NORTH TEXAS STAKEHOLDERS: PERCEPTIONS OF EXTENSIVE GREEN ROOFS

by

MATTHEW HEATH HOUSE

Presented to the Faculty of the Graduate School of
The University of Texas at Arlington in Partial Fulfillment
of the Requirements
for the Degree of

MASTER OF LANDSCAPE ARCHITECTURE

THE UNIVERSTITY OF TEXAS AT ARLINGTON

December 2009

ACKNOWLEDGEMENTS

First, a huge thanks to my family. Mom and Dad, your generous and unhesitating support, both emotional and financial, has kept me going during the past three years of my graduate school education, none of this would have been possible without you. And my brothers and their families, you may not know it, but you all have given me the confidence and strength to tackle any challenge in life that comes my way. And thank you to Ryan for believing in me and helping me feel I've found the right path. And for helping in whatever way was needed most, whether it was dinner, supplies, or just being there when I needed a shoulder to lean on. To my sister, Whitney, for taking care of "the boys;" to my nieces and nephews for never failing to put a smile on my face; and to my friend for the past fifteen years, Courtney, for reminding that there's always gold at the end of the rainbow.

Many thanks to my professors at UTA, especially my thesis committee: David Hopman, who has always encouraged me in school and has guided me through the thesis process; Dr. Pat Taylor for his enthusiasm for research and for many helpful discussions; and Dr. Taner R. Ozdil for always challenging me to push further and dig deeper. Thanks to David Hocker for showing me that design can be elegant and have meaning; and to Gary Robinette whose knowledge of the profession of landscape architecture is truly a treasure to the profession. And thanks to Peter Walker for giving me the opportunity to see how a landscape architecture firm works and sharing his brilliant thoughts. And finally, thank you to my classmate Shawn for all your support and the countless hours we spent together over the past three years, you are one in a million.

November 20, 2009

ABSTRACT

NORTH TEXAS STAKEHOLDERS: PERCEPTIONS

OF EXTENSIVE GREEN ROOFS

Matthew Heath House, M.L.A

The University of Texas at Arlington, 2009

Supervising Professor: David Hopman

Green roofs are not a new technology. The first recorded green roof was the Hanging Gardens of Babylon built by King Nebuchadnezzar for his wife Amyitis who missed her lush homeland (Osmundson 1999). However, since the late 1990s, the term green roof has taken on ecological and social significance beyond its seemingly simplistic description. The term has become an epithet for the reduction of pollution and urban heat islands, for large scale mitigation of storm water run-off, and for maximum utilization of urban land (Cantor 2008).

This research examines perceptions about extensive green roofs held by developers, city officials, architects, and landscape architects in the North Texas region. These professionals offer a set of characteristics that make them uniquely important to the decision making process in the areas of finance, public policy, and design and building practices. Everett Rogers states in his book *Diffusion of Innovations* (2003), that an innovation will have a higher rate of adoption if it is perceived to have a relative advantage over existing strategies, if it is compatible with existing beliefs and values, if it is not perceived as being too complex, if it can be tried on a small scale first, and if it can be seen in place and working in other situations.

To gather perceptions of extensive green roofs in North Texas, qualitative methods were employed. Interviews were conducted with key stakeholders and decision makers in the Dallas/Ft. Worth area. Transcripts of the interviews were analyzed according to Rogers' (2003) theory regarding the diffusion of innovations.

The data showed that stakeholders perceived extensive green roofs as being appropriate for use in North Texas. Concerns were raised regarding plant selection, weight requirements, initial cost, city codes, and aesthetics. Developers and city officials indicated their concern for the performance of green roofs in the extremes of the North Texas climate, while architects and landscape architects spoke of the multitude of benefits and appropriateness for this region. Overall, perceptions of extensive green roofs were favorable, but a lack of adequate research and concerns over cost issues were frequently cited as barriers to implementation.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

1.1.1 History of Green Roofs

Green roofs are not a new technology. The first recorded green roof was the Hanging Gardens of Babylon built by King Nebuchadnezzar for his wife Amyitis who missed her lush homeland Persia (Osmundson 1999). The Nordic Vikings covered their dwellings and great halls with sod for insulation from the ninth through eleventh centuries. Sod structures, most likely an adaptation from Scandinavia, have also been used for cabins in Alaska and were popular among the upper class throughout the Renaissance. (Partnow 2004). More recently, sod roofs were used throughout North America in the 1800s because sod was more available than timber (Conrad 1991). In the 1930s, the British used living roofs for camouflage on military installations, and the Germans installed roof gardens on residences (Frith and Gedge 2005). In sum, living roofs are not a recent innovation, but a straightforward, simple technology with a history and a wide implementation of uses (Oberndorfer, et al. 2007).

Although living roofs have been documented by many ancient civilizations (Dunnett and Kingsbury 2008), it was only after the development of modern building materials and techniques that more extensive creation of rooftop gardens began. With the development of concrete as a roofing material in the mid-1800s, flat-roofed buildings well suited for green roofs began to be constructed in major cities throughout Europe and America.

It wasn't until the twentieth century, however, that improved building techniques promoted the dominance of flat roofs in urban development. The widespread construction of flat roofs that could support relatively large loads led to the development and expansion of roof gardens or intensive green roofs. They were primarily installed for aesthetic reasons and required solid, expensive materials and intensive garden maintenance (Herman 2003). In the second half of the

twentieth century, technology enabled the construction of urban plazas that are, in effect, huge rooftop landscapes in a form that is generally unrecognized by the general public over underground parking lots, roads, and subways (Dunnett and Kingsbury 2008).

This research is not focused on the high-input intensive roof garden. Rather, this research focuses on a different tradition of roofs of the low-input extensive green roof variety—the grass, turf, or sod roof. Grass roofs have been a feature of the vernacular architecture of certain geographic regions—notably Scandinavia and The Fertile Crescent, areas of Turkey, Iraq, Iran, and neighboring countries occupied by Kurdish-speaking peoples (Dunnett and Kingsbury 2008)—for centuries, probably millennia. Mud or earth is a traditional building material in this region. Flat, mud-covered roofs often become colonized with grasses, producing the turf-roof effect. The combined soil and grass on Scandinavian roofs helped reduce heat loss during the long, dark winters (Dunnett and Kingsbury 2008). Traditional Kurdish turf roofs serve to keep in heat during the winter and keep out the burning sun in summer months. Scandinavian immigrants to the United States and Canada brought these ideas with them, and for some time, grass roofs were used on settler log cabins (Cantor 2008).

Traditional houses in China and Japan have also featured rooftop greenery. In Japan, summer rainfall can be very intensive and potentially damaging to roofs made of thatch and other organic materials. However, the rain and high humidity levels were traditionally put to good use, as a number of plants were grown on roofs, their roots serving to bind and strengthen the structure (Cantor 2008).

In Scandinavia, turf grass was basically seen as a cheap, readily available building material. Together with layers of birch bark and twigs or straw, it functioned well to keep the rain out of small houses and cottages. Built over closely fitting wooden boards, the construction of these roofs in some way resembled that of the modern extensive green roof. The birch bark functioned as the sealing membrane, the twig layer as drainage, and the turf cut from a meadow was used as insulation for the house and protected the lower roof layers from the wind and sunlight that otherwise would have reduced the lifespan of the roof (Dunnett and Kingsbury 2008). Various species of

Sedum, Sempervivum, and Jovibarba were sometimes planted on the roofs because their roots had a reinforcing effect on the soil layer. According to Dunnett and Kingsbury (2008), documents show that even Rye (*Secale cereale*) was deliberately sown to reinforce the soil layer. The down side to these grass roofs was that they needed regular maintenance. Grass vegetation had to be cut and spontaneously established trees had to be removed. Vegetated roofs with high organic content and dense grass vegetation were also highly flammable and their lifetime limited. They needed to be changed after twenty years, mainly due to decomposition of the sealing birch-bark layer (Emilsson, 2003).

1.1.2 Contemporary Green Roofs

The origins of the contemporary green roof can be linked most directly to those of the European countries. The combination of an environmentally-aware public, radical pressure from ecological groups, and scientific research resulted in the technology and means for green-roof development, and a social and political climate that fostered and promoted their implementation. The 1960s and 1970s saw a number of projects in Germany and Switzerland that included experiments with new ways of integrating plants and buildings (Dunnett and Kingsbury 2008).

Since the formulation of the distinction between the extensive and intensive styles in the mid-1970s, extensive green roofs have been the focus of most research (Cantor 2008). An important development was the 1977 creation of a green roof study group within the FLL (Forschungsgesellschaft Landschaftesentwicklung Landschaftsbau (The Landscape Research, Development, & Construction Society)), a German-based body which acts as an umbrella organization for research into landscape construction, the definition of specifications, and the setting of industry-wide standards (Dunnett and Kingsbury 2008)

Research into green roofs in Germany was part of a wider movement that recognized the ecological and environmental value of urban habitats and in particular, the benefits to the plants and wildlife of what many people still regard as wasteland or derelict sites (Dunnett and Kingsbury 2008). One of the urban habitats that received attention was the spontaneous flora that developed on gravel- or ballast-covered flat roofs. Later work in the 1960s investigated the techniques and

practicalities of growing plants in thin substrate layers on roofs. From the late 1970s on, research established that roof greening has many benefits, particularly in energy conservation and minimizing water run-off. At the same time, a number of companies began to offer specialized roof-greening services to undertake product development and establish research programs. The modern commercial extensive green roof, which is usually sedum-based, is the result of this product development. While technically dependable, the uniformity and flatness of the modern green roof is a far cry from the more “shaggy,” variable, and diverse origins of roof greening in Germany (Wermann 2007).

In recent times, the concept of growing plants on roofs has moved out of a marginal social position. As many of the ideas of the counter-culture and the environmentalist movement are taken up by mainstream society, the practical advantages are increasingly appreciated and are increasingly being subjected to rigorous scientific and economic evaluation (Dunnett and Kingsbury and Kingsbury 2008). One of the ways in which environmentalist ideas have moved into mainstream thinking is in the areas of environmental costs—the idea that pollution and other damage to the environment is not just damaging to nature, but to the economy as well, as usable resources are adversely affected.

Since the late 1990s, the term green roof has taken on ecological and social significance beyond its seemingly simplistic description. The term has become an epithet for the reduction of pollution and urban heat islands, for large scale mitigation of storm water runoff, and for maximum utilization of urban land (Cantor 2008).

In 1999, Green Roofs for Healthy Cities Inc., a small network consisting of public and private organizations, was founded as a direct result of a research paper written on the benefits of green roofs and the barriers to industry development entitled "Greenbacks from Green Roofs" and prepared by Steven Peck, Monica Kuhn, Dr. Brad Bass, and Chris Callaghan (Green Roofs for Healthy Cities 2009). Green Roofs for Healthy Cities’ mission is to increase awareness of the economic, social, and environmental benefits of green roof infrastructure across North America and to advance the development of the market for green roof products and services. In addition, they are

motivated to facilitate changes that will bring green roof technologies to the forefront of high performance green building design, implementation, and maintenance.

Furthermore, the U.S. Green Building Council (USGBC) has developed a Leadership in Energy and Environmental Design (LEED) green building rating system to encourage and accelerate global adoption of sustainable green building practices by creating a recognized standard for measuring building sustainability. The LEED rating system offers four certification levels for new construction: Certified, Silver, Gold, and Platinum. Each level corresponds to the number of credits earned in five categories—sustainable sites, water efficiency, energy and atmosphere, materials, resources and indoor environmental quality (USGBC 2009).

According the USGBC (2009), the built environment has a vast impact on the natural environment, on human health, and on the economy. By adopting green building strategies, builders can maximize both economic and environmental performance. Sustainable construction methods can be integrated into buildings at any stage—from design to deconstruction and all stages in between. However, the most significant benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project (USGBC 2009).

As more properties across the country are attempting to obtain LEED certification, it is worth noting that a green roof can help a property obtain LEED credits, including credits for reduced site disturbance, for landscape design that reduces urban heat islands, for storm water management, for water efficient landscaping, for innovative wastewater technologies, and for innovation in design. Green buildings striving for LEED certification will earn credits in various categories established by the U.S. Green Building Council. The following are examples of possible sections where green roofs can gain buildings LEED points, as described in the “Operations & Maintenance” section for LEED certification (USGBC 2009).

1) Sustainable Sites
    a) Storm Water Management
    b) Heat Island Reduction
2) Water Efficiency

3) Water Efficient Landscaping

4) Energy and Atmosphere

5) Optimize Energy Performance

6) Innovation and Design Process

a) Green roofs may qualify for innovation and design credits by improving the workplace environment, creating an educational laboratory or a recreational space.

1.1.3 Extensive Green Roof Details

With soil or growing media depths of one to five inches, extensive green roofs are a streamlined sandwich-layering of roof membrane, drainage material, filter fabric, soil matrix, and plantings—a combination that requires minimal or no additional structure for support, with fully saturated weights of ten to thirty-five pounds per square foot (Cantor 2008). Many green roof manufacturers offer their own component assemblies, botanical consulting expertise, and propriety soil mixes. In some areas of the country, efforts have been made to expand the conventional green roof user base from large commercial and institutional projects reliant on proprietary systems to smaller commercial and residential buildings for which generic assemblies and off-the-shelf components would make green roofs more economically feasible (Cantor 2008).

Regardless of the system size or type, the benefits of extensive green roofs extend beyond the advantages for the immediate user to benefit the community at large (Woodward 2005). By providing additional green space, planted roofs reduce the urban heat island effect through vegetative evapotransporation, dampen the surging effects of storm water events, decrease and filter run-off, improve urban air quality by trapping airborne particulates, including heavy metals, and provide habitats for wildlife. By adding another roof layer, extensive green roofs augment sound and thermal insulation, dramatically increase a roof's longevity by reducing rooftop temperature swings and thermal stress on the membrane, reduce a building's life-cycle cost, modulate ambient temperatures around mechanical equipment, beautify unsightly rooftops, and can offer outdoor space for additional occupancy (Woodward 2005).

The concept of green roofs as a way to add pervious surface and usable open space without taking up addition land is easy to understand and should be equally as easy to implement. Consequently, many developers, municipalities, architects, landscape architects, and planners have come to consider them as an integral element of sustainable building practices around the world (Weiler and Scholz-Barth 2009). However, the rate at which these practices are being adopted in the North Texas region is the primary focus of this research. Using Rogers' (2003) theory of adoption, this research investigates the perceptions of key decision makers in North Texas, as to their knowledge of extensive green roofs, the barriers to and facilitators of adoption, and the appropriateness of extensive green roofs for this region.

1.2 Problem Statement

While numerous books, articles, and papers have been written regarding extensive green roofs in Europe (Cantor 2008; Dunnett and Kingsbury 2008; Frith and Gedge 2005; Peck, et al. 1999), green roof literature specific to the United States, and the Southwest in particular, is more difficult to find. Much of this literature is helpful in understanding what landscape architects and allied professionals regard as useful strategies for environmentally sensitive landscape design. However, very few address landscape architecture-related issues of perception specifically associated with green or living roofs.

Using Rogers' (2003) five attributes of innovation as a framework, this research builds upon existing literature to examine the perceptions that affect the rate of adoption of extensive green roofs among decision makers in North Texas.

1.3 Research Questions

The research questions in this study are:

1) What are the perceptions of extensive green roofs among key decision makers in North Texas?
2) How do perceptions of extensive green roofs affect their adoption among decision makers in North Texas?
3) What are the barriers to adoption of extensive green roofs among the respondents?

4) What are the facilitators to adoption of extensive green roofs by the respondents?

5) What are the perceptions of the appropriateness of extensive green roofs among decision makers in North Texas?

6) How do perceptions of the appropriateness of extensive green roofs for North Texas affect their adoption among the respondents?

1.4 Research Methods

This research uses face-to-face, semi-structured interviews to collect data from a sample group consisting of developers, city officials, architects, and landscape architects who work in the North Texas region. Individuals for the sample group were selected because they represent the primary decision makers or are major contributors to decisions made within their respective institutions.

An interview protocol has been created to gather information about the respondents' perceptions of extensive green roofs. First, four questions were asked regarding their general knowledge of and experience with green roofs. Next, two questions were asked about sustainable practices in general. Finally, four questions were asked about extensive green roofs and their appropriateness in North Texas. These questions were designed to be open-ended in order to allow respondents the chance to give a narrative of their personal knowledge and perceptions of these practices without limiting them to a finite set of responses. Unscripted follow-up questions were asked when further clarification or additional information was needed.

The interviews were recorded digitally and sent to a professional transcription service for conversion to written text. These interview transcripts were then analyzed to identify respondents' knowledge and perceptions of extensive green roofs.

1.5 Definitions of Key Terms

Bioretention. A water quality practice that utilizes landscaping and soils to treat storm water run-off by collecting it in shallow depressions before filtering through a fabricated planting soil medium (Stormwater Manager's Resource Center 2008).

Ecological design. Design that minimizes destructive environmental impacts by integrating with living processes to the extent possible (Hopper 2007).

Ecologically performative landscape practices. Landscape strategies that perform a positive ecological function in the landscape, which benefit the ecology of the site (Hopman 2007).

Extensive green roof. A green roof which requires one to five inches of soil depth, uses simple irrigation and drainage systems, and can accommodate many kinds of vegetative ground cover and grasses. This type of green roof adds eight to forty pounds per square foot to the weight of the roof. They are usually not designed for regular access or use (Environmental Protection Agency 2009).

Green roof. Vegetation planted in a growing medium over a waterproofing membrane. Additional layers, such as a root barrier and drainage and irrigation systems, may also be included (Environmental Protection Agency 2009).

Innovation. An idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers 2003).

Intensive green roof. A green roof which requires a minimum of six inches of soil depth, uses complex irrigation and drainage systems and can accommodate large trees and shrubs. This type of green roof adds eighty to 150 pounds per square foot to the weight of the roof. These roofs are usually designed for regular access, maintenance, and human use (Environmental Protection Agency 2009).

Landscape architect. One who's profession encompasses the art and science of analysis, planning, design, management, preservation, and rehabilitation of the land (American Society of Landscape Architects 2009).

LEED (Leadership in Energy and Environmental Design). A voluntary, consensus-based national standard for developing high-performance sustainable buildings (USGBC 2009).

Pervious. Any material that allows for the passage of liquid through it (Stormwater Manager's Resource Center 2008).

Stakeholder. The people most affected by the management of a site because their lives are directly affected by what happens to a particular area (Stein 1997).

Sustainability. Meeting the needs of the present without compromising the ability of future generations to meet their own needs (United Nations 1987).

U.S. Green Building Council (USGBC). A national non-profit that promotes green building practices, technologies, policies, and standards. It established LEED certification guidelines, the country's most commonly used rating system for green buildings (USGBC 2009).

Xeriscape. A landscaping method with the goal of creating a visually attractive landscape with water-efficient plants (Hopper 2007).

1.6 Limitations and Delimitations

This study focuses on the perceptions of extensive green roofs in the subtropic climate of North Texas. More broadly applicable data would have been gathered had the research included areas of Texas with various climates, ecological communities, and populations. Chosen respondents were confined to those located within a sixteen-county area as defined by the North Texas Council of Governments (NCTCOG).

Interviews were conducted with a single person from a variety of companies and municipalities. Persons were chosen based on his/her role in the decision-making process within their respective institutions; however, this does give rise to limitations. For instance, the level of environmental awareness varies from person to person. Therefore, the participants' knowledge about extensive green roofs also varied. Additionally, bias of the perceptions of extensive green roofs is assumed because the study does not gather data from other important decision makers such as builders, engineers, owners, users, or maintenance personal.

Finally, there are some limitations related to the use of Rogers' Five Attributes of Innovations as a framework for research. Diffusion of innovations research tends to have a pro-innovation bias (Rogers 2003), which is the "implication in diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither reinvented nor rejected." Given that this study was completed for the

requirements of a degree in landscape architecture, the researcher does have a bias in favor of the innovation discussed. Also, previous diffusion of innovations research has tended to study innovations that do not have a strong tie to aesthetics. Therefore, innovations in this study are being considered within the context of North Texas, and their aesthetic performance may exert influence over respondents' perceptions.

1.7 Assumptions

For this research, it has been assumed that developers, city officials, and architects play a part in making decisions regarding landscape at their intuitions and that their perceptions of extensive green roofs affects their willingness to implement them. Furthermore, it was assumed that environmental issues faced by decision makers in North Texas, such as water scarcity and problems resulting from concentrated storm run-off, represent a more extreme set of issues than those faced by decision makers in less environmentally-challenged areas.

1.8 Summary

While Texas design professionals have started to respond to the use of extensive green roofs as a means of sustainable building with a few built projects, North Texans have only recently begun researching a regionally appropriate solution. One reason could be a discrepancy between a tradition of building practices and the perception that extensive green roofs are not suitable for the harsh climatic conditions of North Texas. However, many of the characteristics of North Texas that makes it a desirable region to live also lend themselves well to the use of extensive green roofs (Woodward 2005). As a response to the scarcity of literature regarding green roofs in Texas, this research seeks to contribute to the understanding of this discrepancy by focusing on the perceptions held by decision makers in the area.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of research and literature dealing with extensive green roof technology, specifically the use of green roofs as an ecologically performative landscape practice, the use of extensive green roofs by landscape architects, developers, city officials, and architects as well as their attitudes towards ecological design. The review provides the basis for understanding the conflicts that can arise between economic and environmental concerns in North Texas and provides a rationale for the value of this research to landscape architecture and allied professions.

