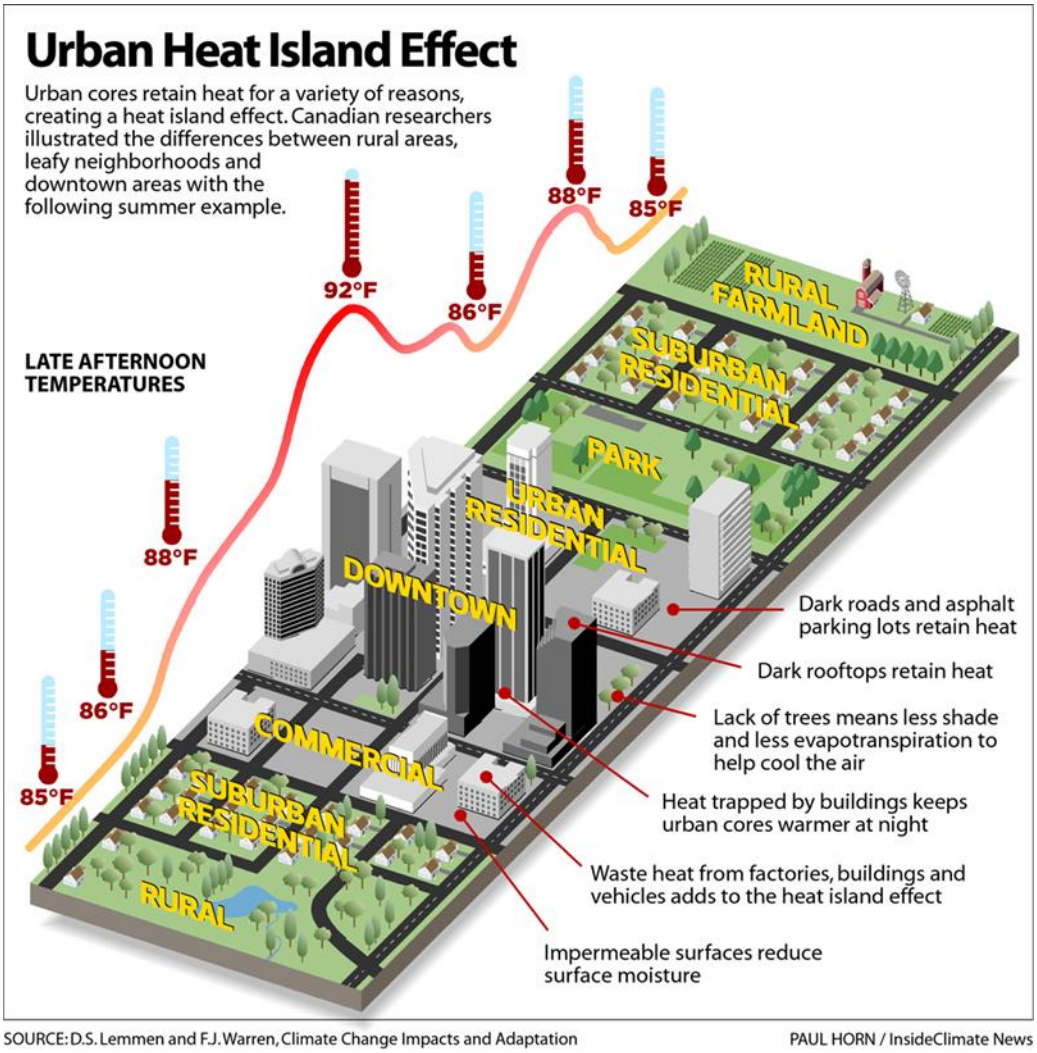
Trees with larger crowns and without space between them maximize the environmental benefits of UHI mitigation, especially during the night. They also concluded that planting trees in high-elevation urban areas reduces the energy consumption of adjacent buildings in city centers (Wang & Hashem, 2016). There are key barriers to adopting blue and white roofs and other high SRI surfaces, that need a comparison between their incremental benefits and costs, therefore this will not be discussed here due to limitations and because it is beyond the concentration of this study.

A study by Kim, Gu, and Kim (2018) analyzed various climate zones and the efficiency of UHI remediation approaches. They created an urban canopy model and used statistical information from Houston, Texas. During the hottest week of the typical meteorological year (TMY3), they employed a simulation model using the urban weather generator (UWG) (Kim, Gu, & Kim, 2018). According to their simulation model for measuring the efficiency level of UHI mitigation strategies, they developed sustainable environments, for which focusing on local climate conditions is critical.

As Kim, Gu, and Kim (2018) concluded, “an urban development direction should be customized to local climate conditions to build sustainable cities.” The results of their adaptation studies necessitate strategic physical modifications of buildings and their landscapes (Smid & Costa, 2017). Additionally, Kim, Gu, and Kim (2018) concluded that in high-rise urban morphology, green roofs are less efficient, while the areas covered by trees and grass exhibit more efficiency in hot weather.

Figure 16

Comparison between Island Effects in Urban and Rural Conditions



Note. Image courtesy of Lemmen & Warren.

Asphaltic concrete (AC) is a contributor to the UHI effect and one of the most common materials for roads and street surfaces. AC has low albedo and sufficient volumetric heat capacity to mitigate the UHI effects in streets and sites. Cool pavements are efficient solutions based on local urban and planning conditions. According to a study by Mohajerani, Bakaric, and Jeffrey-Bailey (2017) both concrete and cool pavements can increase UHI unless other supportive strategies are implemented. Planting and installation of street trees, city parks, and rooftop gardens are efficient strategies in combination with cool pavements

(Mohajerani, Bakaric, & Jeffrey-Bailey, 2017). Their study summarizes the most significant causes of the urban heat island as follows:

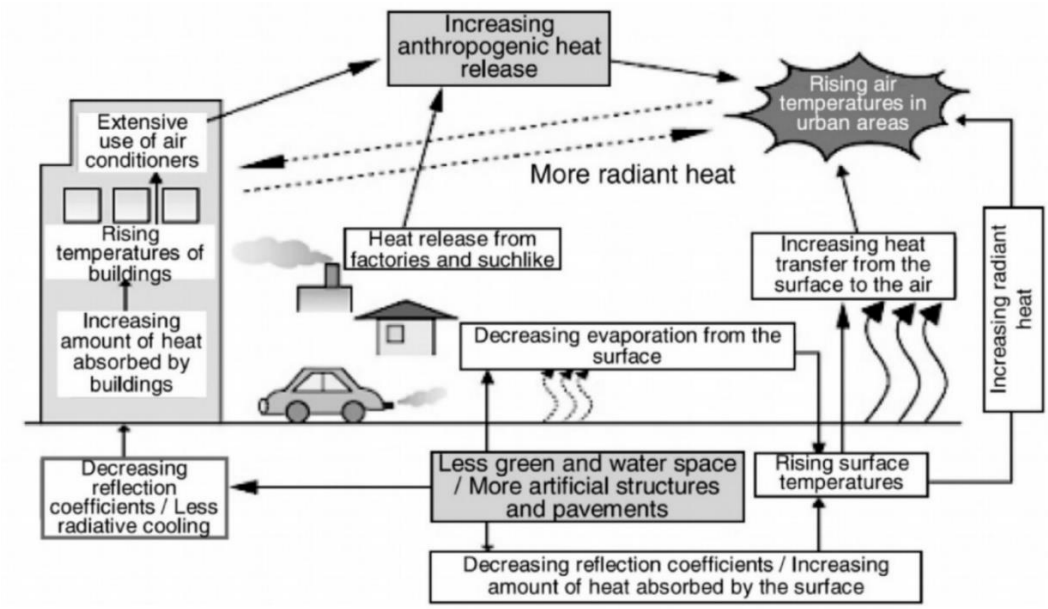
1- Urbanization; expansion of hard and heat-absorbing surfaces, increased construction, and mass density of cities, and decreased urban vegetation, native plants, and natural soil surfaces.

2- Increasing use of manufactured materials that have more heat storage capacity and low albedo.

3- Increasing energy consumption in cities for air conditioning systems and through an extensive review of the literature.

Figure 17

How the Urban Heat Island Occurs



Note. Image sourced from Yamamoto (2006).

Urban Heat Island Effect in Dallas, TX

According to the 2017 Dallas Urban Heat Island Effect Report, "Dallas is heating up faster than any city in the country except for Phoenix." Their study claimed, "Cities do not cause heat waves – they amplify them. Human activities on climate at the city/regional scale, accounting for both land surface changes and emissions of greenhouse gases

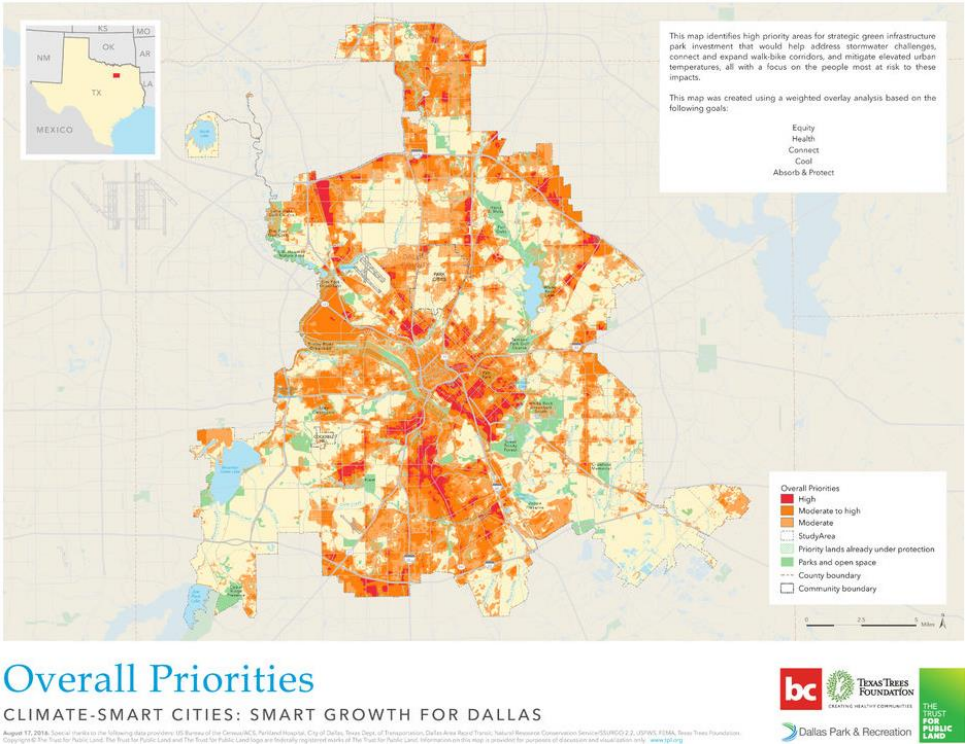
alone." Dallas, with 35% impervious surfaces (i.e., rooftops, parking lots, highways, etc.), is hot – and becoming hotter (Texas Tree Foundation, 2020). The results of their research are summarized below.

1. Heat kills: Heat-related deaths peaked at 52 in 2011 in Dallas County. Heat-related deaths in the United States account for more deaths annually than all other natural disasters combined.

2. Trees cool: Tree planting in the hottest areas with high-density residential areas was found to reduce deaths by more than 20% by merely reducing temperatures.

Figure 18

Overall Priorities for Urban Heath Island Mitigations in Dallas



Note. (Trust for Public Land, 2020).

Health Impact of Urban Heat Island (UHI) and Cooling Effect Intensity (CEI)

Aram, Solgi, Garcia, and Mosavi (2020) researched the cooling effect intensity (CEI) of an urban park in downtown Madrid, Spain. They studied three different distances at the southern borders of the park to evaluate CEI and thermal comfort based on physiological and psychological factors (Aram, Solgi, Garcia,

& Mosavi, 2020). They concluded that large urban parks in densely populated and built cities provide significant thermal comfort for people. They also found that the aspect ratio (H/W) plays a critical role in this regard. Additionally, via a survey, their study demonstrates that the CEI of the park changes the thermal comfort level based on their distance to the green area (Aram, Solgi, Garcia, & Mosavi, 2020).

UHI can negatively affect human well-being and quality of life by increasing air and surface temperatures in addition to the following effects:

Increasing Effects of Air Pollutants and Greenhouse Gases

Increasing air temperature increases energy demand, which results in more air pollution and energy consumption. According to the U.S. Environmental Protection Agency (2020), "elevated air temperatures increase the rate of ground-level ozone formation."

Negative Effects on Human Health, Well-Being, and Environmental Comfort

As the U.S. Environmental Protection Agency (2020) notes, urban heat islands can affect human health by contributing to general discomfort and respiratory difficulties, heat stress, and heat-related mortality: Especially vulnerable populations include children, older adults, people with chronic conditions, and low-income communities.

Degradation of Water Quality

Thermal pollution of urban surfaces negatively impacts water quality. For example, runoff from urban areas is hotter, which eventually increases the water temperature of streams, ponds, rivers, and lakes. The increase in water temperature degrades the quality of the aquatic system and its species (U.S. Environmental Protection Agency, 2020).

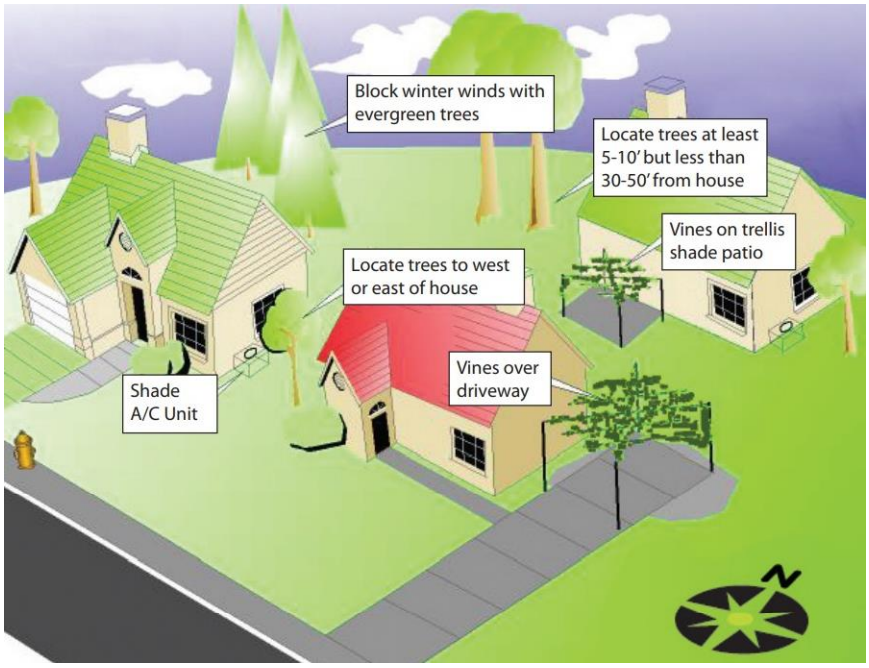
Recent guidelines address the health and environmental benefits of tree placement in residential sites (U.S.Environmental Protection Agency, 2008). These include the following:

1. Decreasing air pollution and greenhouse gas emissions.
2. Reducing energy use.
3. Removing pollutants via the process of dry deposition.
4. Reducing evaporative emissions.
5. Removing and sequestering carbon from the atmosphere.
6. Reducing demands for energy and decreasing greenhouse gases.

7. Full life-carbon cycle reductions.
8. Improved human well-being and health through reduced exposure to UV rays.
9. Enhancing stormwater management and improving water quality.
10. Decreasing maintenance costs for pavements and urban surfaces.
11. Creating habitats for birds and insects and encouraging biodiversity,
12. Increasing property values.

Figure 19

Tree Placement to Maximize Energy Savings



Note. (EPA, 2020).

Heat Island Mitigation Strategies

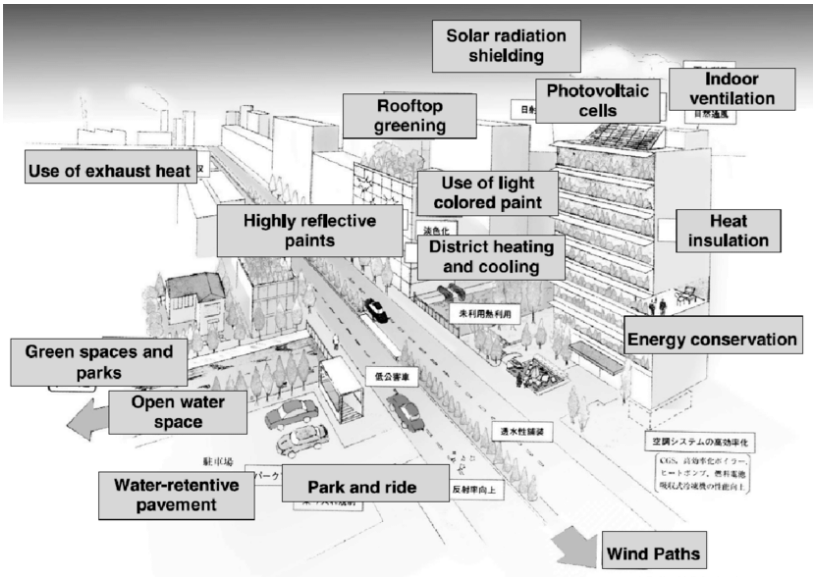
Mohajerani, Bakaric, and Jeffrey-Bailey (2017) summarized key mitigation measures to combat UHI effects. Those strategies include the implementation of cool pavements, increasing the albedo of urban surfaces, planning for more urban green spaces, and using the cooling effects of wind and water. Additionally, their study emphasized the effective implementation of water-retaining pavements, porous pavers, and pervious and permeable pavements to

mitigate urban problems such as heat island effects and stormwater runoff (Qin, 2015; Li, 2015). As Memon, Leung, and Liu (2010) have suggested, the urban morphology has the greatest impact on wind flow patterns that define the effective mitigation strategies for tall buildings and narrow streets, also called urban canyons. As Memon, Leung, and Liu (2010) have stated, "the height/width aspect ratio of a canyon has an enormous effect on the urban canyon albedo (UCA) and UHI mitigation on a city-scale level."Although these strategies are so hard to implement, their long-term therapeutic benefits should be calculated for future research and are beyond the limitations of this study.

According to Erell, Pearlmutter, and Williamson (2011), those characteristics include the density, size, and orientation of buildings, the configuration of open spaces, and heat-absorbing materials. Erell, Pearlmutter, and Williamson (2011) classified strategies and solutions for UHI effects into two different categories, namely adaptation measures and mitigation measures (Aleksandrowicz, Vuckovic, Kiesel, & Mahdavi, 2017). Adaptation strategies are those that are partial and temporary, with immediate and limited responses to UHI effects. In the second category, mitigation strategies target the natural system or urban micro-climate through comprehensive and collective actions. According to Gago, Roldan, Pacheco-Torres, and Ordóñez (2013), mitigation strategies aim to modify the physical environment and transform the microclimate of urban environments. One of the strategies to mitigate the UHI effect is planning for more green spaces and tree canopies in urban landscapes (Stone, Hess, & Frumkin, 2010; Stone & Norman, 2006). Trees provide shade on buildings' street surfaces and reduce wind speeds and cool the air through evapotranspiration (Santamouris, 2015). According to other studies, small urban green spaces can effectively reduce surface temperatures and mitigate UHI effects on a small scale (Doick, Tony, & Hutchings, 2014; Tan, Ka-Lun Laua, & Ng, 2016).

Figure 20

Major-Urban Heat Island Mitigation Measures



Note. From Yamamoto (2006).

Through a quantitative comparison study of published literature, Aleksandrowicz, Vuckovic, Kiesel, and Mahdavi (2017) classified mitigation strategies based on intervention measures, their scales and magnitude, implementation potential, and compatibility on a local scale. They argued that "mitigation efforts usually utilize one of the three action strategies: reduction of solar radiation absorption in urban materials, enhancement of airflow through the city, and active cooling of certain elements in the built environments (usually via evapotranspiration and evaporation of water)" (Aleksandrowicz, Vuckovic, Kiesel, & Mahdavi, 2017).

Aleksandrowicz, Vuckovic, Kiesel, and Mahdavi (2017) classified mitigation measures and major intervention domains as follows:

Building Envelope (Beyond the Scope of this Research)

1. Cool building envelope (beyond the scope of this research)
2. Green roofs (beyond the scope of this research)
3. Green facades (beyond the scope of this research)

Urban Landscaping

One of the most effective strategies to cool the site is by modifying or enhancing the existing urban landscape. These strategies focus on introducing new landscape design, details, and materials on the existing site.

1. **Shade trees:** Shade trees can contribute to heat island remediation and increase the thermal comfort of the site in two different ways. First, they provide shade and reduce the heat absorbed by surfaces, especially hardscapes. Secondly, they release vapor into the air when their leaves are exposed to solar radiation, which is called evapotranspiration.
2. **Ground vegetation:** Covering the ground level via extensive planting can reduce the ambient air temperature on a local scale by absorbing short-wave solar radiation and transforming it into vapor and therefore releasing the heat through evapotranspiration.
3. **Water bodies:** On the small urban scale, water features such as ponds and fountains can absorb heat and mitigate UHI effects via evaporation. Therefore, medium and small-scale bodies of water can create an" urban cool island" in the surroundings.

Pavement

Concrete and asphalt pavements absorb heat under solar radiation during the daytime and release most of this heat during the night.

1. **Cool pavements:** Using materials with higher albedo values in paving design and construction contributes to cool surfaces.
2. **Water retention pavements:** New types of pervious paving materials are being used to facilitate surface water absorption into the subsoil via their water-retentive sub-layer, which then evaporates that water under solar radiation.

Street geometry

1. **Built environment typical section:** For typical sections to reduce UHI in urban open spaces and increase thermal comfort, the height-to-width ratio (H/W) of street canyons is a critical factor during planning and design. Narrow street formation and the "sky view factor," which is the openness of

the street surface to the sky, can reduce direct sun exposure regardless of street orientation. In warmer countries or seasons, narrow streets have lower air temperatures during the daytime.

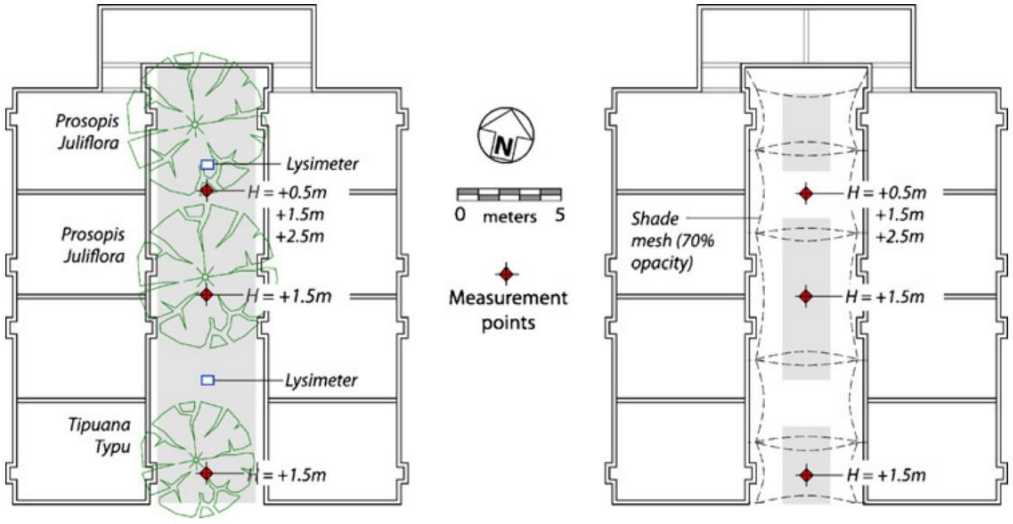
2. **Built environment orientation prevailing wind:** Buildings and structures in cities can block or slow wind flow. According to Aleksandrowicz, Vuckovic, Kiesel, and Mahdavi (2017), "therefore street orientation and to prevailing winds can have a critical effect on the way winds penetrate city streets, as well as on canopy layer wind velocity."

3. **Solar orientation:** The orientation of urban streets can increase the thermal comfort of open spaces via the shading of buildings. As Aleksandrowicz, Vuckovic, Kiesel, and Mahdavi (2017) have argued, "streets of north-south (N-S) orientation will slow lower ground irradiance during summer when compared to the streets of east-west (E-W) orientation, implying they are more likely to provide better outdoor thermal comfort for pedestrians" (p.10).

In 2009, a study by Shashua-Bar, Pearlmutter, and Erell (2009) investigated climate analysis and design strategies in hot-arid regions. They evaluated six landscape strategies that combined tree, lawn, and shade mesh in two semi-enclosed courtyards in an urban context located in the highlands of southern Israel (Shashua-Bar, Pearlmutter, & Erell, 2009). Their research presented empirical findings regarding the cooling effect of vegetation and water use in the built environment. They concluded that, first, the most effective strategy is using a combination of trees and grass. Second, with the same amount of shade from trees, shade mesh caused a small heating effect. Third, shading grass with trees or mesh increases cooling effects and reduces water consumption. Fifth, shading via trees is the most efficient method of cooling air temperature and reducing water consumption and therefore increase the livability and therapeutic properties of the site.

Figure 21

Location of Measurement Points of Trees in the West Courtyard (Left) and Shading Mesh in the East Courtyard



Note. (Shashua-Bar, Pearlmutter, & Erell, 2009).

In 2012, Kleerekoper, van Esch, and Baldiri Salcedo (2012) explored the heat stressors which resulted from UHI and provided tools and guidelines for urban design. The applicability of their design tools was tested for two existing neighborhoods in Nederland. They applied cooling techniques to mitigate UHI effects; their design principles included vegetation, water, built forms, and material. They formulated the following criteria:

1. Locating all dwellings in the proximity of 200m from a green area of a minimum size of 0.37 acre.
2. The most effective orientation for streets is perpendicular to green areas.
3. Construct green filters where there is traffic pressure.
4. Surface water can compensate for the deficiencies of green areas.
5. Green roofs can replace existing flat roofs.

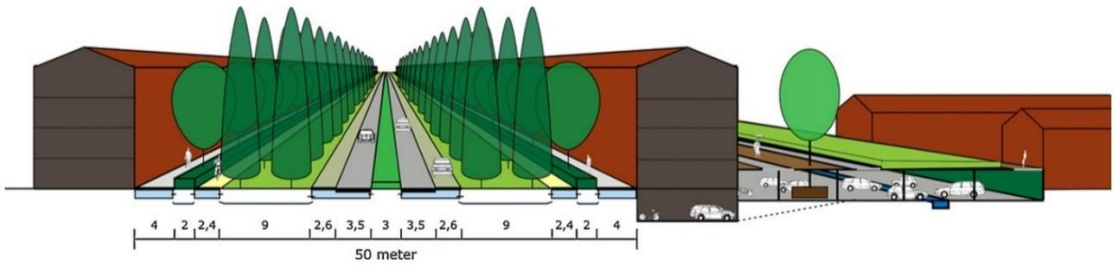
Figure 22

Transvaal with Green Squares, Green Roofs, New Building Typology, and Water System

Note. (Kleerekoper, van Esch, & Baldiri Salcedo, 2012).

Figure 23

Section of the Car and Bus Route Green Zones and Water System



Note. (Kleerekoper, van Esch, & Baldiri Salcedo, 2012).

Artful Rainwater Design

Summary: This section briefly described the Best Management Practice (BMP), addressing stormwater to improve the quality of the environment and ecological health. Then, it explored artful rainwater harvesting strategies and their contemporary design techniques. Next, this section defined the amenity approach in ARD, explained its importance. Finally connected the concept of art rainwater design to aesthetic richness objectives with a focus on landscape architecture.

Green Infrastructure and Holistic Approach in Stormwater Management

Best management practices (BMPs) address stormwater to improve the ecological health of the water system via engineering methods (Echols & Pennypacker, 2008). Currently, interest in rainwater harvesting is growing everywhere from European countries to the Middle East and North America. Therefore, designers, planners, and engineers are creating many methods to manage stormwater runoff in cities and streets.

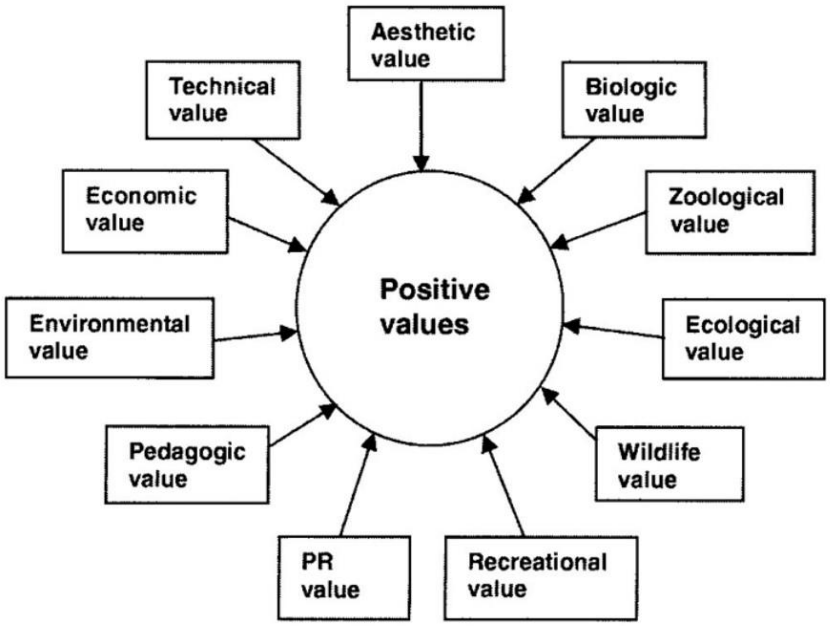
The purpose of evaluating buildings and sites for those credentials is to ensure the consistency of design criteria with regards to sustainable design and stormwater management specifically (Henneman, 2006). BMP design focuses on flood control and spatially treat storm water while LID BMP design, concentrates on the distribution of stormwater, creates green infrastructure (GI) to treat it. Echols and Pennypacker (2008) have discussed, there is valuable potential in BMPs to apply environmentally friendly approaches and integrate them with education and aesthetics. According to USEPA (2005a), urban runoff is the major source of water pollution in the United States. Since 1972, the Clean Water Act has recommended various stormwater management plans to decrease non-point source water pollution (US Environmental Protection Agency, 2005).

Despite the traditional engineering methods which focus on large scales, integrating BMPs to reduce the water pollution at a source on a small scale can improve creativity in landscape design. For decades, site amenities and stormwater management, aesthetically pleasing and well-designed detention ponds, and bio-retention landscaped areas have been recognized as components of stormwater management systems (Bookout, 1944). According to CIRIA (2001), while traditional urban drainage focuses on quantitative aspects of stormwater management, the new sustainable urban drainage paradigm attempts to locate or create a niche from overlaps between three different elements of stormwater management, including quantitative, qualitative, and amenity aspects (CIRIA, 2001). In 2003, the National SUD Working Group classified the positive values and characteristics of the combined approach which

integrates all those mentioned approaches into one holistic strategy (National SUDS Working Group, 2003), which is called the "Amenity Approach." As Stahre (2006) has stated, the positive values of the holistic approach include aesthetic, environmental, economic, biologic, pedagogic, and other values, as illustrated in Fig.2.

Figure 24

Positive Values of Open Storm Drainage



Note. (Stahre, 2005).

Artful Rainwater Harvesting and Design Techniques

In 2008, Echols and Pennypacker researched the abundant literature on stormwater management and addressed the limitations of design discussions, and delineated design techniques and methods. Based on their study, utility aspects of stormwater management improve hydrological function to protect public health, improve user's safety measures, increase welfare, and support aquatic habitats (Echols, Pennypacker, 2008). They classified the design techniques based on the specific objectives for utility elements of stormwater management, as summarized below.

Table 3

Design Techniques and Objectives for Utility Aspects of Stormwater Management

	Systems' Objective	Design Techniques
1	Reduce downstrem flooding	Detention
2	Hold stormwater for reuse	Retention
3	Reduce stormwater pollution	Filtration
4	Promote groundwater recharge	Infiltration
5	Safely convey stormwater away	Conveyance

Note. Adopted from Echols and Pannypacker (2008).

Stormwater management includes both large-scale and local-scale precipitation, while stormwater addresses the runoff. They may pose safety risks, and the "rainwater" focuses on small to moderate scale rains that involve less or no or fewer safety risks. Reducing non-point source pollution in rainwater, especially from the first flush on surface water, lends importance to research regarding small- or moderate-scale water treatment techniques. High-performance stormwater treatment is one of several creative techniques that integrate natural solutions to treat stormwater on a local scale.

Amenity Approach and Artful Rainwater Design

In1997, McElroy, and Winterbottom created the term "artful rainwater" design, which refers to landscape infrastructure for improving social and ecological values (MacElory & Winterbottom, 1997). Echols and Pannypacker (2008) defined the concept of ARD amenities as "features focused on the experience of stormwater in a way that increases the landscape's attractiveness or values." Echols and Pennypacker(2008) provided a long list of goals for amenity approaches via a literature review that includes the following:

1. Convenience goals refer to location, ease of access, and comfortable spaces.
2. Educational goals focus on creating sustainable learning conditions and the physical environment. These educational goals concentrate on learning and teaching about rainwater, runoff, and related

environmental issues. Accordingly, they summarize ideas to educate the public about issues such as the hydrologic cycle, water treatment, and its impact on the ecosystem, wildlife, and plant species of riparians. They then describe the strategies to respond to those educational goals through the following criteria:

3. Design visible, legible treatment systems to attract people via an interesting design.
4. Create gathering spaces close to treatment systems and signages.
5. Plan places for learning purposes and recreational activities related to water treatment and encourage them to explore the site and system.
6. Implement various visible native plant species and create bio-habitats for wildlife such as birds and insects.

Figure 25

Queen Botanical Garden

Note. Designed by Atelier Dreiseitl with Conservation Design Forum; BKSK Architects. Image courtesy of Pennypacker & Echols (2020).

7. Implement recreation goals that provide suitable conditions for people to play and relax.
8. Safety goals aim to reduce risk and exposure to danger.

9. Social interaction goals concentrate on spaces for individuals and groups to communicate and socialize.
10. Public relation goals express the ideas and values of the owner or designer; sometimes they represent or remind one of the shared values and beliefs of users in space.
11. Aesthetic richness goals target the creation of pleasure from beautiful physical features in designed or semi-natural spaces.

Figure 26

10TH@HOYT, Designed by Steven Koch Landscape Architecture

Note. Image courtesy of Pennypacker & Echols (2020).

Henneman (2006) defined three aesthetic richness objectives, including visual, auditory, and tactile interests. According to Echols and Pannypacker (2008), there are design strategies that are associated with designing and creating beautiful spaces and stormwater management as follows:

1. Locate water collection features and basins as focal points.
2. Visually emphasize stormwater direction and elements, such as cisterns, basins, rain chains.
3. Draw attention to the line of surface runoff with bio-swale, downspouts.
4. Thematic design with basins and landscape elements.

5. Emphasize the contrasts between man-made and natural elements and features.
6. Create a dramatic stormwater trail and features.
7. Unify themes, features, elements, and overall design.
8. Design for different water-related plants.
9. Implement water-related hardscapes.
10. Provide space for people to touch stormwater.

Precedent Studies and Projects

Summary: The preceding section included two parts. First, it explored well-known landscape projects and examples of sustainable site designs in healthcare facilities at the international level. Then it concentrated on the district and site level in Dallas, Texas. Here, it focused on a campus landscape restoration proposal and the medical streetscape master plan projects of the Southwestern Medical District of Dallas, Texas. Therefore, it investigated their sustainable design strategies and planning proposals to improve livability and well-being with landscape architecture. Finally, the findings of my Ph.D. dissertation from the University of Maryland College Park have been partially summarized. Its general recommendations concentrated on the design strategies that improve the therapeutic properties of hospitals' landscapes.

Precedent Landscape Projects in Healthcare Facilities

Paimio Sanatorium, Finland

In 1932, Paimio Sanatorium in Paimio, Finland, was completed and became an innovative model of a hospital. After winning an architecture competition (1928-1929). The hospital building and its landscape are on the "Tentative List" of UNESCO for registry as a World Heritage Site (UNESCO, 2015; Ehrström, Jetsonen, & Lindh, 2005). The main function of the building was as a Tuberculosis Sanatorium until the early 1960s. Alvar Alto, a Finish architect, designed the project with a mixture of early modernist characteristics such as ribbon windows, roof terraces, and machine aesthetic.

Alto believed that hospital building itself should contribute to the healing process. On each floor of the hospital, there are sunning balconies and a sun deck on the top floor. The site of the hospital is surrounded by a forest landscape and includes a chapel and social space. The complex provided a communal atmosphere for both the patients and staff, who usually lived in a hospital for a long time (Currie, 2007). Alto concentrated on harnessing and directing the daylight as the major means of "Heliotherapy"[7]. He gave huge importance to window design and view orientation in the landscape, to provide the brightest interiors (Laaksonen, 2015). In Paimio hospital, a roof garden provided fresh air and views to promenade routes through the surrounding natural landscape (Schildt, 1998).

Figure 27

Paimio Sanatorium

Note. Image courtesy of Historical Photograph ©Alvar Aalto Foundation.

7 Light therapy, "Bright light therapy is an effective treatment for seasonal affective disorder (SAD). The most common light therapy uses a special type of light, called a light box. This is much brighter than a lamp or other light fixture in your home." (University of Michigan, 2020)

The Martini Hospital, Netherlands

Another hospital, the Martini Hospital in Groningen was designed by Burger Grunstra Architects and Consultants in the Netherlands. “The design is mainly based on patient and staff needs and the healing environment” (Dutch Hospital Design [DHD], 2015), within a highly innovative approach to indoor and outdoor spaces (Deerns, 2015). The focal point of the landscape is a green inner courtyard next to the Martini Pavilion. The design of the landscape provides a place “Where one can briefly escape from the hospital environment and relax.” (Dutch Hospital Design [DHD], 2015). The prefabricated construction of the hospital aimed to be flexible on-site to future needs and changes (World Architecture News, 2015). Despite many recent American hospitals are constructed on green fields in suburban settings with less attention given to the hospital’s connection to its larger community. The Martini Hospital is an infill replacement facility that is built within a long-established and dense urban neighborhood (Verderber, 2010).

Figure 28

The Martini Hospital in Groningen

Note. (dutchhospitaldesign.com, 2016).

Feldkirch State Hospital, Germany

Feldkirch State Hospital was built between 1992 and 1994 in Vorarlberg, Germany. This hospital was designed by Erich Gutmorgeth. The main idea of design is the interplay between landscape and built form of the hospital (SkyscraperCity, 2015). He aimed to express a local vernacular culture of the site in addition to present the key aspects of "biophilia". The main lobby of this multi-purpose building and coffee house of the hospital provide an opportunity for social interactions (Nickl-Weller & Nickl, 2006). "The site plan describes how the building at once absorbs and reflects its existing earthen contours." (Verderber, 2010). Landscape and waterscape design has been used extensively to provide a spatial portrait of a healing and "biomorphic" place. The complexity of architecture and landscape depicts an organic style of biomorphism and "anthropomorphism" (Nickl-Weller & Nickl, 2012).

Figure 29

Feldkirch State Hospital

Note. The glazing pitched roof of the Feldkirch State hospital, elevated ground, and green roofs provided maximum exposure to nature and views of the landscape.Image source : LKH Feldkirch © VOL.AT / Hartinger.

The Bon Secours St. Francis Cancer Institute, the United States

The Bon Secours St. Francis Cancer Institute is an expansion of St. Francis Medical Center Campus, in Midlothian, Virginia, that was designed by Odell Associations. The main architectural feature of this addition is the use of natural materials, such as wood and stone. The hospital was built between 2003 and 2006 and includes a central courtyard with special emphasis on natural light and views (Verderber, 2010). Detailed design of the landscape with garden and water features, such as a waterfall provides a place for human integration with nature within the constructed site. The Chapel, prayer gardens, fountains, and walking paths are designed to enhance the spiritual aspects of healing, to fulfill the mission of bringing people and communities to health and wholeness (Bon Secours Health System, 2015). The natural imaging of mature trees from inside of the courtyard provides a sense of enclosure to visitors (Healthcare Design Magazine, 2015).

Figure 30

Bon Secours St. Francis Cancer Institute

Note. The site planning of the Bon Secours St. Francis Cancer Institute in Midlothian provided maximum views to the forest, reduced the surface parking, extended open public areas and plazas, improved way-finding across the site. Image courtesy of John Hancock Productions.

Recent Examples of Sustainable Landscape Design in Healthcare Facilities

Historically, the roof surface of hospitals has not been used for any therapeutic purposes. In the past, most of the hospital roofs in the Western world were steep and their function was limited to shedding rainwater and snowfall. While the modernist hospitals had flat roofs, those spaces were specified for mechanical equipment such as elevator shafts and water reservoirs. In recent years, the green roof-scape has been proposed and implemented in a few numbers of hospitals. They have been elements of a larger scale landscape design in the site of those healthcare facilities. They turn the asphalt and concrete roofs of hospitals into healing gardens, rainwater harvesting, vegetable gardens, solar collectors, or heat island effects mitigation. For example, reducing the effects of solar radiation was the main concern of design the green roof in Meyer Children's Hospital in Florence, Italy (Sala, Trombadore, & Alcamo, 2006; World Health Design, 2015).

In the Harrison Memorial Hospital, in Bremerton, Washington, the roofscape consists of a rock garden and winding path with interesting geometry and native plants (Osmundson, 1999). The REHAB Basel Center for Spinal Cord and Brain injuries, in Switzerland, was designed by Herzog and de Meuron between 1999 and 2002. The spherical skylights provide daylight for patients and feature natural wood roof decking (Guenther & Vittori, 2013).

The Holland Bloorview Kids Rehabilitation Hospital in Toronto was constructed between 2003 and 2006. As of 2005, the Centre provides hospital care, outpatient clinics, an integrated kindergarten school program, assistive technology services, and community outreach activities to about 7,000 children and youth with disabilities and their families each year. This healthcare facility has roof terraces on the third floor that provides access to fresh air and seating spaces for patients and families and views toward a narrow steep valley and water ponds (Guenther & Vittori, 2013; Montgomery & Wigle, 2015). The main

idea of design was to integrate modern medicine and technologies naturally into a natural environment. "The building's warm materials – limestone, zinc, and wood – and gently sloping roof form a natural connection to the ravine running along the north end of the building. Unlike the ravine, the roof and terraces are completely accessible to all children with disabilities." (Stantec, 2015). The Pudong Huashan Hospital (2003-2006) in Shanghai, was designed by Wang Yan and Zhong Lu, Architects. This design has transferred ground-level surfaces to a green area by placing parking lots below the ground level. The roof of parking became an aesthetic garden that is available for public use (Verderber, 2010).

Table 4

Recent Ecological, Cultural, and Restorative Approaches in Contemporary Healthcare Design

Strategies	Ecological	Restorative	Cultural
Approaches	The ecological health of the site & community. Biophilia	Exposure to nature, Suburban settings	Place-making
Priorities	Stormwater management, rain harvesting	Healing gardens, prayer gardens	Vernacular,& cultural elements in public spaces
Design features	Roof gardens, green materials	Trails, playgrounds, & family-friendly spaces	Combining restaurants, coffee shops

Note. Adopted from Mabadi (2017).

Figure 31

Meyers Pediatric Hospital

Note. In the Meyers Pediatric Hospital, in Florence, the sustainable design fosters the healing process in a park-like setting. The site design strategies include an extensive green roof, harvest of daylight, and combine the art in open spaces of the site. Image courtesy of Andrew Michler, 2010.

Figure 32

Holland Bloorview Kids Rehabilitation Hospital

Note. Holland Bloorview Kids Rehabilitation Hospital, "a world-class teaching hospital fully affiliated with the University of Toronto". The hospital provides a cafeteria, both indoor and outdoor pools, gym, Snoezelen room, and reflection room with a view of woods (Image courtesy of MyMEDHoliday.com, 2016).

Southwestern Medical District Urban Streetscape Master Plan, Dallas, TX

Historically, the Southwestern Medical District (SWMD) has been recognized as a pioneer in medical innovations and scientific advancements in caring for people. During the early 20th century, hospitals and healthcare facilities were established and expanded, while medical schools and research institutions were incorporated gradually. During the following decades, expansions of the city of Dallas toward the north necessitated better access to the site of SWMD. In 1940, Harry Hines Boulevard was completed (Southwestern Medical Foundation, 2014). City officials then aimed to improve the image of this part of Dallas and implemented several beautification projects such as planting 150 trees close to the

medical facility to make it more aesthetically pleasing. While SWMD was growing internally, seven residential neighborhoods were developed around the SWMD site (Southwestern Medical Foundation, 2014).

Figure 33

Campus Plan for Greater Medical Center of Dallas, 1942, Image courtesy of SWMD.

In 2017, the Texas Tree Foundation released the results of "the State of the Dallas Urban Forest Report" and concluded that the SWMD is the largest heat island in the city of Dallas (the Urban Climate Lab of the Georgia Institute of Technology, 2017). The SWMD has connected and embraced three world-class hospitals, including UT Southwestern Medical Center, Parkland Health and Hospital System, and Children's Medical Center. In 2016, the Texas Tree Foundation initiated research and a visionary streetscape master plan for the SWMD. The master plan integrates hospitals, campuses, and urban public spaces along a 17-mile streetscape planning area that includes the area of 1,000 acres (Texas Tree Foundation, 2020).

In their study, the Texas Tree Foundation concluded that "The SWMD is an area in critical need of urban heat island mitigation, economic development, beautification and connectivity" (Texas Tree Foundation, 2020, p.6). Therefore, they developed the "Streetscape Master Plan" through a holistic

analytical study and communicated with clients and stakeholders for SWMD to provide safe and comfortable environments (Texas Tree Foundation, 2020) As they clearly stated, " the primary goal of the project is to foster a livable district that carefully considers the health of thriving neighborhood systems and the health of all its employees, patients, residents, and visitors" (Texas Tree Foundation, 2020,p.6). The project team established a framework for goals and metrics in three areas: healthy environments, healthy systems, and healthy people (see table.4).

Table 5

Metrics for the Project's Success and their Related Goals

Area of Concern	Improvement Goals
HEALTHY ENVIRONMENT	HEG1: Mitigate heat island effect
	HEG2: Increase tree diversity
	HEG3: Improve overall air quality and reduce carbon footprint
	HEG4: Protect, enhance and create urban habitat to maximize wildlife populations
	HEG5: Filter/Treat stormwater
HEALTHY SYSTEMS	HSG1: Build on economic development opportunities
	HSG2: Improve pedestrian safety
	HSG3: Utilize smart technologies
	HSG4: Improve access, connectivity and circulation for multimodal connections throughout and beyond the district
	HSG5: Minimize overall energy usage along streets
HEALTHY PEOPLE	HPG1: Increase human comfort
	HPG2: Improve user health
	HPG3: Define the SWMD as a destination
	HPG4: Express the SWMD's history
	HPG5: Enhance temporal qualities

*Note. A*dopted from Texas Tree Foundation (2020).

Considering a thorough improvement across the boundaries of the SWMD, they established a design strategy framework as follows:

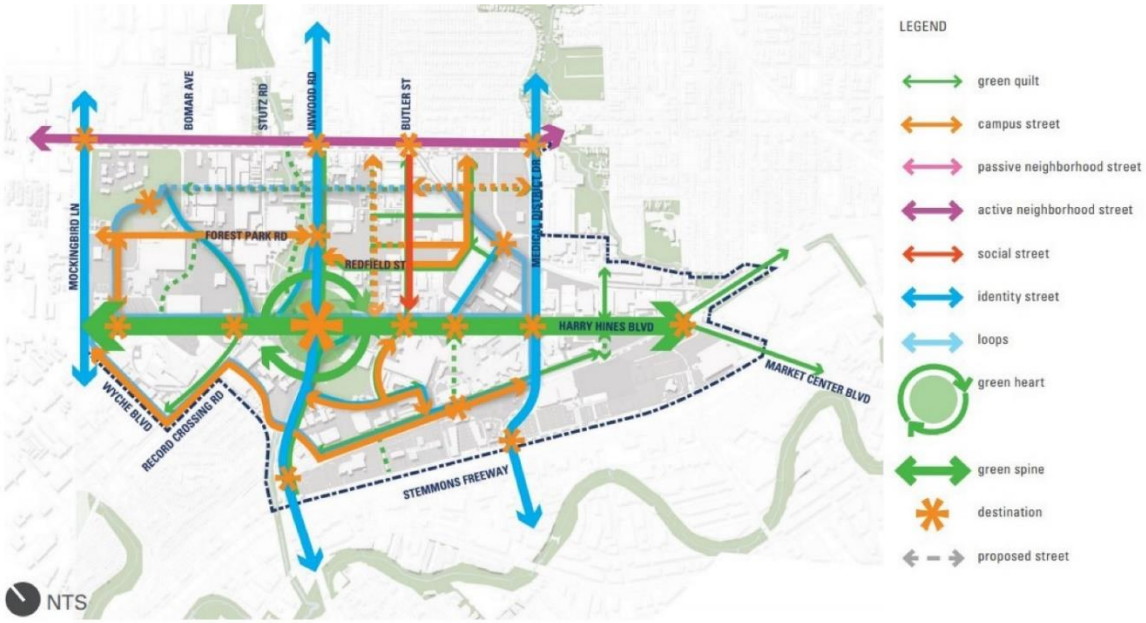
1. Create the "Green Heart" as an iconic ecological, pedestrian, and transit center.
2. Improve a green corridor "Green Spine" to support public activities and pedestrian movement.
3. Increase tree canopy area and natural features, or a "Green Quilt" along the streets in the SWMD.
4. Create recreational spaces or "Loops" via multi-functional paths.

5. Preserve the unique physical and non-physical features of the street inside the area of SWMD.

6. Improve way-finding and place identity by locating "Destinations" on traffic intersections.

Figure 34

Framework Plan



Note. From Texas Tree Foundation (2020).

UT Southwestern Campus Restoration, Dallas, TX

In 2018, HDR, a well-known architectural, engineering, and environmental consulting company provided an innovative and pioneering proposal for the restoration of UT Southwestern's (UTSW) campus. UTSW, with almost 30 acres of land, is a famous medical and academic research institution. According to the analysis by HDR (2018), the campus is the largest heat island in Dallas. The existing campus suffers from major disadvantages, such as "lack of outdoor spaces, limited pedestrian connectivity, and few social amenities" (HDR, 2018). Therefore, HDR proposed a restoration plan for the rehabilitation and future development of the facility. Their holistic approach targeted goals include the following:

1. Land restoration by replacing existing concrete surfaces with greenery and cool material.

2. Improving well-being by planning for a human-centric environment.

3. Creating a sense of community by encouraging social activities on campus.

Figure 35

Connecting the Whole Campus via Green Spaces, and Landscaped Areas

Note. Image courtesy of HDR (2018).

The campus development includes two strategies, namely creating a large roof garden and then connecting the whole campus with green spaces. The restoration project proposed increasing the tree canopies up to 250%, developing landscaped spaces up to 45%, and improving stormwater infiltration, in addition to decreasing solar radiation by 23%, which will result in important mitigation of the heat island effect across the campus.

Figure 36

Increasing the Landscaped Areas and Tree Canopy Will Result in Heat Island Mitigation of the Site

Note. Left, existing condition, and right, proposed design. Image courtesy of HDR (2018).

Design Recommendations to Improve the Therapeutic Landscape for Healthcare Facilities

Despite the contemporary landscape designs and campus planning of health care facilities, future practices should apply innovative strategies and revisit the successful historical approaches. To address a broader concept of the therapeutic landscape and campus planning two sets of recommendations and strategies in two scales come into consideration. According to Mabadi (2017), several design and planning strategies can specifically improve the quality of hospital campuses and extend the restorative values of their landscapes. It is noteworthy that the implications of this study are applicable in both new hospitals and for improvements to existing hospital environments (Mabadi, 2017). Therefore, the design implications are classified as follows:

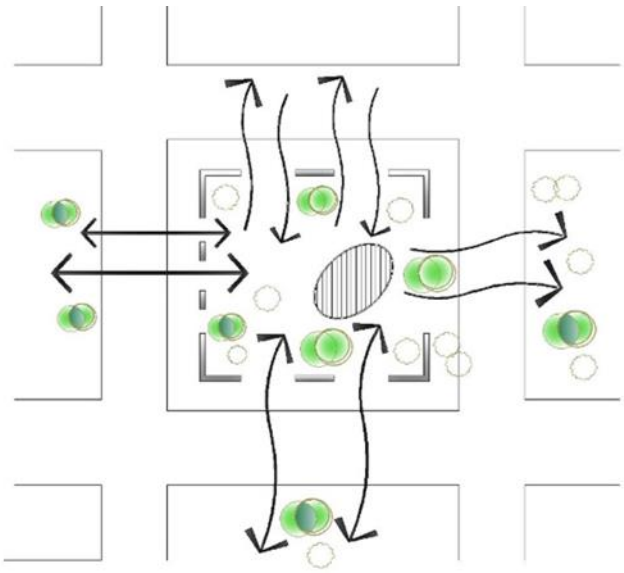
1. During the process of locating a site for a new hospital or remodeling the site of existing healthcare facilities, several influential factors such as microclimate, terrain, and

topographical characteristics, and natural elements on the sites that encourage or discourage the restorative properties of hospital landscapes, should be considered.

2. Considering the historical background, and the socio-cultural context of hospital sites, planning and design can improve the sense of place in future or existing hospitals. Also, by doing this designers and planners can strengthen the hospital's identity and connect it to their communities, which impacts the healing value of those healthcare facilities.
3. According to the results of the studies by Pretty, Peacock, Sellens, & Griffin, (2005); Ward-Thompson (2011); and Jiang (2015), and the conclusions of this dissertation, it can be said that strategies such as person-nature engagement are applicable in every hospital site, in any scale, without limitations. These strategies can heighten the therapeutic characteristics of both the indoor and outdoor spaces in healthcare facilities.
4. The studies of Cooper-Marcus and Sachs (2015), Rawlings (1998), and the results of this dissertation concluded that there are many possibilities and opportunities to design and build a diverse type of healing gardens in hospitals regardless of their scale and specialties.

Figure 37

Permeable Boundaries in Hospital Sites Provide Space for Socio-Cultural Activities

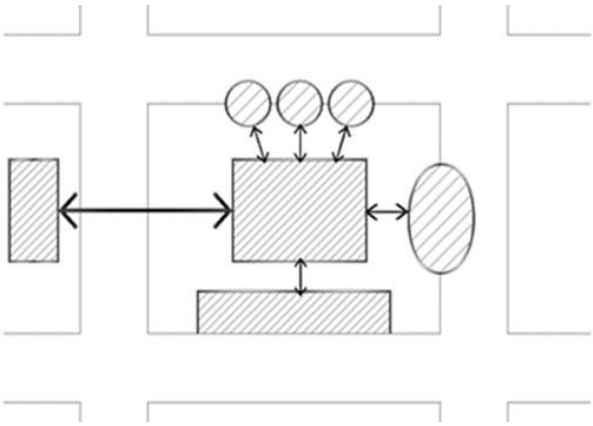


Note. (Mabadi, 2017).

5. Increasing the connectivity to surrounding context, especially in urban areas, will extend the therapeutic impacts of hospital landscapes through the following strategies: making permeable boundaries around the sites, directly connecting sites to urban open spaces, planning places for socio-cultural events, and designing visual connections to nature. These strategies also reactivate the socio-cultural roles of the healing landscape of healthcare facilities (Mabadi, 2017).

Figure 38

Connecting the Hospital Campus to Surrounding Urban Spaces

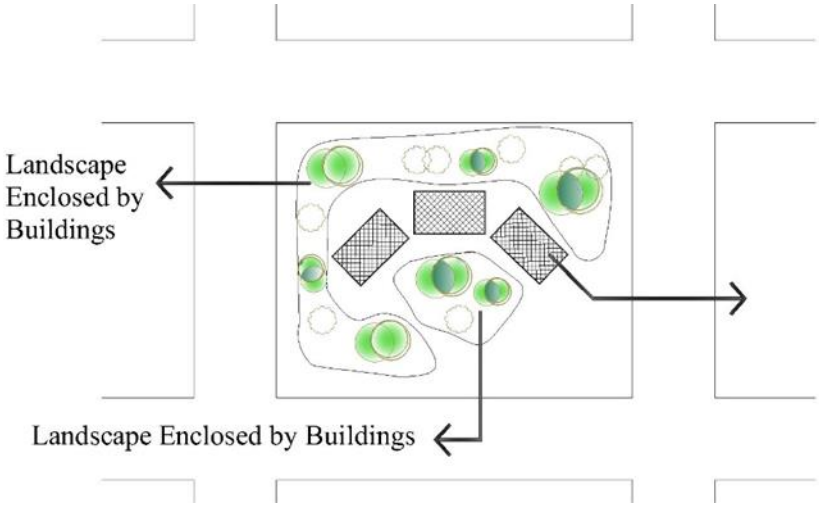


Note. (Mabadi, 2017).

6. Other ideas include embracing landscape through building mass, such as V-shaped patterns, and embracing the building mass by landscape and gardens can positively influence both hospital sites and their indoor environments (Mabadi, 2017).

Figure 39

V-Shaped Arrangement of Hospital Buildings Embracing Gardens

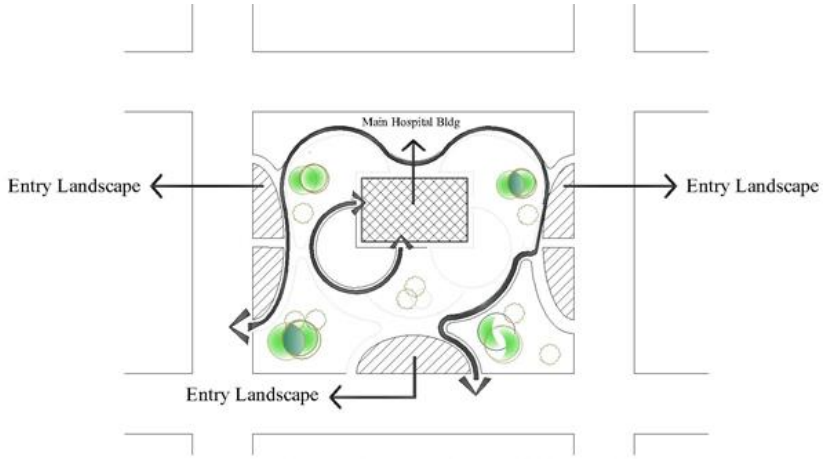


Note. (Mabadi, 2017).

7. According to Mabadi (2017), accessibility via the naturalistic design of hospital outdoor spaces, designing serpentine roads and green entries can improve restorative values of nature in hospital campuses.

Figure 40

Winding Roads and Green Entries in Hospital Campus Design

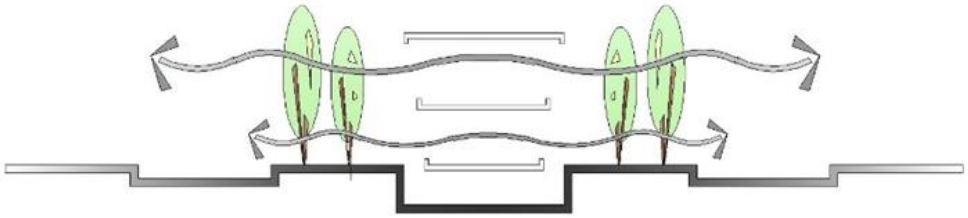


Note. (Mabadi, 2017).

8. In addition to the results of the previous studies, the conclusion of this dissertation emphasizes the architectural design, landscape planning, and engineering methods that improve the therapeutic values of landscapes in healthcare facilities. For example, both the low-rise buildings and transparent architecture improve the connectivity of indoor and outdoor environments; therefore, extending views from inside to landscaped areas can improve the restorative value of hospital environments (Mabadi, 2017).

Figure 41

Low-Rise and Transparent Buildings Encourage the Therapeutic Benefits of Landscape



Note. (Mabadi, 2017).

9. Conversely, high-rise buildings, locating parking lots and garages, in addition to densely constructed hospital campuses, will discourage the healing properties of their landscapes.
10. The results of this dissertation and the study by Schweitzer, Gilpin, and Frampton (2004) argue that ecological strategies not only can heal our environment and earth but also have restorative influence via the metaphor of landscape in both hospitals and non-hospital settings (Mabadi, 2017). Some of those ecological strategies are summarized as follows: using vernacular materials, native plants, stormwater management, artful rainfall harvesting, and Green materials.

CHAPTER 3

METHODOLOGY

Introduction

In this study, I investigated the healthcare facilities in North Texas and interpreted their existing landscape through a constructivist paradigm. This qualitative study aimed to assess the healing and livability characteristics of well-known examples of hospital landscapes. Therefore, this research used the multiple case-study methodology and examined the case studies' embodied units: therapeutic and livability performance, HIM, ARD, and views to the garden. The intention of the current study was to improve the livability and healing values of the landscape of hospitals through an evidence-based study; it also examined the generalizability of this method for other hospital campuses in north Texas.

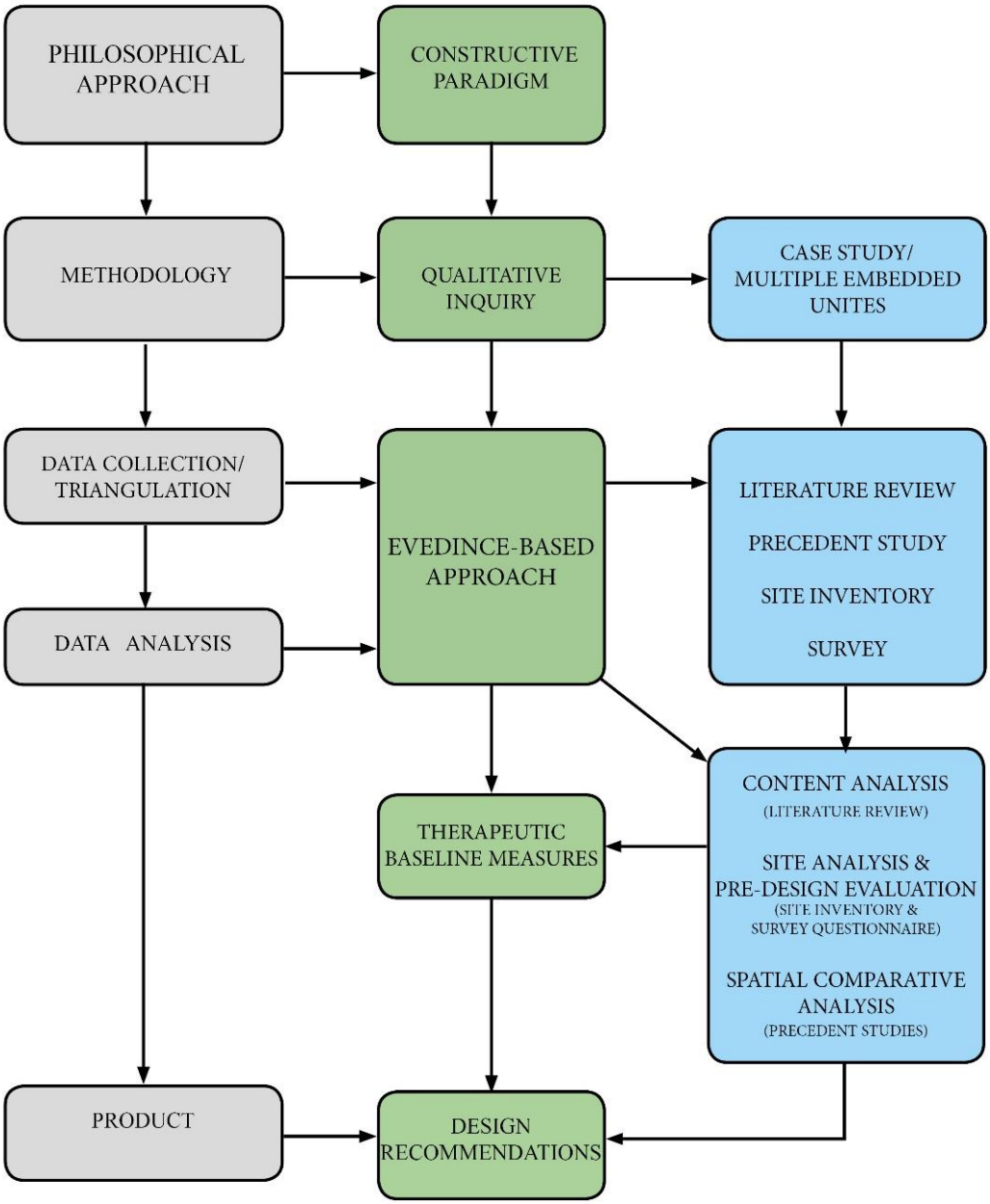
Research Design

This empirical research examined four examples of hospital landscapes through an experimental approach. I observed and documented the constructed landscapes of four hospitals in Dallas, Texas, including Clements University Hospital, Baylor University Medical Center, Texas Health Presbyterian Hospital of Dallas, and New Parkland Hospital. I focused on the potential for HIM and ARD strategies to improve the therapeutic effects of the existing hospital landscapes. I also explored opportunities to enhance the views to gardens and therefore improve the healing properties of the hospitals' landscapes.

I did not intend to discover or prove the healing effects of specific design strategies. Many qualitative and quantitative studies have identified and proven the positive effects of such design and planning methods and their therapeutic impacts on humans and the environment. Therefore, this study employed those conclusions and scientific evidence to establish a foundation for a research-informed design for future studies and practices via an extensive literature review and precedent study. I collected and analyzed the data through an evidence-based approach and established a set of baseline performance measures. These baseline measures assisted me in developing the design metrics to evaluate the existing landscape and generate a set of design recommendations to improve the hospitals' landscapes.

Figure 42

Research Design for Thesis



Generalization of the hypothesis

I first generated a design recommendation to improve the therapeutic properties of a hospital site, then evaluated the results and generalized them for practice in north Texas. Scientific studies do not generalize based on a single experiment. Therefore, I used multiple case studies and applied a triangulation strategy in both phases of data collection and data analysis to increase the credibility of the results. This process is called the *analytical generalization* of a case study or multiple case studies (Yin, 1994).

Study population

The literature review, precedent studies, and case studies in the current research investigated landscapes of hospitals and healing gardens, with a special focus on studies related to north Texas and well-known constructed hospitals in north Texas. The survey questionnaire specifically targeted key informants such as landscape architects, healthcare architects, planners, and educators in the field of landscape architecture, planning, and site development. The survey questionnaire addressed the three major design considerations and planning criteria for landscape architecture on hospital sites, which include site planning, environmental benefits, and social benefits. This study did not survey nor involve medical staff, doctors, or patients.