2.2 Living Roofs

2.2.1 Nomenclature

Living roofs encompass multiple design modes and thus have many names, though commonly all are referred to as “green roofs.” This study also uses the term “living roofs,” as coined by Dusty Gedge (Cantor 2008), implying habitat and stressing the biodiversity function of promoting invertebrates, birds, and other life on a roof ecosystem. Although “green” roofs are not typically green year round, this term is most widely used in professional landscape literature. Other terms such as “bioroof” or “ecoroof,” preferred in Portland (Cantor 2008), suggest the economics and ecologic functions of the roof, while “brown roofs” or “biodiverse roofs” (Kadas 2006) denote living roofs meant to closely resemble natural environments and aimed at conserving urban biodiversity. Natural environments exhibit high biodiversity and provide habitats for species not otherwise seen in urban environments (Kadas 2006).

2.2.2 Extensive Green Roofs

This study focuses on extensive green roofs as a regionally appropriate, ecologically performative landscape practice. This practice was selected because it addresses unique opportunities presented in the subtropic climate of North Texas.

2.2.2.1 Characteristics of Extensive Green Roofs

Green roofs are simply roofs bearing vegetation in various forms. Some are mats of uniform vegetation and thickness, covering a large expanse of flat or sloping roof. There are two basic types of living roofs: extensive and intensive. Extensive green roofs are usually inaccessible installations in which the growing medium is a thin layer (about 1-5 in.) of often inorganic material. Intensive living roofs, on the other hand, typically have deeper soils (over 6 inches), allowing a greater variety in plant choices, including trees. Getter and Rowe (2006) describe intensive green roofs as having "intense" maintenance needs. Additionally, Cantor (2008) notes that the name of intensive roofs originated with the German term "intensiv," loosely translated as "intensive" in English. Intensive green roofs cost and weigh more than extensive green roofs and require more maintenance. A third distinction, which is becoming increasingly common, is a semi-intensive hybrid—a green roof that uses more than six inches of soil, but not so much more that it requires the same load-bearing cost and maintenance of intensive green roofs (Dunnett and Kingsbury 2008). Europeans have tested and established standards for elements of modern green roof designs, including types of roofing materials, waterproofing, growing media, plant materials, etc. European standards and definitions for the various types of green roofs and green roof materials are contained in the FLL (Cantor 2008).

Typical installation (Figure 2.1) of an extensive green roof includes a waterproofing membrane above the roof deck followed by a root-blocking layer. Above the root-blocking layer is an insulation layer, although sometimes the insulation is placed below the waterproofing layer or left out of the design altogether. Next, an optional water storage layer and drainable layer are installed (Werthmann 2007). However, the drainage layer can differ; some roofs use a lightweight aggregate similar to soil, whereas others use a mat that allows subsurface water flow while holding the soil in place.

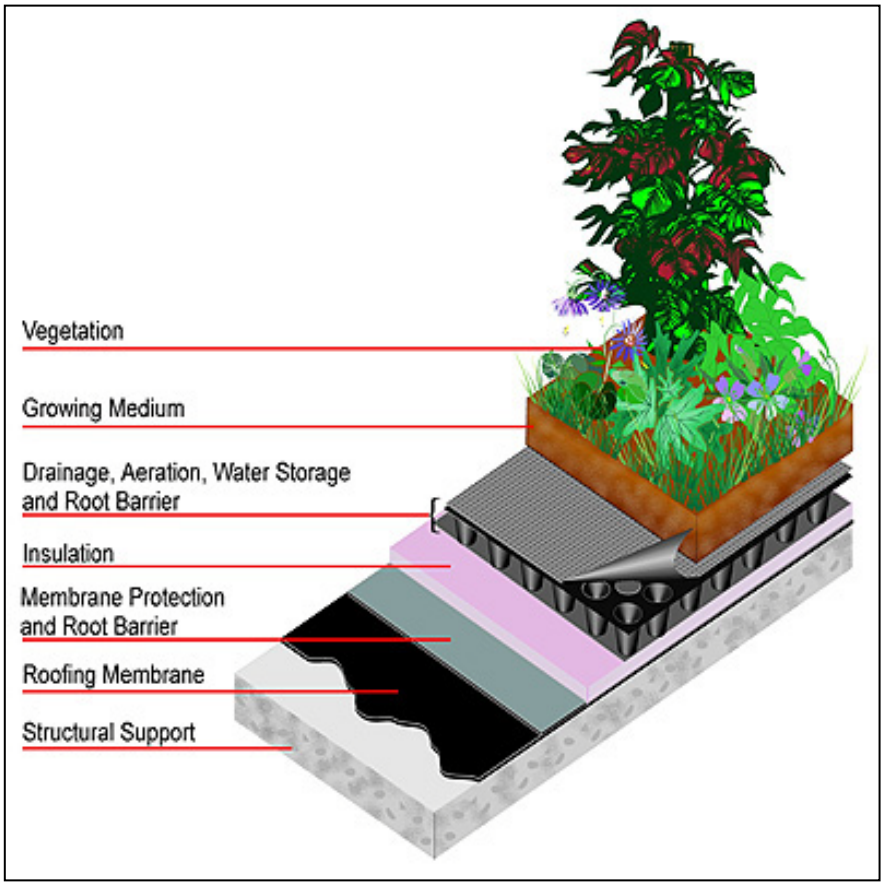


Figure 2.1 Example Green Roof System

An extensive green roof is often guaranteed by most manufacturers for twenty-five years and frequently lasts much longer depending on the waterproofing membrane. In Germany, many living roofs are still functioning beyond fifty years of installation (Porsche and Kohler 2003) because the roof system protects the roofing deck from harmful ultra-violet radiation as well as from hail, wind, and other atmospheric antagonists.

Extensive green roofs are usually installed during the initial construction of a building; however, an increasing number are being retrofitted to existing structures. Extensive green roofs can be applied on most flat roofs as well as angled roofs, permitted the slope is no more than 30-45% because roofs at steeper angles can have problems with hydrology such as soil moisture variation, erosion, and slope stabilization. Solutions do exist for these steeper roofs (Van Woert, et al. 2005), and in fact, some manufacturers can produce vertical living walls (Cantor 2008).

2.2.2.2 Types of Extensive Green Roof Systems

There are two traditional types of extensive green roof systems,--monolithic and modular. Monolithic systems tend to cover the whole roof area with vegetation while modular systems employ the use of containers.

2.2.2.2.1 Monolithic Extensive Green Roof Systems

Monolithic systems are built-in-place and consist of several layers including waterproofing, drainage, water retention, and growing media. Planting is then added once the roof is constructed. Some companies offer the complete range of all layers involved in an extensive green roof, including the waterproofing system applied to the roof deck. These companies also provide warranties against leakage if their entire system is used. Often, such companies have an entire line of choices for extensive green roof designs as well as another group of products for intensive designs, and each collection is advertised under a private label (Cantor 2008). Warranties for these products are provided if they are installed as one system and also include complete specifications as well as the services of LEED-trained staff and other specialists. It is usually desirable to "mix and match" various components from multiple manufacturers to create the best product possible. The downside to this approach is that it can be more difficult to secure guarantees and full warranties because each manufacturer or contractor might blame any problems that occur on someone else's product (Cantor 2008). Also, it may be difficult to conduct testing to confirm how the system will perform, particularly the growing medium, with materials assembled from a number of sources (Dunnett and Kingsbury 2008).

2.2.2.2.2 Modular Extensive Green Roof Systems

The other general approach is to use prefabricated modular units that combine two or more green roof components, a strategy more popular in the United States and Canada than in Europe (Cantor 2008). There are several major manufacturers in America and Canada, and, as with the complete systems, solid warranties are typically included.

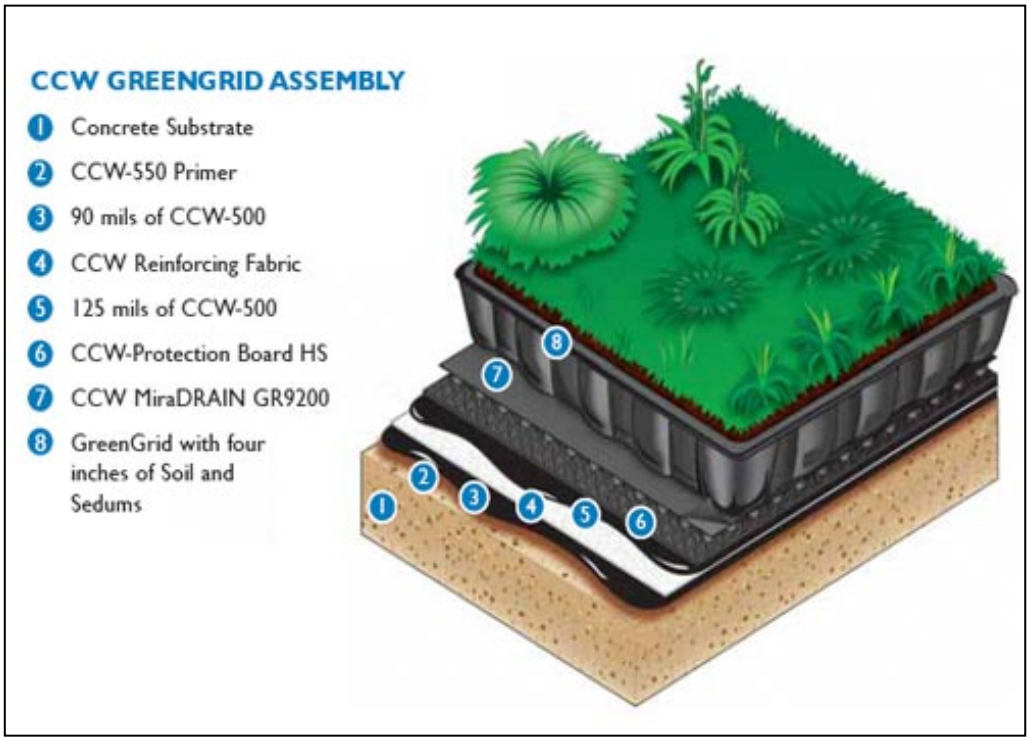


Figure 2.2 Example of Modular Tray Green Roof System

Modular systems have several advantages. System sizes start at a weight that can be handled easily by one person and increase to dimensions and weights that require at least two strong workers to handle. Modular systems work well in areas that are relatively flat and have wide orthogonal edges. Phased installations lend themselves to modular design because each phase can be dovetailed to meet the next one using the same modular components, and each new installation fits snugly against previous installations. Depending on the site and module, the system can be filled with growing medium and plants that are pre-grown prior to installation.

2.2.2.3 Extensive Green Roof Components

An extensive green roof system can be imagined as a thin sandwich of many layers, with top and bottom layers of vegetation and roof deck, respectively. From the top down, these layers include the vegetation, growing medium, filter fabric, drainage and water retention layers, root protection layer, insulation, waterproofing, and roof deck. In the material that follows, all of these layers are discussed, though some can be omitted and manufacturers may combine or mesh various layers to facilitate construction (Cantor 2008).

The vegetation for extensive roof systems in North America is usually a mixture of sedums, grasses, and spreading groundcovers that are well adapted to the thin layers of growing media and to extreme conditions of drought, heat, cold, wind, and exposure (Pledge 2005). According to Cantor (2008), a variety of plant materials is a practical way to ensure diversity on an extensive green roof because some of the species selected for planting may struggle or may not survive, while other species may take over and become well established. In addition, diversity gives some protection against infestations and diseases because some species will be resistant. He also notes that it is risky to try to specify, install, and maintain a rigid quantity of the various plant materials in set patterns because in most cases, some plants will adapt better than others—a natural process that should be encouraged. When aesthetic criteria are applied to extensive green roofs, and the sight of clear forms from a distance is desirable, more maintenance will be required (Cantor 2008).

A well-drained sandy loam is typically used for the growing medium in traditional roof gardens, although it is usually referred to as soil. In more modern roof gardens, as the soil manufacturing industry has developed, lightweight soil mixes that are not primarily topsoil (having little or no clay-size content) and lightweight textural components have become common (Cantor 2008). However, these soil recipes must be close enough to standard topsoil that plants can absorb adequate moisture and nutrients. A cubic foot of wet, standard, well-drained sandy loam may weigh as much as 120 pounds, but a cubic foot of some of the lightweight mixes may weigh about two-thirds to one-half as much (Frith and Gedge 2005). Even on an extensive green roof, however, it is usually essential to minimize the weight of the growing medium to save on the cost of structural support for the roof (Pledge 2005).

A layer of filter fabric separates the bottom of the growing medium from the drainage layer and the water retention system below. According to Dunnett and Kingsbury (2008), the filter fabric, although minimal in thickness, is a critical element because it prevents fine particles of the growing medium from clogging the drainage layers, which could prevent water from flowing or draining freely throughout the entire system. Water buildup can stress the structure of the roof and damage the plants (Cantor 2008).

Except for “one-layer” assemblies in which the medium also provides drainage, all green roof assemblies include some sort of specialized drainage layer (Pledge 2005). This layer may be synthetic or may be composed of high permeable granular mineral material, manufactured or contained in a sheet. The drainage layer collects any excess water not absorbed by the plants and the growing medium and directs it into a network of channels built into the system. According to Cantor (2008), the design of the drainage layer is critical to the success of any green roof assembly.

The literature also states that some kind of protective layer or root barrier is needed to prevent roots from penetrating into the waterproofing layer, causing leaks. Root barriers are usually thermoplastic membranes, but copper foil and root-retardant chemicals have been used with some assemblies (Wiler 2009). Some building codes restrict the use of copper because it may react chemically with other elements and because a slight amount may leach into the water system. Sometimes root barriers are integrated into other layers, such as waterproofing, when the green roof system is being installed. This method is more commonly used in Europe (FLL 2004) where there is considerable information about selecting plants and green roof layers that minimize the chance of root penetration (Cantor 2008).

Depending on the climate, an additional layer of insulation may be installed underneath the root barrier to further limit heat gain and loss (Frith and Gedge 2005). The insulation should be lightweight but have great compressive strength so that it is not crushed or squeezed out of shape by the weight of the material above. Depending on the green roof design goals and the properties of the waterproofing system, insulation may be installed either above or below the waterproofing layer (Cantor 2008) or can replace insulation all together.

Finally, there is the roof deck itself. The most common types of decks encountered in green roof projects are reinforced concrete, pre-cast concrete planks, steel, and steel-concrete composites. However, many projects, particularly retrofit projects, also involve plywood or tongue-and-groove wood decks. Every deck must be investigated for its ability to bear anticipated weight loads and for its tendency for movement (Pledge 2005). Frequently, the type of deck dictates which method of waterproofing is optimal. When greater loads are required, existing decks must be reinforced with

additional support and because of the cost, are limited to only those locations where it is essential. In new buildings, the deck must be built to conform to the load-bearing requirements of the planned green roofs. Sometimes a new roof deck is built uniformly so that its minimum load-bearing capacity is greater than what is being planned for the entire green roof (Cantor 2008).

2.2.2.4 Special Factors

The load or weight requirements and methods for detecting leaks take on particular significance in the design and maintenance of extensive green roofs (Cantor 2008). Since extensive green roofs are dynamic environments which evolve naturally or may be intentionally altered, such considerations much are always acknowledged and revised as necessary (Dunnett and Kingsbury 2008).

2.2.3 Advantages of Extensive Green Roofs

Extensive green roofs offer many advantages over conventional roofs. The following discussion highlights the most significant advantages (Table 2.1) without attempting to determine their relative degree of importance, which may very well depend on the goals of a particular green roof installation (Cantor 2008).

2.2.3.1 Aesthetics

One obvious advantage is the addition to the environment of a visual amenity—a green space that is visible from many vantage points instead of a typical, asphaltic tar or other dreary roof. As gardens, some green roofs, are also accessible to the public and add to the enjoyment of the property for private owners (Cantor 2008). In dense urban environments, the visual impact of even a few green spots is significant, particularly if these green roofs can be seen or used by many people (Werthmann 2007). Studies suggest that viewing green space and nature can reduce stress, ease muscle tension, and lower blood pressure (Ulrich and Simons 1986); furthermore, when viewed at work, natural landscapes can increase job satisfaction and reduce reports of headaches and illness (Kaplan, Talbot, and Kaplan 1988).

Table 2.1 Comparison of Green Roofs and Conventional Roofs (adapted from Cantor 2008)

Function	Green Roof	Conventional roof
Storm water: Volume retention	10-35% during wet season, 65-100% during dry season	None
Storm water: Peak flow mitigation	All storms reduced runoff peaks and lagged response	None
Temperature mitigation	Provides cooling and insulation in addition to building envelope	None
Improved runoff water quality	Retains atmospheric deposition and retards roof material degradation, reducing pollutant loadings	None
Urban heat island	Prevents temperature increase	None
Air quality	Filters air, stores carbon, increases evapotranspiration	None
Energy conservation	Insulates buildings	None
Vegetation	Allows seasonal evapotranspiration; provides photosynthesis, oxygen, carbon, water balance	None
Green space	Replaces green space lost to building footprint	None
Habitat	For insects and birds	None
Livability	Buffers noise, eliminates glare, serves as alternative aesthetic, offers passive recreation	None
Costs	Highly variable: $5-$12 per square foot for new construction; and $7-$20 per square foot for retrofits	Highly variable:$2-$10 per square foot for new construction, and $4-$15 per square foot for retrofits
Cost offsets	Reduced storm water facilities, energy savings, higher rental value, increased property value, reduced need for insulation materials, reduced waste to landfills, added jobs and industry	None
Durability	Waterproof membrane protected from solar and temperature exposure lasts more than 36 years; membrane protected from operations and maintenance staff damage	Little protection, exposure to elements, lasts less than 20 years.
Commercial Infrastructure	Infrastructure for design and construction present only in select areas. Little to none in most areas.	Wide-scale infrastructure in place

2.2.3.2 Storm Water Management

Living roofs mitigate storm water run-off in two ways. First, the commercial growth medium retains 10-35% of the rainfall during the wet season and 65-100% of water during the dry season for Portland, Oregon (Cantor 2008). Precipitation which falls on a green roof can land on the growing media or land directly on a plant and either fall to the soil or evaporate. Retained water evaporates or is transpired by plants (Van Woert, et al. 2005). The precipitation that enters the soil will eventually leave the medium in one of three ways: it might simply pass through the soil and drainage layers and exit the green roof system as runoff, it might be retained by the soil medium and eventually evaporate back into the atmosphere, or it might be drawn into plant tissue to be eventually released into the atmosphere by transpiration.

Second, peak flow of the storm event is both reduced and delayed. When a storm hits an urban area, conventional roofs drain nearly all of the water rapidly into gutters and storm drains. In contrast, a living roof drains only a fraction of fallen precipitation, and the remainder releases slowly over a period of a few hours or a few days following the rain event (Van Woert, et al. 2005), thus lessening and delaying the storm surge. These benefits could be attractive to commercial developments that are not allowed off-site storm water run-off and to municipalities with storm water infrastructure issues. Municipalities would retain more storm water from large-scale implementation living roofs (Cantor 2008). In terms of low-impact development, green roofs are not to be expected to be a type of flood control; however, they do retain the first three-quarters to one and a half inches of rain—the hottest and most polluted part of a storm event.

According to Dunnett and Kingsbury (2008), during and following heavy rains, plant materials, growing medium, and the drainage layer of an extensive green roof system absorb significant quantities of rainfall and storm water run-off. This function can reduce runoff volume and also reduce peak flows for moderately-sized storm events. As a result, storm water systems can be sized smaller and the water quality of streams and rivers can be protected because an extensive system absorbs the heat and pollution from the first flush of rainwater in a storm event (Cantor 2008).

In major urban areas, extensive green roofs may eliminate or reduce incidents of combined sewage and storm water overflows that occur during and after heavy rains (Pledge 2005). By absorbing rainwater, a considerable number of well-designed, extensive green roof systems may allow the storm water system to operate without overflowing into the sewage system. Storm water systems serve large urban areas, and even though the amount of water retained by an extensive green roof is measurable, it would take the combined impact of a whole series of extensive green roofs within the water-shed of a storm drainage system to achieve a significant effect (Cantor 2008). This cumulative impact is being modeled in a number of cities including Winnipeg, Toronto, and Washington, D.C. (Greenroofs.org 2009).

As extensive green roof designs have become more sophisticated, not only do they retard the release of storm water during high-intensity rainfall, but they can also store excess water to be used later for irrigation of green roof plants (Oberndorfer, et al. 2007).

2.2.3.3 Mitigation of the Urban Heat Island

Extensive green roofs have promise as a collective design element to impact the urban heat island effect, well documented in major urban areas. The built environment, particularly dark-colored pavements and construction materials concentrated without intervening plantings, absorbs heat during the day and releases it slowly at night so that most major cities are several degrees warmer than surrounding suburban or rural areas. Solar energy is converted to heat, which hovers in the air around the building so that air-conditioning needs and costs greatly increase. Airborne particulates also contribute to the urban heat island effect (Dunnett and Kingsbury 2008). These contaminants absorb the infrared radiation emitted at ground level at nightfall, when temperatures begin to drop, thereby reducing the amount of cooling. Other major factors associated with the urban heat island effect in large North American cities include an increase in smog formation and air pollution, greater energy consumption, health issues, and stress. Major airports, for example, with vast areas of pavements uninterrupted by vegetative buffer, tend to be islands of heat within already overheated metropolitan environments. In contrast, the process of evaporation from extensive green roofs and transpiration by plants release water and cool the ambient temperature of the building (Cantor 2008).