Study Location

Criteria for Selecting the Case Studies and Their Location

The qualitative case study method generally reveals what is common between cases. Therefore, cases are considered neither unique nor entirely representative of the phenomenon (Baxter, 2010). During this qualitative case study, the emphasis was not on the "more-cases-is-better" approach. Instead, I explored and investigated strategies to enhance the therapeutic landscape of healthcare facilities in north Texas. To achieve greater analytical generalization and transferability, the cases had to be selected carefully (Flyvbjerg, 2006). The criteria for selecting sites for this specific thesis included the following:

1. The site had to have an existing designed landscape, which offers opportunities to evaluate natural or contextual conditions of the site against the constructed landscape.

2. Sites located in medical districts or medical cities were preferred because this adds context and provides opportunities to compare the selected site against other hospitals in the same district.
3. Sites close or adjacent to streams and natural bodies of water were preferred. This allows a more reliable evaluation of the environmental strategies, such as stormwater-management practices, rainwater harvesting at the local scale, and site-specific design methods for reducing and using runoff.
4. A site located in a metropolitan environment with common urban problems such as traffic, heat islands, and runoff was preferred. These issues are opportunities to investigate environmental design strategies, well-being, and public health issues related to landscape design.
5. Site with a history of design and redevelopment were chosen for the study because the cultural context and each hospital's connection to its community could be more fruitfully evaluated.
6. A site with direct access to densely populated urban areas was deemed to be more suitable because the densities of human activities and buildings necessitate high-performing landscapes and create demand for restorative spaces.
7. Hospitals with large windows and more transparency from the interior to the landscape were preferred. This assists investigation of the relationship between the building and the landscape.
8. Sites with well-known or special landscape designs were preferred. These designed landscapes are unique and recognizable, with a recognizable and repeated style that both provides the the opportunity for replicable studies in the future and also improves the chance of generalizability of the results.

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

Based on these selection criteria, four hospitals in Dallas, Texas, were examined in a preliminary study. Table 6 shows that Clements University Hospital emerged as the best match to the research's agenda.

Table 6.

Evaluation Matrix for Selecting the Site

Hospitals/Criteria	Existing & constructed landscape	Location in medical districts	Adjacency to water resources	Exposure to urban problems	History of site re-development	Direct vista & access to populated areas	Large transparent windows to site	Famous designer, or expensive design	Total
Parkland Hospital,	5	5	4	4	5	2	4	4	33/40
Presbyterian Hospital	4	0	5	2	4	3	2	2	22/40
Clements University hospital	**5**	**5**	**5**	**4**	**5**	**5**	**5**	**4**	**38/40**
Baylor Scott & White Hospital	4	2	1	4	4	5	2	2	24/40

Data collection methods

I reviewed and collected the data from both the qualitative and quantitative research within the boundary of the embodied units in the case study. To understand the domain of the case studies and their multiple embedded units, I collected qualitative and quantitative data from both primary and secondary sources. The primary sources included maps, photos from visiting the site of the case study and other studies, the results of a site inventory and analysis, and a predesign evaluation via a survey. The secondary sources were obtained from published research via an extensive literature review and other available information about the previous studies. The steps below outline the various methods used to collect data.

Literature Review

This chapter specified the domain of the research, clarified the area of focus, and assisted the formulation of cogent research questions. The literature review concentrated on the following areas: (a) therapeutic landscapes with a special focus on the healing effects of views to a garden and the healing

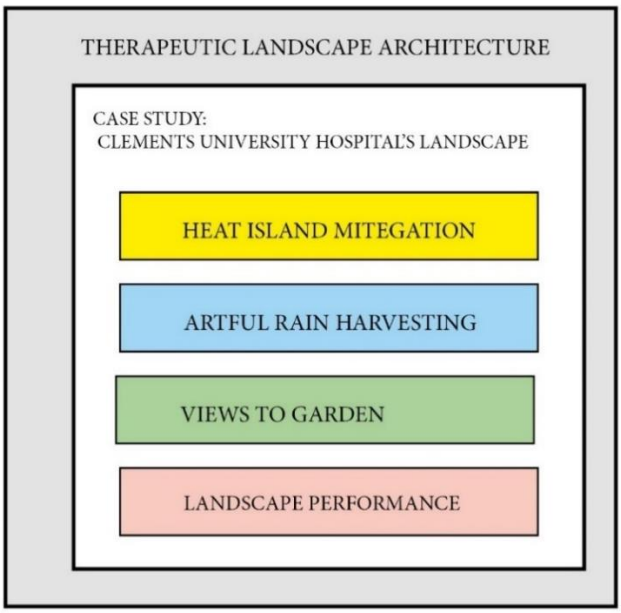
benefits of green infrastructure in healthcare facilities and (b) the implementation of ARD and HIM strategies that increase the livability and therapeutic properties of existing hospital sites.

Precedent Study

This section investigated examples of sustainable and therapeutic design and planning strategies in hospitals in the United States and around the world. First, the precedent study focused on strategies, approaches, and design features that improve the livability and healing properties of hospital campuses. Then, this section explored the projects that focus on the remediation of heat island issues and stormwater management in healthcare facilities in north Texas. This portion of the study built on the conclusion and recommendations of the creation, evolution, and degradation of therapeutic landscape during the 19th and 20th centuries in the United States at the University of Maryland College Park (Mabadi, 2017).

Figure 43

Case Study and Its Theoretical Embodied Units



Survey and Predesign Evaluation

A survey questionnaire was used to address the three major design considerations, including site planning, environmental benefits, and social benefits and planning criteria for the landscape architecture of

hospital sites. This questionnaire qualitatively measured the landscape performance of the existing sites according to selected criteria. Pre-established criteria from the Landscape Architecture Foundation (LAF) uncovered in the literature review was adapted for this study, and previous studies informed the survey design. The proposed criteria included environmental and social benefits in addition to general planning and design principles. Staff, doctors, and patients were not the subject of the research. The survey questionnaire specifically targeted key informants, such as landscape architects, designers, and educators in the field of landscape architecture, planning, and site development, in addition to those architects with experience in healthcare design and planning.

The criteria for selecting participants included:

1- A degree in landscape architecture, architecture, or planning with a specialty in therapeutic environments.

2- A bachelor, master, or Ph.D. in precedent majors.

3- An academic (including research or teaching) or professional background in therapeutic design.

Important considerations of this survey were as follows:

1- Before disseminating the survey questionnaire, the pilot study was performed, and the site was visited two times.

2- Before disseminating the survey questionnaire, IRB approval was obtained on February 24, 2021.

3- All respondents had the right to remain anonymous and to stop answering questions at any time.

The only focus of this survey was on measuring landscape performance and characteristics. The survey did not ask personal questions and did not solicit any data about human subjects such as private and personal information about patients or medical personnel and medical procedures.

IRB Requirements

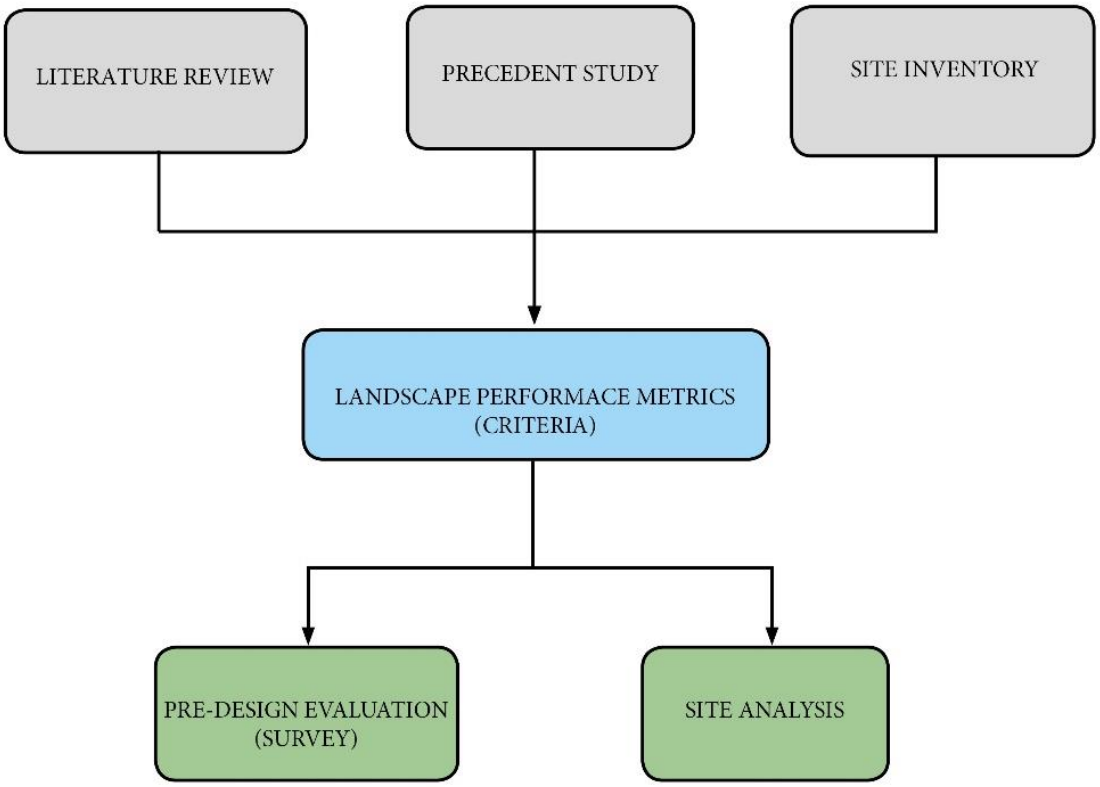
The IRB office of the University of Texas at Arlington approved the IRB application (IRB Approval of Minimal Risk Protocol #2021-0242) for this study on February 24, 2021 (see Appendix 1). According to the IRB requirement by the University of Texas Arlington, the required training, Human Subject Protection Training-(HSP) was passed on January 9, 2021 (see Appendix 2), and the "Informed Consent for Minimal Risk Studies with Adults" was communicated with participants (see Appendix 3).

The Criteria for the Survey and Evaluating Landscape Performance of the Case Studies

The criteria were generated according to the results of an extensive literature review and precedent studies. I disseminated the survey's questions and evaluated the landscape performance of the case studies via site analysis, according to its proposed criteria. Therefore, this research expanded its criteria into three major areas of concern to address research questions. Then, I aimed to collect the data from two different sources: a site analysis of case studies and a survey of key informants.

Figure 44

Creation and Application of the Landscape Performance Criteria



The criteria contained 39 questions and classified them into three areas: “being responsive to sustainability issues,” “improving the livability of the campus,” and “encouraging therapeutic properties of the site.”

Figure 45

Areas of Concern and Questions Addressing Sustainability Issues.

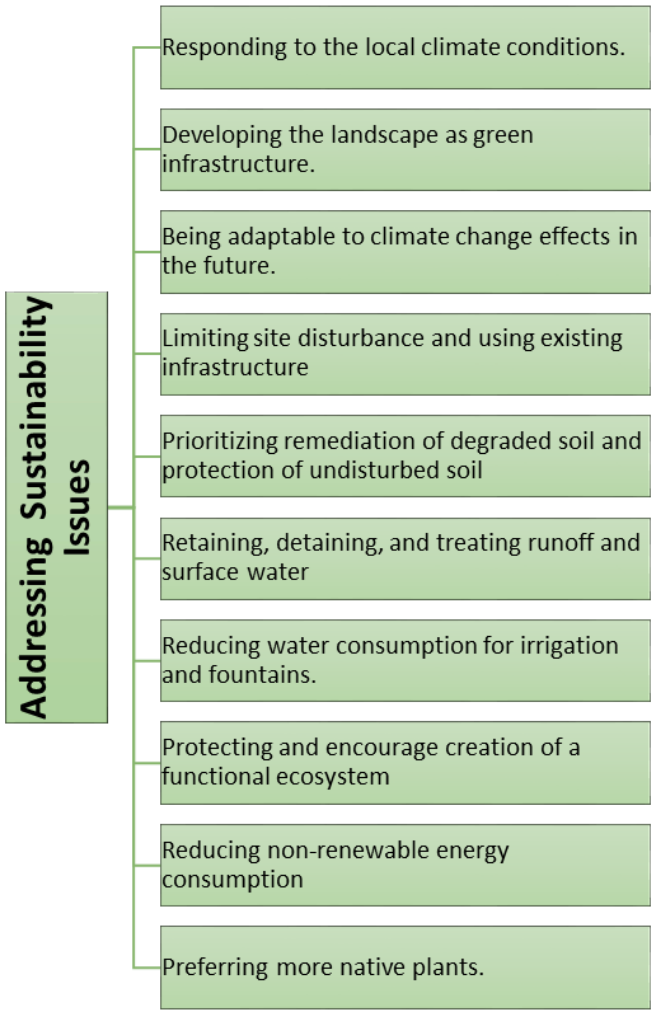


Figure 46

Areas of Concern and Questions Addressing Improving Livability

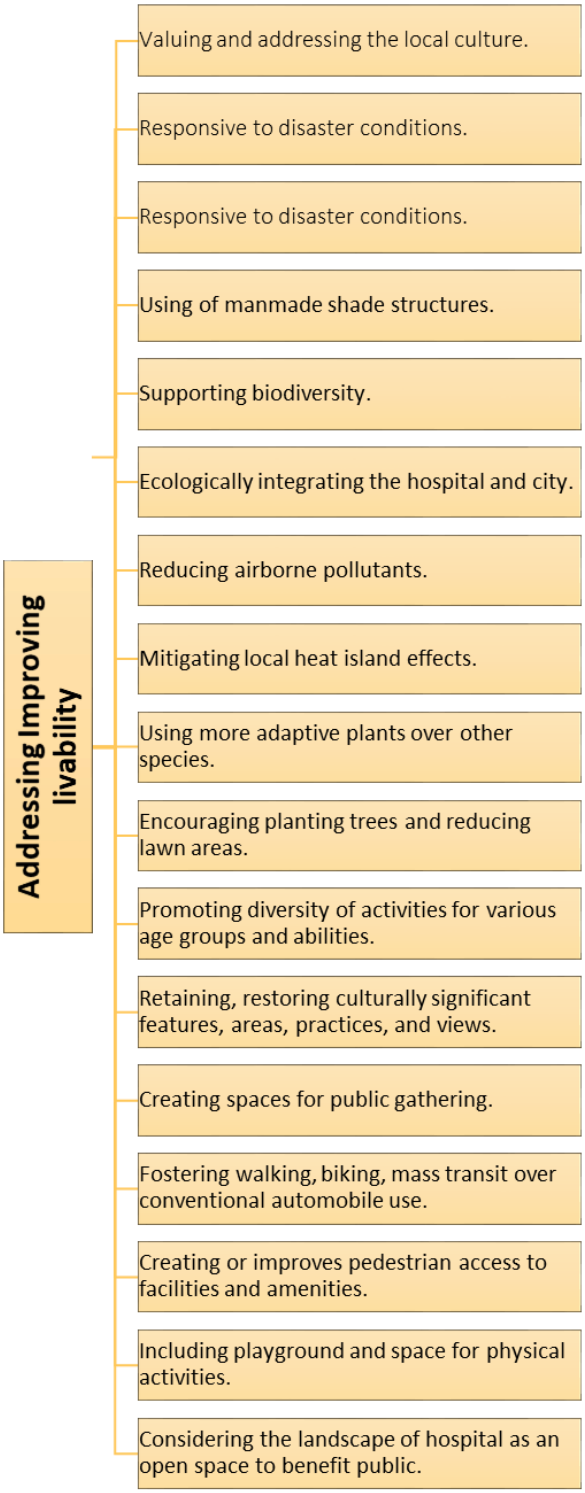
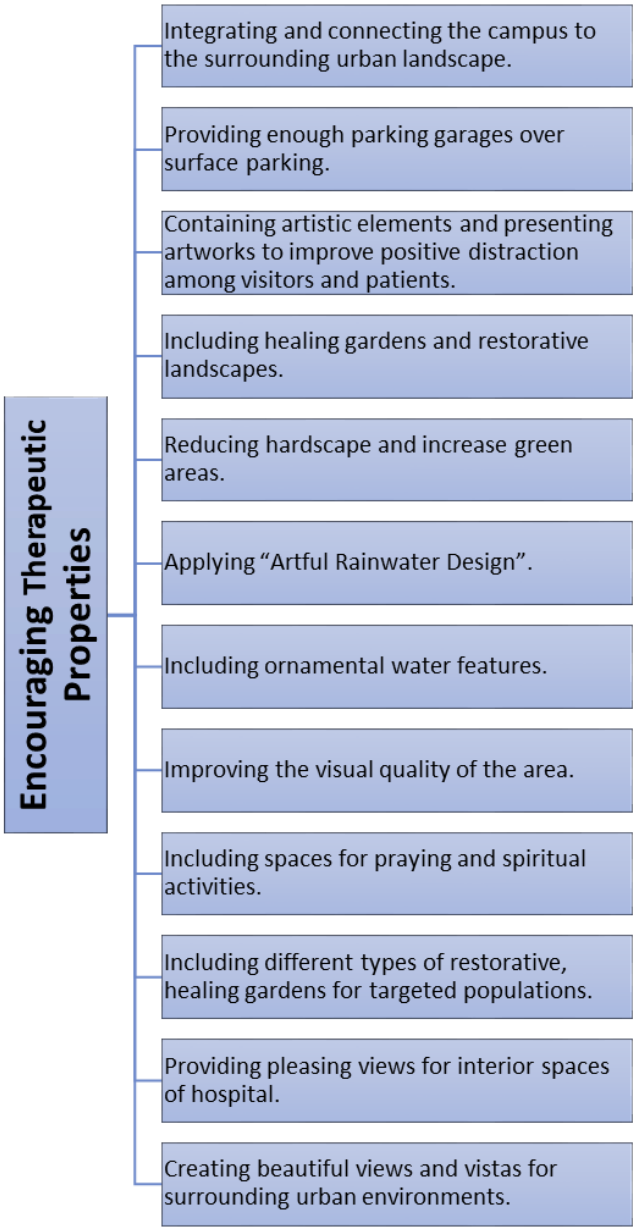


Figure 47

Questions that Addressed Encourage Therapeutic Properties of the Landscape.



Data Analysis Methods

Content Analysis

To analyze the data, I developed an analytical construct or framework based on a literature review, precedent studies, and site inventories. To achieve more certainty, the framework was built upon existing published research, established theories, and successful practices in north Texas. This framework focused on design and planning strategies of green infrastructure on hospital campuses that improve the livability of the site and therapeutic properties of its landscapes.

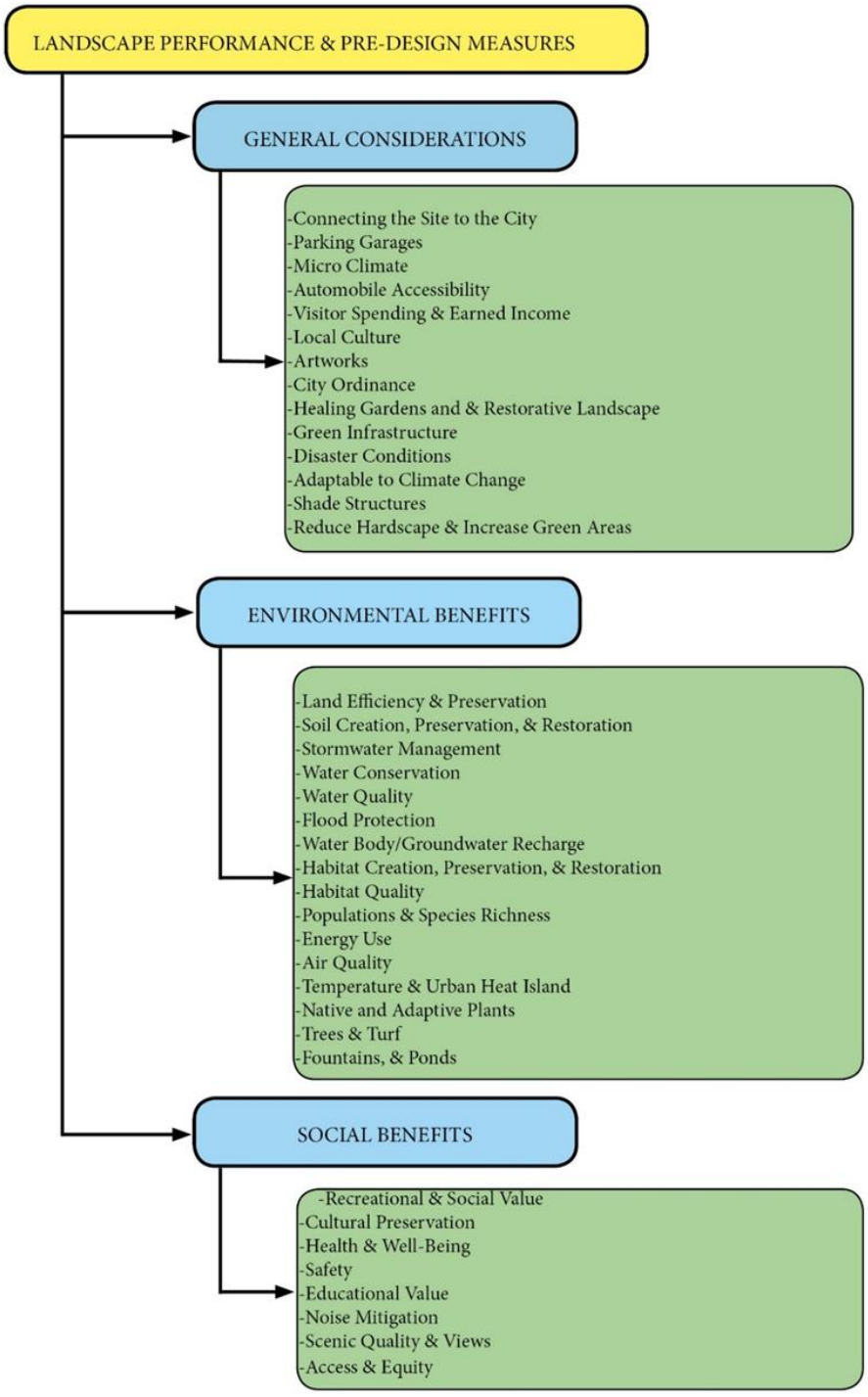
Site Analysis and Predesign Evaluation

To evaluate the landscape performance of the sites, the environmental and social benefits of the existing sites were investigated. The evaluation metrics for the sites adhered to the revised criteria generated for this study. I included a predesign evaluation via a survey questionnaire and site analysis to address the current status of the case studies in north Texas. This evaluation focused on four hospitals in Dallas, Texas: Clements University Hospital, Baylor University Medical Center, Texas Health Presbyterian Hospital of Dallas, and New Parkland Hospital between 2020 and 2021. The landscape performance and predesign measures are summarized in Table 4. The criteria for analyzing the sites of the case studies used the following classifications, according to Mabadi (2017):

1. Person–nature engagement
2. Typology of healing gardens
3. Strategies that encourage healing
4. Strategies that discourage healing
5. Connectivity to the surrounding environment
6. Existence of natural healing elements

Table 7

Landscape Performance and Predesign Measures



Note. Adapted from the Landscape Performance Series.

The Integrated Framework for Spatial Comparative Analysis

This study used spatial comparative analysis (SCA), which was created by Mabadi (2017) to assess the therapeutic characteristics and design strategies that shaped the hospital's landscape. Therefore, an integrated framework was created to study therapeutic landscape design. The framework integrated two spatial-analytical methods, namely, the urban typo-morphological method (UTMM) and landscape characteristic assessment (LCA). In 2017, I partially applied this integrated method in a previous academic study at the University of Maryland College Park within as part of my Ph.D. research.

The Typo-Morphological Method and Variables

The morphological method investigates urban spaces and the urban land through their historical evolution. According to Sima and Zhang (2017), the typo-morphological method focuses on buildings in local and small spaces, such as neighborhoods or campuses. Its application was beneficial for this study because it was flexible and adaptable to the context of landscape and healthcare facilities. This research relied on aerial photographs of the sites of the cases studies, which were obtained from Google Earth. I then examined variables to detect and analyze the therapeutic landscape of the case studies. The variables were introduced and explored by other studies, such as Gulgonen (1988), Nanda, (1989), Koster (2001), Lang (2005), Shayesteh and Steadman (2016), and Mabadi (2017). I then revised and organized the variables into six general areas:

1. person–nature engagement strategies used in the site
2. typology of therapeutic landscape used on site
3. connectivity to the surrounding environment
4. application of healing elements of nature
5. design strategies that encourage healing values of the hospital's landscape
6. design strategies that encourage healing values of the hospital's landscape
7. environmental considerations and sustainable strategies that improve the therapeutic landscape of hospitals

Landscape Characteristic Assessment and Variables

The site characteristics and the built environments of hospitals specify the fundamental components of its therapeutic landscape. Investigating those characteristics explains and clarifies the therapeutic properties of the hospitals' landscapes. The application of the landscape characteristic assessment method was supported by the following:

1. This method assesses and focuses more on the physical elements, rather than socio-cultural factors (Scottish Natural Heritage & The Countryside Agency, 2002).
2. Many qualitative studies in the field of planning and design have successfully used it (Mahony & Wharton, 2016).
3. There are commonalities between urban morphological analysis and landscape characteristic assessment methods. These common criteria generate a reliable comparison of findings and therefore fill the gap of data and information (Tudor & Natural England, 2014).

This method was used to create the following general classifications for variables to evaluate the landscape characteristics of the four selected case studies:

1- geographical context

2- historical significance

3- socio-cultural context

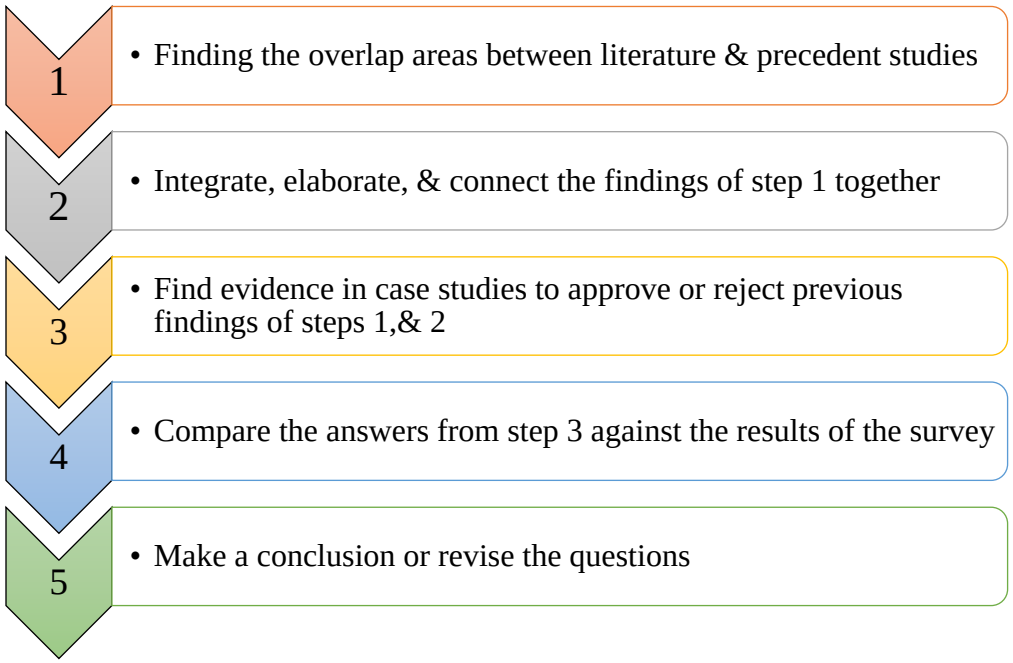
4- design and planning characteristics

5- landscape characteristics

6- environmental considerations

Figure 48

The Process of Making a Conclusion and Answering the Questions



CHAPTER 4

RESULTS OF THE RESEARCH

The following chapter reported the findings of the research and the results of the data collection.

The tables of the first section presented the findings of the literature review, and organized them into three parts include therapeutic landscape, heat island effects, and artful rain design. Then, the results of precedent studies were discussed and classified into four parts include place-making, sustainable practices in therapeutic landscape design, planning recommendations for hospitals' campuses, and planning proposals for SWMD, and UTSWMC. The next section presented the findings of site inventory and analysis of the case studies. The tables and drawings focused on spatial comparative, typo-morphological, and landscape performance analyses. Finally, the survey section briefly discussed the basic information about the survey, respondents, and interpreted the tables according to the research's questions.

Summary and Results of the Literature Review

Therapeutic Landscape, Healing Garden, and Views to the Garden

Table 8

General Classification of Therapeutic Environments and Their Design Features

Classification	Design Features
Restorative effects of nature	Natural elements, & naturalistic design, landscape ground
Healing elements of nature & refuge during a depression	Sanctuary, refuge garden, meditation garden
Viewing nature, windows from hospital	Viewing garden
Typology of human-nature involvement (connection, presence, & exercise)	Trails, exercise amenities, playgrounds,
Parson's nature engagement, (positive, moderate,& active)	Artful rainwater design, viewing garden, borrowed landscape
Environmental Psychology theories (Attention-Restoration Theory, & Biophilia)	Mediation garden, healing garden, wildlife garden, butterfly garden, prayer garden,...

Socio-Cultural elements of restorative spaces	Cultural elements, gathering & social spaces,

Note. (Mabadi, 2017).

Table 9

Synopsis of Discussions or Theories of the Therapeutic Landscape

Authors	Synopsis
Batties (2015)	To measure the healing properties of a therapeutic environment both the physical elements and non-physical aspects should be measured
Wrenn (2015), Grinde & Patil, (2009), Grinde, 1996),	Human experiences in space include seeing, hearing, touching, and smelling. In therapeutic environments we should add spirituality, feeling of safety and well-being
Cooper Marcus (2015), Cimprich, (2007), Kaplan & Kaplan (1989), Jiang (2015)	Three major functions of the therapeutic environment: • Stress-reducing function • Sense of control over the environment • Presence of family
Sachs (2015), Berman, Jonides, & Kaplan (2008),	Main elements of therapeutic environments: • Forms • Symbols • Purity • Hygiene • Renewal
Foote (2015), Imperial College Healthcare NHS Trust (2015), Kellert & Calabrese (2015)	Therapeutic environments include: • Healing building • Family care • A combination of wellness and nature • Art and spirituality
Cooper Marcuse & Barnes (1999), Kim & Mattson, (2002)	Process of well-being in restorative gardens include: • Achieving physical relief from symptoms • Reducing stress
Orians & Heerwagen (1992), Grinde & Patil (2009),	Two characteristics of healing environments: • Encouraging biophilic responses • Discouraging biologic responses
Velarde, Fry, & Tveit (2007), Louv (2008), Hartig, 2004) Grinde & Patil (2009), United States Department of Labor (2019)	Main functions of views to garden in healing environments: • Plants reduce stress • Create effortless attention • Aesthetic stimuli • Proximity to natural settings • Reduce air pollution • Reduce noise pollution • Adjusting humidity • Providing pleasant views and vista • Adjusting daylight depending on the season

Table 10

Heat Island Mitigation Strategies for Improving Public Health and Well-Being

Authors	Strategies
Debbage, & Shepherd (2015), Gago, Roldan, Pacheco-Torres, & Ordóñez (2013)	- Spatial continuity is a critical contributor to UHI effects - To diminish continuity of UHI in a high-density urban environment: 4. Establishing a network of urban plazas 5. Densely planted parks and green areas 6. Tailoring any planning & design solution to its specific site.
Aleksandrowicz, Vuckovic, Kiesel, & Mahdavi (2017), Erell, Pearlmutter, & Williamson (2011), Memon, Leung, & Liu, (2010)	Heat island mitigation strategies with landscape design: 7. Building envelope include: cool building envelope, green roofs, green façade 8. Urban landscape: new design strategies, new materials, and details 9. Shade trees 10. Ground vegetation 11. Water bodies and water features 12. Pavements: cool pavements, water retention pavements 13. Street geometry: urban canyon, sky view factor, orientation to sun & wind.
Wang & Hashem, (2016), Smid & Costa (2017), Stone & Norman, (2006), Kleerekoper, van Esch, & Baldiri Salcedo(2012)	Strategies to maximize the environmental benefits of UHI mitigation with planting design: 14. Urban vegetation is a key factor 15. Trees with larger crowns are better 16. Trees planting patterns make a difference 17. Trees height is critical 18. Minimum space between trees should be considered 19. Planting trees in high elevated areas of the cities 20. Focusing on the local climate conditions of the site.
U.S. Environmental Protection Agency, (2020), Aram, Solgi, Garcia, & Mosavi, (2020), Kim, Gu, & Kim (2018)	When planting trees for UHI mitigation, there are additional environmental benefits include: 21. Decreasing air pollution 22. Reducing energy use 23. Removing air pollution 24. Reducing evaporative emissions 25. Sequestering carbon 26. Reducing exposure to UV rays 27. Enhancing stormwater management 28. Encouraging biodiversity

Table 11

Artful Rainwater Design and Planning for Therapeutic Landscapes

Studies	Artful Rainwater Design
the U.S. Green Building Council (2020), CIRIA, (1996),	The new sustainable urban drainage paradigm includes: 5. Integrate quantitative, qualitative, and amenity aspects into the stormwater management plan. 6. Focus on small and local scale projects 7. The amenity approach concentrates on aesthetic, environmental, and biological values
MacElory & Winterbottom, (1997), US Environmental Protection Agency, (2005)	High-performance stormwater management applies the following: 8. Creative techniques art and natural solutions 9. Reduce non-point source pollution of rainwater in small scale and local level
Pannypacker & Echols (2020), Bookout, (1944), Henneman, (2006)	The goals for amenity approach in stormwater management: 1. **Convenience goals** refer to location include: 10. Ease of access 11. The visible site and details 12. Safety of pedestrian 13. Comfortable spaces 14. Encouraging people to explore the site **2. Educational goals:** 15. Sustainable learning conditions 16. Learning physical environment & place 17. Gathering space 18. Visible native plants 19. Create bio-habitat 20. Create places for social interactions

Table 12

Therapeutic Landscape Design *and* ***Place-Making Approaches***

Therapeutic Landscape Design	Place-Making Approaches
Landscape design & Place-making	21. Pay attention to the local communities 22. "Civic role" for hospital 23. Social cohesiveness 24. Advocating ecological health
The sense of place & environmental design	25. Civic identity 26. Sensibility of place 27. A genuine design solution 28. Considering vernacular culture 29. Ecological health 30. World-wide technologies

Therapeutic-place making approach	31.	Therapeutic site planning
	32.	Healing landscape design
	33.	Overall exposure to nature

Note. (Verderber, 2010).