If extensive green roofs were installed on a large scale, such as on a series of warehouses or terminal buildings at an airport, they would have the potential to mitigate the heat island effect.

2.2.3.4 Acoustical and Heat Insulation

Due to the thickness of the entire installation, from waterproofing to roof membrane, growing media and plant materials, extensive green roofs act as acoustical barriers, reducing the volume of sound from traffic, airplanes, or other sources that penetrate the building. Similarly, because they have insulating properties (due in part to their thickness) and some degree of resistance to energy transmission, extensive green roofs reduce air-conditioning requirements in the summer and lower heating needs in the winter. The cooler ambient temperatures that result from the installation of an extensive green roof also improve the efficiency of air conditioning and lower its cost (Cantor 2008).

In Texas, reduction in summer cooling costs would be a huge benefit for many businesses and residences during the hot summer months. Indeed, green roofs can be a way to cut costs of an already existing building. Peck et al (1999) found that indoor temperatures were reduced by around 4˚C when outdoor temperatures were between 25˚C and 30˚C (77˚F and 86˚F). In their book, Dunnett and Kingsbury (2008) suggest that every 0.5˚C in internal temperature reduction can result in up to 8% reduction in air conditioning electricity costs—a possible 60% reduction in cooling costs based on the previous results (Dunnett and Kingsbury 2008). Green roof implementation on a large scale could make a significant dent in the 65% of total electricity consumption that buildings are responsible for (Kula 2005). However, it is important to note that these reductions in energy consumption could be more cheaply acquired by simply installing more insulation during construction of the buildings themselves (Getter and Rowe 2006).

Studies suggest that the thermal protection soil and plant material provides can extend the life of the membrane by two to three times (Peck, et al. 1999).

2.2.3.5 Filtering

Similar to the impact of any significant plan or existing vegetation, another advantage of extensive green roofs is their ability to filter dust and soot particles from the air. Compared to a bare roof, which has minimal impact, the vegetation on a green roof will trap many particulates that would

otherwise contaminate the air and be inhaled by people or animals (Cantor 2008). Plants are able to act as air filters, removing gaseous pollutants and airborne particulates by incorporating them into tissue or passing them through the roots and into the soil (Getter and Rowe 2006). Getter has also translated the results from a German study that showed a significant reduction of diesel engine air pollution by green roof vegetation (Liesecke and Borgwardt 1997). Another study reported a 37% reduction of sulfur dioxide and a 21% reduction in nitrous acid in the air above a green roof when compared to other air samples taken nearby (Yok, Tan, and Sia 2005)). Other studies have estimated that green roofs can remove 0.2 kg of dust particles per year per square meter of vegetated roof (Peck, et al. 2003).

2.2.3.6 Reduction in Carbon Dioxide

During the process of respiration, plant materials use carbon dioxide from the air to form starch and release oxygen. Given that carbon dioxide is the principal heat trapping gas associated with global warming, the more vegetative plantings can be increased, the greater the potential to reduce the amount of carbon dioxide in the air (Dunnett and Kingsbury 2008). The greatest benefit of extensive green roofs in reducing carbon dioxide emissions, however, is indirect. By reducing ambient temperatures on a building to the extent that cooling and heating cost are mitigated, there is a significant reduction in the use of fossil fuels for cooling and heating—the combustion of which generates large amounts of carbon dioxide.

2.2.3.7 Economic Benefits

Economic benefits of green roofs are more difficult to ascertain due to the many factors involved. Although the initial cost of an extensive green roof is greater than that of a conventional roof, over time, the green roof prolongs the life of the roof by protecting it from direct exposure to ultraviolet and other harmful radiations (Cantor 2008). Thus, the extensive green roof eventually pays for itself. The protection offered by an extensive green roof increases the life of the roof membrane, which is a major economic advantage for a building owner (Porsche and Kohler 2003). In some instances, the manufacturers of roofing systems will increase the warranty on a new roof if it is to be covered by an extensive green roof system. Cantor (2008) also notes that energy savings in

terms of air-conditioning and heating are another major economic benefit. To the degree that the extensive green roof can be considered either a passive or active recreation amenity for residents and users of the building, or adjacent buildings, there is yet another economic benefit (Cantor 2008).

On the planning and governmental level, financial incentives, and tax reductions, which are institutionalized in many European settings, are starting to occur in North America (Cantor 2008). The use of recycled materials on an extensive green roof may lead to associated lower costs for transportation and manufacturing and even to adjustments in taxes. Some jurisdictions require that a certain portion of new buildings be designated for green roofs and provide financial incentives to encourage greening of the city (Pledge 2005). If a reduction in storm water runoff or a reduction in emissions can be documented, the regulating governmental authority may reduce the appropriate fee. However, there is a long way to go before incentives and requirements, long established in Europe, are basic code requirements in North America (Cantor 2008).

The U.S. Green Building Council (USGBC) has developed a Leadership in Energy and Environmental Design (LEED) green building rating system to encourage and accelerate global adoption of sustainable green building practices by creating a recognized standard for measuring building sustainability. The LEED rating system provides certification levels for new construction: Certified, Silver, Gold, and Platinum. Each level corresponds to the number of credits earned in five categories—sustainable sites, water efficiency, energy and atmosphere, materials, resources and indoor environmental quality (Oberndorfer, et al. 2007). The LEED rating system has its benefits, such as publicity, energy efficiency, and sustainability, but a limiting factor is that this system has no official power or authority. Involvement is voluntary, and failure to achieve any level of LEED status has no legal or financial consequence.

2.2.3.8 Increased Efficiency of Photovoltaic's

Some advantages of extensive green roofs come in combination with other new technologies. Photovoltaic panels are often typically on roofs where solar radiation is the most intense, thereby assuring a high degree of efficiency in converting solar energy to electricity. These panels work best, however, within a certain range of temperatures that is without large fluctuations.

Extensive green roofs help modulate the temperatures within the range that best suits the photovoltaic installations. Extensive green roofs tend to stay much cooler during the day than a standard roof—an advantage for photovoltaic installations (Cantor 2008).

2.2.3.9 Habitat Restoration

Just as zoological gardens are becoming laboratories for the study, protection, and breeding of endangered species of animals, some extensive green roofs replicate threatened plant habitats, providing an opportunity to study certain plant communities and establish additional ones. Some extensive green roofs are attempts to create protective habitats for particular species of birds atop roofs. Yet, by their very nature as protected environments for the scientific study of endangered communities, the green roofs inevitably spark controversy because these environments are not made available to people. Open space, whether on the ground or on a roof, is a prized asset. Cantor raises an interesting point in that it is not surprising that as green roofs become more common in design practice, competition and disagreement will arise over what is the best use for such spaces (Cantor 2008). Many green roofs have only limited access and as such, could function as disturbance free habitats for animals and insects. Some argue that the limited biomass possible on an extensive green roof restricts the number of secondary and tertiary consumers that can thrive on a green roof (Baumann 2006). Intensive green roofs may be the ultimate answer if habitat restoration/replication is desired.

2.2.3.10 Environmental Monitoring

As a product of modern technology, some extensive green roofs benefit from the installation of equipment to monitor and test many variables, such as the air temperature and green roof temperature at various times of day, the amount of water absorbed, the storm water run-off amassed, the increase in biomass of plant materials, the extent of leakage, the exact acoustical and solar insulation, etc. In time, this accumulation of data will promote better results in future installations. Based on the knowledge gained from studying the effects of individual extensive green roof planting installations, scientists are using sophisticated computer models to evaluate and predict

the impact of the implementation of extensive green roofs in urban settings on a regional scale (Pledge 2005).

2.2.3.11 Public Education

Well-designed green roofs provide an opportunity to educate the public on many aspects of the environment. Many schools, environmental learning centers, and parks are beginning to utilize green roof technology as examples of sustainable building practices. They are often located where educational displays may reach a large audience (Cantor 2008).

2.3 Landscape Architects and Extensive Green Roofs

According to the American Society of Landscape Architects (ASLA), a central responsibility of the profession is to "manage and minimize environmental risks to the public's health, safety, and welfare through quality design and planning" (American Socitey of Landscape Architects 2008). Thayer (1994) contends that landscape architects must do more than "manage and minimize risks." They must make sustainable landscape visible to all because "the visibility of the sustainable landscape…is critical to its experiential impact and the rate at which it will be adopted by society and emulated in common use." He goes on to say that "a critical function of landscape architecture" is "to continually interpret the relationship of human beings to their environment in spatial, visual terms, " and to "bring core ecologies to the surface [is] an important role of landscape artists and designers" (Thayer 1994).

2.4 Extensive Green Roofs of Texas

2.4.1 Introduction

As of August 2009 there are several green roof research projects being conducted and five built extensive green roof projects in the state of Texas (Table 2.2). The five built projects are the Building E addition at North Lake College in Irving, Texas, The Biology Building at the University of Texas at El Paso, The Burdette Keeland Jr. Design and Exploration Center at the University of Houston, and the Starbucks at Circle C. Ranch in Austin, Texas. Two of the three research projects currently being conducted in the state are located in the Dallas/Ft. Worth area—the test roof at the University of Texas at Arlington, and the research project at Texas Christian University. The final and

oldest research project is being conducted by the Ladybird Johnson Wildflower Center in Austin, Texas. These examples of extensive green roofs and research initiatives in Texas are an indication that extensive green roofs are gaining momentum as a sustainable building practice in this region.

Table 2.2 Current Extensive Green Roofs Applications in the State of Texas

PROJECT	SIZE	BUILT	LOCATION	TYPE	Depth
Burdette Keeland Jr. Design and Exploration Center	1750 sq. ft.	2007	Houston, TX	Built	6”
TCU Green Roof Research Plots	240 sq. ft	2008	Ft. Worth, TX	Testing	4”
UT Arlington Life Science Center Green Roof	1000 sq. ft.	2008	Arlington, TX	Testing	4”
Lady Bird Johnson Wildflower Center	540 sq. ft.	2005	Austin, TX	Testing	4”
Starbucks at Circle C Ranch	9704 sq. ft.	2005	Austin, TX	Built	6”
UT at El Paso Biology Building	9156 sq. ft.	2009	El Paso, TX	Built	6”
Building E Addition at North Lake College	6000 sq. ft	2009	Irving, Tx	Built	4”

2.4.2 North Lake College, Irving, Texas

The extensive green roof at North Lake College in Irving (Figure 2.3), Texas is the first extensive roof application in North Texas. This project is a series of four roofs that can be seen from multiple areas of the building. The four separate areas make up a modular tray system of roughly 6,000 square feet that is planted with a mix of six different kinds of sedums, including Tri-color and John Creche varieties. According to the company that installed the system, the system was not installed with irrigation because “it will need no more watering than was done at installation.” As the first extensive green roof in North Texas, this project supports the timeliness and significance of this research as an example of how early adopters are beginning to embrace this technology as a regionally appropriate solution.

Figure 2.3 The Extensive Green Roof at North Lake College, Irving, Texas

2.4.2 The University of Texas at El Paso, El Paso, Texas

The second extensive green roof in Texas is found at the University of Texas at El Paso (UTEP) and was completed in early 2009. Approximately 9,156 square feet of the Biology Building's roof is covered with plants such as Regal Mist (*Muhlenbergia capillaries*), White Evening Primrose (*Oenothera caespitosa*), and Sun Gold Gazania (*Gazania rigens cv. 'Sun Gold'*) to improve the building's energy performance, to create biodiversity, and to extend the roof's life span.

The project took ninety days to complete, and consists of a modular tray system (Figure 2.4) that sits on top of the roofing membrane. The pre-planted trays are attached to an irrigation system that runs on a watering cycle and has a growing medium depth of four inches. According to Soltero (2009), the green roof is expected to moderate the building's temperature by reducing heat gains and losses, which in turn decreases the building's energy cost.

Figure 2.4 Detail of The Modular Tray System used on the Extensive Green Roof at the University of Texas at El Paso

2.4.3 The Burdette Keeland Jr. Design and Exploration Center, Houston, Texas

This extensive green roof is a 1,750 square foot, sloped roof on the Burdette Keeland Jr. Design and Exploration Center at the University of Houston (Figure 2.5). The roof is planted with native plants and flowers such as Gulf Muhly (*Muhlenbergia capillaries*), Butterfly Weed (*Asclepias tuberosa*), and Mexican Feather Grass (*Nassella tenuissima*).

Figure 2.5 The Burdette Keeland Jr. Design and Exploration Center at the University of Houston

As Houston's first extensive green roof and with a growing medium depth of six inches, this project was a culmination of a tremendous amount of work on the part students and faculty. A mock-up of the Keeland roof was built by students in late-May of 2005 to test which plants would survive and thrive in Houston's weather.

2.4.4 Starbucks at Circle C Ranch, Austin, Texas

This extensive green roof is an installation of approximately 8,000 square feet of a modular tray system adjacent to a Starbucks building at the corner of Loop 1 and Slaughter Lane in South Austin (Figure 2.6). The Lady Bird Johnson Wildflower Center contracted with Stratus Properties to design and install this green roof system in September 2005 (Simmons, et al. 2008). Completed in October 2005, The Circle C Escarpment Village Starbucks green roof can be seen from inside Starbucks though large glass windows.

Figure 2.6 Green Roof at the Starbucks at Circle C Ranch in Austin, Texas

2.4.5 UT Arlington Life Science Center, Arlington, Texas

This 1,000 square foot test roof at the University of Texas at Arlington was installed on April 18, 2008 (Figure 2.7). Two test beds were constructed beside the Biology Department greenhouse on the sixth-floor roof of the Life Sciences Building. Under the supervision of Landscape Architecture Assistant Professor David Hopman, the green roof is used to test plants, soils, planting systems, and irrigation systems to determine which combinations perform well in the extreme conditions of North Texas. This extensive green test roof is constructed in two 500 square foot sections. Both sections use four inches of soil and have two iterations of the same plant materials. One section was provided by Weston Solutions, using their Green Grid modular tray system and proprietary soil mix. The other section was provided by American Hydro tech and uses their garden roof assembly and proprietary soil mix. The Weston side is irrigated by a dramm system designed

for green roofs, and the Hydrotech side is irrigated by Netafim Drip. Both sides of the six-story roof will be monitored for light, moisture, and temperature by a team from the UT Arlington computer science engineering department led by Doctor Yonghe Loiu.

Figure 2.7 The Life Science Center at The University of Texas at Arlington

The plant materials for the initial trials are heavily biased towards Texas natives and include plants and grasses such as Sideoats Grama (*Bouteloua curtipendula)*, Buffalo Grass (*Buchloe dactyloides)*, Autumn Sage *(Salvia greggii)*, Frogfruit *(Phyla nodiflora)*, Woolly Stemodia *(Stemodia lanata)*, and Red Yucca *(Hesperaloe parviflora)* (Greenroofs.com 2006).

2.4.6 Green Roof Research at TCU, Ft. Worth, Texas

The second research project is being conducted at Texas Christian University in Fort Worth, Texas (Figure 2.8). This study is being carried out using fifteen test modules, constructed from treated lumber, with inner dimensions of 4'x4' by 6" deep. They stand three feet above the ground in order to reduce the effects of ground temperature and moisture. According to graduate student David Williams (2009), they are applying biomimicry design principles to advance implementation of living roofs in North Texas. The Walnut Limestone barrens and glades communities are being used as an

appropriate ecosystem from which to choose plant species and soil mixes for use on living roofs in North Texas. (Williams 2009).

Figure 2.8 Research Project by Texas Christian University at the
Fort Worth Nature Center, Fort Worth, Texas

2.4.7 Lady Bird Johnson Wildflower Center

The final and longest running research project is being done in Austin, Texas at The Lady Bird Johnson Wildflower Center. According to Greenroofs.com (2006), The Lady Bird Johnson Wildflower Center at the University of Texas at Austin is dedicated to increasing the sustainable use and conservation of native plants and landscapes (Figure 2.9). Founded by former first lady, Lady Bird Johnson, in 1982, the Wildflower Center maintains an extensive native plant botanic garden and offers professional and adult education programming. The Wildflower Center also conducts research on landscape restoration and plant conservation at its 279-acre site, promoting the role of native plants and plant communities in addressing ecological problems.

With funding from Roof Consultants Institute Foundation, the City of Austin, and TGB partners, the Lady Bird Johnson Wildflower Center installed twenty-four test rooftops on a research

plot adjacent to the Center's Restoration Research Trail to see which plants do better in the often harsh local conditions, to see which growing media work best, and to see how surface temperatures vary with different types of roofs.

Figure 2.9 Research project at the Lady Bird Johnson Wildflower Center in Austin, Texas

The project is supported with labor and materials from local roofing contractors and a roofing industry group. Each test roof features a 5' x 6' green or conventional roof assembly that is three feet off the ground. The mini green roofs contain thirty square feet on twenty-four platforms for a total of 540 square feet (Greenroofs.com 2006).

During this three to five year research study, the Wildflower Center will determine which native plants work best for green roof projects in Texas. While other green roof projects have used non-native plants, this is the first study of its kind to test Texas native plants for green roofs in a sub-tropical environment like Austin (Greenroofs.com 2006).

The study also focuses on testing the key elements that can influence green roof design. Wildflower Center ecologists will determine a roof's ability to retain enough water to sustains plant life without retaining excessive water that would make the roof system too heavy. The Wildflower

Center will assess how to take native, drought-tolerant plant species and create an extensive green roof that has all the normal advantages of a green roof and maintains the regional character and natural heritage of the place where they exist (Greenroofs.com 2006).

The research project will test the efficacy of native vegetation for use on extensive green roofs and clarify storm water retention rates, water quality, and thermal properties of green roofing for subtropical regions. Plants currently being tested at the Wildflower Center include Antelope Horns (*Asclepias asperula*), Winecup (*Callirhoe involucrate*), Damianita (*Chrysactinia Mexicana*), Indian Blanket (*Gaillardia pulchella*), For-nerve Daisy (*Tetraneuris scaposa*), Barbara's Buttons (*Marshallia caespitosa*), and Blackfoot Daisy (*Melampodium leucanthum*). The Wildflower Center produces graphics that show some of the data that is being collected and updates them on their website on a regular basis. They show both the amount of water coming off the various roofs, as well as the membrane temperature for all of the roofs. There is a traditional black top, a white top for use as controls, and green roofs from six various manufacturers.

2.5 Negative Perceptions of Extensive Green Roofs

Johnson (2009) argues in a letter from the editor of *Landscape Architecture Magazine* that extensive green roofs are to be a sustainable practice. Regarding the California Academy of Sciences (CAS) green roof in San Francisco, he feels that the maintenance and installation costs of this roof is more of a "starchictect's" interpretation of an environmental solution. Developing an extensive green roof that is aesthetically pleasing, economically appropriate, and ecologically performative is the challenge of designers of the future (Johnson 2009). In addition, there have been many letters to the editor in response to his statements. One in particular was written by Cornelia Hahn Oberlander, FASLA, and she agrees that the challenge for landscape architects is to get serious about studying green roof systems. In addition, she states that landscape architects need to be completely familiar with green roof technology and must commit themselves to overseeing the installation of all the components of the green roof with frequent site visits during the maintenance period (Oberlander 2009).

Another common criticism of green roofs is that they have more demanding structural needs. According to Porshe and Kohler (2003), some existing buildings cannot be retrofitted with a green roof because of the weight load of the growing medium and vegetation. Also, depending on what kind of roof it is, the maintenance costs can be higher. In addition, green roofs can place higher demands on the waterproofing system of the structure both because water is retained on the roof and because of the possibility of roots penetrating the waterproof membrane. Installing adequate waterproofing systems and root barriers can increase the cost of the roof (Porsche and Kohler 2003).

According to Tarquinio (2009), office landlords have been increasingly wooing prospective tenants in recent years by marketing their buildings as environmentally friendly. Typically, these buildings are energy-efficient or recycle water. But even in these buildings, one environmental feature has been rare: a green roof. Though green roof projects are popular with environmentalists because they reduce rainwater runoff, most landlords of multi-tenant office buildings have shied away from incorporating green roofs into their renovation plans because such features are relatively expensive to install, and many roofs cannot be easily adapted (Tarquinio 2009).

Lstiburek (2008) argues in his article for the ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Journal in November of 2008, that vegetative roofs are not energy efficient. In addition, he poses the following questions.

> *"Which saves more energy: 2 inches of dirt or 2 inches of insulation? Which saves more energy: grass or a white-colored membrane? Which is more expensive and does not save energy: grass and dirt or insulation and a white-colored membrane? Which needs to be watered to keep the grass from dying and blowing away?"*

Using these questions, Lstiburek (2008) is trying to point out the obvious shortcomings of a vegetative roof from an engineer's point of view. While he believes that vegetative roofs are beautiful to look at, he also argues that the aesthetic argument would have to outweigh the importance of cost and energy savings since there are more economical ways to deal with problems such as the heat island effects and storm water runoff (Lstiburek 2008).

2. 6 Attitudes toward Extensive Green Roofs

2.6.1 Barriers to the Adoption of Green Roofs

Extensive green roofs have some important advantages over traditional roofing; however, they involve higher costs, higher maintenance, and some potential problems that should be considered. Besides higher costs, green roofs pose other potential drawbacks:

1. higher maintenance costs,
2. restrictions involving climate and weather conditions,
3. complex drainage systems,
4. eventually, stronger roof beams in order to support the several green roof layers, namely the soil layer, and
5. more costly repairs and fixings.