Table 13

A Brief Review of Sustainable Practices in Hospitals' Site Design and Planning

Hospital		Design features, strategies, or elements
Paimio Sanatorium Laaksonen (2015), Schildt (1998)	34.	Machine aesthetic
	35.	Roof terraces, sunny balconies
	36.	Chapel
	37.	Communal facilities
	38.	Daylight harnessing
	39.	Fresh air
	40.	Views to forest landscape
	41.	Promenade routes in a natural setting
Martini Hospital DHD (2015), World Architecture News (2015)	42.	Green inner courtyard
	43.	Pavilion, social space
	44.	Refuge landscape
	45.	Flexible building features
Feldkirch State Hospital Nickl-Weller & Nickl, (2012)	46.	The interplay between landscape and building form
	47.	Expressing the local & vernacular culture
	48.	Key aspects of biophilia
	49.	Main lobby as the social interaction space
	50.	The building design reflects the earth & topography
	51.	Waterscape features
	52.	The organic style of architecture
Bon Secours St. Francis Cancer Institute Healthcare Design Magazine (2015)	53.	Natural materials, wood, stone
	54.	Central courtyard
	55.	Emphasize natural light
	56.	Focus on views
	57.	Chapel prayer garden
	58.	Fountain & waterscape
	59.	Walking path for a spiritual journey
	60.	Gathering space for community

Table 14

*Planning and **D**esign **S**trategies to **I**mprove the **T**herapeutic **L**andscape of SWMD*

Precedent study/Author	Design features, strategies, or elements
Historical beautification movement SWMD (Texas Tree Foundation, 2020)	61. Improving the aesthetic qualities of the site by planting trees
Streetscape master plan of SWMD (Texas Tree Foundation, 2020)	Primary goal: To foster a livable district for all Other important goals: 62. Integrate and connect the hospitals to urban public spaces 63. Mitigate heat island effects 64. Increase tree diversity & population 65. Improve air quality 66. Create urban habitat 67. Treat stormwater 68. Improve pedestrian safety 69. Improve access & connectivity 70. Increase human comfort 71. Improve user health 72. Express the SWMD history
UT South Campus Restoration (HDR, 2018)	The Proposal offered: 73. Lands restoration, reducing concrete surfaces 74. Using greenery & cool material 75. Planning for a human-centric environment 76. Creating a sense of community 77. Creating a large roof garden 78. Increasing tree population
UT South Campus Restoration (HDR, 2018)	Disadvantages of the existing UTSW site: 79. Lack of the outdoor space 80. Limited pedestrian connectivity 81. A few social amenities

Table 15

Planning and Design Recommendations

Planning or design strategy	Goal(s)
Considering historical background & socio-cultural context	82. To improve the sense of place & identity, 83. To connect the site to the community
Person-nature engagement	84. To heighten therapeutic properties of the site in any scale and level
Planning for various type of healing gardens at the same site	85. To increase the chance of exposure to the therapeutic environments for people, maximize the impact, & maximize the audiences

Making permeable boundaries in the urban context	86. Connect the site to the city, 87. Extend the therapeutic impact of the landscape beyond the boundary of the hospital campus
Embracing buildings with gardens	88. Positively influence the indoor spaces 89. Visually connects both the indoor & outdoor spaces of the hospital
Naturalistic design, adding winding paths	90. Improve restorative values of hospital landscape 91. Encourage the sense of curiosity for visitors
Transparent architectural façade, large windows to garden	92. Improve the restorative impacts of indoor environments of hospital
Environmental planning & remediation	93. Heal the earth, save natural resources 94. Have restorative influence via the metaphor of landscape, and natural elements 95. Encourage bio-diversity, advocating for vernacular materials, native plants

Note. Mabadi (2017).

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

Summary and Results of the Case Studies

Site Inventory and Analysis

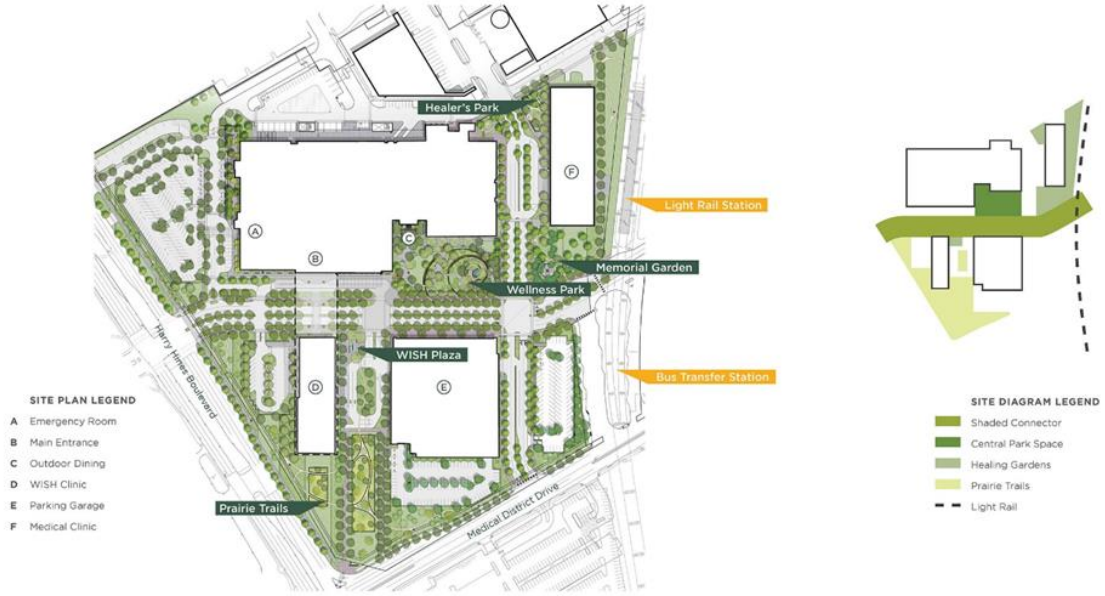
The New Parkland Hospital, Dallas, TX

The New Parkland Hospital replaced the Memorial Hospital with a new 64-acre healthcare campus. Located in Southwestern Medical District, the New Parkland Hospital is a teaching hospital of Texas Southwestern (UTSW) school of Medicine. From the beginning of the design phase, the concept focused on connecting the site to its surrounding urban context. Therefore, during the phase of site development, a joint design team of HDR and Corgan concentrated on the following strategies:

- Relying on different modes of public transportation.
- Integrating several green spaces, or "Linear Parks," into the master plan.
- Using tree patterns on the south-facing lobby that resemble summer canopy (HDR, 2020).

Figure 49

Campus Plan and Gardens



Note. Image courtesy of Studio Outside (2021).

Figure 50

Campus Plan and Gardens

Note. Source of image: Google Earth (2021).

As stated, on the hospital website, “this aspect of the New Parkland Hospital was thoughtfully planned to enhance the patient experience but still preserve safe, quality care” (Parkland, 2020).

A joint design team of two landscape firms, Studio Outside and Ten Eyck Landscape Architects, created the gardens and landscape of the campus. The Texas Blackland Prairie inspired their concept. According to Studio Outside (2020), “the design team created a resilient landscape that promotes healing and celebrates the beauty of Dallas’ natural context.” The robust planting strategy created tranquil gardens with wildflowers and native grasses of North Texas (Studio Outside, 2020). The following four gardens have been integrated into the campus plan:

- Healer’s Park as a healing garden.
- Memorial Garden is another healing garden.
- Wellness Park is a shaded avenue that connects the campus to the surrounding urban areas.

- Wish Plaza is a combination of prairie landscape features and a trail system.

Figure 51

View from Lobby to the Wellness Park and Healing Garden

Figure 52

View from the Dining Area to Wellness Park and Healing Garden

According to the pilot study and site inventory conducted for this research in September 2020, the wellness park is the most significant and functional garden of the hospital because the main entry, lobbies, and restaurant of the facility have direct access to this garden, and the facades and windows of the surrounding buildings provide excellent and extensive views to its beautiful hardscape and landscape elements. The only disadvantage of the existing condition of this garden is the walls locating on the east and south sides. These walls block the view from the streets and prevent people from entering the garden from urban pedestrian paths due to security considerations.

Figure 53

View from Wellness Park and its Healing Garden

Figure 54

View to Prairie Trail

Figure 55

Site Inventory and Analysis of The New Parkland Hospital, 1 & 2

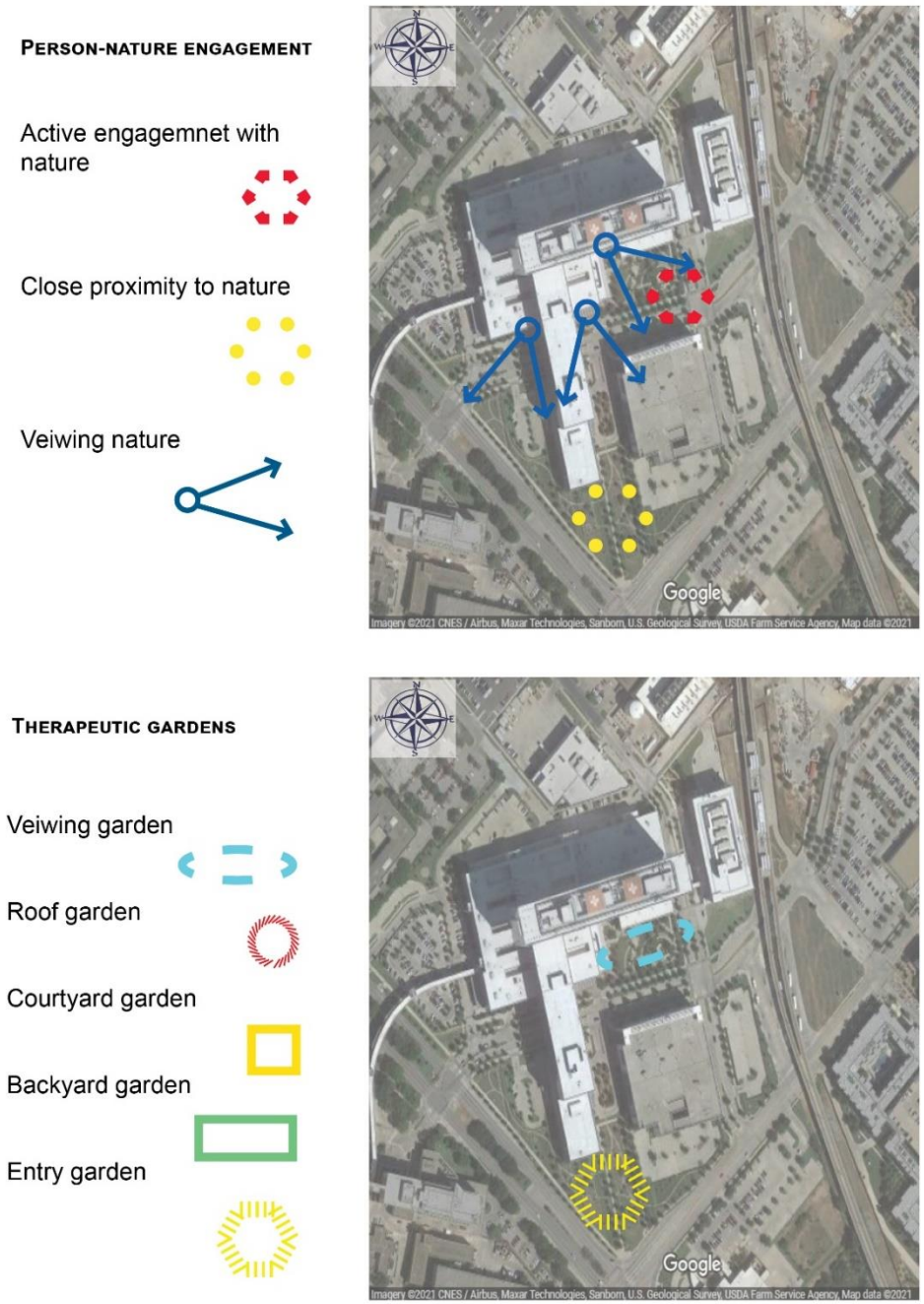


Figure 56

Site Inventory and Analysis of The New Parkland Hospital, 3 & 4

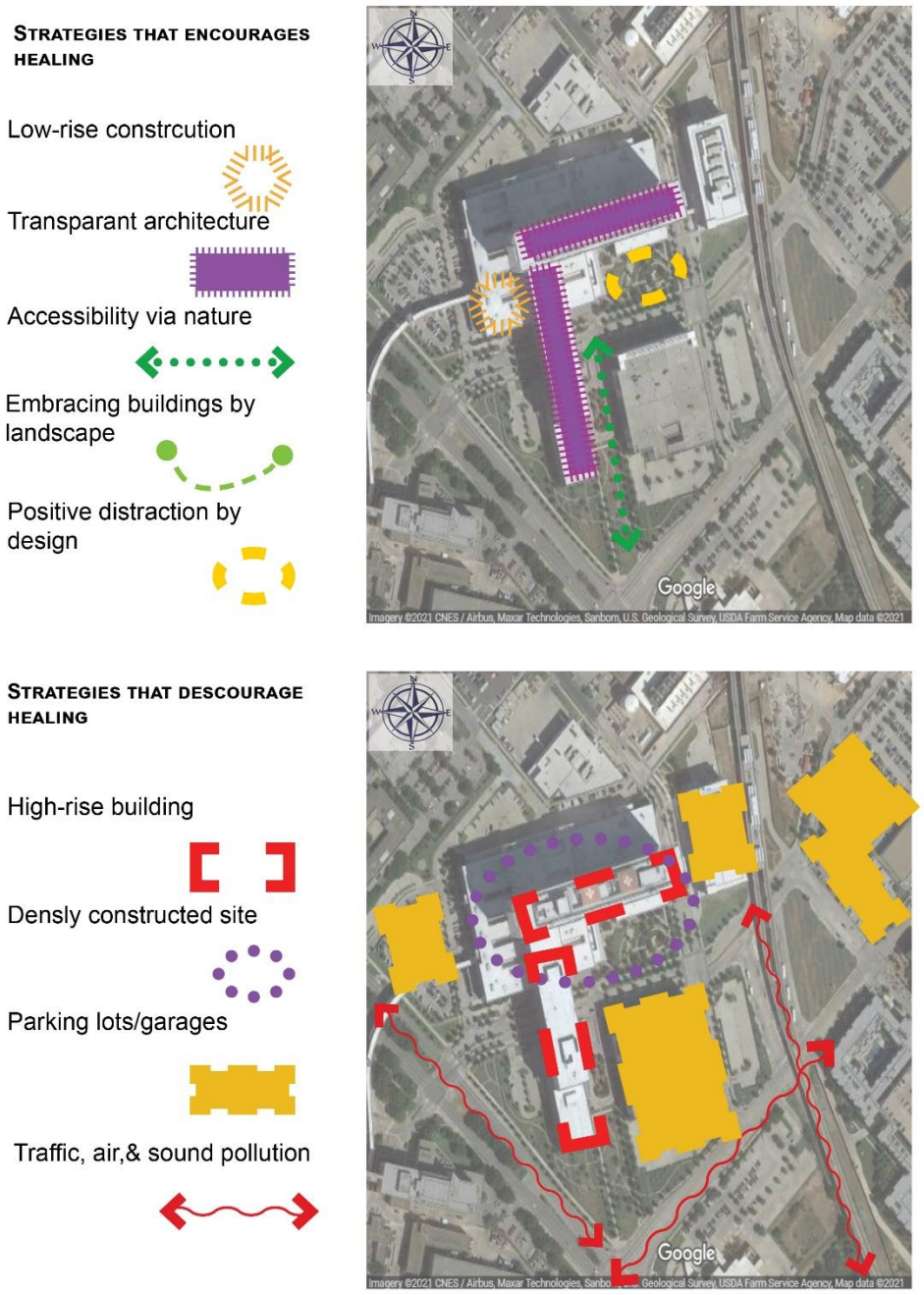
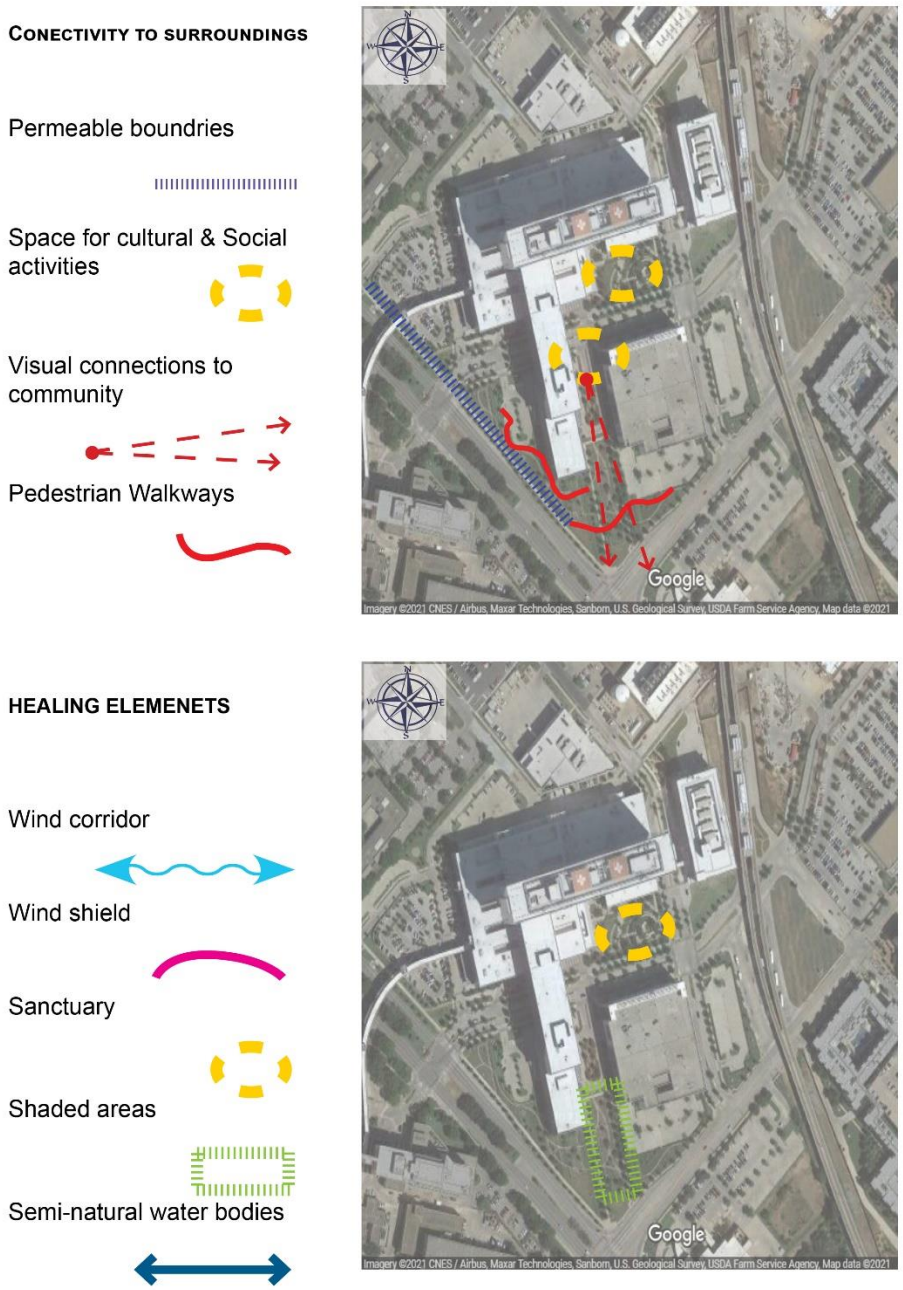


Figure 57

Site Inventory and Analysis of The New Parkland Hospital, 5 & 6

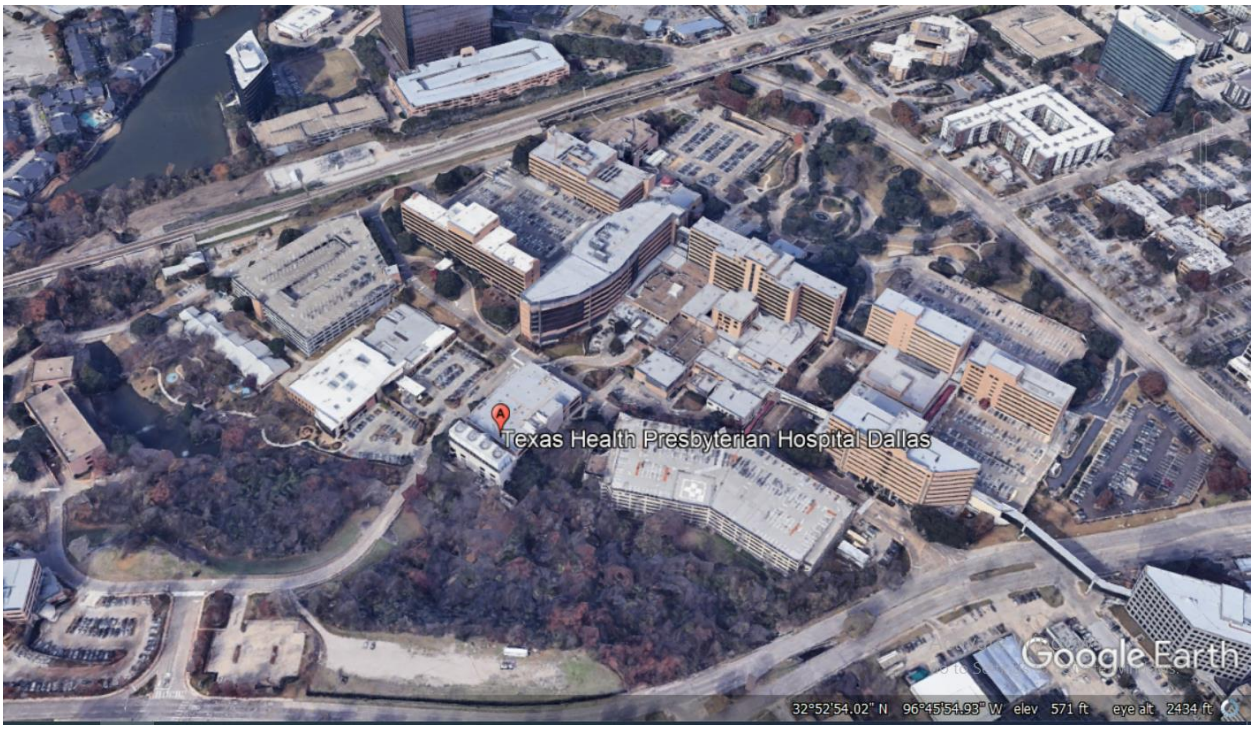


Texas Health Presbyterian Hospital of Dallas, TX

Texas Health Presbyterian Hospital Dallas has provided care for 50 years. The hospital has many specialties from heart health and oncology to advanced emergency (Texas Health Resources, 2020). In 2008, Walnut Hill Campus underwent extensive expansion and renovation projects. In addition to many medical departments such as a new building for cardiovascular services, a new emergency department, etc., the campus master plan organized parking garages around the buildings. The proposed plan aimed to improve vehicular circulation, way-finding, and the signage system. The close collaboration among HKS architects, Talley Associates (landscape architects), stakeholders, and hospital managers resulted in important improvements to the indoor and outdoor spaces of the hospital (Talley Associates, 2020).

Figure 58

Aerial View of Texas Health Presbyterian Hospital Dallas



Note. Image from Google Earth (2021).

Figure 59

Campus Master Plan of Texas Health Presbyterian Hospital Dallas

Note. Image from Talley Associates (2021).

Figure 60

Forest-Like the Entrance of the Hospital with its Shaded Green Areas and Water Features

Figure 61

Green Wall in the Parking Lot of Cancer Center

The master plan of the hospital implemented various strategies to improve the quality of the campus environment. In general, those strategies include increasing green areas and improving the aesthetic qualities of the existing landscape by installing artworks, and well-designed plants. Second, they include constructing parking garages, facilitating vehicular movement, and organizing pedestrian and car circulation across the campus. Space planning and landscape architecture strategies that have been implemented include the following:

The linear organization of the hospital's buildings stretched from north to south and divided the campus into two parts. The front space is the main entrance of the hospital with the forest-like shaded ground and constructed waterscape. This space created an inviting environment on the northwest side of the campus. A combination of the tall evergreen and deciduous trees provides a sanctuary from the prevailing wind and traffic.

Figure 62

Dedicated Sculpture to Oncology Staff

Figure 63

Texas Health Presbyterian Hospital Dallas Patio/Butterfly Garden

Figure 64

Large Windows of Cancer Center Toward to Naturalistic Landscape, Exercise Area and Butterfly Garden

Figure 65

Serpentine Paths, Play Area of Childcare Center with Views to the Naturalistic Landscape

On the eastside, an extensive naturalistic landscape with exercise spaces, furniture, artifacts, a playground, trail, and stormwater features created a forest-like backyard to restore the mind and soil for patients, staff, and visitors. One of the sustainable features is a green wall constructed with vines which converted the parking lot of the Cancer Center into a more pleasing space. On the eastern side of the campus, dedication monuments, memorial sculptures, and healing and butterfly gardens incorporate a sense of place and identity on the campus. The new Oncology and Cancer Center buildings' architectural design integrated the indoor spaces with the outdoor environment via extensive windows and a transparent building envelope. On the east and south campus, mature trees provide shade for trails, a playground, and seating furniture that is especially important during the hot seasons in Northern Texas, while the water features and stormwater management practices such as artificial lake cool air and circulate it under the trees.

Figure 66

An Artificial Lake, Implementation of Stormwater Management, and Views to the Picturesque Landscape

Figure 67

A Combination of Way-Finding, Signage Design with Landscape Architecture

Figure 68

Site Inventory and Analysis of Texas Health Presbyterian Hospital of Dallas 1 & 2

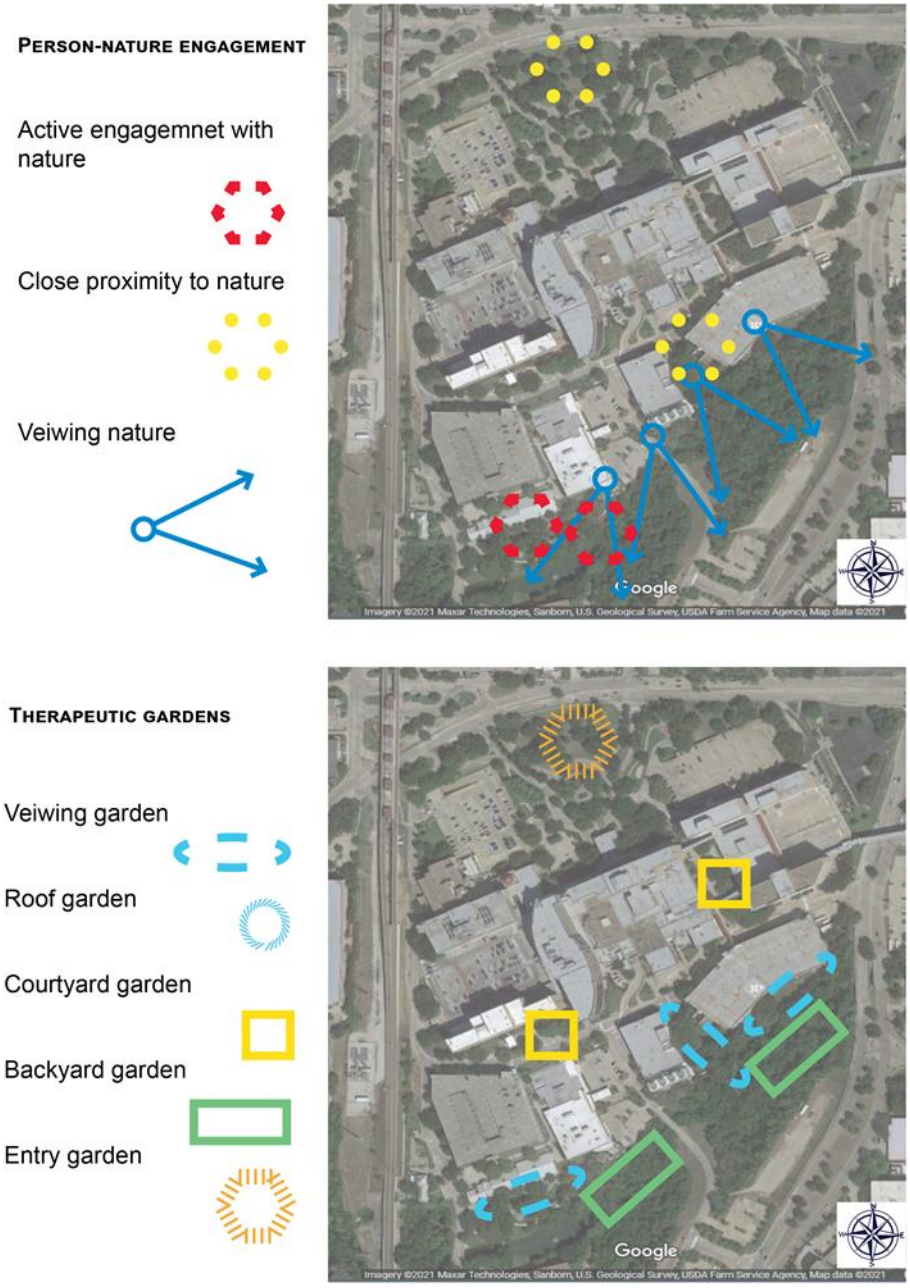


Figure 69

Site Inventory and Analysis of Texas Health Presbyterian Hospital of Dallas 3 & 4

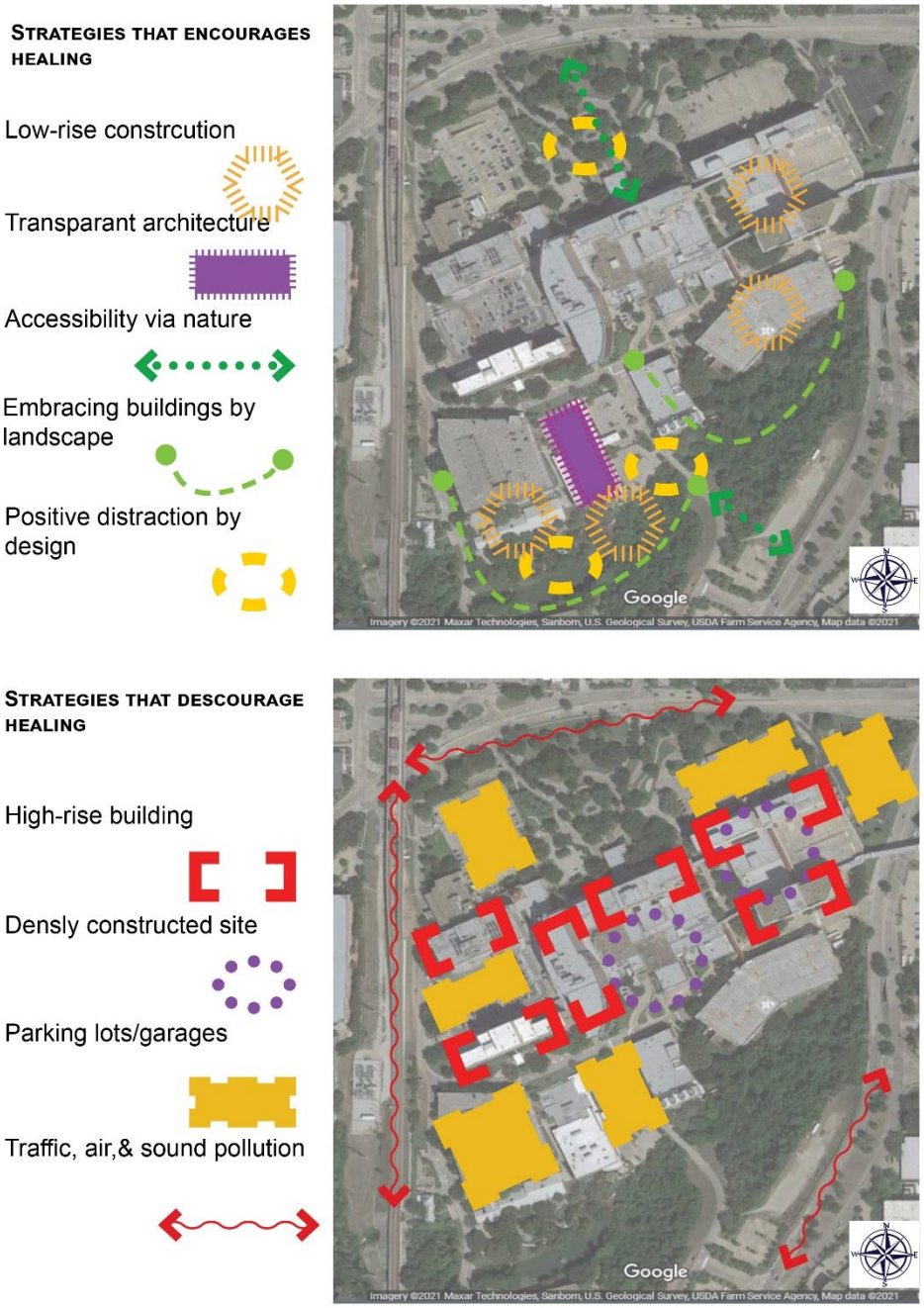
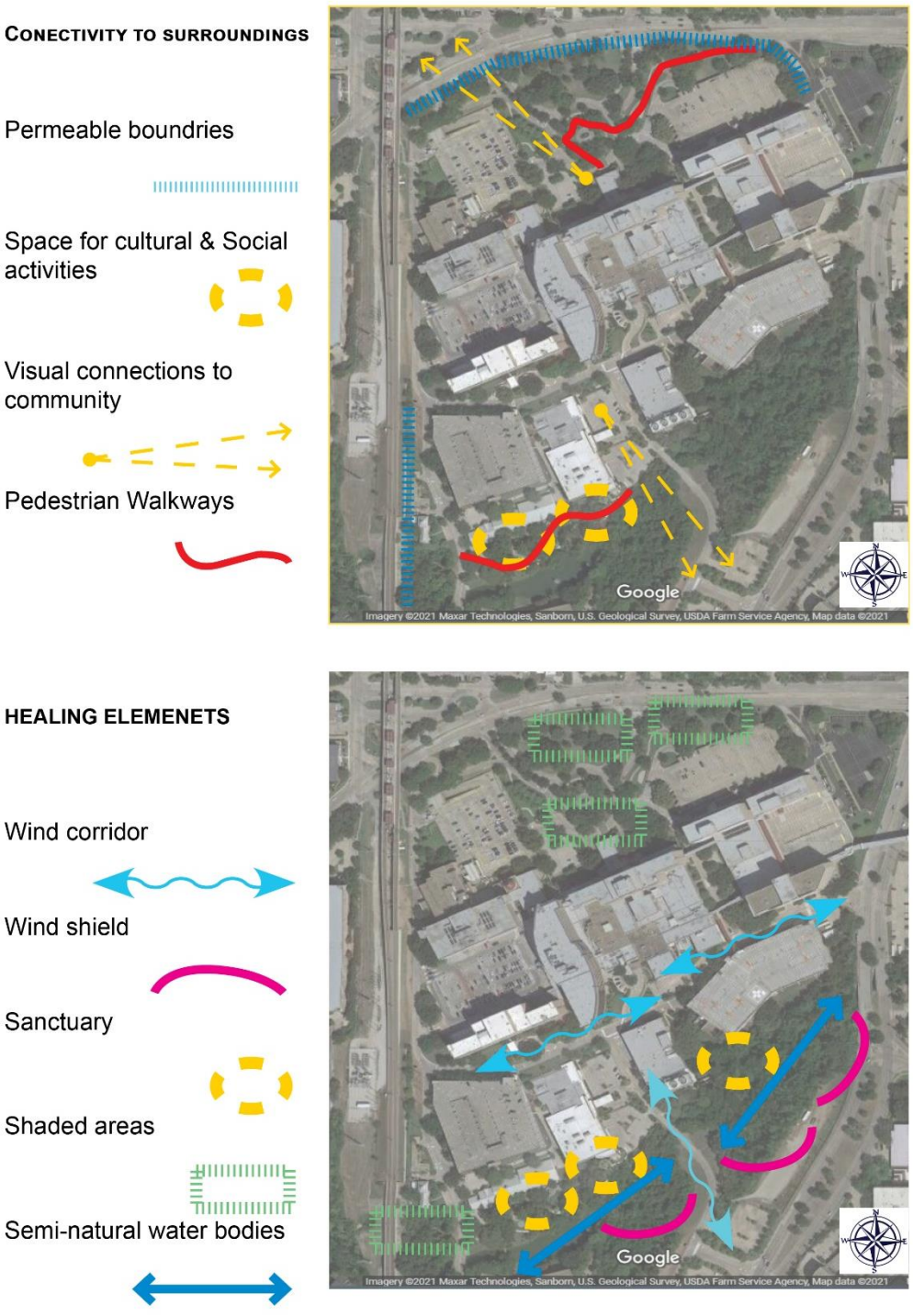


Figure 70

Site Inventory and Analysis of Texas Health Presbyterian Hospital of Dallas 5 & 6



Baylor University Medical Center, Dallas, TX

In 1903, the Baylor University Medical Center opened as the Texas Baptist Memorial Sanitarium. After many expansions and renaming the institution, as well as the establishment of the Baylor Healthcare System in 1981, the Baylor University Medical Center became the flagship of it (Baylor Scott & White Health, 2020). Once the fifth-largest general hospital in the country, the extensively constructed campus with high-rise buildings and parking garages now suffers from a lack of green space, especially in the northern and central parts of the site.

Figure 71

Baylor University Medical Center Site Plan

Note. Image source: Google Earth (2021).

There are four memorable gardens and landscaped areas include:

1- The garden and entrance of Karl and Esther Memorial Hospital at Gaston Ave. is a medium-sized garden with mature live oaks, fountain, and water features that provides shaded seating areas for patients and visitors.

The serpentine paths are designed to invite people from the sidewalks of Gaston Ave. and surrounding urban spaces into the garden and lead them to the hospital's entrances.

Figure 72

Garden and Entrance of Karl and Esther Memorial Hospital at Baylor University Medical Center

Figure 73

Seating Areas and Hardscape Design at the Garden

2- The Baylor Medical Plaza entrance is a small courtyard planted extensively with exotic and native species. This semi-enclosed open space creates full views of the garden through transparent walls between the lobby and other interior spaces and a courtyard garden.

3- The ground of the hospital is located at the south side of the site between Pauline St. and N. Washington Ave. This large green area is covered with turf and trees. There is a small water fountain in front of the Lady Center. Previously, a large stormwater pond was located at the southern end of this area, which was converted to lawn surface and trees in 2018.

4- Baylor University Medical Center's Interfaith Garden is a prayer garden for patients and visitors. This garden is constructed in a semi-enclosed outdoor space featuring a water fountain, two fountain walls, a prayer path in the form of a classical labyrinth, and playful quotations inscribed throughout the garden (RVI, 2021).

Figure 74

Baylor Medical Plaza Entrance with Transparent Walls and Views to Plaza Garden

Figure 75

Water Features, and Shaded Seating Areas at Baylor University Medical Center

Figure 76

The Artful Design of Water Features and Extensive View to Interfaith Garden Prayer

Note. Image courtesy of RVI (2021).

Figure 77

Artworks and Colorful Sculptures Have Been Installed across the Site

Note. Image courtesy of The Cultural Landscape Foundation (2021).

Figure 78

Site Inventory and Analysis of Baylor University Medical Center, 1 & 2

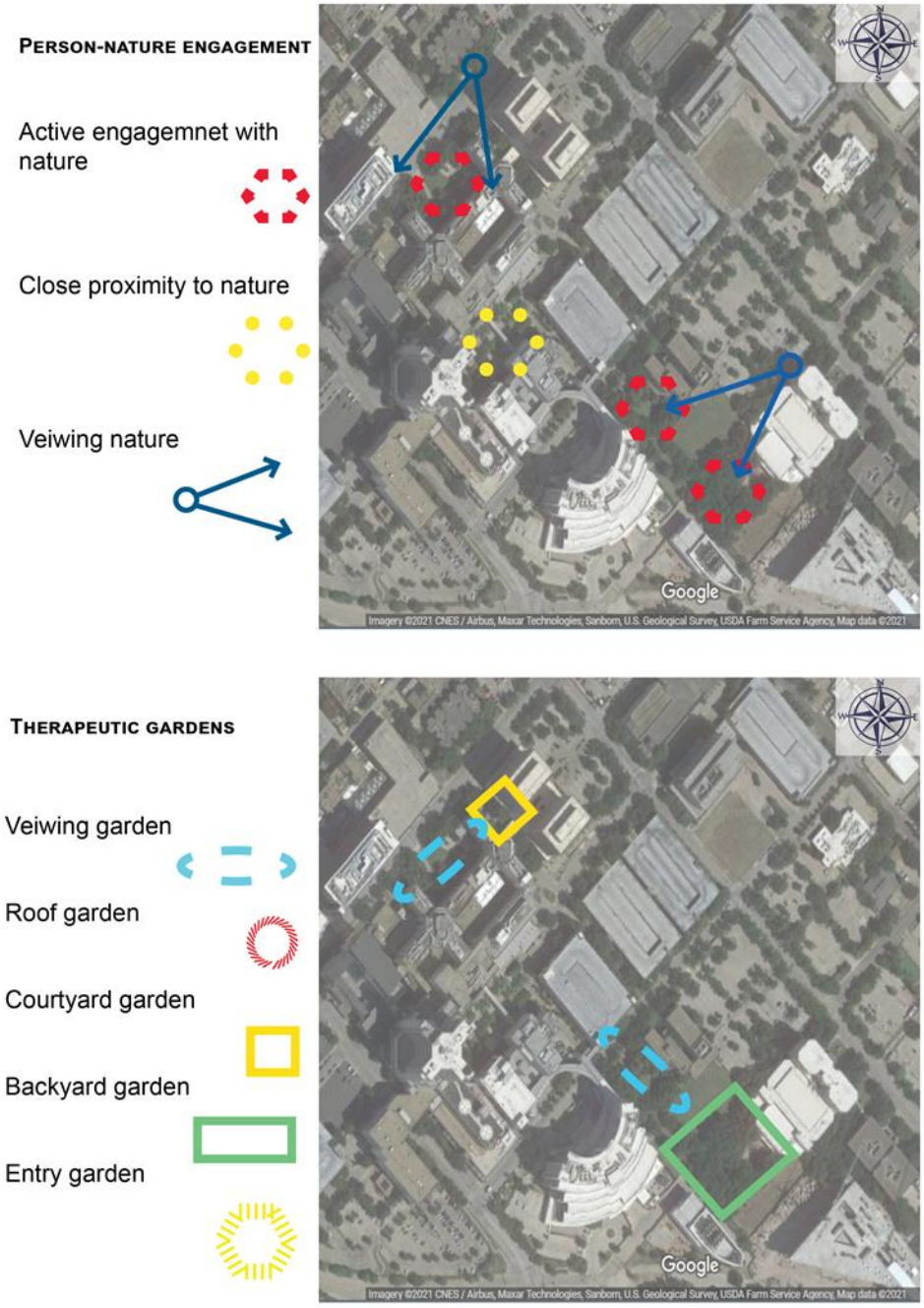
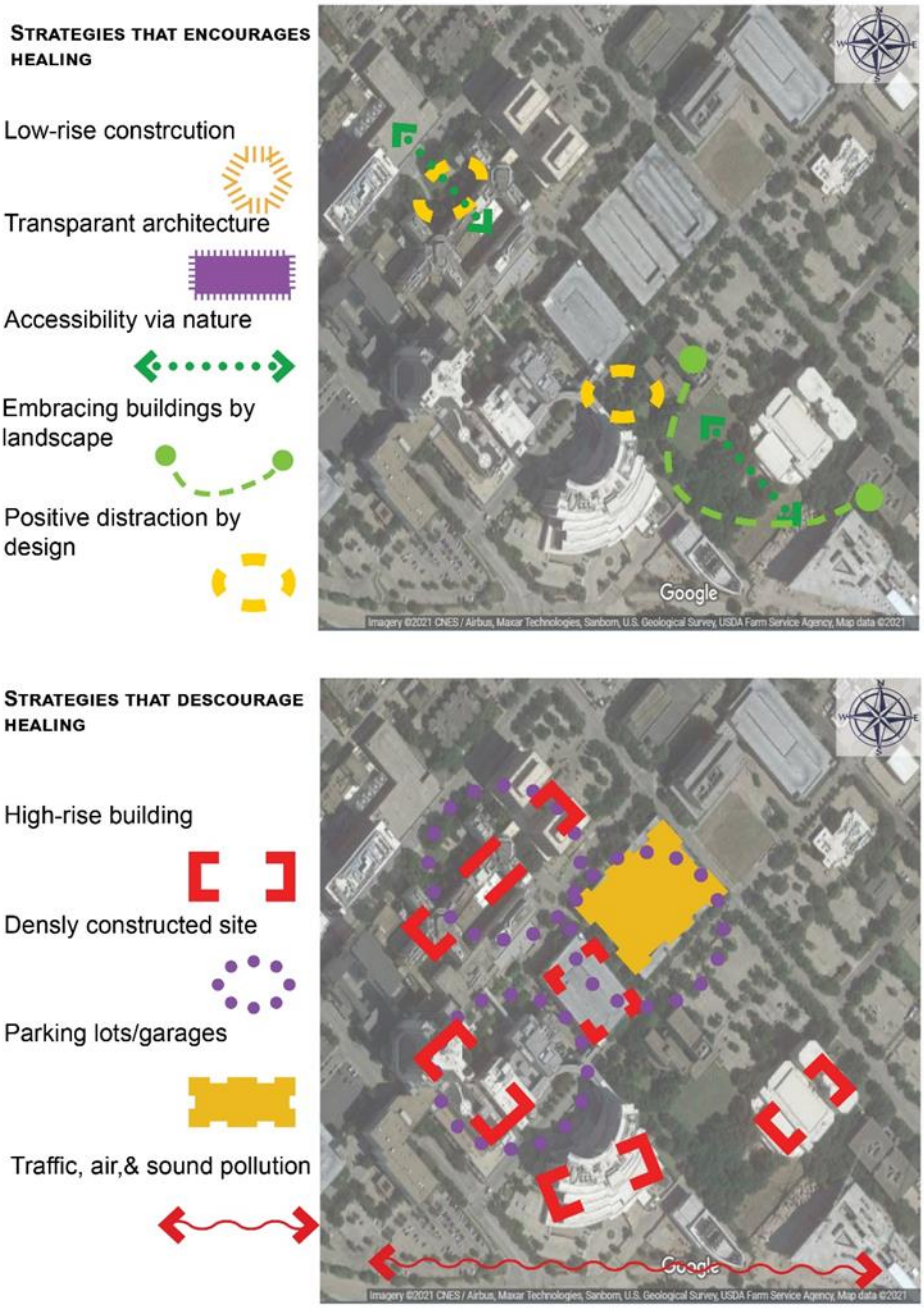


Figure 79

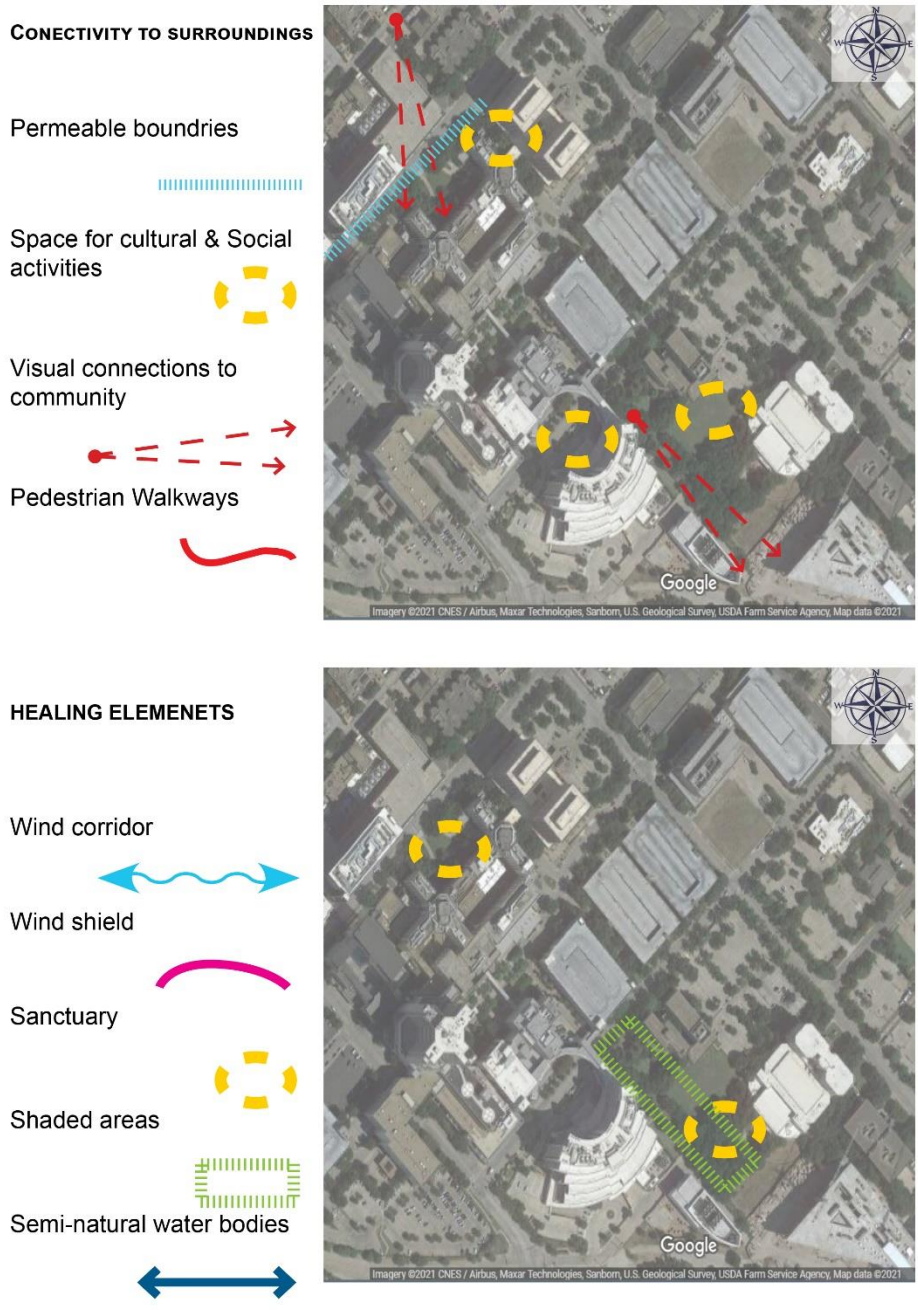
Site Inventory and Analysis of Baylor University Medical Center, 3 & 4



Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

Figure 80

Site Inventory and Analysis of Baylor University Medical Center, 5 & 6



William P. Clements Jr. University Hospital, Dallas, TX

According to UTSWMED (2020), the William P. Clements Jr. University Hospital was "designed to integrate the process and fruits of discovery into patient care. The facility has more than 35,000 sq. ft of space dedicated to research and learning." From the beginning of the design phase, three major objectives inspired the architecture of the hospital, including quality, safety, and efficiency. Other strategies such as the W shape design of the main building to reduce the commuting distance for medical staff, planning for better adjacencies, and improving way-finding determined the overall layout of the hospital building (UTSWMED, 2020). Additionally, designing colorful floors minimizes the risk of accidents, and an advanced air filtration system provides fresh and clean air inside the hospital.

Figure 81

Aerial View of the Site and Surroundings of the New Parkland Hospital

Note. Image source: Google Earth (2021).

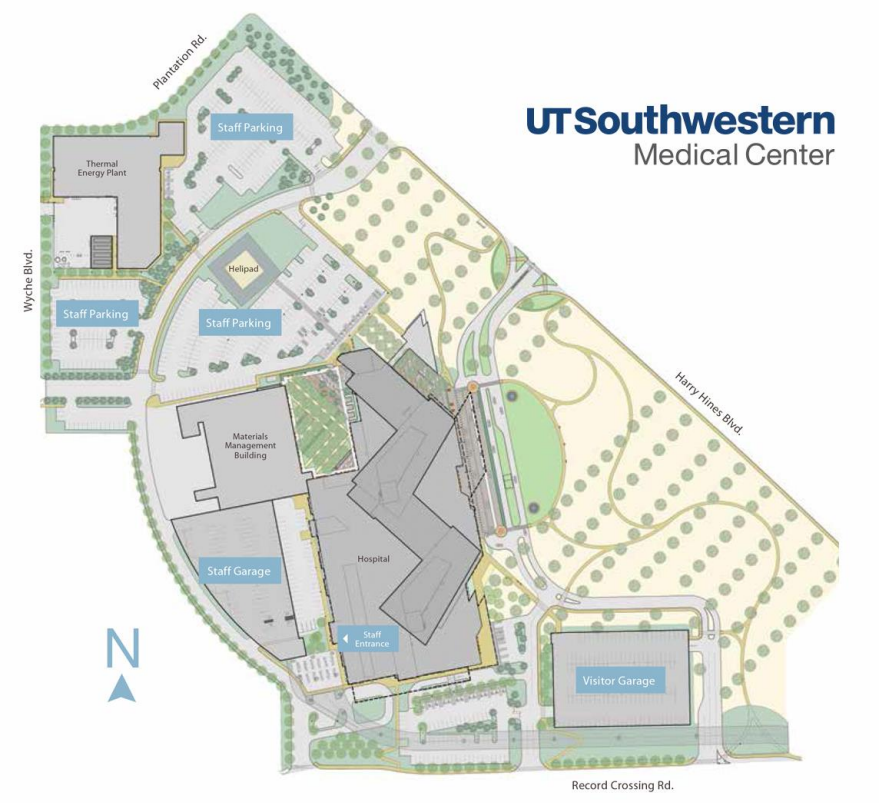
Figure 82

A Panorama View to the Contradictory Design of Building and Landscape

The prominent landscape architect Peter Walker designed the green areas of the hospital and the McDermott Foundation gifted $4.5 million to build it (UTSMC, 2020). According to Dr. Daniel Podolsky, "A truly patient-centric environment demands the positive effects induced by green spaces and calming gardens" (UTSMC, 2020).

Figure 83

W. P. Clements Jr. University Hospital Campus Master Plan



Note. Source of image: UTSWMC (no-scale).The main goal of the proposed design is to provide a therapeutic environment for the patients, encourage well-being among staff, and offer a sanctuary for recuperating people. According to UTSMC (2020), his design intention was to calm nervousness. The other concern that has been stressed by UTSMC decision-makers was improving the restorative properties of views from hospital windows to the site. As stated previously, Peter Walker intentionally designed a private garden for family and patients to support their emotional relations and thereby reduce patients' stress (UTSMC, 2020).

Figure 84

The Universal and Pragmatic Architecture of the Hospital

Figure 85

Xeriscaping Practices in Small Scale

Figure 86

A Garden That Provides Light and View for the Restaurant and Kitchen of the Hospital

Figure 87

Right: Seating Space Without Shade, Privacy, and Pleasing Views

The whole site includes the following gardens and landscaped areas:

The main ground is 6.2 acres of land extended along Harry Hines Blvd. between the hospital buildings and the boulevard. In 2011, the previous site and hospital were completely demolished. In 2015, the existing ground and the main garden of the hospital replaced the previous garden. By the end of 2015. the trees, ground cover, and hardscape were completed according to Peter Walker's design. The landscape designer intended to create a forestlike garden on the main ground and locate the giant building among the parallel rows of cypress trees to the boulevard. A system of curved paths functions as the main access across the garden and among trees. A pair of self-contained fountains have been designed and installed at the entryway of the hospital.

The sanctuary courtyard garden was located at the west side and back of the W-shaped building. This garden featured a combination of abstract hardscape design and cypress trees and lawn. In 2015, the garden was constructed and was used until early 2018, when it was demolished and replaced by a new building.

Figure 88

A View from the Main Building's Entrance to the Landscape

Figure 89

One of Two Self-Containing Water Fountains on the Site

Figure 90

Site Inventory and Analysis of William P. Clements Jr. University Hospital, 1 & 2

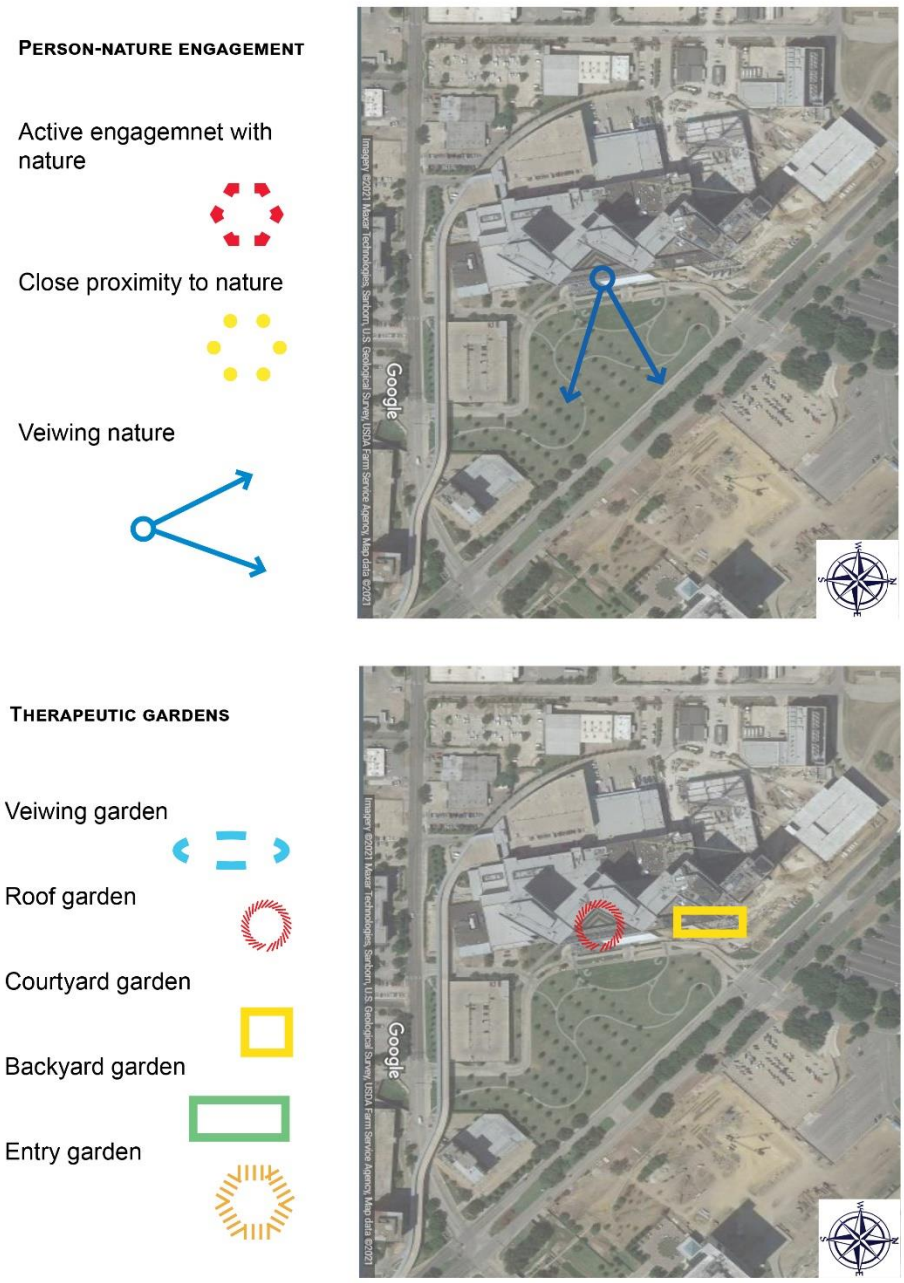


Figure 91

Site Inventory and Analysis of William P. Clements Jr. University Hospital, 3 & 4

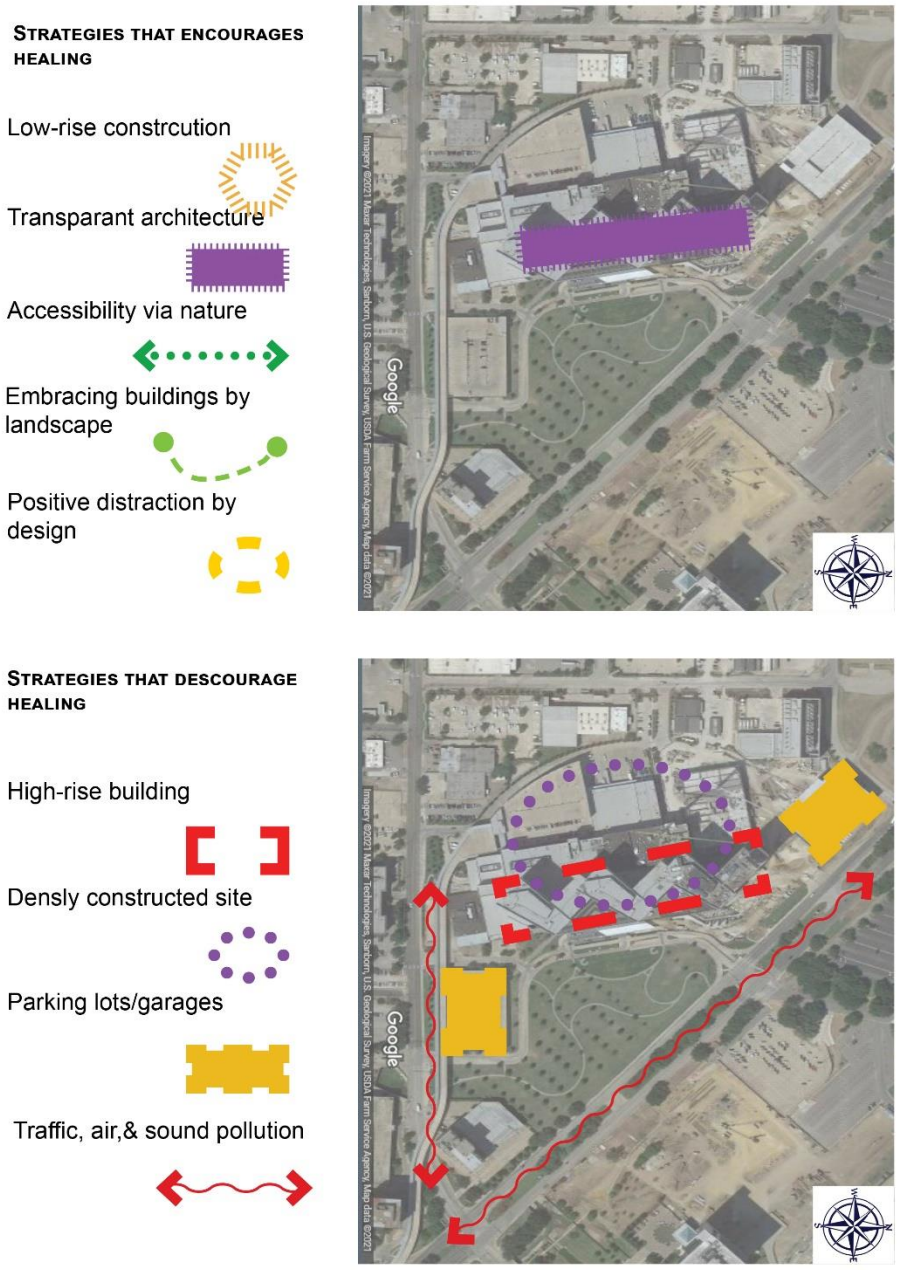


Figure 92

Site Inventory and Analysis of William P. Clements Jr. University Hospital, 5 & 6.