Potentially, increased weight can cause roof damage. Lstiburek (2008) believes it is difficult to forecast the added weight a heavy rain would cause if proper drainage is not achieved. According to Lstiburek (2008), the washing away of soil or debris can potentially clog drainage spouts. There are also pockets within a roof garden that can become breeding grounds for mosquitoes and fire ants (Lstiburek 2008). Moreover, pesticides and fertilizers can become airborne and run the risk of polluting surrounding neighborhoods. According to Lstiburek (2008), proper insulation can accomplish the same energy saving factors of a roof garden for the building on which it is located.

According to Peck (1999), architects, engineers, roofers, developers, manufacturers, policy makers, and energy management consultants identified major barriers to technology diffusion at a November 1998 workshop held in Toronto, Canada. The major types of barriers are:

1. Lack of knowledge and awareness –Although these technologies offer many benefits, both quantitative and qualitative, they are not well known among the development industry, municipal officials, or the general public.

2. Lack of incentives to implement—In North America, there are virtually no government incentives in support of green roof technology diffusion, despite their many proven public and private benefits.
3. Costs-based Barriers—More information needs to be assembled about the full range of "traditional" and "public" costs and benefits of these technologies in different applications. The current market does not recognize many of these benefits.
4. Technical Issues and Risks Associated with Uncertainty—These types of barriers cover a wide spectrum including: lack of specialized products on the market, few examples of roof and vertical garden installations, and no industry technical standards for green roofs and no standards in building codes.

These barriers have resulted in a failure of the Canadian market to adopt these technologies, which are very well established in many countries in Europe. For example, in Germany over ten million square meters of green roofs were developed in 1996 (Peck, et al. 1999).

2.6.2 Facilitators to the Adoption of Green Roofs

According to Philippi (2006), until recently, almost every green roof built in the USA has been an individual solution. Custom made solutions are complicated and costly and bear a rather high risk of failure (Philippi 2006).

Establishing complete systems with a certified quality standard would also make American green roof construction easier, safer, and cheaper:

1. easier for architects and landscape architects to design and specify green roofs,
2. easier for the contractor to calculate and purchase materials,
3. safer for specifiers and contractors, because individual solutions can fail easily, and
4. cheaper for the client because standardized materials can be produced and used more efficiently and with less risk.

While American Standard Testing Methods (ASTM) regulations in this field are just now being developed, existing standards developed in Europe certainly can be a useful guideline (Cantor

2008). The goal is to provide a common basis and to avoid failures, as failures could impede further growth in the American green roof market.

The FLL has been working on standards for green roof technology for twenty-five years. The FLL's Guideline for the Planning, Execution and Upkeep of Green-Roof Sites reflects the latest developments in German-acknowledged, state-of-the-art technology. Although these guidelines don't give solutions for all green roof problems, they are a basic tool for the construction of reliable, high-quality green roofs (Dunnett and Kingsbury 2008).

The latest edition of the FLL, from January 2002, was released in English in 2004. From a legal standpoint, this German guideline cannot substitute for future American standards; however, it is a good source of reliable information based on the experience of almost one billion square feet of green roofs constructed (Philippi 2006).

In addition Peck (1999) argues that green roof technologies can simultaneously address a number of important economic, social, and environmental challenges. They provide an outstanding number of public benefits in areas such as air quality improvement, reduction of greenhouse gases, storm water quality and quantity improvements, as well as long term economic benefits for building owners. In Europe, policy makers have established various measures to support the application of these technologies, resulting in the formation of a new green roof industry. Peck (1999) believes that the many public benefits attainable from green roofs present a strong case for federal, provincial, and municipal government support. Additionally, Peck suggests this support is fundamental to overcoming market barriers and thereby creating a viable market for green roof technologies (Peck, et al. 1999).

2.7 Changing Attitudes towards Extensive Green Roofs

While commercial property owners are motivated by return on investment, residents and visitors are members of the public who are likely to be interested in scenic views and who may be willing to pay more for locations that have these views (Kaufman, et al. 2006). At the same time, the public is also concerned with environmental quality. Kaufman's research supported the willingness of residents and visitors to pay for views of green roofs; attitude surveys conducted determined these

groups would find the idea attractive. This provides policymakers a general overview of public opinion (Kaufman, et al. 2006).

2.8 Summary

Chapter Two reviewed research and literature pertaining to various elements that could create a conflict between installation cost and benefits of extensive green roofs. In addition, this chapter demonstrated that although extensive green roofs are an important part of ecologically performative landscape practices, there are barriers to implementation stemming from perceptions of cost and aesthetics.

CHAPTER 3

RESEARCH METHODS

3.1 Introduction

This research utilized face-to-face interviews to collect data from a sample consisting of developers, city officials, architects, and landscape architects who work in the North Texas region, as it is defined by the North Texas Council of Governments (NCTCOG). Semi-structured, face-to-face interviews were conducted to gather information about participants' perceptions of extensive green roofs in the region. Individuals were selected for the study because they represent the primary decision makers or are major contributors to decisions made within their respective institutions. A conversational, open-ended interview allowed respondents to offer a narrative of their perceptions and attitudes towards extensive green roofs without limiting them to a finite set of responses that would have resulted from a quantitative survey.

The interview transcripts were analyzed to identify respondents' perceptions of extensive green roofs. The data was then compared to the five attributes of innovations as defined by Rogers (2003). Rogers states that an innovation will have a higher rate of adoptions if it:

1) is perceived to have a relative advantage over existing strategies,
2) is compatible with existing beliefs and values,
3) is not perceived as being too complex,
4) can be tried on a small scale first, and
5) can be seen in place and working in other situations.

3.2 Research Perspective

Rogers states that regardless of the industry or field in which an innovation is proposed, there are five variables that contribute to the rate of adoption:

1) the perceived attributes of innovations,

2) the type of innovation-decision,

3) communications channels,

4) the nature of the social system, and

5) the extent of change agents' promotion efforts (Rogers 2003).

This research focuses on the first variable, "perceived attributes of innovations," a category which can be broken down further into five elements that are generally applicable to all innovations, regardless of industry. These include:

1) Relative advantage,

2) Compatibility,

3) Complexity,

4) Trialability, and

5) Observability

3.2.1 Relative Advantage

Relative advantage refers to the "degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers 2003), and may include improvements in profitability, performance, and status. The perception that extensive green roofs can offer some sort of an advantage to projects in terms of status, return on investment, or increased competitiveness contributes to the relative advantage of the innovation.

3.2.2 Compatibility

Rogers (2003) defines compatibility as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters." For example, an innovation with high compatibility would be less "unknown" to the potential adopter and would lead to a greater rate of adoption. By this definition, perceptions about the compatibility of extensive green roofs with the regions climate, structural systems, aesthetics, expectations, zoning restrictions, and personal beliefs will contribute to the rate of adoption (Rogers 2003).

3.2.3 Complexity

Complexity is the "degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers 2003). Rogers (2003) believes that how one gages the complexity of an innovation has a direct effect on its rate of adoption. Thus, a high level of perceived complexity will lead to a reduced rate of adoption.

3.2.4 Trialability

Trialability, or "the degree to which an innovation may be experimented with on a limited basis," also contributes to a greater rate of adoption (Rogers 2003). Trialability does not refer to whether or not green roofs can be tested on a small scale; rather, trialability refers to how the public views whether or not green roofs can be tested on a small scale.

3.2.5 Observability

Finally, observability is the "degree to which the results of an innovation are visible to others" (Rogers 2003). Rogers (2003) associates greater observability of an innovation with a greater rate of adoption. Traditionally, observability refers to the ability of a member of the social system being studied—in this case, decision makers in DFW—to see the innovation implemented and working so that he might be influenced to adopt the practice himself (Rogers 2003).

3.3 Research Design

Rogers (2003) identifies eight types of research that have foundations in diffusion theory. The majority of diffusion research is concerned with the characteristics of the individual and how he/she affects the rate of adoption of an innovation. Based on these characteristics, the individual is classified as belonging to one of the following adopter categories: innovator, early adopter, early majority, late majority, or laggard. Other popular types of diffusion research are concerned with the communication channels used to distribute information about an innovation, the innovation decision process, and the role of opinion leaders in diffusion networks. Relatively little research has been done regarding how the rate of adoption of an innovation is affected by the perceptions of its attributes; however, Rogers (2003) states that this "type of research can be valuable in predicting the reactions of people to an innovation." This research used diffusion theory as a framework and

organization tool to identify perceptions of extensive green roofs and evaluate how these perceptions affect rates of adoption among the sample community (Rogers 2003).

Interviews were digitally recorded using a Sony Digital Voice Recorder. These digital files were sent via file transfer protocol (FTP) to a Santa Monica, California based company called Verbalink.com for transcription. Employees of Verbalink.com transcribed the interviews and e-mailed them to the researcher in the form of Microsoft Office Word documents. The researcher read the interviews, searching for indications of perceptions related to the Rogers' (2003) five attributes of innovations. Related perceptions from all respondents were grouped according to three categories based on the interview questions—sustainability, intensive green roofs, and extensive green roofs—and analyzed for recurring themes and pertinent details.

3.4 Interview Protocol

The interviews were conducted using a semi-structured approach with open-ended questions. After identifying the sample properties and gathering contact information and entrée, appointments were scheduled to conduct interviews and collect data. All interviews were recorded with a Sony Digital Recorder and then submitted to Verbalink.com for a verbatim transcription. The meetings were conversational in nature, and although the interview script served as a guide to learn about the decision makers' perceptions, subjects were not limited to discussing only the questions in the script.

3.5 Research Questions

The research questions in this study are:

1) What are the perceptions of extensive green roofs among key decision makers in North Texas?
2) How do perceptions of extensive green roofs affect their adoption among decision makers in North Texas?
3) What are the barriers to adoption of extensive green roofs among the respondents?
4) What are the facilitators to adoption of extensive green roofs among the respondents?

5) What are the perceptions of the appropriateness of extensive green roofs among decision makers in North Texas?

6) How do perceptions of the appropriateness of extensive green roofs for North Texas affect their adoption among the respondents?

3.6 Research Sample

The research sample consisted of eight decision makers within the North Texas region (Figure 3.1), as it is defined by The North Central Texas Council of Governments (NCTCOG). NCTCOG is a voluntary association of, by, and for local governments that was established to assist local governments in planning for common needs, cooperating for mutual benefit, and coordinating for sound regional development. NCTCOG's purpose is to strengthen both the individual and collective power of local governments, helping them to recognize regional opportunities, eliminate unnecessary duplication, and make joint decisions.

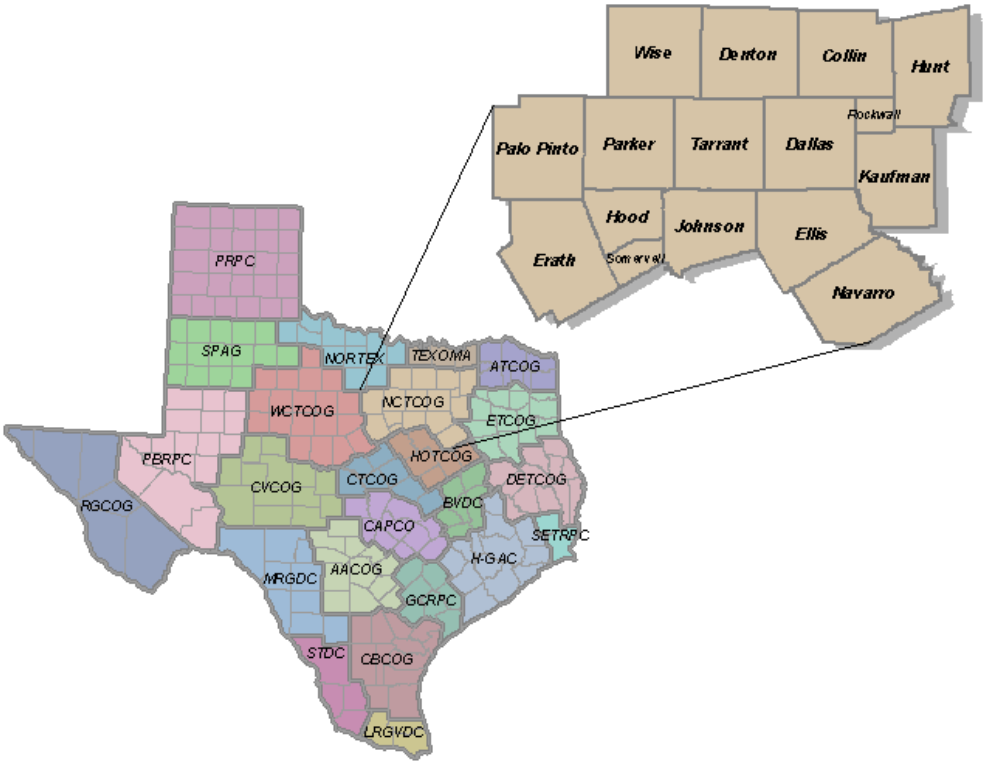


Figure 3.1 Map of the Sixteen County District that Defines NCTCOG

North Texas was selected as the location for this study for several reasons. First and foremost, as of 2009, North Texas has only one built and installed extensive green roof. As stated above, many regions and municipalities across North America have both established networks of extensive green roofs as well as public policy incentives to encourage future development. Therefore, compared to other major metropolitan areas in the US and Canada, North Texas is sluggish in adopting this ecologically performative landscape practice. Second, North Texas represents a region with a high level of water concerns due to a climate in which more water is lost through evapotranspiration than falls in precipitation. Therefore, there is a large reliance on reservoir storage throughout the region. Finally, North Texas was selected because the concentration of the sample group into one geographical location enabled the completion of interviews within a reasonable amount of time.

The first step in the process of identifying subjects for the sample group called for the creation of a list of developers, city officials, architects, and landscape architects in the region using multiple database systems. This list included developers, investors, owners, city planners, city council members, mayors, city managers, registered architects, and registered landscape architects who work or practice in North Texas.

From this list, a working set of individuals who fell within a set range for certain characteristics was identified. Parameters were set for location, profession, and years of experience in North Texas. All subjects must be located, be employed, or conduct business in North Texas. These individuals were further classified into three groups: developers, city officials, and architects. All individuals who had been practicing in North Texas for less than five years were then eliminated because they are less familiar with the regional issues associated with this study, leaving only stakeholders with regional awareness located in North Texas in the sample group (Table 3.1). In this research, a numbering system was used to protect the identity of the selected individuals.

Table 3.1 List of Respondents' Information and Code Labels

RESPONDENT INFORMATION Final Subject List			
Respondent	**Profession**	**Local Experience**	**Location of Affiliation**
Developer One (R1)	Developer	10 years	Dallas, TX
Developer Two (R2)	Developer	8 years	Irving, TX
City Planner One (R3)	City Planner	20 years	Addison, TX
City Planner Two (R4)	City Planner	16 years	Allen, TX
Architect One (R5)	Architect	15 years	Ft. Worth, TX
Architect Two (R6)	Architect	12 years	Addison, TX
Landscape Architect One (R7)	Landscape Architect	10 years	Dallas, TX
Landscape Architect Two (R8)	Landscape Architect	6 years	Dallas, TX

3.7 Bias and Error

While the selected individuals do have similar interests, variations exist in the roles in which these individuals play in the decision making process. All of the individuals fall into the "stakeholder" category as designated by Stein (1997) in her thesis regarding how rural stakeholders value and benefit from natural landscapes. Another potential difference is microclimate. Although all the individuals practice in North Texas and within the North Texas ecosystem, variation in topography, elevation, vegetation amounts and placement, and orientation contribute to a unique microclimate for each extensive green roof throughout the region.

One criticism of diffusion of innovations research is that it tends to have a pro-innovation bias. There is the "implication in diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected" (Rogers 2003). This study does have a bias in favor of the innovations (extensive green roofs) discussed, which should be taken into account in evaluating the results and implications in the following two chapters.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Interviews were conducted with key decision makers in North Texas to gather their perceptions of extensive green roofs. Transcripts of the interviews were analyzed according to Rogers' (2003) theory regarding five attributes of innovations that affect the adoption rates of innovations or practices. The data showed that stakeholders' overall perceptions of extensive green roofs were favorable regarding appropriateness for use in North Texas. However, concerns were raised regarding space requirements, initial cost, return on investment, city codes, and aesthetics. Some respondents cited initial construction cost as the primary barrier to adoption. Conversely, others spoke about the importance of making such practices visible, as a means of exerting positive influence on both the project's image and on end users. Lack of time for adequate research as well as concerns about costs were frequently cited as a barriers to implementation.

4.2 Analysis of the Interviews

Interviews were digitally recorded using a Sony Digital Voice Recorder. These digital files were sent via file transfer protocol (FTP) to a Santa Monica, California based company called Verbalink.com for transcription. Employees of Verbalink.com transcribed the interviews and e-mailed them to the researcher in the form of Microsoft Office Word documents. The researcher read the interviews, searching for indications of perceptions related to the Rogers' Five Attributes of Innovations (2003). Related perceptions from all respondents were grouped according to one of three categories—sustainability, intensive green roofs, and extensive green roofs, and analyzed for recurring themes and pertinent details.

4.2.1 The Role and Importance of Sustainability in the Decision Making Process

Two introductory questions were asked about the importance of sustainability in the decision making process.

1) How important are sustainable building practices in the decision making process?
2) Have you ever used sustainable building practices in past projects? Please explain why or why not.

In response to the first question regarding sustainability in the decision making process, four respondents described sustainability as common sense. Architect One said, "We refer to everything sustainable as common sense 'cause you go to any ancient culture and that's the way things were built." At Architect Two's company they, "take all the consumptive and non-consumptive sustainability objectives and incorporate some common sense…to the living condition and try to meld and mesh all these different things to make a building that's…more in concert with the earth and the impact that it makes." Landscape Architect Two said, "I think going into a project we should already inherently be in tune with sustainability and good building practice," and "…whether the client specifically says, 'This is part of my program,' or you educate the client—I do think it's our responsibility to educate them on all aspects of trying to create a more holistic project." Finally,

Architect Two believes that sustainability is "…becoming more important all the time…for a variety of reasons—obviously, energy conservation, the lower dependence on fossil fuels, lower electricity cost, and less of an impact on natural resources."

Conversely, five respondents still felt that sustainability was an objective of the client or program. Landscape Architect One said, "… it depends on who's asking the question and what kind of ethic the client has…," and as Architect One explains it, "depending on your client it really varies, and your project type." City Planner One stated, "We had a huge push from our citizens to go green. They wanted sustainability. They wanted to be the greenest city in Texas."

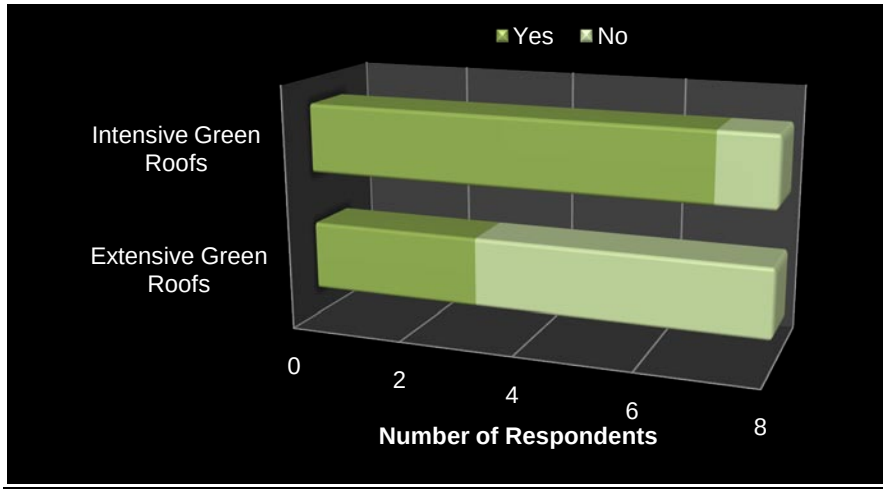
Other responses included "…sustainability is very much about the planning process…" and "these things are important because they can reduce our development costs, but also if we can let

an individual piece of property and let it define what needs to be built in it going into the future, I think it's easier to build a product that seems natural."

In response to the second question, all respondents claimed to have implemented multiple sustainable building practices such as "specifying low maintenance, drought tolerant native landscapes…," "bio swales that allow…water to be purified over land for some distance," "taking advantage of building orientation for solar gain and providing for daylight so that you can minimize the amount of lighting…," and that "the fact that you can educate and get your client and architect and whole team to want to, let's say relocate trees or even invest money in subsurface root pruning, aerating, things like this where the building is going to impact existing trees. Making those decisions is very sustainable."

One respondent also has experience with bioremediation: "we restored or are restoring a man-made lake to its…fully operating natural systems by collecting the water through a series of pumps and day lighting that water into new constructed wetland cells that are filled with wetland plants. It brings the nitrogen [and] phosphorous filled water at five gallons a minute into the wetland cell. The water then works its way through the system over the course of about three days and by the time it gets to the last cell, it's basically purified by the wetland plants, and then it returns back to the lake."

Table 4.1 Respondents' Familiarity with Green Roof Systems[1]



[1] See Appendix C for responses by individual respondents.