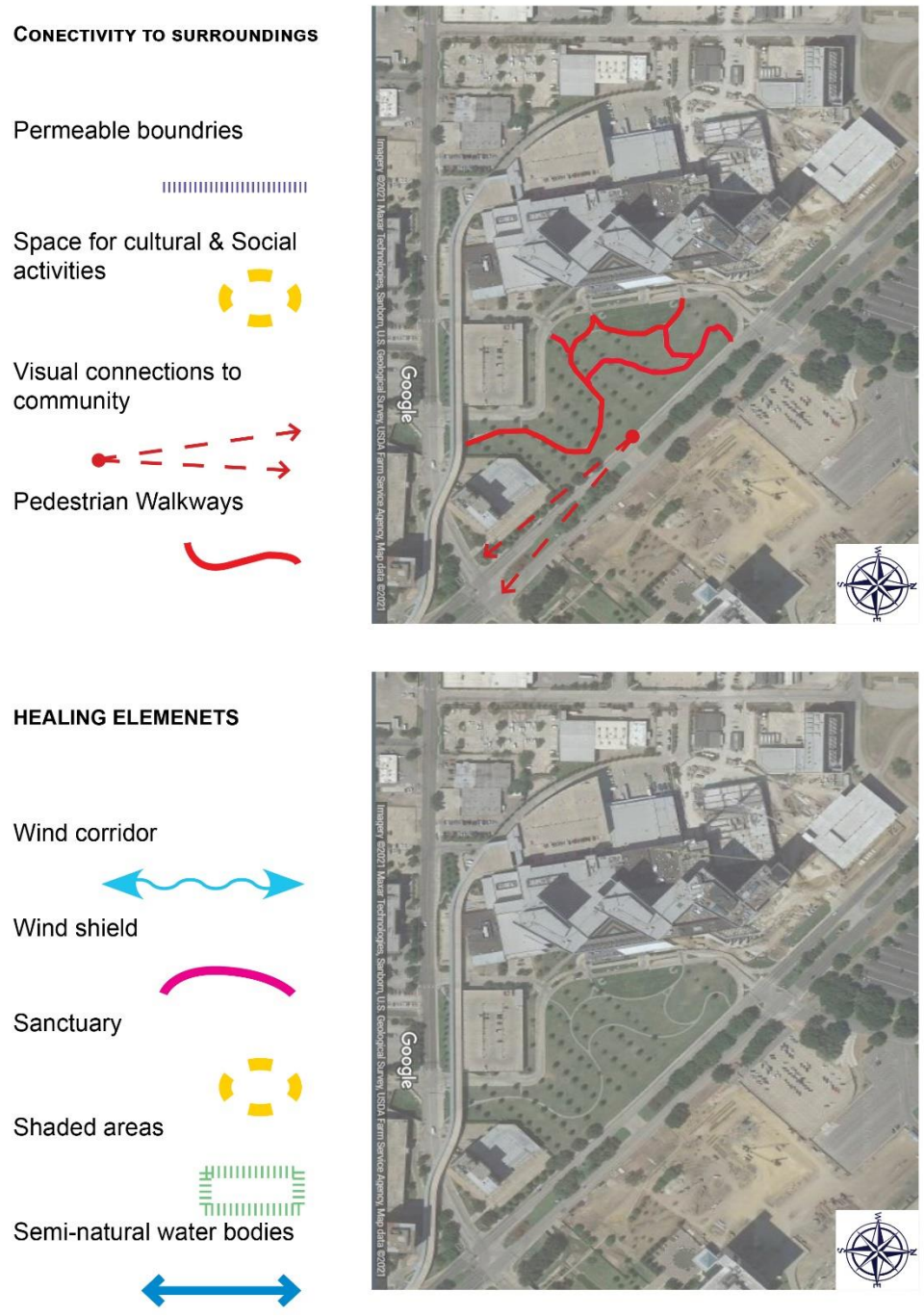
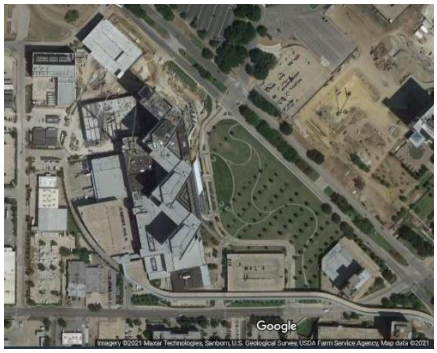
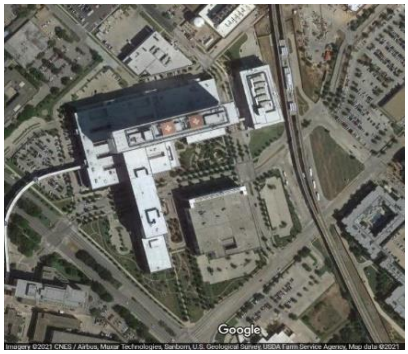


Table 16

Spatial Comparative Analysis-1

		Case Study#1 Clements University Hospital	Case Study#2 Parkland Hospital
Area of Analysis	 Aerial images: Google Map, 2021		
	Criteria of Analysis		
Geographical Context	Macro & Microclimates	Humid subtropical with hot summers/Urban heat islands	Humid subtropical with hot summers/Urban heat islands
	Terrain characteristics	Mostly flat, heavy Blackland soils, sandy clays in the west; drains to Trinity River.	Mostly flat, heavy Blackland soils, sandy clays in the west; drains to Trinity River.
	Previous land use	Healthcare facility	City park/ Healthcare facility
	Natural elements	NA	NA
	Topography	The site slope is from north to south and east to west	The site is flat with no considerable slope
Historical Significance	Notable periods	In 2016, $4.5 million gifts from Mrs. Eugene McDermott in concert with the McDermott Foundation to improve the site/ In 2019, the hospital was ranked as the top hospital in Dallas-Fort Worth.	In 1963, the assassination of United States President John F. Kennedy. In 2017 for Advanced Certification for Comprehensive Stroke Centers.
	Major events	Former Texas Gov. William P. Clements Jr., who in 2009 made a landmark $100 million contribution	In 1954, Parkland moved to Harry Hines Blvd about a mile from its original site. The facility was officially dedicated in March 2015.
	Valuable monument	Landscape and site	The main building and the gardens

	Development stages	The hospital's three towers were built on a total $1.2 Billion budget between 2014 and 2020	In 1913, a brick building replaced the wooden facility. In 2010, The formal groundbreaking was held.
Socio-Cultural Context	Cultural context	University hospital	n 2009 the Greater Dallas Planning Council awarded the Dream Study Award to the district due to the district's master plan for its hospital
	Cultural significance	NA	Associated with the assassination of United States President John F. Kennedy.
	Dominant social context	Research, and innovation of a world-class medical institution	Public hospital
	Religious affiliations	NA	Memorial institution
	Establishment	1989	1894
Design & Planning Characteristics	Setting (urban, sub-urban)	Urban	Urban
	Neighborhood zoning	UT Southwestern Medical District	UT Southwestern Medical District
	Urban, landscape & architectural monuments	The site is designed by PWP Landscape Architecture	Two landscape firms, Studio Outside and Ten Eyck Landscape Architects created the gardens and landscape of the campus.
	Architectural style	International	Modernist
	Hospital specialties	Emergency care, as well as general inpatient and outpatient services, and treatment in key areas of specialty medicine, cardiology, imaging, and interventional radiology, maternity and newborn care, oncology,	The hospital focused on patients with congestive heart failure, and includes patients with diabetes, acute myocardial infarction, and pneumonia. Level I Trauma Centers.
Landscape Characteristics	Site design (morphology, geometry)	Minimalist / Abstract	Urban garden with the restorative and adaptive landscape. Inspired by the Texas Blackland Prairie ecosystem.
	Exposure to nature	Minimum	Urban garden, like a city park
	Landscape architecture style	Minimalist with geometric design	Modernist design with a resilient landscape style that celebrates the beauty of Dallas' natural context.

	Therapeutic elements of landscape	NA	The healing garden with a park-like atmosphere and meandering paths, so both employees and patients could enjoy a relaxing stroll.
Environmental Considerations	Restorative activities	NA	Three types of gardens provide a soothing environment to heal the body and mind.
	Sustainable or eco-friendly materials	NA	Featuring native and adaptive plants, and stone planter walls in a hypnotic, swirling pattern, the landscape
	Eco-friendly technologies	NA	A smart irrigation system
	Engineering & scientific methods applied	Contemporary site grading methods	Rain sensors, drip irrigation, and a weather station reduce water usage on the LEED Gold certified
	HIE mitigation practices	NA	NA
	Bio habitat creation	NA	Yes, the gardens, plants selection

Table 17

Spatial Comparative Analysis-2

		Case Study#3 Presbyterian Hospital	Case Study#4 Baylor University Medical Center
Area of Analysis	 Aerial images: Google Map, 2021		
	Criteria of Analysis		
Geographical Context	Macro & Microclimates	Humid subtropical with hot summers/Urban heat islands	Humid subtropical with hot summers/Urban heat islands
	Terrain characteristics	Mostly flat, heavy Blackland soils, sandy clays in the west; drains to Trinity River.	Mostly flat, heavy Blackland soils, sandy clays in the west; drains to Trinity River.
	Previous land use	Farm	Sanitarium
	Natural elements	Jenkins branch creek, white rock creek, Harrys moss park	NA
	Topography	The slope decrease from north to south, and decreases from west to east.	The slope decrease from north to south, and decreases from west to east.
Historical Significance	Notable periods	1966	1970-1972
	Major events	In 2014, the hospital was thrust into the national spotlight as the site of the first Ebola case diagnosed in the United States	In 1903, Baylor University Medical Center at Dallas is established as Texas Baptist Memorial Sanitarium. In 1963, the Hospital and Scott, Sherwood, and Brindley Foundation move atop the hill in south Temple, once known as Killarney Heights.
	Valuable monument	Landscape and Garden	Courtyard gardens
	Development stages	2001, development of medical buildings and parking garages	In 1970-1972, Jonsson Medical and Surgical Hospital, Carr P. Collins

			A. Webb Roberts Center for Continuing Education. In 1973, the Twin towers, open as part of the Baylor Medical Plaza.
Socio-Cultural Context	Cultural context	Presbyterian healthcare institute	Baptist General Convention of Texas.
	Cultural significance	The largest healthcare system in North Texas.	The largest not-for-profit healthcare system in Texas,
	Dominant social context	Vickery Meadow, an ethnically diverse neighborhood, immigrants and refugees, as "kind of the melting pot of America"	A not-for-profit hospital in Dallas, a teaching hospital.
	Religious affiliations	Presbyterian	Baptism
	Establishment	1966	1897
Design & Planning Characteristics	Setting (urban, sub-urban)	Dense urban neighborhood	Dense urban neighborhood
	Neighborhood zoning	Mixed used, residential	Mixed used, residential
	Urban & architectural monuments	The main building	NA
	Architectural style	Modernist	International style
	Hospital specialties	Heart health, oncology, neurosurgery, and women's health/infant care. Level II Trauma Center and Comprehensive Stroke Center, and advanced emergency care.	Anesthesiology, dermatology, diagnostic radiology, emergency medicine, family medicine, general surgery, …
Landscape Characteristics	Site design (morphology, geometry)	Extensive parking garages, surface parking, two separated landscaped area in north and south.	Extensive parking garages, surface parking, two separated courtyard gardens in the north, and a landscaped ground in the south.
	Exposure to nature	Southern campus gardens	Front courtyard and southern campus gardens
	Landscape architecture style	Naturalistic, ground, healing gardens, entry garden	Landscaped ground and courtyards
	Therapeutic elements of landscape	Creek, water fountains, shaded areas, Healing gardens	Water fountains, shaded areas, Healing gardens
	Restorative activities	Playground, trail, outdoor exercise amenities on site	Trail, outdoor exercise amenities on site

Environmental Considerations	Sustainable or eco-friendly materials	Few native and more adaptive plants	Adaptive plants
	Eco-friendly technologies	Bio-habitat creation, green walls	NA
	Engineering & scientific methods applied	Storm water management	Storm water management in a southern garden
	HIE mitigation practices	Yes, but not the major focus	Landscape ground in the southern part of the campus
	Bio habitat creation	Yes, but not the major focus	NA

Table 18

Typo-Morphological Analysis

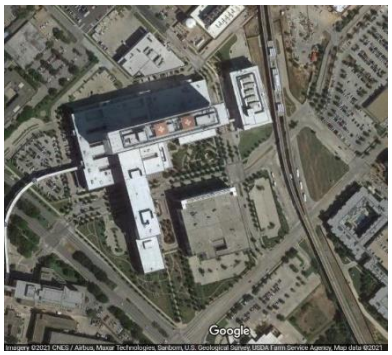
Area of Analysis	Criteria of Analysis	Case Study#1 Clements University Hospital	Case Study#2 Parkland Hospital	Case Study#3 Presbyterian Hospital	Case Study#4 Baylor University Medical Center
	Primary emphasis ⊕				
	Secondary emphasis ⊕				
Person-Nature Engagement Strategies used in the site	Viewing nature	⊕	⊕	⊕	⊕
	Being close to nature	---	⊕	⊕	⊕
	Being present in urban nature	---	⊕	⊕	⊕
	Active engagement with nature	---	⊕	⊕	---
Typology of therapeutic landscape used on site	Viewing garden	⊕	⊕	⊕	⊕
	Roof garden	⊕	---	---	---
	Courtyard garden	---	⊕	---	⊕
	Backyard garden	---	---	⊕	⊕
	Nature & fitness trail	---	---	⊕	⊕
	Extensive landscape ground	⊕	---	⊕	⊕
	Greenhouse, farmlands	---	---	---	---
	Eatery gardens	---	⊕	⊕	⊕
	Healing garden	---	⊕	⊕	⊕

	Water garden	---	---	---	---
Connectivity to the surrounding context	Permeable boundaries of the site	◍	●	●	◍
	Direct connections to urban open space	◍	●	◍	●
	Provide a place for cultural or social activities	---	●	◍	●
	Visual connections to its community	◍	●	◍	●
Application of healing elements of nature	Sunlight	●	●	◍	●
	Fresh & clean air	◍	◍	●	◍
	Wind & breeze	---	---	●	---
	Pleasing view & vista	---	◍	◍	---
	Windshield by landscape	---	---	---	---
	Sanctuary for rest & privacy	---	---	●	---
	Shade trees	---	◍	●	◍
Design strategies that encourage healing values of the hospital's landscape	Low rise building	---	---	---	---
	Transparent Architecture to landscape	●	◍	◍	◍
	Accessibility via nature in arrival zones	---	◍	●	◍
	Embracing landscape by buildings mass	---	---	◍	---
	Positive distractions for stress reduction	---	◍	◍	◍
Planning strategies that	High-rise building	●	●	●	●
	Locating parking & garages in close	◍	●	◍	◍

	distance to the medical buildings				
	Proximity to traffic, air & sound pollution	⊕	⊕	⊕	⊕
	Densely constructed campus	⊕	⊕	⊕	⊕
Ecological considerations & Sustainable strategies that improve the therapeutic landscape of hospitals	Using vernacular materials	---	⊕	⊕	---
	Native plants	---	⊕	---	---
	Considering Micro-climate	---	---	---	---
	Stormwater management	---	---	⊕	---
	Rainfall harvesting	---	---	---	---
	Heat island mitigation	---	---	⊕	---
	Green material	---	⊕	---	---

Table 19

Landscape Performance Analysis-1

Extensively applied Some examples applied No example applied		Case Study#1 Clements University Hospital	Case Study#2 Parkland Hospital
Area of Analysis	Aerial images: Google Map, 2021		
	Criteria of Analysis		
General Consideration	Integrate and connect the campus to the surrounding		
	Prioritize parking garages over surface parking		
	Respond to the local climate conditions		
	Prioritize automobile accessibility on the campus		
	Value and address the local culture		
	Contain artistic elements and present artworks		
	Include healing gardens and restorative landscapes		
	Develop the landscape as green infrastructure		
	Responsive to disaster conditions		
	Adaptable to climate change effects in the future		

	Use of manmade shade structures		
	Reduce hardscape and increase green areas		
Environmental Benefits	Limit site disturbance & use existing infrastructure		
	Prioritize remediation of degraded soil & protection of undisturbed soil.		
	Retain, detain, and treat runoff and surface water		
	Reduce water consumption for irrigation and fountains		
	Apply “Artful Rainwater Design”		
	Protect and encourage the creation of a functional ecosystem		
	Ecologically integrate the hospital and city		
	Create Bio-habitat & support biodiversity		
	Reduce non-renewable energy consumption		
	Reduce airborne pollutants		
	Mitigate local heat island effects		
	Prefer more native plants over other species		
	Use more adaptive plants over other species		
	Encourage planting trees & reducing lawn areas		
	Include ornamental water features		
Social Benefits	Promote diversity of activities for various age groups and abilities		

Retain, restore culturally significant features, areas, practices, and views.		
Create spaces for public gathering		
improve the visual quality of the area		
Foster walking, biking, mass transit		
Create or improves pedestrian access to facilities & amenities		
Include playground and space for physical activities		
include spaces for praying and spiritual activities		
Consider the landscape of the hospital as an open space to benefit public		
Include different types of restorative, healing gardens for targeted populations		
provide pleasing views for interior spaces of the hospital		
create beautiful views and vistas for surrounding urban environments		

Table 20

Landscape Performance Analysis-2

Extensively applied Some examples applied No example applied		Case Study#3	Case Study#4
Area of Analysis	Aerial images: Google Map, 2021		
	Criteria of Analysis		
General Consideration	Integrate and connect the campus to the surrounding		
	Prioritize parking garages over surface parking		
	Respond to the local climate conditions		
	Prioritize automobile accessibility on the campus		
	Value and address the local culture		
	Contain artistic elements and present artworks		
	Include healing gardens and restorative landscapes		
	Develop the landscape as green infrastructure		
	Responsive to disaster conditions		
	Adaptable to climate change effects in the future		

	Use of manmade shade structures		
	Reduce hardscape and increase green areas		
Environmental Benefits	Limit site disturbance & use existing infrastructure		
	Prioritize remediation of degraded soil & protection of undisturbed soil.		
	Retain, detain, and treat runoff and surface water		
	Reduce water consumption for irrigation and fountains		
	Apply “Artful Rainwater Design”		
	Protect and encourage the creation of a functional ecosystem		
	Ecologically integrate the hospital and city		
	Create Bio-habitat & support biodiversity		
	Reduce non-renewable energy consumption		
	Reduce airborne pollutants		
	Mitigate local heat island effects		
	Prefer more native plants over other species		
	Use more adaptive plants over other species		
	Encourage planting trees & reducing lawn areas		
	Include ornamental water features		
Social Benefits	Promote diversity of activities for various age groups and abilities		

Retain, restore culturally significant features, areas, practices, and views.		
Create spaces for public gathering		
improve the visual quality of the area		
Foster walking, biking, mass transit		
Create or improves pedestrian access to facilities & amenities		
Include playground and space for physical activities		
include spaces for praying and spiritual activities		
Consider the landscape of the hospital as an open space to benefit public		
Include different types of restorative, healing gardens for targeted populations		
provide pleasing views for interior spaces of the hospital		
create beautiful views and vistas for surrounding urban environments		

Summary and Results of the Survey on Landscape Performance

The survey was disseminated among professional designers and university professors in the field landscape architecture, architecture, and planning with academic expertise or professional experience in the field of therapeutic environments.

The Response Rate of the Survey

The survey questionnaire was disseminated among 115 key informants via Question Pro online survey software. A total of 47 of them responded to the survey that constituted the response rate of 40.86%. The response rate of 41% shows a success beyond the typical rate because the average response rate for the online-external survey is 10-15%8.

Completion Rate of the Survey

Among 47 respondents, 5 people dropped out or partially answered the questions due to the length of the survey. Therefore a total of 42 people answered all 43 questions of the survey that presented a completion rate of 89.36%. Generally, when a survey has 40 questions, the average completion rate is 79%9, considering that this survey exceeded the average completion rate by 10%, which is beyond the typical.

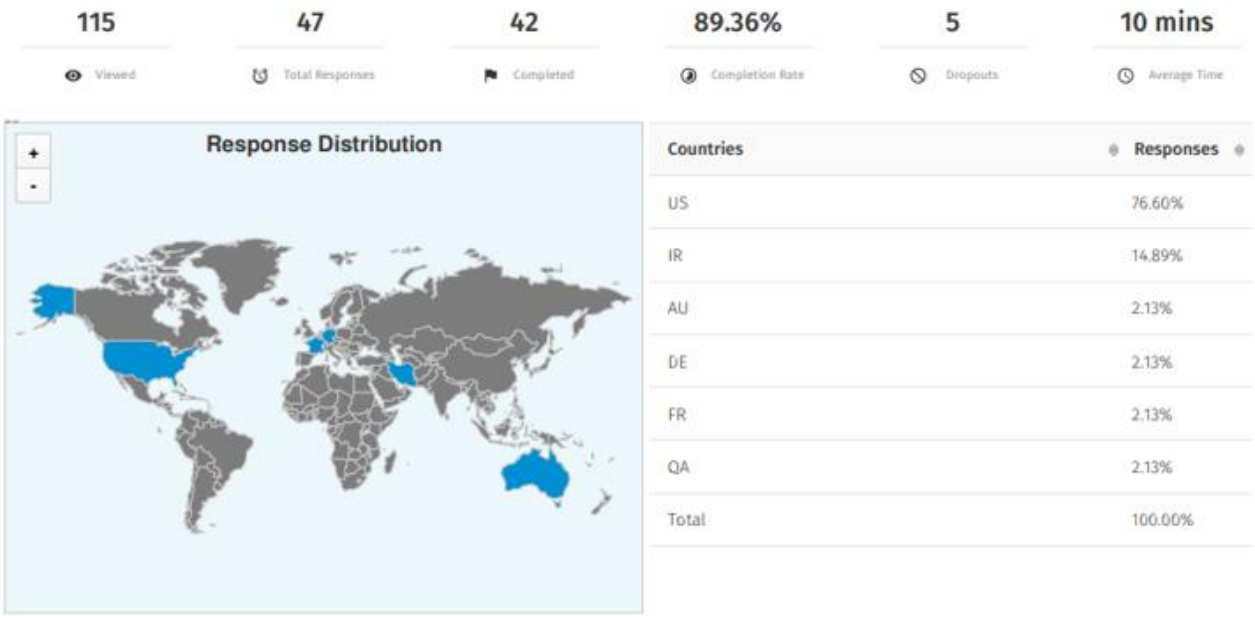
Distribution and Location of the Participants

The respondents of the survey were distributed in six countries including, the U.S.A, Australia, Germany, France, Iran, and Qatar. Respondents from the United States constituted 76.60% of the total. Because this research aimed to generalize its findings to North Texas, the United States, and also the case studies were selected in the same area, therefore such a high response rate from the United States will generate more reliable results.

8 According to www.surveymonkey.com
9 According to www.surveymonkey.com

Table 21

Total Responses, Completion Rate, and Location of Respondents



Occupation of the Respondents

According to table 22, the pie chart 4-1 illustrated the occupation of respondents in three major categories. As shown, professional designers were accounted for 67.50% of all participants (a total of 27 people). Then people who were working in both the academia and professional environment made up 17.5% (a total of 7 people), followed by the university professors with 15% (a total of 6 people).

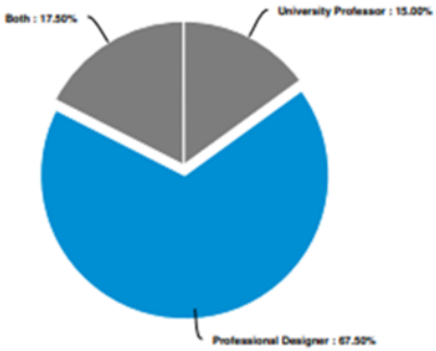
The Educational Background of the Respondents

Base on table 22, graph 4-2 presented that the survey classified its respondents' educational background in three major specialties. As the graph suggested the largest population were landscape architects that constituted 50% of all (a total of 21 people). The second-largest population was architects constituted 42.86% of all (a total of 18 people). While the urban planners only made 7.14% (3 people

Table 22

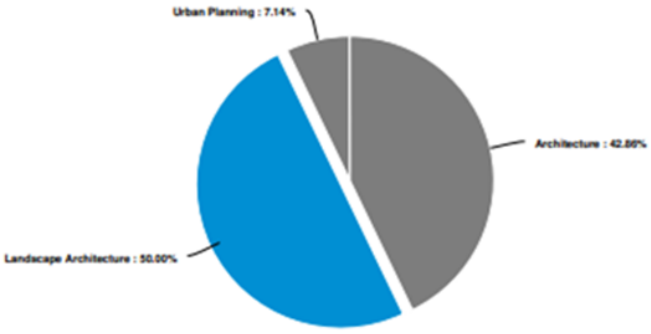
Occupation and Educational Background of Respondents

4-1- Which of the following describes you?



Answer	Count	Percent	20%	40%	60%	80%	100%
University Professor	6	15%					
Professional Designer	27	67.5%					
Both	7	17.5%					
Total	**40**	**100%**					

4-2- Which of the following describes your educational background?



Answer	Count	Percent	20%	40%	60%	80%	100%
Architecture	18	42.86%					
Landscape Architecture	21	50%					
Urban Planning	3	7.14%					
Total	**42**	**100%**					

The Highest Level of Education of the Respondents

According to table 23, the pie chart 4-3 compared three categories of the highest level of education among the participants. As this graph showed the respondents holding a Master's degree constituted the largest population with 54.76% (23 people) and the next were participants holding Ph.D. constituted 30.95 % (13 people). The participant with a Bachelor's degree only made up 14.29% of the total respondents.

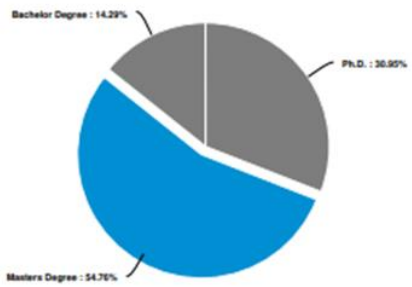
The Respondents' Experience in the Field of the Therapeutic Design

In table 23, graph 4.4 demonstrated the length of the experience of participants in therapeutic design. As shown, the largest population were professional designers with more than 10 years of experience that constituted 28.57% (12 people), and closely was followed by respondents with less than two years of experience that made up 26.19% (11 people). The next was participants with no experience that comprised 21.43%. This was an error due to the selection method of participants. This category included people that graduated from universities or with degrees in therapeutic design but were not working in the same field.

Table 23

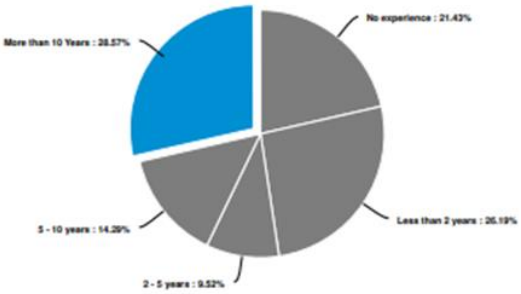
The Highest Level of Education and the Length of Experience in the Therapeutic Design of Respondents

4-3- Which of the following describes your highest level of education?



Answer	Count	Percent	20%	40%	60%	80%	100%
Ph.D.	13	30.95%					
Masters Degree	23	54.76%					
Bachelor Degree	6	14.29%					
Total	42	100%					

4-4- Which of the following describes the length of your experience in the field of therapeutic design, restorative environments, or healing gardens?



Answer	Count	Percent	20%	40%	60%	80%	100%
No experience	9	21.43%					
Less than 2 years	11	26.19%					
2 - 5 years	4	9.52%					
5 - 10 years	6	14.29%					
More than 10 Years	12	28.57%					
Total	42	100%					

Interpretation of the Results and Findings of the Survey

In this study, **descriptive statistics** were used to describe the basic features of the collected data from the survey. The following paragraphs and tables presented quantitative descriptions to simplify the interpretation of the collected data. In this study, the **distribution** of the data was presented as the percent of responses to the most popular answer (or options) of each question. The **central tendency** of the distribution for the selected answer to each question was reviewed against the distribution (percent).

Therefore, the **Mean** was used for describing the central tendency of each answer. **Standard Deviation (SD)** was an indication that showed how far the answers from participants to a specific question varied and deviated from the central tendency (Mean). It demonstrated that how much the answers to a selected question were concentrated around the Mean or how much they were scattered. It is noteworthy to mention here that SD does not indicate better or worse, and a lower SD does not necessarily mean more accuracy. It simply describes the distribution10.

1. As shown in Table 24, the SD for questions 1-2, and 1-10 are more than number one (1) which means there was less concentration on the most popular answers to these two questions. One possible reason for such a minor deviation might be found in the landscape design knowledge of architects as the second most populated participants. It can be said that while prioritizing parking garages and adaptability to climate change strategies are still very important but the responses to them were scattered among 47 respondents.

2. According to Table 25, the SD for questions 2-13, and 2-14 showed scatter distribution (1.09 for both). One possible reason for this deviation might be the special concentration of these question on plants and required knowledge about them that architects and urban planner are not expected to know.

3. As presented in Table 26, the SD for questions 3-4, and 3-10 were above one (1) and indicated scattered responses. That means there was less concentration on creating space for public gatherings and spiritual activities and prayers.

10 According to www.greenbook.org/company/DataStar-Inc

4. In conclusion, a total of 28 design strategies (out of 39) were considered "Very Important" while a total of 11 design strategies were specified as "Fairly Important" or "Important". It should be mentioned here that during the process of dissemination of the survey, the options of "Fairly important" and "Important" were inadvertently placed out of order, which potentially could cause an error. Therefore, all 11 questions were considered "Fairly Important" to avoid overemphasizing the answers and mitigate the impact of this mistake on the findings.

5. Only one question (out of 39) was considered "Less Important", which concentrated on the use of ornamental water features in the landscape.

Table 24

Classification of General Design and Planning Considerations According to the Answers

	Question #	Strategy	Expected Goal	Percent	Mean	SD
Very Important	1-1	integrate and connect the campus to the surrounding urban landscape	Encouraging therapeutic properties	65.22	3.43	0.873
	1-2	prioritize providing enough parking garages over surface parking	Encouraging therapeutic properties	32.61	2.72	1.109
	1-3	Carefully respond to the local climate conditions	Addressing Sustainability issues	69.57	3.59	0.686
	1-5	Value and address the local culture.	Improving livability	47.83	3.33	0.790
	1-6	Contain artistic elements and present artworks to improve positive distraction among visitors and patients	Encouraging therapeutic properties	37.78	3.07	0.889
	1-7	Include healing gardens and restorative landscapes.	Encouraging therapeutic properties	58.70	3.30	0.963
	1-8	Develop the landscape as green infrastructure	Addressing Sustainability issues	58.70	3.33	0.920
	1-9	Be responsive to disaster conditions	Improving livability	73.91	3.59	0.748
	1-10	Be adaptable to climate change effects in the future	Addressing Sustainability issues	69.57	3.43	1.003

Fairly Important & Important	1-4	Prioritize automobile accessibility across the campus	Improving livability	36.96	2.50	1.090
	1-11	Maximize the use of manmade shade structures.	Improving livability	45.65	2.33	1.055
	1-12	Reduce hardscape and increase green areas	Encouraging therapeutic properties	45.65	3.17	0.902
Less Important						

Table 25

Classification of Environmental Benefits and Its Design Strategies

	Question #	Strategy	Expected Goal	Percent	Mean	SD
Very Important	2-3	Retain, detain, and treat runoff and surface water	Responsive to sustainability issues	25.58	3.47	0.735
	2-4	Reduce water consumption for irrigation and fountains.	Responsive to sustainability issues	48.84	3.35	0.720
	2-8	Should support biodiversity	Improving livability	39.53	3.05	0.975
	2-9	Reduce non-renewable energy consumption.	Responsive to sustainability issues	62.79	3.44	0.796
	2-10	Reduce airborne pollutants.	Improving livability	72.09	3.60	0.728
	2-11	Mitigate local heat island effects.	Improving livability	46.51	3.37	0.655
	2-12	Prefer more native plants.	Responsive to sustainability issues	55.81	3.33	0.919
	2-13	Use more adaptive plants over other species.	Improving livability	34.88	2.84	1.090

	2-14	Encourage planting trees and reducing lawn areas.	Improving livability	34.88	2.84	1.090
Fairly Important & Important	2-1	Limit site disturbance and use existing infrastructure when possible.	Responsive to sustainability issues	30.23	2.81	0.982
	2-2	Prioritize remediation of degraded soil and protection of undisturbed soil.	Responsive to sustainability issues	34.88	2.93	0.884
	2-5	Apply "Artful Rainwater Design"	Encouraging therapeutic properties	34.88	2.44	1.119
	2-6	Protect and encourage the creation of a functional ecosystem in hospital campus	Responsive to sustainability issues	41.86	2.84	0.924
	2-7	Ecologically integrate the hospital and city	Improving livability	40.48	2.86	0.977
Less Important	2-15	Include ornamental water features.	Encouraging therapeutic properties	44.19	1.88	1.005

Table 26

Classification of Social Benefits and Its Design Strategies

	Question #	Strategy	Expected Goal	Percent	Mean	SD
Very Important	3-1	Promote diversity of activities for various age groups and abilities.	Improving livability	48.78	3.15	0.989
	3-3	Improve the visual quality of the area.	Encouraging therapeutic properties	56.10	3.39	0.802
	3-4	Create spaces for public gathering	Improving livability	36.59	2.93	1.034
	3-5	Foster walking, biking, mass transit over conventional automobile use	Improving livability	53.66	3.24	0.943
	3-6	Create or improves pedestrian access to facilities and amenities	Improving livability	68.29	3.61	0.628

	3-7	Include playground and space for physical activities.	Improving livability	36.59	2.95	0.973
	3-10	Include different types of restorative, healing gardens for targeted populations	Encouraging therapeutic properties	48.78	3.02	1.084
	3-11	Provide pleasing views for interior spaces of the hospital.	Encouraging therapeutic properties	51.22	3.24	0.888
	3-12	Create beautiful views and vistas for surrounding urban environments	Encouraging therapeutic properties	36.59	2.93	0.985
Fairly Important & Important	3-2	Retain, restore culturally significant features, areas, practices, and views	Improving livability	56.10	2.78	0.962
	3-8	Include spaces for praying and spiritual activities	Encouraging therapeutic properties	39.02	2.54	1.002
	3-9	Consider the landscape of the hospital as an open space to benefit the public.	Improving livability	34.15	3.02	1.084
Less Important	-	-	-	-	-	-

Table 27

Performance Evaluation of Environmental, Social Metrics

	Environmental metrics	Given value: Importance	Site Inventory & Analysis: Implementation	Spatial comparative & Typo-morphologic: Implementation	Pre-design evaluation (survey): Respondent's Agreement	Total Value
1	Limiting site disturbance	+	✗	✗	✗	0
2	Remediation of degraded soil	+	✗	✗	✗	0
	Water					
3	Surface water treatment	✓	✗	+	+	20
4	Reducing water consumption	✓		+	+	20
5	Artful Rainwater Design	✓	✗	✗	✗	0
	Habitat & Ecology					
6	Creation of a functional ecosystem	+	+	✗	✗	5
7	Ecologically integrating the hospital to city	+	✗	✗	✗	0
8	Supporting biodiversity	+	+	+	+	15
9	More native plants	+	+	✗	✓	15
10	More adaptive plants	+	+	+	+	15
11	Encouraging planting trees	+	+	✗	+	10
12	Ornamental water features	+	+	✓	✗	10

	Carbon, Energy, & Air Quality					
13	Reducing non-renewable energy	+	+	+	✓	20
14	Reducing airborne pollutants	✓	✗	✗	✓	20
15	Mitigating local heat island effects	✓	✗	+	+	20
16	Responding to the local climate conditions	+	✗	+	+	10
17	Adaptable to climate change	✓	✗	✗	+	10
	Social metrics					
	Recreational & Social Values					
18	Promoting divers activities for various age groups and abilities	✓	+	+	+	30
19	Spaces for public gatherings	+	✗	✗	+	5
20	Playground & space for physical activities.	✓	+	+	+	30
21	Connecting the campus to urban landscape	+	✗	✗	+	5
22	Open space to benefit the public	✓	✗	+	+	20
23	Beautiful views and vistas for city	+	✗	+	+	10
	Cultural Preservation					
24	Addressing the local culture	+	✗	✗	+	5
25	Restore culturally significant features	+	✗	✗	✓	10
	Health & Well-being					
26	Improve positive distraction among visitors and patients	+	+	+	+	15
27	Including healing gardens and restorative landscapes	✓	+	+	+	30

28	Responding to disaster conditions	✓	✗	✗	+	10
29	Using of manmade shade structures	+	✗	✗	✗	0
30	Reducing hardscape and increase green areas	+	+	✗	✗	5
31	Improving the visual quality of the area	+	+	+	✓	20
32	Providing space for praying and spiritual activities	+	+	+	+	15
33	Creating various types of healing gardens	✓	+	+	+	30
34	Pleasing views for the interior spaces	✓	+	+	✓	40
	Accessibility & Transportation					
35	Preferring parking garages over surface parking	✓	✓	✓	+	50
36	Prioritize automobile accessibility across the campus	✓	✓	✓	✗	40
37	Fostering walking, biking, mass transit	+	+	+	✓	20
38	Improving pedestrian access	+	✗	+	+	10

Given Values	Importance	Implementation	Respondent's Agreement
Very Important, or Addressed (equals 2) ✓	Addressed = Ten (10)	Thoroughly implemented = Ten (10)	Response above 50% = Ten (10)
Important, or partially addressed (equals 1) +	Partially addressed = Five (5)	Partially implemented = Five (5)	Response below 50% = Five (5)
Less important, or ignored (equals 0) ✗	Ignored = Zero (0)	Not Implemented = Zero (0)	Not selected = Zero (0)

CHAPTER 5

DISCUSSION

Conclusions

This chapter first answers the questions of the research, then describes the limitations and mitigating measures that have been taken to minimize the impacts of those limitations on the conclusion, and finally recommends future studies. The following sections address the questions and concerns of this research and expand their findings according to the results of the previous chapter and applied methodology. Then, those findings and conclusions are summarized into figures. These figures classify major design strategies and planning recommendations into subcategories.