Table 4.2 Respondents' Opinions Regarding Appropriateness of Green Roofs to North Texas

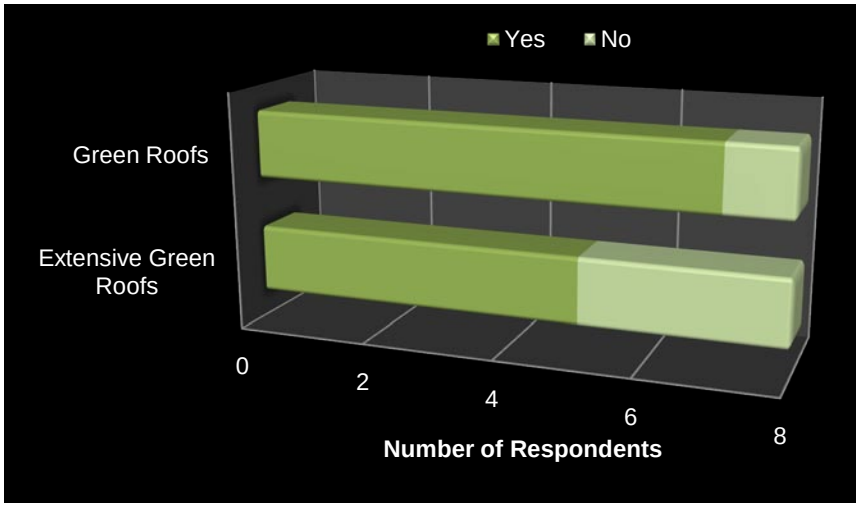
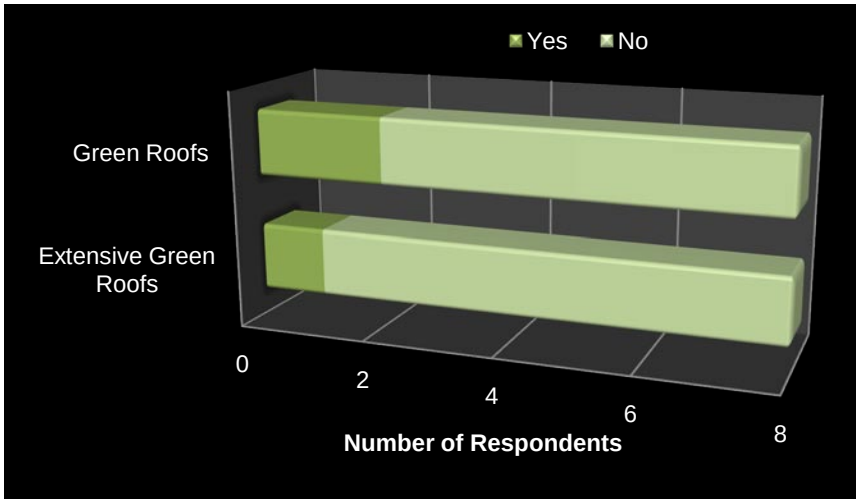


Table 4.3 Respondents' Experience with Green Roofs outside of North Texas



4.2.2 Green Roofs

The first set of perception-related questions dealt with green roofs in general.

1) Are you familiar with green roofs?
2) Please describe green roofs as you understand them.
3) What do you believe are the benefits and/or negatives of green roofs?
4) Have you used green roof technology in past projects? Please explain why or why not.

All eight respondents described themselves as being familiar with green roofs, though one had reservations about the nomenclature (Table 4.1). City Planner Two identified green roofs with a sustainable building practice however, was more comfortable with the term living roof to describe a roof that contained a growing medium and plant community.

Furthermore, all eight respondents were able to present multiple benefits of a green roof once a clear definition was explained. Six respondents clearly expressed cost of insulation to be the primary negative. Landscape Architect One stated, "...the negatives would be the cost of the initial installation…," and Developer Two believes "…[the additional structural support needed] drives up the cost." However, Landscape Architect Two was able to rationalize the initial cost, based on personal preference: "I personally like them, I have very few negatives and seem to be able to rationalize any con somebody else brings up." In addition, Architect One believed that the upfront cost is dramatically reduced in new construction compared to the overall cost of the project, stating that "…there are some negatives [associated] with the cost with existing buildings, but if you figure it into your building up front…it may not add much to the project cost. Be less than a percent…compared to an overall cost for the project."

None of the respondents' affiliations had ever used green roof technology in past projects; yet, two of the respondents stated that they have specified and designed green roofs into past projects, none of which were ultimately built (Table 4.2). Landscape Architect Two stated that, "we've designed and had it proposed on multiple projects, and don't have anything yet built. They've gotten value engineered out. We do have upcoming projects where I think this will work." Landscape Architect One said, "…we have specified it and researched it….," and "we've looked at green roofs for some of our multi-family towers and it eventually becomes less of a green roof and more about pool deck or active [recreation], they've got seating, decking, pools, that sort so thing….so the true green roof has not been…fully vetted out in any of our projects."

4.2.2.1 Perceptions of Relative Advantage Regarding Intensive Green Roofs

All eight respondents indicated a perceived relative advantage related to green roofs. Landscape Architect One stated that "aesthetically, [green roofs] provide for greener urban

environments that could be interactive and could make for better view sheds or view corridors out of buildings to the urban environment." Architect One believes "there's a ton of positive things, reducing your heat island… managing runoff…filtering the water that comes off the roof and cleaning the air." Also, multiple respondents can be quoted as believing green roofs help to reduce a buildings carbon footprint. However, as mentioned above, cost concerns were frequently mentioned regarding green roofs as a sustainable building practice. This is related to relative advantage in that decision makers try to minimize spending in order to maximize profits. Landscape Architect One described various cost associated with green roofs such as "the cost of the initial installation…, the cost of ongoing maintenance, [and] potential irrigation needs." While Architect One also described upfront cost as a negative, he believes "… [Cost] will come down as we…get more into a green roof kind of world."

4.2.2.2 Perceptions of Compatibility Regarding Intensive Green Roofs

The comments of two respondents indicated perceptions of green roofs related to compatibility. One was a positive association with the practice in North Texas and one was negative. Landscape Architect Two spoke about the perceived compatibility of green roofs with the climate and weather conditions in North Texas when they said, "…Texas is a crazy place weather wise….as long as you're mimicking some rainfall and give it that supplemental water, [that] pushes it into a pretty acceptable measure." While City Planner One thought green roofs would not be compatible with the local climate, stating "I don't see anyone doing one in this climate in the short-term…" and "even in the ground with good irrigation there's a limited number of plants that we can get to make work [in this area]."

In contrast, City Planner One and two other respondents did speak about their perceptions of the compatibility of green roofs regarding their use in urban environments in North Texas. City Planner One's perception was "…where you have no green space and you can provide a space for your customers, your tenants, your residents… I see a lot of benefit for [green roofs] in that they add green space in urban environments." Landscape Architect One spoke of the value of aesthetics in the urban environment, saying that "aesthetically, it provides for a greener urban environment that could be interactive and provide…a better view shed or view corridors out of buildings….instead of

seeing an asphalted roof, you're seeing green park-like space from your office or living space." Finally Architect One said, "[c]reating…more usable urban space that's green and aesthetically pleasing [is] hard to put a price on, but it's substantial I think."

4.2.2.3 Perceptions of Complexity Regarding Intensive Green Roofs

Only one respondent voiced the perception of complexity regarding green roofs. When asked to describe green roofs as he understood them, City Planner Two seemed to want more explanation about the term "green roof", saying "my superficial understanding would be it's either a technology kind of situation; therefore, green in terms of its self-supporting, self-sufficient or close to it or it is a landscape plant material application." While he seemed to have a general understanding of a living roof, he wasn't sure of how this research was defining the term "green."

4.2.2.4 Perceptions of Trialability Regarding Intensive Green Roofs

No perceptions pertaining to trialability associated with green roofs were found in the interview transcripts.

4.2.2.5 Perceptions of Observability Regarding Intensive Green Roofs

No perceptions pertaining to observability associated with green roofs were found in the interview transcripts.

4.2.3 Extensive Green Roofs

The final set of perception-related questions dealt with extensive green roofs in general.

1) Are you familiar with extensive green roofs? If so, please explain.
2) Are extensive green roofs ecologically appropriate for use in north Central Texas? Please explain why or why not.
3) Are extensive green roofs environmentally appropriate for use in north Central Texas? Please explain why or why not.
4) Are extensive green roofs economically appropriate for use in north Central Texas? Please explain why or why not.

Of the eight respondents, three described themselves as being familiar with extensive green roofs. Given that two of the respondents are landscape architects and one is an architect, this was

not surprising. One respondent, who had researched and designed an extensive green roof for an upcoming project, exhibited the greatest familiarity with the practice and discussed the various system types and applications.

The remaining five were unfamiliar with extensive green roofs and required a definition of the term be read to them before being asked if they thought extensive green roofs were appropriate for use in North Texas (Table 4.3). Upon hearing the definition, one respondent had concerns regarding the structural implications of them, stating that structural additions to support the weight of an extensive green roof presents a challenge. Developer Two said, "…[t]he structural aspects of doing the deck [are] pretty significant. It's a lot of pounds per square foot and drives up the cost…" At the other end of the spectrum, Architect Two felt that extensive green roofs were a structural solution rather than a challenge, stating "[y]ou've got a lot less growing medium… therefore you don't have to build the building as stout to maintain that weight."

All but one of the respondents viewed extensive green roofs as appropriate for use in North Texas. The one who felt they were not appropriate cited the harsh North Texas climate and its limited plant palette as the basis for reasoning. None of the eight respondents have implemented extensive green roofs in North Texas.

4.2.3.1 Perceptions of Relative Advantage Regarding Extensive Green Roofs

All eight respondents indicated a perceived relative advantage related to extensive green roofs. These perceptions were related to both a benefit in profitability—with extensive green roofs, "there's surely a savings, a payback over time…"—and an improvement in competitiveness among clients due to an aesthetic enhancement to a particular site, believing "it would make a rooftop unique, probably bring more rent, and get people interested in being in that building." Many other positive perceptions related to relative advantage were found. Landscape Architect One believed that "if you're trying to reduce heat island, if you're trying to save energy and further insulate your building they have their place." Also, Architect Two said, "…I can see it from a practical standpoint and cost-containment for original construction, and just the practicality of it, of insulation the building…" City Planner Two said, "…the greening of the footprint…the biological benefits of [an

extensive green roof]…" Conversely, Landscape Architect Two had reservations; he stated, "…I'm always an optimist, so I think done right with the right plant material, yes I think they are [appropriate]…"

4.2.3.2 Perceptions of Compatibility Regarding Extensive Green Roofs

Three respondents have concerns about the compatibility of extensive green roofs in North Texas, due to the region's limited plant palette. Landscape Architect One said, "I know that sedums are the primary…plant used in the Northeast and Pacific Northwest because they do very well in those kind of environments. Regarding the Southwest and South…those kinds of plants don't hold up here as well because of the heat and the wind." City Planner One said, "even in the ground with good irrigation there are a limited number of plants we can get to make work." Finally, Architect One also had reservations about plant selection, stating that, "…we just have to find out what will grow here on a hot windy roof…"

4.2.3.3 Perceptions of Complexity Regarding Extensive Green Roofs

City Planner One's perceptions of extensive green roofs indicated that with their present understand they are not likely to pursue adoption of the practice, stating "It just doesn't look to me like it makes any sense, and putting that much water on your roof is something no architect or engineer wants to do…." Five of the eight respondents were unfamiliar with extensive green roofs and required that a definition of the term be read to them before being asked if they thought extensive green roofs were appropriate for use in North Texas. This is related to the complexity of extensive green roofs in that the technology is not fully understood. When City Planner Two was asked if they had any knowledge of extensive green roofs, their response was simply, "No, I don't…"

4.2.3.4 Perceptions of Trialability Regarding Extensive Green Roofs

Four perceptions found can be tied to the trialability of extensive green roofs. The first three were from respondents whose comments related to their knowledge of and interest in the various research projects that are being conducted in Texas. Architect One stated, "It's definitely on the radar and that's why I've been following the research they are doing at UTA…it looks like they are finding some plants that can survive the pretty harsh climate." Also Landscape Architect Two said,

"that's where field trials and stuff are important, because we're talking about trying to grow short grasses and things like that…" The third perception found in regards to trialability was from Landscape Architect One, who stated, "I know there are studies and trials being done by the Ladybird Johnson Wildflower Center and UTA to establish what particular plant species seem to be the most successful in this environment." The fourth perception related to trialability came from City Planner Two, who felt that "the tray system would allow you to test the plants selected prior to the full installation," and though they have not done this themselves, their perception that it could be done was related to the trialability of extensive green roofs.

4.2.3.5 Perceptions of Observability Regarding Extensive Green Roofs

Landscape Architect Two had observed extensive green roofs in other areas of the country and internationally. He said, "I've seen… the massive green roofs [that] are coming out of the Midwest and California." Architect One had seen an extensive green roof, saying "I've been following and visited [the green roof] at UTA…"

Architect Two also talked about the positive aspect of having an observable extensive green roof, saying "the place to use them would be where you have a view of that roof from some other building…we have a lot of projects where we focus on view corridors." Further, Architect One said, "At a high rise building looking down at a roof we're creating more urban space that's green and aesthetically pleasing. It's hard to put a cost or value there, but it's substantial I think."

4.3 Summary of Findings

Both intensive and extensive green roofs had multiple positive perceptions related to relative advantage and very few negative perceptions (Table 4.4). There were three frequently cited negatives—cost of installation, maintenance, and liability—while the most commonly cited positive perceptions were aesthetics, the management of storm water run-off, insulation, and the reduction of reflective and radiant heat. With multiple occurrences, perceptions related to relative advantage outnumbered the other four attributes.

The perceptions related to compatibility tended toward the negative, with more negative than positive perceptions for the compatibility of green roof technology in North Texas. Common

perceptions of structural limitations, climate and weather related issues, and meeting expectations were cited throughout interview transcripts.

Both intensive and extensive green roofs elicited only negative perceptions relating to complexity. Five respondents were unfamiliar with the term extensive green roof, requiring a definition to be read to them.

Four perceptions found tied to the trialability of green roofs. The first three were from respondents whose comments related to their knowledge of the various research projects being conducted throughout the state of Texas. The fourth perception related to trialability came from Landscape Architect Two, who felt that the tray system would allow you to test the plants selected prior to the full installation.

Finally, there were three positive perceptions related to the observability of intensive green roofs and only one positive perception related to extensive green roofs. All of these positive perceptions pertained to increased property value, aesthetics, and view corridors in urban environments.

Table 4.4 Summary of Positive and Negative Perceptions of Green Roofs

Theory of Innovation	**Intensive Green Roofs**		**Extensive Green Roofs**		**Perception Totals**		
Attributes	Positive	Negative	Positive	Negative	Totals		
Relative Advantage	5	3	8	0	16	13	Positive
						3	Negative
Compatibility	3	5	0	1	9	3	Positive
						6	Negative
Complexity	0	1	0	7	8	0	Positive
						8	Negative
Trialability	0	0	4	0	4	4	Positive
						0	Negative
Observability	3	0	1	0	4	4	Positive
						0	Negative
Total	11	9	13	8	41	24	Positive
						17	Negative

CHAPTER 5

CONCLUSIONS

5.1 Introduction

This chapter discusses the findings from the in-depth interviews conducted on green roofs in North Texas and how these findings address the primary research questions:

1) What are the perceptions of extensive green roofs among key decision makers in North Texas?
2) How do perceptions of extensive green roofs affect their adoption among decision makers in North Texas?
3) What are the barriers to adoption of extensive green roofs among the respondents?
4) What are the facilitators to adoption of extensive green roofs by the respondents?
5) What are the perceptions of the appropriateness of extensive green roofs among decision makers in North Texas?
6) How do perceptions of the appropriateness of extensive green roofs for North Texas affect their adoption among the respondents?

This chapter also cross-references the findings of these interviews with those of the literature review. Correlations are established between the information gathered from decision makers in North Texas and what the literature states is occurring nationwide and even internationally. This chapter also illustrates the importance of the data to the landscape architecture profession. Future research opportunities are discussed because the research prompted many additional questions about the use and perception of green roofs and questions about issues with their overall design.

5.2 Research Findings

According to Rogers (2003), an increased rate of adoption of an innovation should be predicted by a prevalence of positive perceptions held by potential adopters relating to the five

attributes of innovations—relative advantage, compatibility, complexity, trialability, and observability. According to this theory, a relatively high rate of adoption should be seen for green roofs in North Texas. Green roofs elicited a total of 41 associated perceptions, 24 positive and 17 negative. These findings suggest that an improvement in the understanding of green roof technology among decision makers in North Texas would further increase its rate of adoption.

Extensive green roofs elicited 13 positive and 8 negative perceptions. However, five of the eight respondents required the definition of extensive green roofs be read to them prior to answering any further questions. The 13 positive perceptions for extensive green roofs were gained in the areas of relative advantage, trialability, and observability. Negative perceptions appeared in the areas of compatibility and complexity. The prevalence of negative perceptions of extensive green roofs indicated a lower rate of adoption than intensive green roofs.

Beyond an analysis corresponding to Rogers' Attributes of Innovations, some overall themes were observed. First, while three of the respondents, two landscape architects and one architect, cited a desire to utilize green roof technology based on their personal beliefs and aesthetics, the other respondents, city officials, developers, and one architect showed an overriding concern with installation cost and return on investment. This concern seemed to guide the majority of the decisions regarding green roof technology. City Planner One, a city planner, discussed the prioritization of sustainable building practices and budget allocations, stating, "there are alternatives [to green roofs] that are less expensive and achieve similar goals." Furthermore, upon learning of extensive green roofs, Developer Two, a developer, immediately saw the possibility of using green roofs to improve the property value or lease rate for views of green roofs compared to those of bare roofs.

Second, education and exposure to green roofs are important factors in familiarizing clients and citizens with extensive green roofs. While the majority of the respondents were familiar with intensive green roofs, fewer had an understanding of extensive green roofs. Furthermore, incorrect assumptions were made about green roofs, possibly increasing resistance to adoption of them as a regionally appropriate solution. Many of the respondents considered themselves to be familiar with

green roofs; however, their experience was limited to intensive green roofs and roof top gardens, so they were largely unaware of the benefits and low profile design of an extensive green roof. They were also unaware that most extensive green roof systems can be implemented with very little to no additional support in new construction and when retrofitting existing architecture. With this information, respondents might consider extensive green roofs as a viable option in the future. As part of this effort to familiarize clients with extensive green roofs, landscape architects should demonstrate that they need not conflict with existing structural conditions. This could be accomplished by sharing of photos of well executed examples, site visits to successfully implemented systems, and the inclusion of articles in developer, engineering, and planning publications in which landscape architects offer explanations and discussions of benefits as compared to cost and structural requirements.

Finally, an effort should be made to encourage the incorporation of green roof technology in the criteria for LEED certification, industry awards, and other forms of status recognition. For example, Landscape Architect One discussed his efforts to obtain a LEED Silver status for an upcoming project, which is scheduled to include a green roof. If the criteria for earning this distinction included a greater point value for green roofs, he believes his client would be less likely to cut it from the program if the budget gets tight, as past clients have done in his experience.

5.3 Relevance to the Profession of Landscape Architecture

A central responsibility of the profession of landscape architecture is to “manage and minimize environmental risks to the public’s health, safety, and welfare through quality design and planning” (American Society of Landscape Architects 2008). With this mission, the implementation of sustainable building practices in general should be prevalent among landscape architects. Although studies show there is much discussion of these practices and their value, “implementation…lags substantially behind discourse” (Calkins 2005). The reasons for this discrepancy stems, in part, from a resistance to these practices from clients. In order to respond to this resistance, landscape architects must have a clear understanding of why resistance exists as

well as contributing factors. Landscape architects cannot begin to address these reasons for resistance until resistance is clearly understood.

By gathering perceptions from one-on-one interviews, this research sheds light on how decision makers in North Texas perceive extensive green roofs. Findings suggest that by taking a proactive stance in demonstrating a return on investment, landscape architects could address one aspect of client resistance. One way to do this is to focus on informing their clients as to the importance of conserving natural resources. Prevailing attitudes towards energy efficiency, sustainability, and aesthetics are changing as buying power shifts to younger generations. If decision makers in North Texas understand that extensive green roofs are valued, even demanded, by potential clients and residents, an argument is made that will contribute to an increase in competitiveness in the market.

This research also suggest that educating clients about the value, aesthetics, and mechanics of extensive green roofs is another crucial step toward counteracting incorrect assumptions made because information is incomplete.

5.4 Suggestions for Further Research

Based on the findings of this study, further studies should be done in which:

1) decision makers from a various urban center throughout Texas are included in the sample to yield a broader view of how green roofs are perceived in urban climates with various environmental issues;
2) analysis is performed on the perceptions of green roofs held by other stakeholders in North Texas, such as building owners, management companies, maintenance personal, tenants, and potential users; perceptions of each group of stakeholders could be compared with the perceptions of others for information on possible assumptions which influence the rate of adoption;
3) data is gathered specifically about the complexity of extensive green roofs;
4) more information is collected about the respondent to gauge the influence the person's background has on the way they perceive green roofs;

5) data is gathered through Global Information Systems (GIS) as to the number of support systems of flat roofs within the region to determine the market potential for North Texas;
6) photo elicitation is used to gather perceptions about the aesthetics and appropriateness of use of extensive green roofs in North Texas and other regions in the South and Southwest;
7) city officials are interviewed to gain further information on public policy as it relates to green roofs in various municipalities;
8) data is collected regarding city ordinances to gauge the attitude that city has regarding sustainable building practices;
9) state and federal data is collected regarding mandates and laws in other geographical locations;
10) a market analysis is done on other regions that have shown an increased level of adoption for extensive green roofs;
11) data is gathered to create case studies of the current projects in North Texas;
12) plant selection is tested and compared to research projects that have been done throughout Texas to create an appropriate plant palette for North Texas;
13) hydrological data is gathered from the three research projects and is compared to findings in literature to determine the hydrological performance of green roofs in Texas;
14) the financial impact of extensive green roofs within North Texas, as compared to their impact in other regions of the country; and
15) other research methods used to study the same questions posed in this paper, including quantitative methods such as structured interviews or internet based surveys.

5.5 Summary

Chapter Five summarizes the data analyzed in Chapter Four and places the information in more of a thematic approach to detail important findings and trends in the research questions addressed in this research study. The findings are correlated with the interview questions, the research questions, and the literature review. The findings are then examined to determine there

importance to the profession of landscape architecture. Ideas for future research studies are then presented regarding the use of extensive green roofs and landscape architecture.

This research also revealed the need for city officials and developers in North Texas to become more knowledgeable of extensive green roofs and revealed perceptions of cost and lack of incentives as major barriers to adoption. This lack of knowledge is a major contributor to the regions sluggish rate of adoption. Additionally, both city officials and developers expressed the belief that when green roof technology works its way into standard building codes through mandates, incentives, and public policy, the green roof market will emerge. This perception alone identifies a need for stronger political influence within the region. As stated in Chapter Two, many cities across North America and the world have begun requiring that certain percentages of new flat roof construction be covered by green roof systems. Concurrently, these cities and municipalities are leading the way in green roof technology, marketplace, and product development. Finally, due to the prevalence of misconceptions regarding extensive green roofs, this research suggest that a movement to increase public education and awareness would positively affect the rate at which North Texas adopts green roofs as a regionally appropriate solution.

APPENDIX A

INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

First I'd like to find out more about your perceptions of sustainable building practices in general.

- How important are sustainable building practices in the land development process?
- Have you ever used sustainable building practices in past projects? Please explain why or why not.

Now I'd like to ask you a couple questions about your knowledge and perceptions of green roofs.

- Are you familiar with green roofs?
- Please describe green roofs as you understand them.
- What do you believe are the benefits and/or negatives of green roofs?
- Have you used green roof technology in past projects?

And finally I have a few questions about your knowledge of EXTENSIVE green roofs and their appropriateness to the North Texas region.

- Are you familiar with extensive green roofs? If so, please explain.
- Are extensive green roofs are ecologically appropriate for use in North Texas? Please explain why or why not.
- Are extensive green roofs are environmentally appropriate for use in North Texas? Please explain why or why not.
- Are extensive green roofs are economically appropriate for use in North Texas? Please explain why or why not.

APPENDIX B

INTERVIEW TRANCRIPTS

RESPONDENT #1 (DEVELOPER): INTERVIEW TRANSCRIPTS

HH: Are you familiar with green roofs?

R1: I am, yes.

HH: Please describe green roofs as you understand them.

R1: It's a roofing structure that uses kind of a living biosphere or living material to shade, deal with storm water, use insulation, um, instead of kind of more conventional means.

HH: Okay. Um, what do you believe benefits or negatives of green roofs to be?

R1: Um, I think there's some very big benefits as it comes to dealing with, um – well, obviously dealing with runoff in very dense environments. Um, I think there are some – there was at least a big discussion on the insulative values that, uh – that they create. Um, I think there's a pretty big kind of marketing but also just general perception that can be used. I think they can they be used as an amenity as opposed to an area which is generally seen as a liability to a – to, um, a building.

I think they're unproven at this point in time. Um, I don't necessarily see that as a huge negative, but I know that they'll be some development issues as we deal with – especially in North Texas. What happens in the summer? We don't want to water our roof, but we do have kind of very long periods in our summers without rain and extreme heat that could, you know, create a maintenance issue. Um, and then from a long-term standpoint, I think we've – we've got some issues of what happens when kind of maintenance needs to be done to a roof.

Roofs break down. They leak. All of them will do that. Um, both from a – in a leasing standpoint, from a tenant standpoint, from a – your ability to use it as an amenity and people's expectations. Um, kind of how do we – how do we do all the things that we need to do, uh, to a roof to keep it operate – a building operating, but, uh, do so kind of cost effectively? I just – I – my experience in green roofs is not extensive, but I haven't seen any research that, um, kind of quantifies what those long-term costs are, and as a developer, that's – that's kind of where we, I don't know, I guess regress to the mean. But when you can quantify something from a – from a cost standpoint, you – even if those costs are a little bit higher, you like it because they're, at least in theory, predictable.

HH: Absolutely. Um, have you ever used a green roof technology in any past projects or, um – and if so, explain or explain.

R1: We've not.

HH: Okay.

R1: We have not. We've dealt – we've been involved kind of from the outside with a couple of projects and – and have studied them, but have not done a green roof project yet.

HH: Um, now I'm gonna ask you a couple questions about your perceptions of sustainability –

R1: Mm-hmm.

HH: – practices in general. Um, how important are sustainable building practices in the decision making ?

R1: I think they're – you know, I think they're hugely important. We have – here in North Texas we have an abundance of land and a very – um, there are very, very few kind of barriers to entry, and so, um, if you're a new developer with a new piece of land, you really, really like that. If you're an older developer or a developer that has a piece of property that's closer in or that is – is – is in its, um, middle phase or the phases of its life, it, uh – it can be problematic. And I think sustainability is something that, um, can continue to provide, um, value that goes beyond a newer development.

As – we're developers that buy greenfield tracks. That's historically been our business. Uh, we've always called ourself, uh, second-cycle buyers, which means, um, if we're in – if today is part of a cycle, we – the stuff we are purchasing is going to be two cycles out; so, you know, 14 to 20 years. Um, and so it's a little – it's a little funny for us to be talking about sustainable projects except that we have the benefit of being able to plan for a very long time, um, on our projects without having to kind of – we don't – we don't have the intensity of, uh – of – of budget for those things because our planning process can be fairly long.

Um, but once we get started, um, we really want to know that these larger tracks that we've purchased are going to be someplace that people want to come for the lifetime, not only of our development timeframe, but for the lifetime of our project. Uh, a young development company, we need to be able to point back to properties that we've done that are not only profitable to us so that we can stay in business, but are – become kind of calling cards, part of our brand when they've been built in the future. It just makes doing things easier as you go forward.

Um, for us sustainability is very, very much so about the planning process, um, and less so about specific product types or kind of planning schematics. We – we – we'd like to not get stuck into a traditional neighborhood design or new urbanism or a, you know, typical subdivision or coving or whatever it may be. Um, when we purchase properties, because we've got an amount of time to plan them, we really like to see what a piece – what an individual piece of property we think yields itself. How does it relate to the, uh – the topography, the, uh – the natural, um – natural drainage?

I mean all these things, for us, are important because they can reduce our development costs, but also because if we can leave – if we can let – if we can look at that individual piece of property and let it define kind of what needs to be built in it going into the future, I think it's easier to build a product that seems natural. Even if you do, uh – even if you do a typical, you know, 50 by 100 foot lot on a deal, if you can turn it to – so that it looks at the sun the right way or if you can turn it so that the view or the wind or whatever follows the

flow. I think some of those from a planning standpoint are very, very important for us from a sustainability, um, and then as a – any – any number of things

You know, access to amenities, amenities being not just, um, a big pool or a massive garden, but a small pocket park or a space that in a – a neighborhood can call its own, um, or, you know, a walking trail or even a – you know, a grocery store as an amenity. Some of the things that – for a day-to-day lifestyle that we need. You know, people go to grocery store once a week, and they go to, you know, a big lake probably once a month; so – and they go to their coffee shop two, three, four times a week; so some of those things we view as amenities that really need to be thought about very carefully as you place them.

Sometimes they just need to be at the corners, but sometimes we need to have those things tucked in, uh, into our developments, and again, all that comes back, from our standpoint, to planning, um, and, you know, what is hundreds and hundreds of hours of really sketches on a notebook and brainstorming as we try to put these – put these pieces together.

HH: Mm-hmm. Um, and finally, I guess couple questions back about green roofs.

R1: Okay.

HH: 'Cause I mean the next question was have you ever used sustainable building practices in past projects, and I feel, you know, you definitely have –

R1: Sure.

HH: – explained how you've used 'em. Um, are there any specifics maybe? I guess as a follow-up question, are there any specific projects where, you know, you can say that building orientation was, you know, looked at or, you know, drainage? Any specific projects maybe?

R1: Yeah. In – in – in my past – kind of in – in past companies when I worked for –

HH: Mm-hmm. Absolutely.

R1: When I worked for Kimball Hills Homes, it was a fairly regular occurrence for us to purchase a piece of property, um, and have – that either had a plat approved. Uh, we would purchase phases that had already been, you know, partially completed. We did not have the benefit of timing there.

HH: Right.

R1: Um, it was primarily a home building company, and our lot development activities were viewed as a way to supply – you know, get a two by four there on time.

HH: Mm-hmm.

R1: Um, I tried to take a – an approach of, you know, if – of – of – of maximizing what we could do, um, to not only make that two by four cost less, that lost cost less, but also so that – so

that it made sense. And an example is a property that we had down – excuse me – down in Arlington. It's called South Wind Estates. It's, uh – it's still under development now or they're still building houses in there, but when we bought it, we bought it with a completely approved plat. Um, and there was a big push to go ahead and – and – and do the plat as it was. Uh, but the site itself had hundreds and hundreds and hundreds of mature blackjack oaks, live oaks, pecan trees, um, and some fairly significant, um, drainage issues. Uh, what – what were wetlands concerns that just had not been looked at.

HH: Mm-hmm.

R1: Um, so we took a step back after – after walking the site after purchase, um, and said wait, this is – what we have going on here is really not going to work, um, and actually redesigned the plat. Got it re-approved and were able to work with the City of Arlington because some of the tree savings that we did, uh, as well as – as – as keeping some of the natural amenities there. Um, and really went from – from effectively taking the entire site down and building it back up, you know, cuts and fills that were very significant to trying to adapt that – that land plan, um, to get – to get the cuts and fills down so that we didn't just have a flat piece of property. Used some of that topo that was there, but also keep those trees.

Um, and a lot of that meant, um – it – it wasn't as fancy as a green roof. It was as simple as sometimes putting a – a drainage easement that went from a lot to another and working with the City to understand why we needed that, but it let us keep a grove of trees –

HH: Yeah.

R1: – that was in the back corner of a – of a house.

HH: But I think it – and ultimately some of those – not to cut you off, but make – those are – it's interesting to hear you talk about it.

R1: Sure.

HH: Because when you – a lot of times when you talk to people about sustainability, they automatically go to LEED in certain things, and this impacts – and that you understand that this impacts so much more than all of those things do. Those are like band aids compared to what you just explained.

R1: Right. And for – and for us, um, it's – it really was – I was very young when I did it. It just seemed to make general sense, and – and I could quantify it because, uh, it was – it saved me – it – it truthfully saved me a little bit in the money in the development spectrum, um, and it probably saved me a little bit of time, which was more important than that. We were able to make back the time, uh, and this is probably a rare example. A lot of times you don't end up saving money.

Um, but we were able to save a little bit of money and some time on our development spectrum because we cut our dirt work down, and the City of Arlington was pretty good to – to work with on that. Um, but in the end, we – since we were selling lots to the general

public, we were selling it to our home building company, um, we didn't – we didn't see the benefit. But then the home building company, for those sites that had mature trees, they were able to get between a $5,000.00 and $20,000.00 premium on all those lots, and so, um, that – that really quantified – or that – what that – that spoke to – I mean it could have taken us a year longer to do it.

HH: Mm-hmm.

R1: And we would have paid ourselves back. Um, the volume was – was very good, uh, and they were able to kind push their price points. Uh, you know, now in the – in the future phases I think you've seen, um, that – that property was sold to another developer, and they – they did not take the same approach, uh, they were – they – they lost a lot of their lot premiums that they were able to get, um, within that development. So it's, uh – it was – it was – it was a really neat site, and we've been able to do that on – on almost all – you know, a tree is a – especially here in North Texas is a tree is a tree. Um, and sometimes they're just – you hate to say it, but they are just in the way.

They are where something vital needs to be. Um, but we like to look at moving – moving things instead of moving trees. Trees are very difficult to be moved. Um, many of 'em here in North Texas don't – don't like – don't tolerate it very well. That's not to speak lightly of LEED or any of those things.

HH: Absolutely not.

R1: But very often – it's funny. Very often you'll see a LEED certified building – you know, LEED certified or a LEED silver. You don't see it very often in the upper-end LEEDs, but it took a site that had a big hill and a lot of trees on it, and it cut it down and then they were able to get their LEED certification because the HVAC system and they – they had lighting controls. And to me those – from a long-term standpoint, they're pretty interesting, but they kind of ignore what the short-term goal is.

HH: Yeah.

R1: Um, and that's to have a, um – you know, a project that you can make money on that, uh – that – that benefits the greater community as well.

HH: Mm-hmm.

R1: Um, and that becomes a – a – a property, uh, whether it's a park or a building, a house, a – a – an overall development that 25 years from now is still differentiatable.

HH: Mm-hmm.

R1: 'Cause it's pretty easy – it's pretty easy to differentiate yourself when you have a marketing campaign, and you have a sales staff, and you have, uh – you know, you have your newness. You're still – you're still, uh – you're still keepin' – you know, the paint is fresh and it looks good. The real – the real question is what happens in 25 years when the

community's taken it over and it – they've either – they've either embraced it and continued to maintain it or it's become, uh, disposable, and we see – we see projects like that. They come up every single day.

HH: Absolutely. So I guess finally a couple questions about extensive green roofs. And are you familiar with extensive green roofs?

R1: Um, I think I am, but is that a – I don't know if that's a – I guess I should say no since I don't understand the –

HH: So basically what an extensive green roof is is it's – instead of like a, um, rooftop garden, which will have between like six inches to, you know, three feet of soil and stuff. You know? A lot of times you don't even know you're on a rooftop because you – you know, it's –

R1: Right. So –

HH: – so much soil, and they have paving and all kinds of stuff, and they're generally accessible, which is, um – it's – you know, they're called intensive green roofs and then the defining – you know, the definer would be extensive green roofs are below six inches of – and it's not even really soil. It's a soil medium, which is like fired clay or expanded shale, and, um you know, there are – they can be irrigated, but a lot of 'em outside of North Texas aren't irrigated at all.

R1: Right.

HH: We're a whole different story, Texas in general. The Southwest in general is a whole different story. You know, any green roof in the Southwest is gonna have to be irrigated.

R1: Right.

HH: But not necessarily like what you would think, you know, drip irrigation with – you know, off of air conditioner condensate, not, you know, pulling it from, you know, actually, you know –

R1: Water supply.

HH: Yeah. Exactly. So, um – and it's not accessible. You know, these – extensive green roofs are really more about, you know, you know, waterproofing your roof and, you know, insulating and reducing heat island effect, and, um, storm water. You know, and it doesn't really like – the thing about North Texas, from the research that I've found, is that extensive green roofs, they catch the first like eighth of an inch of the flash – you know, the – the ran that we get.

R1: Right.

HH: And it filters that out and the rest it basically just slows it all down. It's not really going to filter everything out, but it's a way of catching that first hottest, dirtiest part of the rain.

R1: Right.

HH: You know, that first flash; so, um, if – with that kind of description, would you – do you think that they would be appropriate like – I have it broken into three kind of categories; so – and I'll talk first about ecologically. Do you think it would be ecologically appropriate for this area, for Texas?

R1: I can – I mean I can see – I could see products where you would – where you would use it, um, and I think probably, um, the place to use it would be more in – at least on our projects would be where you have a view of that roof from some other building, and you want to try to blend it in. We have a lot of projects that – where we focus on our view corridors down to whatever flood plain, some far off.

HH: Yeah. I have a, um, article I can forward you from The New York Times about that's what they're doing a lot in Manhattan is the mid-rise buildings are putting green roofs in, these extensive green roofs 'cause they're low maintenance.

R1: Right.

HH: Like you don't ever – they maybe have to be weeded once, twice a year, but other than that you don't go on 'em. You don't touch 'em.

R1: Right.

HH: A lot of times they put sensors in so you know how much water's in there. If there's a water problem, the sensor will tell you there's a water problem, where there's a water problem. It's all very grided out, and, you know, much more scientific.

R1: Right.

HH: But it – they're able to charge such a premium for those spaces that view these mid-level buildings.

R1: Right.

HH: And there's a lot o high rise mixed with mid-level in New York; so in that case, just like you were speaking.

R1: Yep. I think – I think that would be a place for it. Um, I think you would have – I think from an ecological standpoint you – that would – that would work. Um, I think that – we've had problems on – on roofs in – in kinda the – the hail damage and the long-term common area maintenance problems that come with that. North Texas weather is – it just – when you have to – when you have to plan for the worst, you end up spending so much money either in the initial construction or the long-term maintenance.

HH: Mm-hmm.

R1: Uh, and I would be very interested in – in kind of the use of extensive roofs there, you know, just not knowing as much as I – as – as much as we would need to to plan it into a program. Um –

HH: Well, that kinda goes into the next question. I'm – economically, do you feel like they're economically appropriate for North Texas? The cost, the – you know, if you think about it.

R1: Yeah. I think they – they could – could be. I don't – I don't know what – and unfortunately I don't know what their – what their costs are when you compare 'em with a – with an average, you know, overlay roof or something that might be used in a building where I think they're appropriate. Um, there would be office buildings probably more so where you're – where you – you know, you have full-service leases. Just from a development standpoint, from a financial standpoint, where you have – you have the exposure to the – to the electricity costs and the – and all the maintenance costs.

I can see – I can see where they would provide the very real benefit. Um, I think they could provide a benefit when you use them kind of in conjunction with your larger plan, either get better zoning, a – a use that you felt was more specific, um, some sort of the – sort or reduction in – in other costs. Um, that has been – has been fairly rare to see that in some of the developing cities in North Texas. Um, a lot of what they want to see is, um, kind of something on top of it, and that's not necessarily a bad thing, um, but it does – on some – in your first phases especially you – you are running a very – on greenfield development you run a very, um, real problem of being able to show that you have a special place.

And, um, in those – in those first couple of phases, you – you look – even if you use the most sustainable and – and – and most, um – if you use the highest quality stuff in those first couple of phases, you have a problem in proving that you've done anything different because everybody's product is still new. And so that – I think that's an issue that you run into from an economic standpoint with anything that costs more and why you see a lot of developers that shy away from it. If it's – if it's – if it's unknown and – and it costs a little bit more or the same, a lot of guys will stay – stay away from it just because, um, if you have a – a smaller deal especially and you're only gonna be in it for three to four years, you never get a benefit from it.

Um, now, on a lot of our projects that are larger that have 20- and 25-year lifetimes, um, I think there's a very real need to, uh – to pursue and look at those things so that we – as we get into our 5th and 6th and 7th year, those things could start to provide some real value for us.

HH: Yeah.

R1: That – I – I would see it has hard on smaller deals.

HH: Mm-hmm.

R1: It's unfortunate, but when you have a smaller deal, you start to be – it – it makes it harder to take a more global, kind of community-wide approach from a – just when you look at it strictly from a financial standpoint.

HH: Right on. Um, one last question. Environmentally, you know, kinda speaking about sustainability. I mean do you feel – and this is, you know, kind of in general for North Texas. Um, you know, where people's minds are at, you know, environmentally. Are we, you know, informed enough to feel like this would make a difference in, you know – in your opinion?

R1: I think you've seen a pretty big difference in what – in what buyers, from a housing standpoint, demand. You know, some of it comes from their kids. Some of it comes from their own personal feelings. Um, the interesting thing for us from a green standpoint or from a sustainable standpoint is, um, we feel like if you are making – if you're making a green decision, a green product, uh, a sustainable product that costs somebody more in the long run, you're never gonna get 'em to buy into it. It's just not gonna work, and so, um, there – well, let me take a step back.

The market for that is very, very shallow. There are people that will make distinct lifestyle decisions that are willing to, you know um – they're willing to go to – to take steps every single day in their life to – to live green because it's a policy they have. That market is not very deep in North Texas, um, or really I think in Texas in general. Um, but we're getting to a point with a lot of sustainable stuff that you can – it makes an impact in your pocketbook month to month, uh, or it makes an impact in your free time, which is – which with a lot of our products that are – that are geared towards families, is very, very important.

So, um, some of the irrigation systems, some of the really plant choices that you put in initially from, um, your native species or species that have been – the kind of plants that have been designed to – to tolerate our – our climate, uh, in some particular uses. I think those can be hugely successful, Um, again for us – I hate to make it sound very, very simple, but for us it's a planning standpoint. It's if you – if you can think about it, um, if you can buy a product, um, if you can take a long-term approach, which we – we – we're fortunate to have some investors that have taken a very long-term approach. From a patience standpoint, you have enough time to plan these things in there, um, and that's not to make – not to say that we aren't gonna make 100,000 mistakes when we – when we do this.

But, uh you know, I think we have enough time to think about them, and – and – and also admit that when we're – when we're in a product or a project, the changes need to kinda continually be made. Part of sustainability is, um – is having – really is having a community, someone buy into your thing. They need to own it just like – they need to be as passionate or more passionate about it as you are. Um, but it's – it's – it's living; so you can't – you can't be stuck to one plan. You may – you may decide that all the planning in the world has – has created a – a terrible design, and if you – and if you really start to – to notice that people are using a space in a different way, um, you can – you can affect the sustainability of your product pretty significantly just by listening to the people that use it. Seeing how it's used, um, and either adjusting what your, you know – your – how you – how you orient people to a space or what product you offer or just adjusting what your expectations are, um,

for that particular area and, uh, trying to take advantage of what, you know – what people use to – or how they are using it now and – and knowing that that's gonna change in the future.