In response to the first question, the findings conclude that HIM strategies and ARD improve the livability of hospital campuses by disconnecting spatial continuity, increasing human comfort and safety, and planning for public gatherings and human activities. The findings related to the second question show that improving garden views in hospitals encourages livability and increases the healing values of the sites. Finally, for the third question, the results show the extent that improving landscape performance can increase the therapeutic values of sites. It concludes that the landscape-social and landscape-environmental metrics have different either greater or moderate therapeutic impacts and then summarize them.

How Can ARD and HIM Strategies Increase the Livability of a Hospital Site?

To answer this research question, the overlaps between HIM strategies and ARD were investigated, then planning and landscape architecture solutions that increase the livability of a hospital site were addressed.

According to the reviewed literature, spatial continuity is a critical contributor to HIM effects in urban and public spaces (see Table 10). The studies suggested that to diminish this continuity, urban and site planning should reduce building density in cities and properly address the construction of buildings in urban conditions. Therefore, establishing a network of open spaces and urban plazas, providing densely

planted green areas between them, and tailoring design solutions to specific site and local conditions can improve the well-being and livability of large sites (see Table 10). On small scales, landscape design strategies such as shade trees, ground vegetation, water bodies, water features, cool pavements, and water retention pavements can play a critical role.

Other general site planning considerations, such as building and site orientation to sun and wind, topography, urban morphology, urban canyons, and local climate are important factors that should be studied and addressed by urban and landscape planners with a focus on HIM and ARD. As indicated in the reviewed literature, planting trees mitigates HIE and reduces the harmful effects of UV rays. Planting trees has many other environmental benefits, which include encouraging biodiversity, enhancing stormwater management, removing air pollution, and reducing the urban temperature by cooling the air via transpiration and evapotranspiration and shading non reflective surfaces (see Tables 10 and 11).

The results of the precedent studies indicate that addressing the local community, using place-making approaches, and planning for social cohesiveness improve the livability of the space (see Table 12). Accordingly, successful HIE mitigation and ARD should respect civic identity, be sensitive to local conditions of place, and create high-performance design solutions. For example, a brief review of sustainable site design practices (see Table 13) of four European and American hospitals illustrated common design features, strategies, and landscape elements that directly improve the livability of their sites. These include roof terraces, sunny balconies, public pavilions, spaces for social interaction, waterscape, expressing vernacular culture and materials, and extensive use of trees and other plant materials.

The third section of the precedent study explored proposals, planning, and design strategies that aimed to improve the livability of the landscape and campuses in SWMD of Dallas, North Texas. As presented in the previous chapter, those proposed strategies and design solutions are aligned with the findings of the literature review and include integrating hospitals into urban public spaces, mitigating HIE on a local scale with a focus on using plants and trees, increasing tree population and diversity, using cool

materials, creating large roof gardens, and advocating for everyday outdoor spaces and the improvement of human comfort in the site (see Table 14).

The other precedent study recommended planning for environmental remediation of the site to reduce the temperature via saving natural resources and developing healing gardens beyond the exiting hospitals' properties, making permeable boundaries for hospital grounds, and advocating for vernacular materials and native plants to increase the livability of the hospital landscapes (see Table 15).

This research investigated four case studies via site inventory and site analysis, spatial comparative analysis, and an evaluation of their landscape performance. First, the findings of the site inventory and site analysis confirmed that spatial continuity is a major determinant of HIE on these sites. For example, the campus planning at three of four case studies features partially disconnected building masses and spatial continuity on the edges and corners, with medical buildings and parking garages densely constructed in the center of their sites. But the overall building mass is still considered spatially connected to surrounding buildings through other supporting buildings, garages, and surface parking.

Second, through site observations and studying the aerial maps, it was found that in three of those hospitals, the green areas with trees were concentrated on the southern parts of the site, which experienced maximum exposure to sunlight. This investigation confirmed that plant concentration as a planning strategy partially mitigated HIE in the campuses. Examining other site-planning solutions that can potentially remediate HIE, such as water bodies and shade structures, suggested a considerable deficiency. For instance,, only Presbyterian Hospital efficiently implemented water bodies, while two others had small artificial fountains and ponds with seating amenities under shade trees. However, the artificial and decorative so-called self-contained fountains of Clements Hospital, featured in the fourth case study, had no special functionality regarding HIE remediation and stormwater management.

The findings of the spatial comparative analysis illustrate that the main landscape and open spaces of the hospitals face direct sunlight from south and southeast sunlight. For example: only the Presbyterian Hospital campus development divided the landscape into two large northern and southern sections. In this

case, the densely planted southern part, with a stormwater pond and mature tree canopies, mitigated the HIE on the overall site and adjacent buildings. On the northern section, the shade of tall buildings, Savannah-like planted areas, and an artificial fountain at the entry garden improved the human comfort and therapeutic values of the site. In Baylor Hospital, the small, enclosed courtyard gardens disconnected the building mass and provide connections to public city spaces through Gaston Avenue which is also shaded with buildings and trees. The location of the two gardens of Baylor Hospital on the northwest side of the campus, behind the high-rise medical buildings, created comfortable spaces with constant protection from HIE.

Both the landscapes of Parkland and Presbyterian hospitals feature trails and walking spaces that improve physical activities and livability. While the open spaces of Parkland hospital are either enclosed with walls and separated from the public or protected under the shade of the tall buildings and garages, the open ground of Presbyterian Hospital enjoys exercise amenities and playgrounds under the shade of mature trees in semi-natural landscape adjacent to a stormwater pond. While both hospitals implemented stormwater management on their site, the landscape architecture of both contain some ARD components, which are less noteworthy due to their location, scale, and functionality. By contrast, the stormwater management design on the southern part of the Presbyterian Hospital campus provides an environment for gathering, walking, and exercise and creates a bio-habitat that greatly improves livability (see Table 17).

The typo-morphological analysis of the case studies illustrated that the campus of Presbyterian Hospital benefits from clean air and breezes through its semi-natural landscape. This densely planted area provides bird sanctuary and supports biodiversity (see Table 18). While the enclosed healing garden and fruit garden of Parkland hospital partially support biodiversity, they did not create a sanctuary for other species (see Table 18).

According to the landscape performance analysis, Presbyterian Campus is integrated and connected to the surrounding urban environments, while the Parkland and Baylor hospital sites are partially connected to the public spaces, and the Clements Hospital's site is disconnected. The stormwater management pond

at Presbyterian Hospital retains and collects surface runoff from throughout the campus to use for the irrigation of landscaped areas. The extensively landscaped grounds and stormwater ponds of Presbyterian hospital ecologically connect the campus to the city and create a biohabitat. It also promotes diverse activities for various age groups, from kindergarten to the elderly (se Tables 19 and 20). In Parkland hospital, separated landscaped areas create small, fragmented bio-habitats because the site planning prioritized automobile accessibility and disconnected the trails and sidewalk system from…. The gardens of Parkland Hospital provide ornamental water features and shaded areas that foster livability (see Tables 19 and 20).

The results and findings of the survey (predesign evaluation), have been classified into three sections, including the master plan's general considerations, environmental benefits, and social benefits. They address and discuss those strategies that improve the livability of a hospital landscape, with a special focus on HIE and ARD (see table 24 & 25). These findings are interpreted into design recommendations classified into three major categories, as Figure 93 illustrates. All major categories reveal various design and planning strategies that enhance and encourage the livability of a hospital's campus, and these are presented in Figures 93, 94, and 95.

Figure 93

General Classification of HIM Strategies and ARD That Improve the Livability of a Hospital Campus

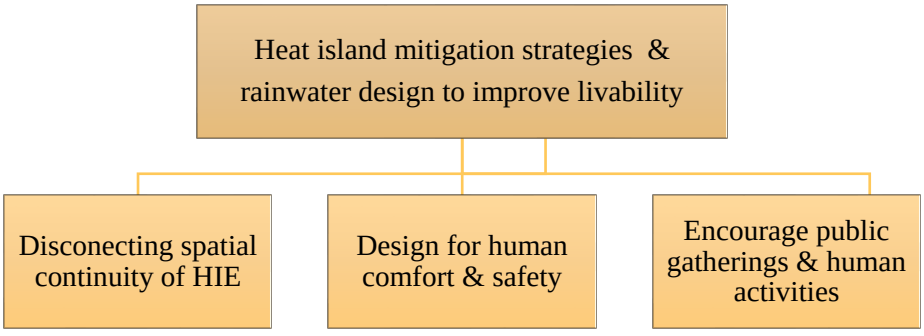


Figure 94

Design and Planning Strategies to Disconnect Spatial Continuity and Mitigate HIE on the Hospital Campus

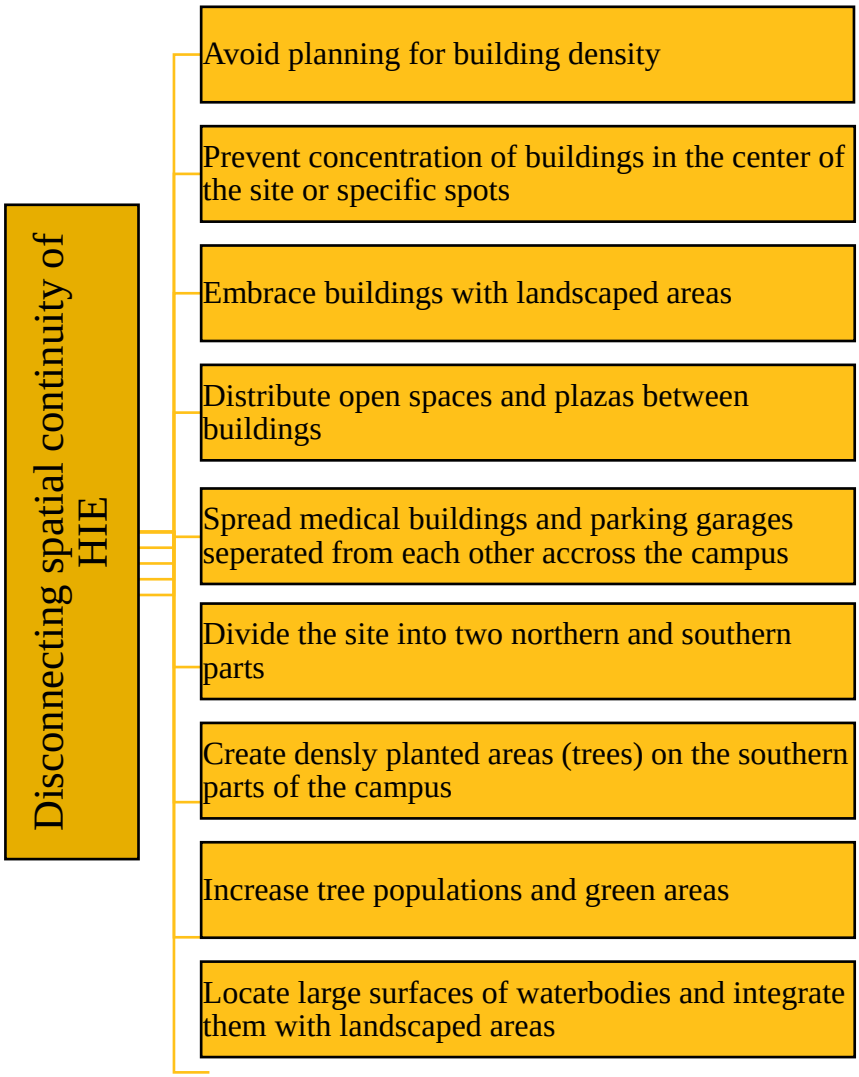


Figure 95

Planning and Design Strategies to Improve the Livability of the Site Via Considering Human Comfort and Safety

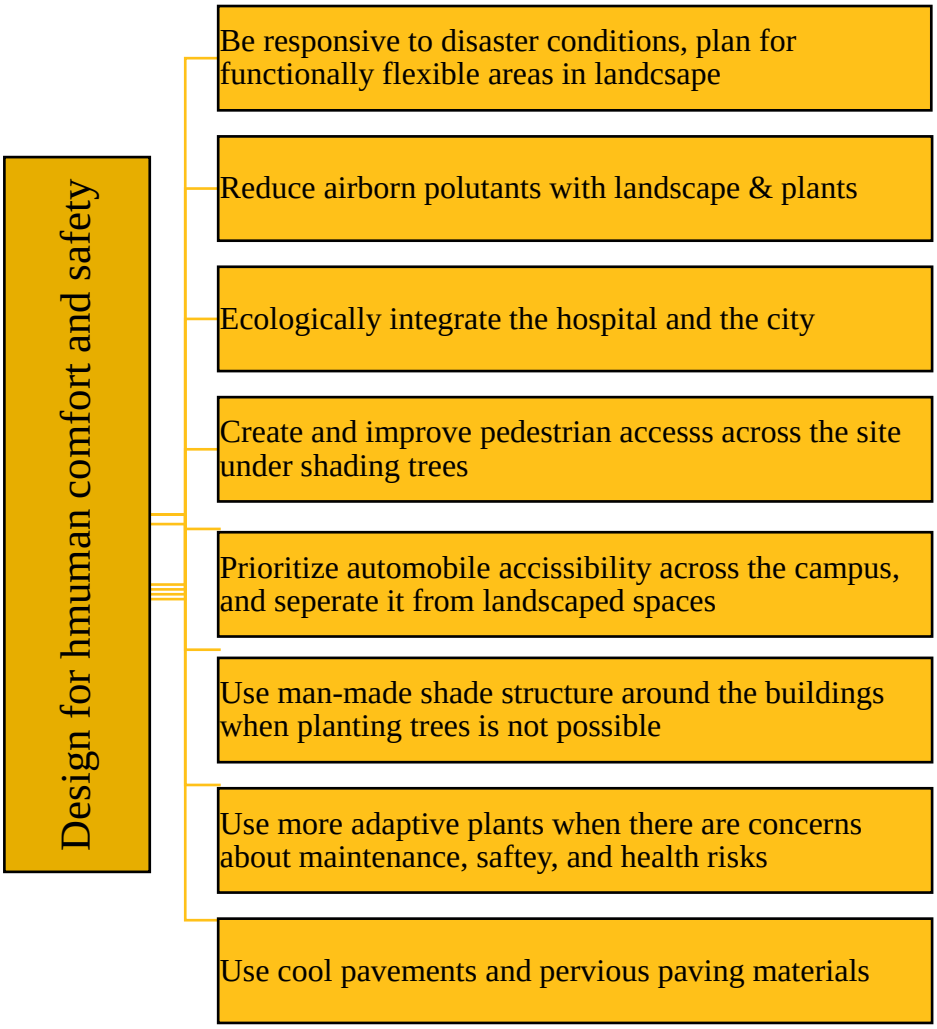
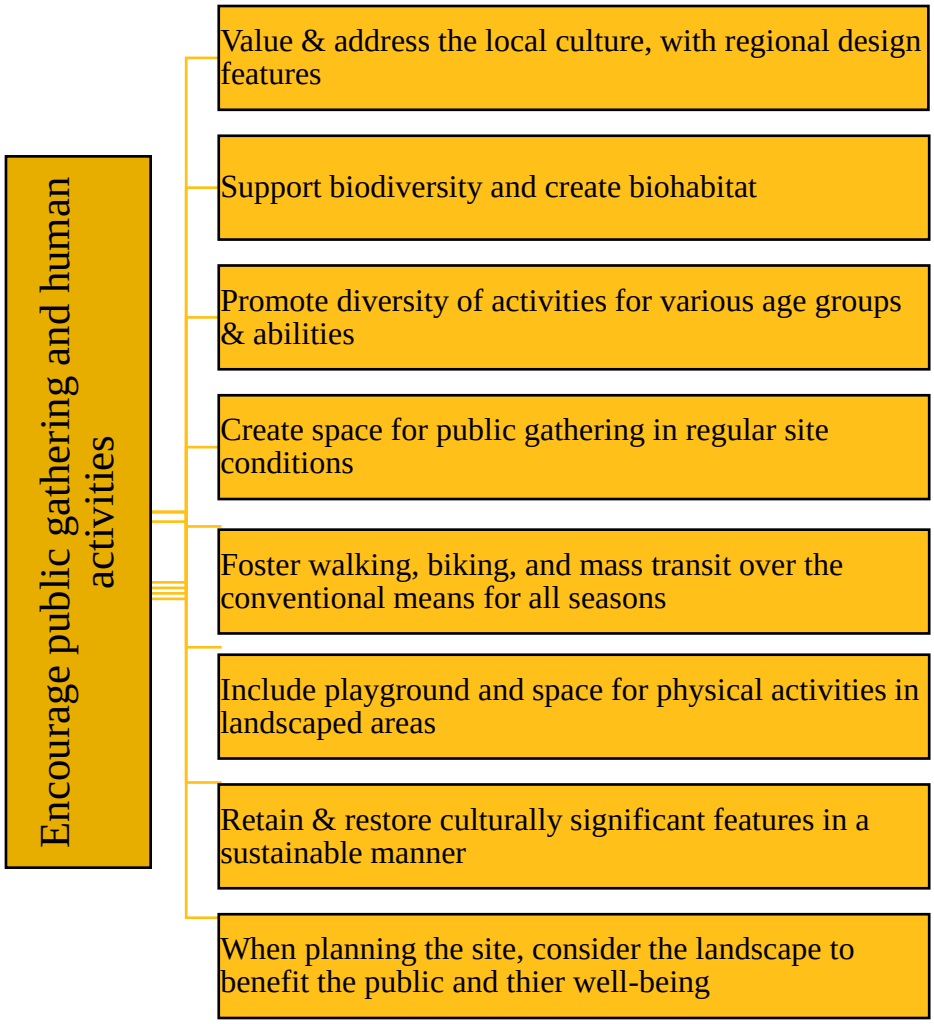


Figure 96

Planning and Design Strategies to Improve the Livability of the Site Via Encouraging Public Gathering and Human Activities



What Are the Most Important uconsiderations in North Texas for Using Views of the Garden in the Creation of Therapeutic Outdoor Environments in Hospitals?

This section illustrates the most important considerations in the creation of a therapeutic landscape with a special focus on improving garden views in hospitals' campuses in north Texas. According to the findings of this study, improving views in hospitals encourages therapeutic values in two ways. First, it

enhances the restorative properties of the landscape and outdoor environments. Second, it positively influences the healing characteristics of indoor spaces, such as patients' rooms and pavilions. This research classified those strategies that improve the livability of a hospital's landscape into three levels to include: environmental, social, and site master plan, which has been reexamined through case studies and the predesign evaluation.

The findings of the literature review discussed the restorative effects of natural elements viewed through the lens of the environmental psychology processes of attention restoration theory, aesthetic stimuli, and restorative emotional influences (see Table 8). According to those evidence-based studies, major restorative functions of gardens in healthcare facilities include stress-reducing functions, a sense of control over place, positive distractions, and improving human concentration (see Table 9). The studies show that hospital gardens have additional environmental benefits, such as increasing human comfort, improving daylighting design, reducing UV rays, cooling the air temperature, and mitigating the overall HIE on the site (see Table 10). The results of previous studies on healing environments presented the importance of connectivity between indoor and outdoor spaces, which can be achieved by increasing accessibility, views to the outdoors, and way-finding of landscape (see Table 10).

A review of the sustainable practices of four European and American healthcare facilities confirmed the theories studied in the literature review. These hospitals have implemented various design strategies to bring nature into their campus or to provide a maximum view of nature for indoor spaces. For example, while Paimio Sanatorium focused on the extensive views to a surrounding forest landscape, the Martini hospital developed its views around a green inner courtyard. In other examples, the Field Kirch State Hospital site plan interplayed between landscape and building form to create maximum views of the landscape and to take advantage of the topography. Likewise, Bon Seours St. Francis Cancer Institute has a central courtyard that was built with natural materials, creating views and a waterscape, and offering a walking path for a spiritual journey through a woodland (Table 13).

According to the findings of the precedent studies, planting trees was historically considered as a strategy to enhance the aesthetic qualities and landscape views of SWMD in Dallas, Texas. Both the streetscape master plan and the UT South Campus Restoration proposal aimed to connect the sites to urban spaces by developing green areas and gardens. Their approach to increase trees and other vegetated areas would enhance views of SWMD and UT SWMC and therefore improve the therapeutic properties of the sites (Table 14).

Finally, the precedent studies demonstrated that some design and planning strategies, such as surrounding buildings with gardens, can positively influence both the indoor and outdoor spaces of hospitals and visually connect gardens to interior spaces. These recommendations also propose connecting the site to the city via landscaped areas to improve the restorative values of hospital campuses, as well as designing permeable boundaries to invite people into the hospital's campus (Table 15).

This research examined four case studies to clarify the importance of views to gardens in modern hospitals in north Texas. According to the findings of the site inventory and site analysis, garden views played an important role in the landscape architecture of those contemporary projects. For example, in Parkland Hospital, the landscape was organized around the main medical building. The healing garden and entry garden were located as the focal points of its landscape. One was designed as the main pedestrian entry garden, with fruit-bearing trees and seating amenities that provide an extended view and vista. The second was designed as an enclosed healing garden that provides pleasing views and seating areas for the entry pavilion and food court.

The second example is Presbyterian Hospital, which provides extensive views of the landscape on both the north and south sides. The semi-naturalistic southern side features a stormwater pond and densely planted areas that extend into the surrounding urban context and neighborhoods. The north part was created as a savannah-like woodland that accommodates both pedestrian and automobile access within its welcoming and shaded environment. The transparent walls on the ground floor, as well as large and continuous windows on the upper levels, provide maximum views toward the garden and landscape. In the

third case study, two semi-enclosed courtyards of Baylor Hospital have been planted with trees and understory trees and have been connected both visually and ecologically to urban public space via a line of trees alongside the street. Both courtyards have transparent walls or windows provide maximum visibility and views to gardens.

Three reviewed case studies demonstrated the successful application of garden views in healthcare facilities on different scales. By contrast, the landscape architecture of Clements hospital did not benefit from sites, topography, or view to its open campus. The landscape architecture of the hospital also did not design pleasing views of the garden. It is noteworthy that the original landscape design of Clements University Hospital had an enclosed courtyard garden, which was replaced with a building.

The findings of the typo-morphological analysis of the four case studies examined person–nature engagement, the typology of the gardens, and the connectivity to the landscape in order to evaluate the importance of garden views in their therapeutic design. For example, viewing nature was emphasized in Parkland Hospital, while in other cases it gained less attention. As spatial comparative analysis and typo-morphological analysis of the case studies demonstrates, various types of healing gardens have been designed and constructed in Parkland, Presbyterian, and Baylor hospitals. However, they also show that the current campus design of Clements Hospital does not have any of these types of gardens (see Tables 16, 17, and 18).

Based on the results of the landscape performance analysis, it can be determined that the importance of healing gardens has been partially acknowledged in some cases such, as Baylor and Presbyterian hospitals. In Parkland hospital, the healing is a focal point, but in Clements hospital, the imperative to design a healing garden was ignored. Additionally, this landscape performance analysis illustrates that planning for different types of healing gardens can target a greater population and extend the therapeutic benefits of therapeutic landscapes to larger areas and more people (see Tables 19 20).

The findings of the predesign evaluation demonstrate that in the master plan phase, integrating and connecting the campus to its urban context via landscape architecture enhances the quality of views and

enhances the therapeutic properties of a site. It also concludes that prioritizing parking garages over surface parking provides more space for gardens, which improves the healing potential of the landscape. Other planning strategies that increase social benefits and heighten other therapeutic characteristics of hospital landscapes include the following:

1. improving the visual qualities of the landscape
2. including various types of healing gardens
3. diversifying garden design strategies, themes, and sizes
4. designing pleasing outdoor gardens to increase the healing values of indoor spaces
5. creating beautiful campus plans and landscapes to improve views and vistas of neighborhoods and communities.

Figure 97

Garden Views Improve the Therapeutic Properties of Hospital Sites Via Increasing Livability and Healing Value

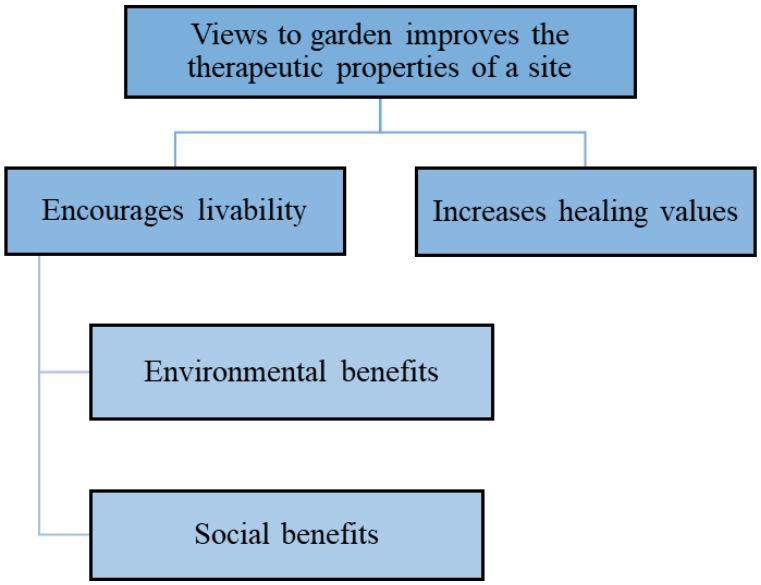


Figure 98

How Creating Views to Garden Improves the Restorative and Healing Properties of Space

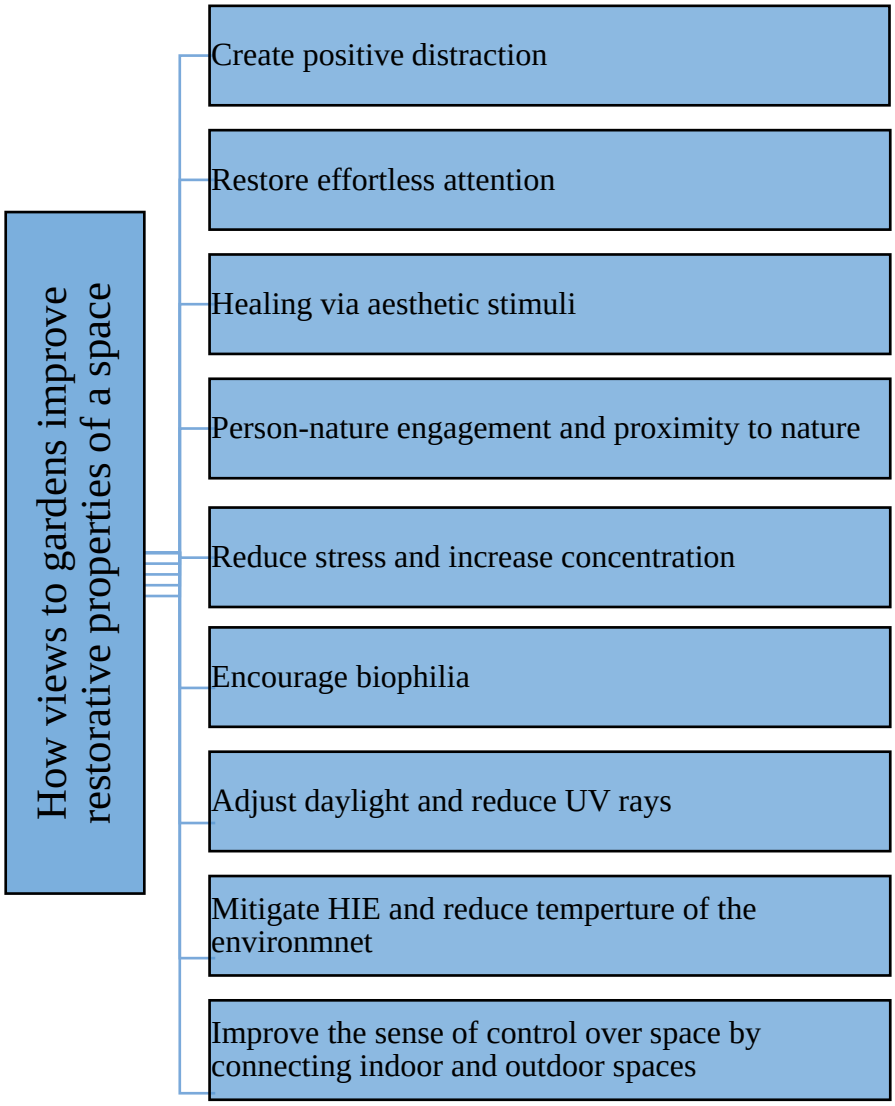
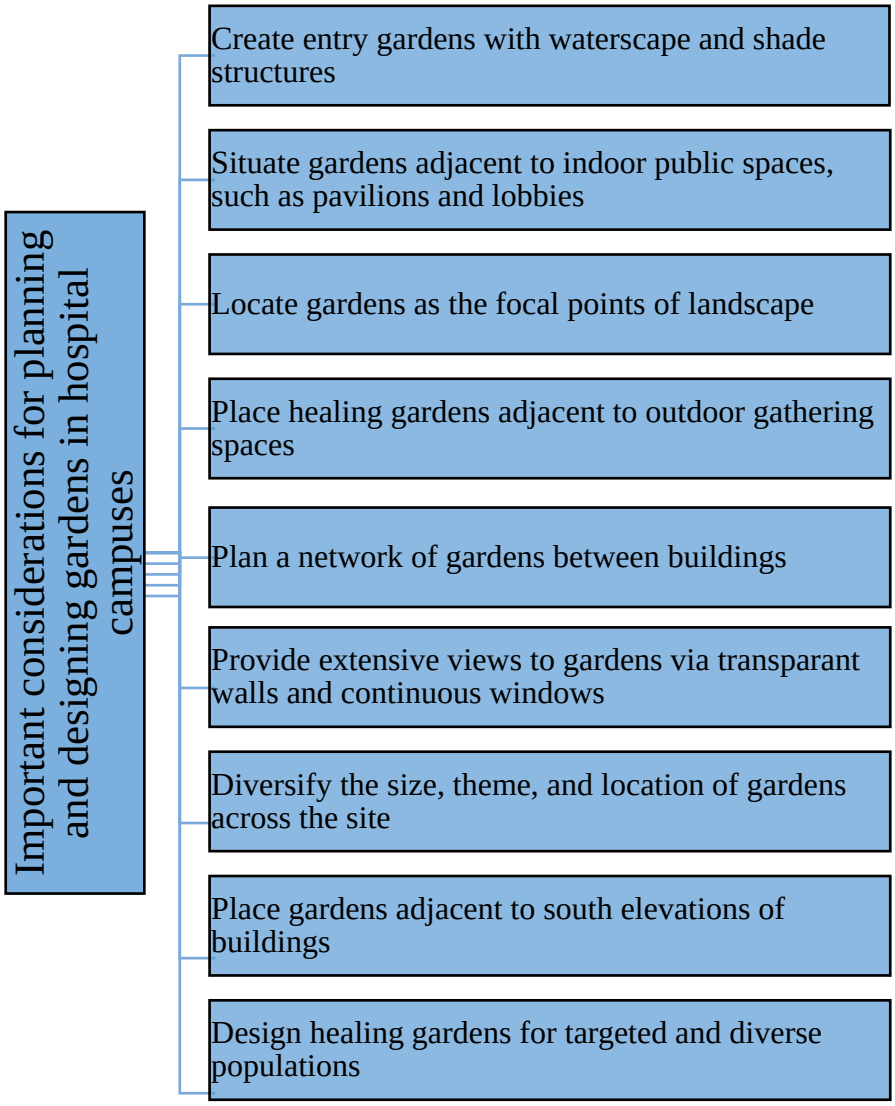


Figure 99

Important Considerations for Designing Gardens in Hospitals



To What Extent Can Improving the Landscape Performance of a Hospital Increase the Therapeutic Values of a Site?