I mean really as – as people's lives change, as they – as they use parks in different manners, as – as people's opinion on the safety of communities or the world at large change. I mean we saw – we saw a huge change in – in people's mindset, you know, kind of after September 11. And people made a lot of changes, um, that were pretty significant, but now we're – we're slowly kind of getting of back to where we, you know, have opened up and expanded our horizons. Everybody kinda clamped down.

HH: Yeah.

R1: So you just have – you have to have a real flexible space, and I think that's key to sustainability.

HH: Yeah.

R1: Um, any – anything that's got – anything that has one use and one use forever is quickly going to be vacant and obsolete.

HH: Which is not sustainable.

R1: No.

HH: No.

R1: No. And it – the problem is it becomes dated.

HH: Yeah.

R1: I mean – so that's –

HH: And it's a – the whole process of redevelopment is not – is – is – you know, that's not thinking about the land.

R1: Right.

HH: That's not the principle of sustainability –

R1: Right.

HH: – by all means.

R1: And I think it's expensive.

HH: Yeah.

R1: I mean there's, uh – for us – and I – I know this interview's about green roofs.

HH: Oh yeah.

R1: Uh, I apologize for not –

HH: No worries. No, that's – that's – it's the nature – that's why I have a follow up question that says things change. It's perfect.

R1: Yeah. Um, but from that standpoint, you know, we – I – I could see – I mean I really could see some of our residential product using it, which is – which has not really been done here in North Texas. There's a couple of green houses that are – that show how you can use kind of bioinsulation, but I can see – we have – we have a couple of products that have enough topo where I could see using a – a green roof to, uh – to – to fade, um – to fade product into that, um – into the environment.

HH: Mm-hmm.

R1: So that each person that is kind of purchasing along feels like they are right on the edge of it instead of – instead of removed.

HH: Yeah.

R1: So –

HH: Right on. How – speaking of how expensive it is to tear it down, have – you're in Dallas a lot; so you see the, um, Reunion Arena, they way they're tearing that thing down. Isn't that amazing?

R1: Just kind of how can we – and I – they're just trying to sell every little piece, and we're not gonna – we're gonna finance our next deconstruction be either selling or – oh, here's $100.00. I mean it's almost like a kid building a tree house.

HH: Yeah.

R1: Get my allowance and I buy seven two by fours.

HH: It's unbelievable.

R1: Yep.

HH: But it's – it – and I don't know. Do you know why the roof is on there? Yeah.

R1: I don't.

HH: It's – it's crazy though. I guess though that they can keep working down in there even if it rains.

R1: Yeah. I mean –

HH: 'Cause they're gonna take the roof down.

R1: Yeah.

HH: You know, 'cause aren't they – they're breaking it up; so they're gonna take the roof down. It's just a matter of – I guess they just want more work days, you know, less $100.00, right?

R1: Yeah. And I think – you know, you see a lot of, uh – you see a lot of – there's a, uh – the car dealership that's right here on 635, _____. I can't remember what it used to be. That's just east of, um – of the galleria.

HH: Yeah.

R1: They've kind of taken – they're taken all the windows out of it.

HH: Yeah.

R1: And they have all the roofs up. Um, and I – I think they do it just because you – there's no – there's no real work that's left to be done there, but I think it provides some vertical structure. Um you know, it – there's not really room for vandalism. It provides something to look at instead of just a flat area that's – that's pretty easy to drive by and not look at.

HH: Yeah.

R1: So I – I think some of it's a calling card, um, as a way to kind of keep your – keep eyes on it, keep people kinda talking about. Um you know, they – they say in that business that activity begets activity.

HH: Yeah.

R1: So if, uh – if you can kind of – you'll see that – you'll see that on a lot of projects right now, projects that have effectively been shelved because of the way the economy's going, but they keep somebody out there. There's something out there just moving around.

HH: Mm-hmm.

R1: Uh, so that hopefully it doesn't go stale. Um –

HH: Yeah.

R1: And that's less about sustainability and more about just keeping people thinking about my project.

HH: Absolutely.

R1: Yeah.

HH: Which right now, you know, is huge. I was talking with uh, um, a planner from Addison yesterday, and just – she's just talking about, you know, nobody's building anything.

R1: Right.

HH: You know, you're doing anything anybody wants to get them to build in your town, you know, 'cause there ain't nothing goin' on; so she's like LEED has kinda dropped off. You know, before, you know –

R1: It started –

HH: – this hit, all of her whole city, everybody – you know, she said everybody was screaming, everything needed to be LEED, we want to be the greenest city in American, you know, all this kind of stuff. And they're like, "We need to pay our bills." [Laughs]

R1: Right. Need some permanent revenue and –

HH: Yeah.

R1: And I think that – that is – that is un – it's a necessary evil, but it begins to be unfortunate.

HH: Yeah.

R1: And I think it also a little bit speaks to – I'm not a huge LEED fan.

HH: Mmm.

R1: Because I think it is a little bit of a band aid, and a lot of people were doing most of that stuff already.

HH: Right.

R1: Now you just pay a LEED person to, uh – to come in and certify it, and it's kind of an extra cost without a huge benefit to the area.

HH: Yeah.

R1: Um, the benefit to it is it gets a lot of people to focus on it. Um –

HH: And, um, this woman was saying yesterday too they're kind of letting go of LEED as well because basically all the roles that they feel are necessary with LEED are being worked into the IC.

R1: Yeah. International Construction Code.

HH: Exactly. So they, um – she was like, "We're just," you know, "We're just sticking with what we know, you know, if someone wants to do a LEED project, fine." You know?

R1: Yeah.

HH: "But the thing is is also we can't control like, um," –

R1: How you get LEED.

HH: Right. Like, "We – if we tell everybody they have to, we're making it – the entity is beyond us; so someone else can stall projects in our area." So they're like, "We're not gonna do that either; so we're not gonna require anybody to do it because then we're taking the control out of our hands." They want to keep the control in their – you know.

R1: Yeah.

HH: To allow development otherwise people could be holding up projects, you know, LEED could be holding up projects for trying to get this or trying to get 'em to do this.

R1: And I think, you know, a basic community knows what – they – they hear from their people, right? Um, it's funny. People talk about, um, the Woodlands in Houston, and it's got – it's a district, and it's got a whole bunch of different things, but basically every 600 homes is a district in the Woodlands the way it works out. And the – so there's space – there's five city council people or directors for every 600 homes; so chances are you live within a block and a half of one of your directors. And you listen to those guys talk and they say, "Look, we hear about it 'cause I'm in my backyard mowing my yard, and someone sticks their head either over the fence or they see me in the front yard and they say, 'Hey, I did not like what you did.'"

And you compare that to, you know, kind of City of Dallas or any major city where there's 5 for 100,000 or 5 for 300,000 or 5 for 3 million or 7. You know? And it's pretty easy to kind of insulate yourself, but for us we're making decisions that, you know, affect – we're gonna spend our neighbors money.

HH: Yeah.

R1: Our neighbors, our block, you know, our block makes up seven percent of the homes that we're making a decision for; so that –

HH: Yeah.

R1: It – it's pretty interesting to talk about that kind of in the ultimate grassroots accountability system. It's not the perfect way to do it, but it is interesting to hear about how that affects what – how they make their decision because Bob, at the football game, is upset with you.

HH: Yeah.

R1: So you have to think about it.

HH: It's – exactly. Um, and I think the Woodlands is – it was probably one of the most sustainable developments ever.

R1: Yeah.

HH: You know, and that was before people were even using that word.

R1: Yeah.

HH: You know?

R1: The flip side is it was way out there.

HH: Yeah.

R1: I mean from a – from a – from kind of a definition of kind of sustainability, probably didn't meet that definition. It wasn't the next piece out.

HH: Right.

R1: It was a piece that needed a lot of highway to get to it, but from what they did internally –

HH: Yeah.

R1: It's been – it's been hugely effective as a project that's now, I mean, 40 years old.

HH: Mm-hmm.

R1: And still they can command a premium.

HH: Yeah.

R1: And people still know where it is and still talked about – I mean it's a pretty neat little deal.

HH: Yeah.

R1: And nobody's really thinking about anything other than, you know, how do we get people to walk. They weren't talking about sustainability. They were talking about how to make people want to buy a house out here.

HH: Yeah. And basically to – he saved 'em so much money on – instead of coming in and doing all this draining – 'cause it was swamp.

R1: It was a huge swamp.

HH: Yeah. So instead of doing what the – the engineers were saying, he said, “Instead let’s, you know, just,” –

R1: Put it in there.

HH: Yeah.

R1: Leave it some – alone.

HH: Yeah.

R1: I mean and that’s the funny thing is, um, to do a project like the Woodlands now would be – I think would be almost impossible from a federal standpoint. You just would never be able to get that much remediation. It would be cost prohibitive, but I think they did a really good job with it.

HH: Yeah. It’s a cool place.

R1: Yeah.

HH: All right, man. Well, I really appreciate it.

[End of Audio]

RESPONDENT #2 (DEVELOPER): INTERVIEW TRANCRIPTS

HH: So first I'm going to just ask you a couple questions about your perceptions of sustainability or sustainable building practices in general. How important would you say that sustainability is in the decision making process?

R2: You know it kind of depends on the project. In our company we've got such a diverse building, well diverse project mix. We've got everything from retail to I guess single family town homes and neighborhoods and that kind of thing. In some of these projects it makes more economic sense than other ones. There's more money in the budget to do things with, but a lot of it is still market driven really regardless of what project. In our office stuff we've run a lot of numbers and we've seen that it's $2.00 or $3.00 a square foot to do something as opposed to doing nothing.

Some of the things are easy to do, but we've got a lead building that we did here recently I think that we were doing on gold standard. It did pencil out to work, and I think it's something that this company is trying to do when it makes sense to do. We're definitely looking at it pretty much across the board even out here where it's more site related issues than building related, and so in the case of this company most of our projects are built among a lot of land that's already owned, and so we can kind of think a little bit more longer term than some guys where you try to flip something or what have you.

HH: Absolutely.

R2: So in that case I mean just as an example, when you're dealing with something like 1,000 acres you start to think about wells and plant material becomes incredibly important just in terms of utility costs and things of that nature, so we've spent a lot of time looking at not only just to get the water to the plant but the plant material too, and our horizontal infrastructure related to water in particular, we try to capture runoff, use detention ponds where we can, and oftentimes will try to preserve areas that are already doing a job of filtering water and things like that. More often than not the analysis on site work has been easier to accomplish sometimes than the building cost.

In the case of the office buildings we have also done things like during construction we've had to separate different kinds of trash, this department recycling program I guess I'm getting at. During construction we've also done that too. Ironically the single family market sometimes has the smallest budget, but that one seems to be more of a market almost demand than anything else. People expect the Energy Star ratings and the good windows and what have you. That product actually has a lot of drivers that almost make it mandatory. It doesn't mean you can always get it paid for by the guys buying the houses, but just to compete among builders you've definitely got to have a list of what you're doing.

It's not so much that we see people coming in asking for green initiatives. They just want low utility bills. There's a few that do ask about what kind of green items are in the house and what have you, but I think most people just look at it as it's a question that they're supposed to ask. "Is it Energy Star?" whatever.

HH: Absolutely. So now I'm gonna ask you a couple questions about your knowledge or perception of green roofs. Are you familiar with green roofs?

R2: Mm hmm, somewhat. We haven't done it. We've looked at doing it. I would say in terms of truly doing a green roof the closest we've gotten to doing that is probably putting a lot of plants on a roof terrace or something like that but never so far as truly doing a it's got grass and it's planted and so on. I think we would be very keen to do it because I think we like the look of it. I had worked on a project, gosh, it's probably been ten years now. It was actually a building downtown in south Florida that the neighboring building, which was quite old, had a green roof on it, a truly green roof downtown. People didn't notice it because it was probably four stories tall or so.

They just never really even – unless you got to the fifth story you never noticed the darn thing. It was pretty expensive, but honestly the thing that scared us away from it was just the water-proofing and that's gonna happen if this, if that, and all that. We looked at it as a good opportunity to create an amenity that – the building otherwise didn't really have much going for it except it had a front door and elevator and that was about it. It would've made the rooftop unique and it probably would've at least – I don't know if it would've brought any more rent, but it probably would've at least gotten people interested in being in that building.

HH: Right on. Can you describe green roofs as you understand them?

R2: I think so. I mean I think the green roofs would be – I mean to me they're ones that are insulated by natural materials I guess maybe, just to sort of make it very generic, but more often than not that usually turns into vegetation. I guess I don't see it as much as well insulated just being enough to call it a green roof. At least my perception is that it takes it a step further and it's a little more adventurous than just building up the insulation value.

HH: Absolutely. What would you believe the benefits or negatives of a green roof to be?

R2: Probably just the water-proofing is probably the biggest one and the times that we've looked at seriously doing it, the structural aspects of doing the deck _____ better are pretty significant. It's lots of pounds per square foot and drives up the cost and all that. We've actually looked at doing where we've got a building and a parking garage. The parking garage is separate from the building, but it's very close to the building and maybe even attached to the building where the building has floors that are looking – it's high enough that you look down on the parking garage. In that case we've really struggled with hating the view from the fifth floor up and trying to come up with something that maybe it's a partial green roof. Maybe it's not the whole top of the parking garage, but there's something off that floor that isn't near the top of the parking garage where there's a deck or something, that at least it's visually more pleasing.

HH: Yeah. I've seen that's one of the biggest benefits for green roofs is that the idea of there's so many buildings that are a building and then you have the parking around it. Surface level to parking garages, whatever it is, and a lot of times there's another level before you get to that. Sometimes it is the parking garage. Sometimes it's just like the second floor

and the people looking out over that it makes such a difference in the value of those, the leasing value, the market value as well as like you said an amenity as well.

R2: Yeah. Well we've seen things too where we sort of – that transition from parking garage to building has presented itself a time or two where it's also not just to reduce the amount of concrete and the hard surfaces and all that, but there's a big temperature change that you can get out of it too. Here that's a significant thing to go from 100 to 85 if you can get that far. That's a big accomplishment. I mean I was mentioning Florida before. People were used to thinking that way; here not so much. Here you sort of get in your car and you go to your office and there's not much outdoor spaces generally, but I think people are realizing that there's better ways to do things.

HH: Absolutely. Speaking of structural support, a lot of times with parking garages you already have that structural support so you're not really having to increase a lot of your cost to increase that support. It's already there, so the green roof is really more reasonable.

R2: Right. I agree.

HH: You've touched on this, but just so I ask, have you ever used green roof technology in past projects? Please explain why or why not. Basically like you were saying you've researched it but never actually gone -

R2: We haven't quite pulled the trigger yet. We actually have a lot of things that are on the boards that we're trying to get done, but we haven't quite gotten to the finish line of just getting one done.

HH: Do you feel like the economy has kind of messed with even that too, the pushing of new technology, or do you feel like new technology is something that's actually able to break through the downturn in the economy?

R2: You know we still get proposals for office buildings, spec type of projects where at least the development stuff that we're doing in the case where it particularly involves a public company, it still is on top of the list. For them it's PR or they really believe it, but yeah, as far as the proposals that come to us for a building that we might build for somebody, if it's a large company, particularly a public company, it's still top of the list.

HH: Cool. Then I guess finally a couple questions about the appropriateness for north Texas. Do you feel that green roofs would be ecologically appropriate for north Texas?

R2: That's probably a good question. I mean I would think that this environment here would benefit a lot from having a cooler, more inhabitable roof deck amenity. What's funny about that is we've gotten to the point where we usually run the numbers and feel like it's a viable solution, a parking garage or something like that, we haven't gotten so far into this that we've started to understand the limitations on plant material except things like wind and things like that.

That's probably the biggest thing that we've seen is just plants getting beat up basically, and how much lateral support does a tree need and all that stuff over the long-term. Yeah you can tie it down for a while, but how much rooting does it really need to have? You don't wanna invest ten years in a tree that's just gonna blow over with the first bad storm. I can't say that we've gotten our hands around this is a good plant list for something five stories in the air.

HH: For this area.

R2: Right.

HH: How about economically appropriate? Do you feel like if we could work that out, if there's the research behind it and say this is a good plant list, this is something we could do, do you feel like economically it's something feasible?

R2: Yeah I think so. I think we'll probably end up being able to do it when it's a concrete structure and it'll either first happen on the top parking garage level, and the building that is served by the parking garage is probably class A building that's trying to bring in quality tenants and that's the kind of stuff they're looking for. That would probably be most likely first case we would encounter. The second one might be a concrete structure where there's some condos in that sort of upper band of price per square foot.

HH: Well right on. That wasn't too bad, right

R2: No.

HH: Not too bad at all. So yeah, I really appreciate it. Basically I'm looking at just different people's perceptions, developers, city officials, architects and landscape architects to get an idea of where everybody's kind of perception or where their mindset is because across the country there are green roofs all over and just in North Texas there's not – there's some rooftop gardens here. That takes like a good foot to three feet of soil. A green roof tends to go around six inches of soil so you can get away with a lot less structural support, and there's not one in DFW.

There's not one extensive green roof in North Texas, so that's what led me to this research. It's like, why? A lot of people think it's because of the weather. We have such a harsh – but there are other places where the weather is just as rough, like you say Florida. I did my undergrad at Florida State and lived in Miami for a while and there's some really – it's really hot. They have hurricanes, but -

R2: And they have the wind and the sun.

HH: Yeah. The one thing that's really hard for us is the no rain, so you do have to water, and that scares a lot of people like you were saying 'cause of the water-proofing. If you don't have a good water-proofing membrane, then you're really putting – don't we spend most of our time as builders trying to get water off the roof? Why are we putting water on the roof?

The one good thing I found is all of the different companies that are installing and building these green roofs are more - the water-proofing and they are -

R2: So they're building and just finishing the whole thing, sort of turn key.

HH: Yeah and I think that's what's really gonna help it too from what I'm finding out is that once there's a big enough market, the suppliers are gonna really start to push them really great. Like in other markets, Seattle they have some really big companies that do this. They are set up for green roofs, they build green roofs, they know how to do it, they have a specific plant list, they know how much to water if they have to water. Up there they don't really have to water near as much as we would, but they are – and I think once we start to get in more of an understanding here I think the market will kind of like you said, drive itself, but until then we have some -

R2: Well you know I grew up here, so I can speak to that. I mean I've lived in Florida and Boston and not really out west for any length of time. For whatever reason it's just harder to get people interested in the topic, you know?

HH: Yeah. Absolutely. I completely agree. I grew up here as well and I lived in New York, I lived in L.A., I lived in Miami, and it is. There's just something about this -

R2: I don't know if it's just they don't want to. I hate to blame it on things like I.Q. or something, but [Laughing] -

HH: I just don't know. If it's not that then it may just be the abundance of land. "We can do anything we want. We just spread it out. Why would we need to have a rooftop garden? We can build a big park right here 'cause we have 2,000 acres."

R2: That's a big part of it, and that ends up being I think a lot of times why it doesn't really happen, but there still is a general just disinterest in even just being informed.

HH: Yeah. I agree. I think any time that you can start to really marry the landscape with the architecture you get a much more meaningful project. Don't get me wrong, there are some beautiful buildings that are stand alone, beautiful architecture, but any time from even just a single family home all the way up to a corporate or a university campus when it's married to the architecture it just makes so much more – or married to the landscape, it makes so much more of an impact on people because we really are nature. Nature does invoke a feeling in us, so to be connected to nature in any way is a positive thing. It's just a matter of the market. It's hard.

R2: Yeah. The thing we didn't touch on was, 'cause we've had this issue on other things when we're trying to get something done, we just can't find anybody that knows how to do it. I don't know how many subcontractors in this area would be able to do it if you wanted to do it.

HH: Absolutely. There's really two companies right now that are running the show. As far as green roofs go if you need one built, they're the only two companies that know how and

will do it, and it's proprietary information right now. They won't give out how to do it. Even their soil mixes, 'cause they don't put soil up there. What they do is they put like a fired clay or expanded shell, and so it's really a gravel roof and then they plant plants that can survive in gravel.

R2: I see, so they just drain out?

HH: Yeah. You're dealing with the sediment coming out and clogging up fabric and clogging up your drain systems and stuff 'cause there is no sediment. It's just all gravel.

R2: Yeah.

HH: Yeah. All right, well I appreciate it, man, I really do.

[End of Audio]

RESPONDENT #3 (CITY PLANNER): INTERVIEW TRANSCRIPTS

HH: So basically I'm just gonna ask you some questions -

R3: Okay.

HH: - about green roofs, and it's just your perception. There's no right or wrong answer.

R3: Okay.

HH: And they tend to be open-ended, so you can, you know, elaborate as much as you like. Um, first I'm gonna ask questions about your knowledge of green roofs.

R3: Okay.

HH: Are you familiar with green roofs?

R3: I am.

HH: Um, can you describe them as you understand them?

R3: I have taken the, the courses and the training for lead certification. I haven't taken actually the lead certification exam. Not sure that I am gonna do that, but I did go through the lead training and I understand the concept of green roofs and kinda how they work and what they can accomplish.

HH: Okay. Um, what would you, what do you believe that the benefits and/or negatives of a green roof would be?

R3: Certainly there are benefits and in some environments where you, uh, to me the benefits as a landscape architect go beyond the lead points that you get for them. They are a green space. If you're in Chicago, Chicago City Hall, a good example where you have no green space and you can provide a space for your customers, your tenants, your residents, those kinds of things. I see a lot of benefit for those is that they add green space in urban environments.