To answer the third question, this research employed a qualitative method to measure the effectiveness of existing hospital landscapes in north Texas. It investigated the general planning, design

features, and landscape elements of case studies to define the effectiveness of sustainable solutions that encourage therapeutic properties of hospital campuses, directly improve environmental conditions, and increase human health and well-being. The inquiry focused on standard metrics that have been defined by The Landscape Architecture Foundation (2018) and evaluated literature, precedent studies, and case studies. The LAF guidebook suggests additional metrics, but this research focused on those that are more aligned with the objectives and purpose of the study.

According to the finding of the literature review, an extensively landscaped site plan improves the performance and increases therapeutic properties of a hospital campus in the following ways:

1. Maximizes views of nature and transparency of the building façade that faces green areas.
2. Increases active engagement with nature via trails, exercise amenities, and playgrounds.
3. Encourages livability by planning various types of healing gardens that address the hospital's specialties.
4. Increases human comfort by designing shade structures, shade from trees, and other architectural means.
5. Improves way-finding with ARD and addresses small-scale runoff on the site.
6. Encourages biodiversity via planting design and plant species.
7. Mitigates heat island effects through site zoning and building orientation.
8. Creates more social and public spaces.

The results of the precedent studies indicated that the site plan can reflect the identity of local communities and the culture of the city or neighborhood. A culturally informed design provides spaces for social gatherings and cultural events, heightens the sense of identity, and improves the social benefits of the site (see Table 12). The precedent studies present successful examples that implement effective design strategies, such as creating social spaces, including pavilions and lobbies that connect to prayer spaces and spiritual places in nature (see Table 13).

Both the Streetscape Master Plan for SWMD and the UT South Campus Restoration projects proposed similar planning solutions to improve the performance of the existing sites and increase well-

being and health. They targeted various performance metrics, including environmental metrics such as HIE mitigation, storm water treatments, creation of urban habitat, and safety. Their social metrics addressed human well-being, such as planning for a human-centric environment, increasing human comfort, walkability, and pedestrian accessibility (see table 14, & 15).

In this study, the landscape performance evaluation compared and integrated the results of a predesign evaluation, spatial comparative analysis, and site inventory to address the most important metrics and design features that improve the landscape performance of a hospital (see Table 29). Accordingly, it can be argued that improving social benefits and metrics showed a greater impact on landscape performance than environmental metrics (see Table 29). The social metrics that increase landscape performance and consequently improve therapeutic properties of a site are classified in two groups with greater and moderate impacts, as presented in the following figures.

Figure 100

Social Performance Metrics with Greater Therapeutic Impacts

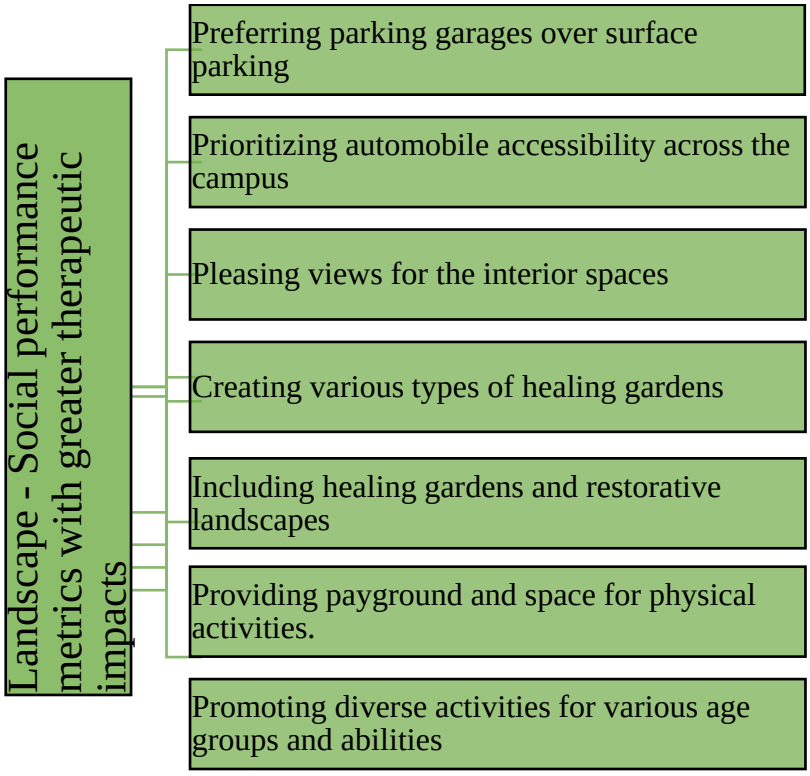


Figure 101

Landscape-Social Performance Metrics with Moderate Therapeutic Impacts

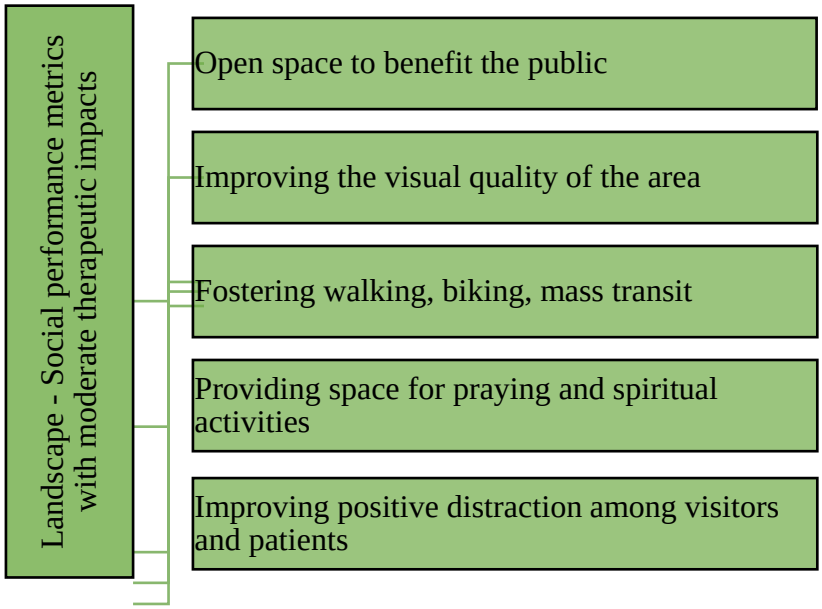
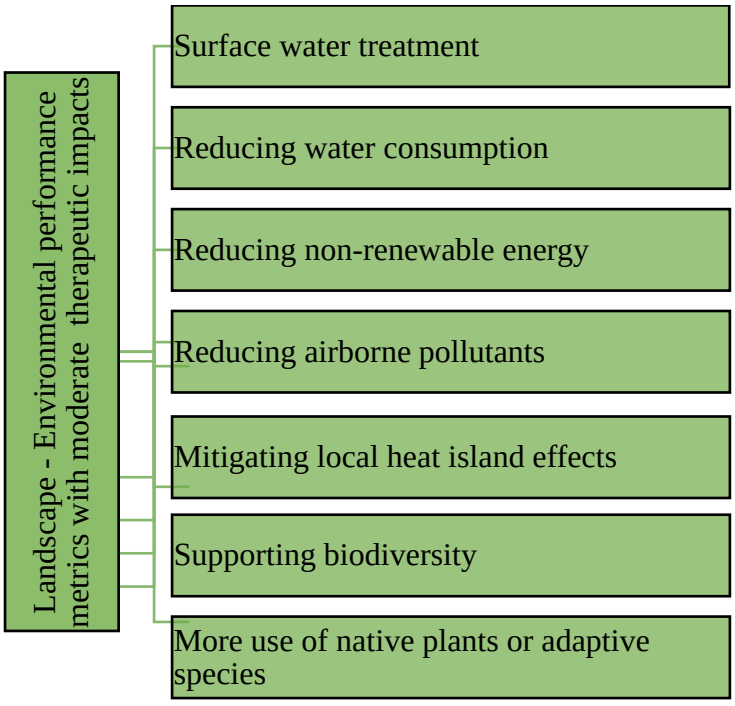


Figure 102

Environmental Performance Metrics with Greater Therapeutic Impacts



Revisiting the Research Hypothesis

This study had three hypotheses: The first hypothesis was that integrating sustainable strategies, such as HIM and ARD, improve the livability of the site by disconnecting spatial continuity of HIE, increasing human comfort and safety, and encouraging public gathering and human activities. The second hypothesis was that improving hospital gardens via applying an evidence-based approach can enhance the therapeutic properties of the site and encourage the livability of healthcare facilities via increasing environmental and social benefits. The third hypothesis was that the results would be generalizable and applicable to other hospital campuses in north Texas. The performance metrics, including the landscape-environmental and landscape-social metrics, can be applied with a therapeutic impact for north Texas.

Contribution to Literature

The existing literature on therapeutic environments did not specially discuss the impacts of sustainable practices and landscape performance on hospital sites. This study focused on two sustainable strategies of HIE mitigation and ARD and evaluated their effects on the healing properties of the case studies to generalize them to north Texas. It is noteworthy that while there have been many studies on HIE, less investigation has been done regarding the significance of ARD in hospital projects. The published studies did not thoroughly examine the importance of ARD strategies, but ARD implementation in the hospital landscape can improve visibility and way-finding, encourage positive distraction, and increase the attention and concentration of patients and staff. Additionally, ARD can educate people on public health issues and environmental preservation.

Contribution to Methodology

This research applied a qualitative multiple case-studies approach to investigate well-known examples of hospital campuses in north Texas. This study integrated a qualitative case study and evidence-based research to introduce a practical and replicable methodology for improving the livability of hospital sites. A triangulation strategy in data collection and data analysis was applied to improve the credibility of the hypothesis. This qualitative inquiry utilized both deductive reasoning (literature review, precedent study, and case study) and abductive inference (survey analysis) to expand the understanding of the relationship between therapeutic design practice and sustainable planning strategies. Therefore, a combination of multiple case studies, spatial-comparative analysis, and predesign evaluation methods was developed that focused on the landscape performance of hospital campuses to improve the livability and therapeutic properties of their sites.

Contribution to Design Practice

The results and conclusion of this study indicated that a combination of sustainable practices and therapeutic principles can incredibly improve the livability and healing values of hospital campuses in north Texas. The findings of this research generated a set of landscape design and planning recommendations generalizable to north Texas. These recommendations addressed HIE mitigation; ARD strategies include disconnecting the spatial continuity of HIE, improving human comfort and safety, and encouraging public gathering and human activities. The study then described the significance of garden views and their social and environmental benefits, which improve healing values of landscape in healthcare facilities. Finally, this study specified social and environmental landscape performance metrics and classified them according to their impact.

Figure 103

Landscape design recommendations 1

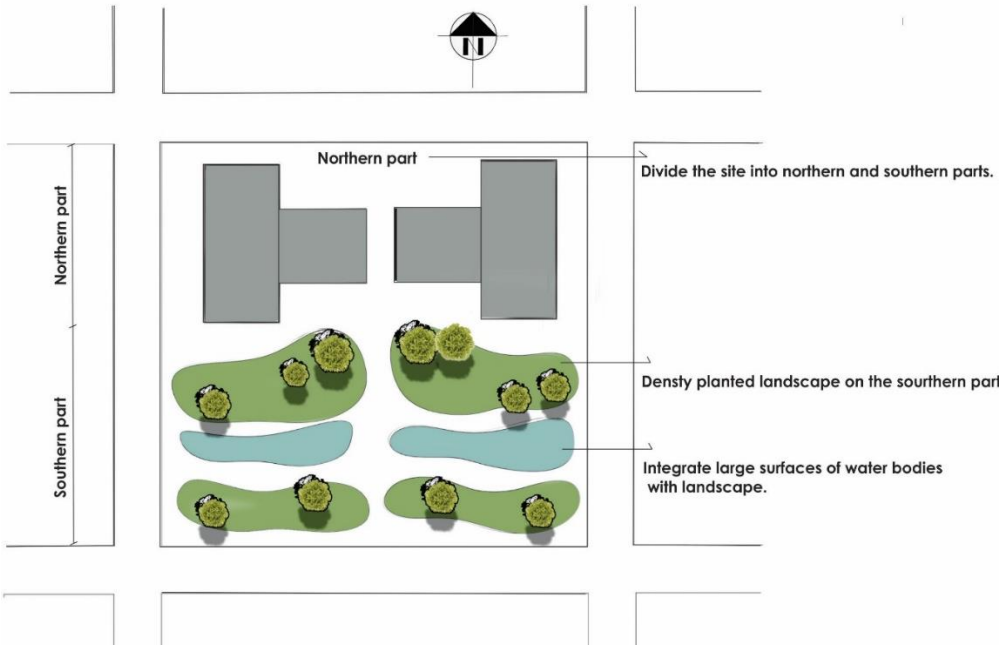
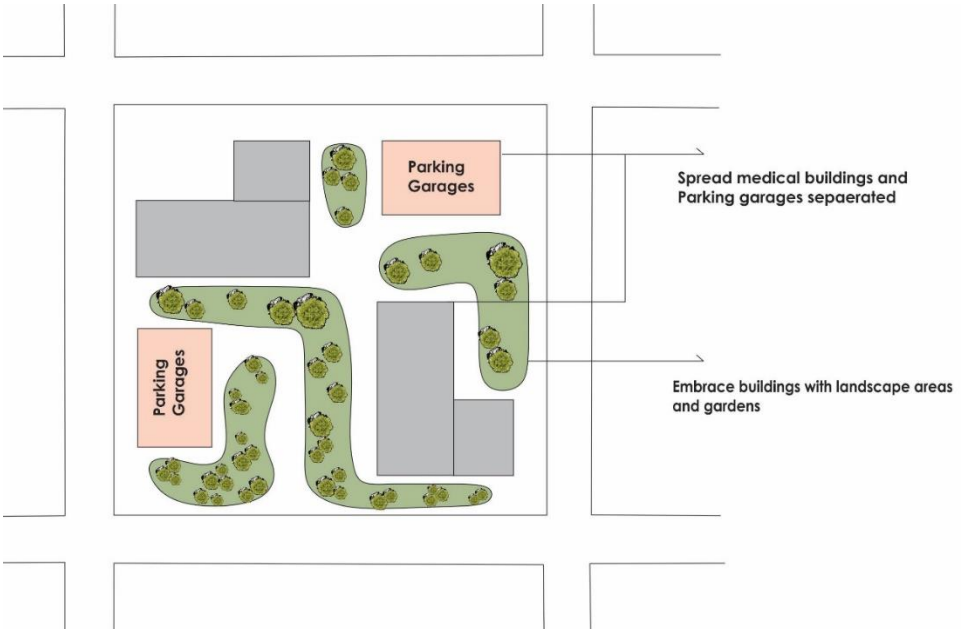


Figure 104

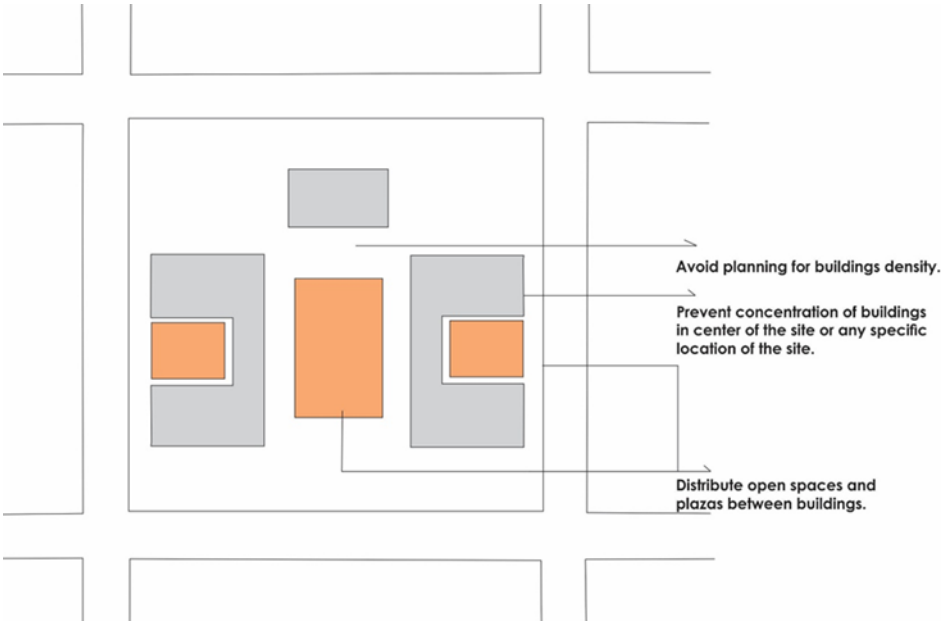
Landscape design recommendations 2



Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

Figure 105

Landscape design recommendations 3



Limitations

The limitations of this research include both methodological limitations and constraints of the researcher.

Methodological Limitations:

While implementing one specific method can produce biases in findings and conclusions, this thesis applied a qualitative approach to study hospital landscapes. Although this inquiry partially used the findings of evidence-based research, it would be more beneficial to interpret the findings of other quantitative methods and use their data to support this research.

Generally, in qualitative case study methods, the number of samples is limited. During the spatial-comparative and typo-morphological analyses, studying more hospitals in north Texas could improve the

representative distribution of the examined population and increase the generalizability of the conclusion. Therefore, the section of the precedent study expanded to and included four other well-known examples of hospitals.

This qualitative methodology established criteria and standards based on the literature review to apply for site analysis. The process of generating the criteria was limited to the available literature and the knowledge of the researcher. This could potentially be a source of biases or ignoring other important aspects. To mitigate the impacts of this problem, the findings of the literature review were evaluated against the results of precedent studies.

Although many studies of therapeutic environments, healing gardens, and hospital design have been published, the lack of current research on hospital landscape design focusing on HIE mitigation, and ARD practices were major constraints during the data collection phase. It should be acknowledged that there is a deficiency regarding ARD implementation in hospital sites, which can be an opportunity for future studies.

Although this study benefited from evidence-based published research, the data collection methods such as site inventory and site analysis are considered as self-reported data, which cannot be independently verified. Therefore, to remediate its negative effects on findings, a pre-design questionnaire survey was disseminated among key experts, such as landscape professionals and academicians with therapeutic design experience and expertise.

Constraints of the researcher:

This study started in September 2020 and finished in April 2021. During this period, all hospitals in north Texas were affected by the COVID-19 pandemic. Therefore, the access to the sites and especially inside the hospitals to evaluate the garden views were restricted. Additionally, due to organizational regulations of Clements University Hospital in Dallas, the facility managers and site engineers were not able to participate in the survey and give feedback regarding the landscape performance of the existing site. To avoid the negative effects of these limitations on the conclusions, this research increased the number of

case studies in north Texas and disseminated the survey questionnaire among healthcare architects, landscape architects, and planners.

This study has been subjected to temporal effects. For example, the defense due date, other school obligations, and delays resulting from personal health issues of the researcher, as well as a winter storm in Texas, were constraints that affected the time devoted to the study. To complete the study on time, the literature review and precedent studies were narrowed down to site planning and overall design of the hospital landscapes with a focus on HIE and ARD practices in north Texas.

Negative Results

One of the negative results that unexpectedly challenged the hypothesis and findings of this study was generated from the responses of the survey. According to Table 22, 47% of respondents were architects and urban planners with less knowledge and expertise regarding landscape elements such as plants or sustainable landscape practices such as ARD. The contradictions in responses between landscape architects and architects did not suppress the overall findings and conclusions but imply that their answers require additional interpretation and comparison.

Recommendation for Future Research

This research intends to provide a framework to understand the integration of sustainable strategies, such as HIM, artful rainwater design, and improving views of hospitals' gardens, by applying an evidence-based approach that can enhance the therapeutic properties and improve the livability of healthcare facilities.

First, although the conclusion of this study was proposed for hospital landscapes, it could be fruitful to examine and use this methodology for urban parks or other public green spaces.

Second, as mentioned, integrating some quantitative methods and data into qualitative studies will improve the validity of the results.

Third, the literature review and precedent studies reviewed HIE mitigation and stormwater management strategies that improve livability and healing values of a site. More qualitative and quantitative investigations with a special focus on patient and medical staff satisfaction and well-being would be beneficial.

Fourth, integrating hospital landscapes into their urban communities and increasing connectivity to their surrounding neighborhoods will not only enhance the therapeutic impacts of hospital landscapes, but also improve their socio-cultural roles. Therefore, future studies on typologies and an in-depth investigation of the socio-cultural significance of hospital landscapes will be valuable.

Fifth, the findings of this research revealed there is a deficiency regarding ARD implementation in hospital sites, which can be an opportunity for future studies.

Finally, according to the results and findings of this study, there are contradictions in responses between landscape architects, architects, and urban planners that require additional interpretation and comparison.

APPENDIX 1

IRB APPROVAL OF MINIMAL RISK: PROTOCOL #2021-0242

UNIVERSITY OF TEXAS ARLINGTON | OFFICE OF RESEARCH ADMINISTRATION REGULATORY SERVICES

2/24/2021

IRB Approval of Minimal Risk (MR) Protocol

PI: Reza Mabadi
Faculty Advisor: David Hopman
Department: Planning and Landscape Architecture
IRB Protocol #: 2021-0242
Study Title: *Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating Artful Rain Harvesting and Heat Island Mitigation approaches in landscape design.*

Effective Approval: 2/24/2021

The IRB has approved the above referenced submission in accordance with applicable regulations and/or UTA's IRB Standard Operating Procedures.

Principal Investigator and Faculty Advisor Responsibilities

All personnel conducting human subject research must comply with UTA's IRB Standard Operating Procedures and RA-PO4, Statement of Principles and Policies Regarding Human Subjects in Research. Important items for PIs and Faculty Advisors are as follows:

- **Notify Regulatory Services of proposed, new, or changing funding source**
- Fulfill research oversight responsibilities, IV.F and IV.G.
- Obtain approval prior to initiating changes in research or personnel, IX.B.
- Report Serious Adverse Events (SAEs) and Unanticipated Problems (UPs), IX.C.
- Fulfill Continuing Review requirements, if applicable, IX.A.
- Protect human subject data (XV.) and maintain records (XXI.C.).
- Maintain HSP (3 years), GCP (3 years), and RCR (4 years) training as applicable.

REGULATORY SERVICES | The University of Texas at Arlington, Center for Innovation
202 E. Border Street, Suite 300, Arlington, Texas 76010, Box #19188
(Phone) 817-272-3723 (Email) regulatoryservices@uta.edu (Web) www.uta.edu/rs

APPENDIX 2

HUMAN SUBJECT PROTECTION TRAINING-(HSP)

The University of Texas ARLINGTON™

Human Subjects Protection Training (HSP) Training Complete

This document certifies that Reza Mahadi completed the training entitled "Human Subjects Protection Training (HSP)" in its entirety on January 9th, 2021.

Certificate ID 5f43b4e5f655bae9882fc5a6c52b6b was generated by Electronic Research Administration on behalf of The University of Texas at Arlington.

APPENDIX 3

INFORMED CONSENT FOR MINIMAL RISK STUDIES WITH ADULTS

The University of Texas at Arlington (UTA)

Informed Consent for Minimal Risk Studies with Adults

My name is Reza Mabadi, and I am asking you to participate in a UT Arlington research study titled, "Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating Artful Rain Harvesting and Heat Island Mitigation approaches in landscape design." This research study is about evaluating and examining the implementation of Heat Island Mitigation (HIM) and Artful Rain Design (ARD) strategies to enhance the therapeutic properties of a hospital site. You can choose to participate in this research study if you are at least 18 years old and have a professional degree in landscape architecture or planning and design.

Reasons why you might want to participate in this study include

- To assist the researcher developing a holistic approach to integrate therapeutic design principles and sustainable planning strategies for the landscape design of healthcare in North Texas.
- To help introducing and address the full extent of potential healing benefits of landscape design into the heath care facility design.
- To suggest practical and replicable design methods for improving the restorative properties of existing hospitals and new facilities in North Texas.
- To participate creating guidelines for designing extensive therapeutic landscapes in healthcare settings.

but you might not want to participate if you are uncomfortable answering multiple answer questions based on your professional experiences , academic expertise or if you are not able to commit to taking a survey between 5-8 minutes in one sitting. Your decision about whether to participate is entirely up to you. If you decide not to be in the study, there won't be any punishment or penalty; whatever your choice, there will be no impact on any benefits or services that you would normally receive. Even if you choose to begin the study, you can also change your mind and quit at any time without any consequences.

If you decide to participate in this research study, the list of activities that I will ask you to complete for the research are (1) Complete the consent form (2) Select "I agree" (3) Answer the question as you wish, (4) Submit your responses after finishing. It should take about 6-8 minutes. Although you probably won't experience any personal benefits from participating , the study activities are not expected to pose any additional risks beyond those that you would normally experience in your regular everyday life or during routine medical / psychological visits. All the questions that I will ask are about non-sensitive information. You will not be paid for completing this study. There are no alternative options to this research project.

The researcher is committed to protecting your rights and privacy as a research subject. I may publish or present the results, but your name will not be used. Although no identifiable information will be collected, the data will be stored in sanctioned cloud services such as UTA O365 OneDrive. The data will not be shared with other parties. The data will only be used for academic purpose and for MLA thesis. While absolute confidentiality cannot be guaranteed, the research team will make every effort to protect the confidentiality of your records as described here and to the extent permitted by law. If you have questions about the study, you can contact me at rxm2133@mavs.uta.edu, or 682.324.1060. For questions about your rights or to report complaints, contact the UTA Research Office at 817-272-3723 or regulatoryservices@uta.edu.

The subject's consent:
Ex: You are indicating your voluntary agreement to participate by completing and returning the survey.

APPENDIX 4

PRE-DESIGN EVALUATION: THE SURVEY AND QUESTIONNAIRE SCRIPT

This survey questionnaire aims to address the four major design considerations and planning criteria for the landscape architecture of hospital sites. This questionnaire partially collects the required data for a Master's thesis in landscape architecture. The thesis intends to address the livability and healing values of the existing landscape of the Clements University Hospital through evidence-based research and examines the generalizability of this method for other hospital campuses in Northern Texas. It also intends to generate a design guideline for healthcare facilities. This survey questionnaire qualitatively measures the landscape performance of the existing site according to the pre-established criteria that were provided by the Landscape Architecture Foundation (LAF), including environmental, social, and economic benefits in addition to general planning principles. This study does not intend to survey medical staff, doctors, and patients, and it never involves them.

This survey questionnaire specifically targets key informants such as landscape architects, designers, and educators in the field of landscape architecture, planning, and site development in addition to those architects that have experience in healthcare design and planning.

Important considerations of this survey are as follows:

A. Before disseminating the survey questionnaire, the pilot study has been performed, and the site has been visited two times.

B. Before disseminating the survey questionnaire, IRB approval has been obtained.

C. All respondents have the right to remain anonymous if they wish or to stop answering at any time.

D. The only focus of this survey is on measuring the landscape performance, and this survey does not ask personal questions and does not solicit any data about human subjects such as private and personal information about patients or medical personnel and medical procedures.

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

The questions

When you design a hospital's landscape in a dense constructed urban environment such as Dallas, North Texas, the United States, how do you rate the level of importance of the following design and planning criteria?

Part one: ***General Considerations***

1-1- The master plan should **integrate and connect the campus to the surrounding urban landscape.**

Less important Fairly Important Important Very important

1-2- The master plan should **prioritize providing enough parking garages over surface parking**.

Less important Fairly Important Important Very important

1-3- The master plan should **carefully respond to the local climate conditions**.

Less important Fairly Important Important Very important

1-4- The master plan should **prioritize automobile accessibility across the campus**.

Less important Fairly Important Important Very important

1-5- The master plan should **value and address the local culture**.

Less important Fairly Important Important Very important

1-6- The master plan should **contain artistic elements and present artworks to improve positive distraction among visitors and patients**.

Less important Fairly Important Important Very important

1-7- The master plan should **include healing gardens and restorative landscapes**.

Less important Fairly Important Important Very important

1-8- The master plan should **develop the landscape as a green infrastructure**.

Less important Fairly Important Important Very important

1-9- The master plan should be **responsive to disaster conditions**.

Less important Fairly Important Important Very important

1-10- The master plan should be **adaptable to climate change effects in the future**.

Less important Fairly Important Important Very important

1-11- The master plan should maximize the **use of manmade shade structures.**

Less important Fairly Important Important Very important

1-12- The master plan should **reduce hardscape and increase green areas.**

Less important Fairly Important Important Very important

……...

Part two: ***Environmental Benefits***

2-1- The design should **limit site disturbance and use existing infrastructure when possible**.

Less important Fairly Important Important Very important

2-2- The site design should **prioritize remediation of degraded soil and protection of undisturbed soil**.

Less important Fairly Important Important Very important

2-3- The site design should **retain, detain, and treat runoff and surface water**.

Less important Fairly Important Important Very important

2-4- The site design should **reduce water consumption for irrigation and fountains**.

Less important Fairly Important Important Very important

2-5- The site design should **apply "Artful Rainwater Design"**.

Less important Fairly Important Important Very important

2-6- The site design should **protect and encourage the creation of a functional ecosystem in the hospital campus**.

Less important Fairly Important Important Very important

2-7- The site design should **ecologically integrate the hospital and city**.

Less important Fairly Important Important Very important

2-8- The site design should **support biodiversity**.

Less important Fairly Important Important Very important

2-9- The site design should **reduce non-renewable energy consumption**.

Less important Fairly Important Important Very important

2-10- The site design should **reduce airborne pollutants**.

Less important Fairly Important Important Very important

2-11- The site design should **mitigate local heat island effects**.

Less important Fairly Important Important Very important

2-12- The site design should **prefer more native plants.**

Less important Fairly Important Important Very important

2-13- The site design should **use more adaptive plants over other species.**

Less important Fairly Important Important Very important

2-14- The site design should **encourage planting trees and reducing lawn areas.**

Less important Fairly Important Important Very important

2-15- The site design should **include ornamental water features**.

Less important Fairly Important Important Very important

……...

Part three: ***Social Benefits***

3-1- The site design should **promote divers of activities for various age groups and abilities.**

Less important Fairly Important Important Very important

3-2- The site design should **retain, restore culturally significant features, areas, practices, and views**.

Less important Fairly Important Important Very important

3-2- The site design should create **spaces for public gatherings**.

Less important Fairly Important Important Very important

3-4- The site design should **improve the visual quality of the area**.

Less important Fairly Important Important Very important

3-5- The site design should **foster walking, biking, mass transit over conventional automobile use**.

Less important Fairly Important Important Very important

3-6- The site design should **create or improves pedestrian access to facilities and amenities.**

Less important Fairly Important Important Very important

3-7- The site design should **include a playground and space for physical activities.**

Less important Fairly Important Important Very important

3-8- The site design should **include spaces for praying and spiritual activities.**

Less important Fairly Important Important Very important

3-9- The site design should **consider the landscape of the hospital as an open space to benefit the public.**

Less important Fairly Important Important Very important

3-10- The site design should **include different types of restorative, healing gardens for targeted populations.**

Improving the livability and therapeutic properties of hospital campuses in North Texas by integrating artful rain harvesting and heat island mitigation approaches**.**

Less important Fairly Important Important Very important

3-11- The site design should **provide pleasing views for the interior spaces of the hospital.**

Less important Fairly Important Important Very important

3-12- The site design should **create beautiful views and vistas for surrounding urban environments.**

Less important Fairly Important Important Very important

……*This is the end of the questions*…….

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