My conversations with architects, builders, and engineers is that they, they're very problematic, they're very heavy, the structural adds that you have to do to have the roof support all that height, all that, uh, additional weight, and that water is, is nightmarish, and I don't know anyone that's doing one. I think they are – even going through the lead training with my lead trainer said, you know, for the points that you got for a grain roof you could do so much better. You could accomplish so more with so much less money by focusing on other areas.

HH: Absolutely. Under the – we found the same thing. Under the current lead rating system you can get so much more out of your money by doing other things.

R3: Yeah. Exactly.

HH: I think when they, they change the certifications a little bit to include bio mass I think that might make a big difference because you're gonna have a lot more bio mass when you have a green roof, but as of these, as of now you're absolutely correct.

R3: Yeah. We haven't found anyone that's run the numbers on it and said, "Yeah, this works."

HH: Yep.

R3: And -

HH: There's not one in north Texas. There's not one in DFW built.

R3: There's one in Arlington, but is it legitimate or is it -?

HH: It's a researcher. If it's our roof and we're – it's 1,000 square foot, feet, and we're researching, so we're testing plants and it's not the entire roof. The entire roof is something like 5,000 square feet and we're doing 1,000 square feet of it.

R3: Well in some climates where you can get by with less irrigation and you have less heat -

HH: Or no irrigation.

R3: Or no irrigation and you have less heat -

HH: Absolutely.

R3: - than we have, it makes sense for us. It just doesn't look to me like it makes any sense, and putting that much water on your roof is something no architect or engineer wants to do. Then I've had other folks say, "I really don't want people walking around on my roof where my AC and my vent stacks and my grease flumes and some of those other things are. I really don't want the liability of having someone walking around up there", and in Texas we have lots of land.

HH: Mm hmm.

R3: So you can always buy more land and recycle your rainwater or put your green space somewhere else. You can structure your parking and you can do something else. I don't see anyone doing one in this climate in the short-term.

HH: Yeah, and the wind too.

R3: Oh yeah.

HH: Whole other thing.

R3: Oh, don't even begin. Plus too, even in the ground with good irrigation there's a limited number of plants that we can get to make work.

HH: Absolutely.

R3: It's not like we have – we're not Seattle. It's not like we have this unlimited palette.

HH: Absolutely. I definitely agree. Um, one of the things we're finding in our research is almost every other city, you know, especially northeast, northwest, their base is in sedum plants. Well sedums absolutely don't work here.

R3: No.

HH: You know? David's tried every one that everybody said to try and every single one of 'em has died.

R3: Yeah.

HH: So it's just that plant, which is so good for everybody else, doesn't work here, so he has found some really great plants -

R3: Good.

HH: - that do work, and I think in the next couple years his research is gonna come out and I think it's going to be a lot, you know, better suited for this area.

R3: Yeah.

HH: But right now you're absolutely correct.

R3: Well like I said, I think the only value is the rooftop garden value for people who need a green space in an urban setting.

HH: Mm hmm.

R3: And for us we, we just really don't. You could do so many other things that not only would they get you in more lead points, they're just more energy efficient with less cash outline, and then you've got the nightmarish issues that we've heard from some people about the mow, the insurance people don't wanna insure the roofs, the – for a variety of just your general liability, your mow, your rot, your water damage, this – we, we kind of laughed through that whole chapter when we were doing our lead training.

HH: Mm hmm. Well next, um, so the next question was have you ever used green roof technology?

R3: I have not.

HH: Okay, so that one we already kind of answered, um, but next is more about, um, sustainable building practices in general. Um, how important do you feel they are in the land development process?

R3: They – it's interesting. We had a huge push from our citizens to go green. They wanted sustainability. I mean they wanted to be the leading greenest city in Texas. They wanted to be the greenest people. They wanted to do all this, and then the economy went soft and now they're just begging anybody to build anything under any circumstances. We're coming forward with just the standard editions to the code, the national electrical code, and our city manager is jerking out going, "Well how much is this gonna cost to do child-safe outlets?"

Well yeah, there's a cost to that, and he's saying, "I don't want unintended consequences", and then he said yesterday in a meeting, "I've got a real heartburn about some of this green stuff and how much it's gonna cost." The challenge for us in this environment is when we're all competing for development and there's none to be had for any of us. If you're the guy that makes it cost more and makes it harder then that's not the position you wanna be in.

HH: Yeah.

R3: When we're losing tenants to Plano like crazy we don't wanna be harder or more expensive to build. I think for a while too the – I think this will come back around. I think what we're in is a short-term lull of a long-term scenario, but gas got cheaper, so now everybody quit caring about how much I'm gonna drive to work or how much I'm gonna go or how much my heating and my electricity is gonna cost 'cause gas got cheaper. It's inching back up. It'll go back up. It's not – I don't believe there's unlimited gas for the next 30-40 years.

HH: Absolutely.

R3: So it'll go back up, but right now today I can't get anybody interested in sustainability, and we, we actually did a project in this neighborhood right near, the Vetruvian Park, and when we were permitting that and going through the zoning process of oh my goodness, we're gonna be as green as possible. Well when we started into actual design and construction docs, man, when those items started hitting 'em as how much those were gonna cost they just dropped by the wayside one after one and what I expect, and I went through the lead training and the lead certification and we were gonna do what Dallas has done and we were gonna adopt lead and we were gonna do all these things. From a municipality's perspective lead is very difficult because it's not enforced by us. It's enforced by the USGVC.

HH: Mm hmm.

R3: And what I believe is that the codes that we do enforce, the IBC, the _____ codes, they are putting the lead requirements in and they will I believe wean out the ones that make sense and the ones that don't. I think they'll get rid of advanced parking, better parking

places for hybrids. They'll get rid of green – they may keep green roofs. I don't know, but I think they will go through what USGVC has done, take the most practical, practicable parts of that like the, the, um, ash tray 90.1 and all that kind of stuff, and they'll put that in the code.

HH: Right.

R3: And that's what we're waiting for, because for us to enforce lead and say, "You have to be lead", all these cities jumped on this bandwagon and said, "Okay. You've got to be lead silver." Well the challenge was that, is we have no control over whether somebody gets lead silver or not. They can do everything that they can do, and something at USGVC hold 'em up, and we put a requirement on 'em that we don't have the ability to really -

HH: You have no control over.

R3: Yeah, and so we -

HH: That is a good point.

R3: - are not gonna do that. We're gonna wait and let energy efficiency work itself into the standard code, which it already is.

HH: Yeah.

R3: It's getting more so with every edition.

HH: Yeah. I absolutely agree.

R3: Yeah.

HH: Um, I guess finally would be, um, to find out your, um, knowledge of extensive green roofs. Are you familiar with extensive green roofs?

R3: No, I am not.

HH: Um, basic extensive green roofs are six inches and under of growing medium. They call it soil, but it's not really soil 'cause it's manufactured soil. It's expanded shell and fired clay and stuff. Um, but it's under six inches so it keeps the profile really low, the weight really low, and it's more of an environmental thing compared to a rooftop garden, which would be, you know, six inches and they have three feet of soil sometimes, you know, over a parking garage.

Sometimes you don't even know you're on a rooftop garden. You think it's the ground. So the difference being extensive green roofs are more focused on storm water management, insulation, um, ambient temperature, uh, reflective, all that kind of stuff. Um, so I guess would you, do you feel like those kind of roofs would be more appropriate for DFW than the more intensive, heavy, heavy structural, you know, rooftop gardens?

R3: As you've described it, yes. I don't know enough about it to make a qualified opinion, but our heartburn with those has been the weight, the depth, the water.

HH: Yeah. Well and extensive green roofs too, there's a couple different companies that are doing them right now that also insure and put warranties on the roof and the water proofing membrane and all that kind of stuff, so a lot of that insurance stuff that we're having problems with now, um, these extensive green roof companies have built that into their business plan.

R3: Yeah.

HH: Which is a smart, I think a smart idea. It's just a matter of understanding what a green roof is, or extensive green roof is.

R3: Has anybody compared – let's say you were Grand Prairie and you had acres and acres and acres of warehouses. Has anybody kinda run the numbers of what would save more energy to do all those green roofs or put solar collectors on all of 'em?

HH: I think -

R3: Because -

HH: I don't -

R3: That would be something to think through, that sometimes a green roof, when you've got a big, flat roof, you have another opportunity there -

HH: Mm hmm.

R3: - for a different technology that, that we've got lots of sun.

HH: For Sure. Well I, I think that's it.

R3: Okay.

HH: You were great. That was exactly what I wanted to know.

R3: All right.

HH: Um, I appreciate it. When I'm done with everything I'll send you a copy of my thesis just to say thank you if you like.

R3: Okay. Perfect.

HH: Awesome.

R3: Okay.

HH: So I really appreciate it.

R3: Good luck.

HH: It was great to meet you. Thank you.

R3: Great meeting you.

[End of Audio]

RESPONDENT #4 (CITY PLANNER): INTERVIEW TRANCRIPTS

HH: So basically, um, what I'm gonna do is I'm first gonna ask you a couple of questions just about green roofs.

R4: Mm-hmm.

HH: So are you familiar with green roofs, and if you are, can you describe them as you understand them?

R4: Only superficially, and my superficial understanding would be it's either a technology kind of situation; therefore, green in terms of it's self-supporting, self-sufficient or close to it or it is a landscape plant material application.

HH: Okay. So, um, do you – with your understanding, what do you believe would be the benefits or negatives of green roofs?

R4: Well, benefits would be, you know, take a reduction of carbon footprint, which is, you know, no question the flavor of the month and needs to be. Um, I think that depending on what it is, if it's more technology, it has one effect, and that's primarily a carbon footprint thing. If it's more of a landscape, plant material type of situation, more earthen type thing, then it also adds a tremendous aesthetic potential there. Did that answer anything?

HH: Yeah, absolutely.

R4: Okay. Okay.

HH: Absolutely. Have you guys ever used any green – green roof technology in past projects?

R4: We are – we are currently doing it, as a matter of fact. We're doing a retrofit for our – our courts and parks building right over here. If you lean – if you lean forward, you see that angled roof?

HH: Yeah.

R4: They're going – they have panels ordered already to install after the fact, and our new service center, it's about a $22 million facility. We're going to have extensive use of solar panels as part of the overall roof system, and I've noticed that we don't have regulation right now, Heath, that says you can or you can't. It's just silent, and that's not unusual. I'm sure you've found that out.

HH: Right.

R4: We are starting to see some commercial applications and some private residential applications where people are putting panels up. Matter of fact, they just gave me this, a couple of days ago. There's a church that's looking at integrating this product. It's actually integral. It's like a –

HH: Oh cool.

R4: It's like – it's like an appliqué.

HH: Yeah.

R4: It – it goes straight on the standing metal seams; so it's not a device that has penetrations, per say, or – or –

HH: Yeah.

R4: – mechanisms or whatever. You're welcome to take that if you've not run across that.

HH: That is really cool. No, I have not seen it, but I can look 'em up online. You keep that.

R4: Okay. Well, very neat. But it's like a film.

HH: Yeah.

R4: So you could put it on any surface, depending – independent of shape. It could be round or whatever. And to me when they – and they showed – 'cause when they first came in and said, "Hey, we're gonna do a solar roof," I was goin', "Great. We don't have any standards. It's gonna look like you know what."

HH: Yeah.

R4: And – 'cause it'll look like something applied to a roof, you know, as a separate structure, and what about rain and hail and the look and the colors and the structure and all that good stuff.

HH: Absolutely.

R4: When they showed me this, I went, "Man, that is cool."

HH: That's cool.

R4: So – so the answer is yes. We are incorporating it. I will tell you this that we are right now a part of a kind of a grouping of cities that are testing the waters on just alternative energy sources in general, wind turbines and including solar panels for green roofing. And I would imagine before the end of 2010 we'll have some kind of ordinance in place 'cause it's coming at us.

HH: Yeah. Do you, um – any planted green roofs?

R4: No, not – not that I'm aware of. Certainly not in our city inventory, and I'm not aware of anything out here –

HH: Okay.

R4: – as far as the private side goes.

HH: Um, now I'm gonna ask just a little bit more about sustainability and sustainable building practices, green building practices in general. How important do you feel that these sustainable or green building practices are in the land development process?

R4: I think they're extremely important. Again, carbon footprint related issues as well as, you know – there's a – there's an advertisement, and I'm not advertising this – this company, but on the back of one of the planning magazines I noticed there's an ad – yeah, this is cool. That – that right there says it all. "How much of the planet is in your plan?" Anything you can – we can do to reduce the impact is an important thing.

HH: Absolutely.

R4: And on a municipal level and regional, nationally and everything else. So it's extremely important. It has to be balanced though with property values, and that's principally driven by aesthetics.

HH: Yeah.

R4: But, uh, it's a – as long as it can be done in a such a way that it doesn't negatively impact values, I mean property values, and that can be structure-related stuff. It could be, you know, aesthetic-related stuff. I – we're good to go with it. That's what spooked us though right now, and most – most people that have to regulate land use are very aware of and supportive of the concept. We're just a little spooked about how you're gonna apply it.

HH: How do you feel about LEED?

R4: About LEED?

HH: Yeah.

R4: I don't know a lot about it. Okay? I know that – I – I – I sense that it is probably the winner in like the beta/VHS war in terms of what the standard is.

HH: Mm-hmm.

R4: I know that we're embracing it. As little as we know about it, we're embracing it whole hog because when a developer comes in and says, "We're gonna go for LEED," everybody gets bright smiles on their face and things get passed. We are specifying LEED – LEED technologies and attempting to get LEED points on all of our new city projects. As a matter of fact, um, Montgomery Farms over here has the first LEED mixed use development that's been designated as such, and Watters Creek, as I understand, is a LEED mixed use

commercial product; so we have a – we have a LEED designated mixed – neighborhood in a LEED achieved mixed use development. So it's – it's – it's good stuff.

HH: So I was talking to, um, a director of – I have to look at her card.

R4: Mm-hmm.

HH: Um, uh, from Addison.

R4: Mm-hmm.

HH: And she was saying, and she made a really good point, um, that she's all for LEED, "I'm all for buildings doing it and people going for it," but it's not something that they're gonna regulate on a city level because basically that's taking control out of their hands, and it's giving it to some other entity. 'Cause if they're saying that it's not approved, it's not approved, it's gonna hold up their development.

R4: Mm-hmm.

HH: So as far as they're going – as far as they say, "You can go for LEED, but we're not gonna require you to. We're gonna wait until the LEED specifications work their way into ICC."

R4: I totally agree with that.

HH: Yeah.

R4: I think that's a smart move.

HH: Because they're going to.

R4: Yeah. I – I agree.

HH: You can already see that they are.

R4: Sure.

HH: There are certain things in this new, I guess she was saying, in the new code that are already very similar to LEED, and you know, basically ICC is gonna just really figure out the important ones and the valuable ones, and they will work their way in.

R4: Right.

HH: Because some of the LEED certifications are kind of out of whack a little bit.

R4: Mm-hmm.

HH: The fact that you don't get any more points for a green roof.

R4: Mm-hmm.

HH: You know, a planted roof, makes no sense. Now, they say that the new codes or new, whatever you call 'em, requirements are gonna include biomass; so you get points and credits for biomass and which a planted roof would really increase the amount of, you know, um, points you would get there. So, um – but I totally agreed with her as well. I'm like that's absolute – that's a – I think that's a great stance to take because, you know, you don't really want to give up much of the control you – the little control we do have.

R4: Right.

HH: You know, to another entity.

R4: I agree. I like that, and that's – without question the way we would evolve also. I think that the danger – not the danger, but the discomfort with the transition is that there are certain things that LEED points that are not non-traditional in terms of our standards, and we want to be open minded, but at the same time, we want to make sure that we get what meets the code 'cause that's what we're bound by. And having said that, in addition to that, what you do in terms of implementing a LEED element is not maybe the same way I would handle it.

HH: Right.

R4: So not all of 'em are created equally.

HH: Absolutely.

R4: Okay? And so we end up, under the rubric of LEED, we could end up with some interesting things out that there that we maybe – may regret. That's why, from a municipality enforcement perspective, I totally agree with what she's saying. Once it wins its way into the ICC, it's something we can point to and say, "Hey."

HH: Yeah.

R4: And it's got a credibility associated with it.

HH: And there's a huge difference when you look at a LEED archetype building and a LEED project where a landscape architect was involved.

R4: Oh, I understand that. Yeah. For just –

HH: Night and day.

R4: That's true almost in everything. Okay? I mean you know me, I'm pretty biased, but that's true across the board. But I'm – especially so since the LEED is based on a lot of biomass-related elements.

HH: Yeah.

R4: I could see the difference.

HH: Yeah. So – and then finally, um – well, actually before we move on, have – have you guys, um – I – you kind of explained this, but, um, have you guys ever used any sustainable building practices in past projects, like specifics? Like –

R4: Well, we have without question adopted the use of certain light bulbs and light fixtures and those sorts of things.

HH: Okay. Exactly.

R4: Okay? I know in – in – in – as a – actually as a requirement for some state senate bill stuff that came down a couple of years ago we were required to gain certain degrees of energy efficiency through lights and switches and things. I know that we have incorporated architectural elements like – what the hell – what do you – pardon my language.

HH: Shade?

R4: Yes, exactly. Yes like shade and those –

HH: Shade shutters over windows.

R4: We've done that kind of thing. Orientation's a big issue for us.

HH: Orientation, sure, sure.

R4: As far as points of the compass and then I would say principally the use of the different light fixtures and light bulb types. I would image there's more, and if you're interested, I could contact our building guy and say, "Hey." I mean there are – there are probably like mechanical system changes we've done.

HH: Yeah, yeah.

R4: Or efficiencies on the ratings and – numbers.

R4: We clearly have done that.

HH: Okay.

R4: The last two cities I've worked with clearly were doing that also as I was leaving.

HH: Okay. That's good to know.

R4: Because we had state mandated situations as well as just a general change of attitudes about how we addressed this kind of thing.

HH: How 'bout from your residents? From people? Do you hear that a lot?

R4: Absolutely. Yeah, we are. We're hearing a lot, and it's a little – it gets a little tension forming because we don't have some guidelines to work with. We're getting a lot – we're getting more than – I don't want to say a lot. We're getting quite a few calls on wind turbines. We're getting quite a few calls on solar panels. We're getting quite a few calls on a variety of different issues. The use of compost piles and just al kinds of things that are really, really cool. And we're not opposed to any of it, but we can't – it can't just be a free for all because, you know, what would it like, a 200-unit subdivision with 200 individual wind turbines?

HH: Yeah.

R4: You know, or a 200-unit subdivision with every manner of – type of color and style of solar panel that can be created. I mean there has to be some type of –

HH: Or even a 200-unit with 1 big wind turbine that annoys everybody else in there.

R4: Oh, I understand. Exactly.

HH: You know what I mean?

R4: Exactly.

HH: Because that's what they're having to look out at.

R4: Right.

HH: You know?

R4: Ooh, ooh, I need – at Celebration Park, I don't know where we stand on this, but parks was pursuing a federal grant for a wind turbine project at – and Celebration Park is this humongous park. I mean the damn things' probably 70 acres.

HH: Wow.

R4: It's huge and wide open spread. And we were actually looking at a – an array of smaller wind turbines that had like an art element to 'em. They – they had kind of an artistic feel to them.

HH: That would be really cool.

R4: Yeah, it's really cool, and I don't know where we stand on that, but I know that via the emails, we were really looking forward to doing that. So I think that's a –

HH: Yeah. I've – a lot of what I've been hearing too is that residents have been – were super on the green bandwagon until the turn – economy went south and then it's a little less on the

priority list. Paying their bills and heating and electricity and gas and everything is –nave become more important.

R4: Yeah, yeah.

HH: You know, but at the same time, before they – you know, different cities have said they've wanted to be the greenest, you know, city in DFW, different things like that.

R4: Mm-hmm.

HH: And, you know, like Chicago, they now are required every city – municipal building is required to have 70 percent of their roof covered by planted materials.

R4: No kidding? Wow.

HH: Yeah.

R4: That's – that's cool.

HH: And that's – you know, he just took a stand, Daley – Mayor Daley took a stand and said, "You know, we're gonna do this. This is a practice that we believe in, and we're gonna make it a requirement."

R4: Excellent.

HH: So, yeah, I think that's – I think it's pretty cool, and if you go to Chicago, you really get to see it. Like most of my photographs are from Chicago. You know?

R4: Mm-hmm.

HH: And it is a great client – climate for green roofs, you know, for planted roofs because it's not like here, where they don't have 110 degree baking sun, and on a roof 140 degree baking sun –

R4: Yeah. Sure.

HH: – for three months out of the year.

R4: Mm-hmm. No rain.

HH: You know? With no rain.

R4: Yeah.

HH: And then when you do get a rain, it's like their water is 100 degrees.

R4: I gotcha.

HH: You know, the first amount of water is – that's really hard on a plant. You know?

R4: Yeah, yeah.

HH: And the wind. You know, we're wide open spaces. That wind – if you're on a six-story building, you're gonna get some aggressive wind up there. So –

R4: I agree with that.

HH: It is.

R4: You know, I think what you're gonna find too, 'cause again, I would tell you that not only we as an organization, but the – the – the City is – in general is very pro-green. And, uh – and it's not just because it's, you know, avant-garde or the flavor of the month to do that. I think our demographic is a fairly – is a very educated demographic. Average, you know, bachelor's degree. A high percentage – or – or above that.

HH: Mm-hmm.

R4: And it's a – it's a professional kind of – and I think they see the value there.

HH: Yep.

R4: And so I think what you will find is you will find different areas of the world that are gonna have a greater appreciation for it and then – and then less so.

HH: I absolutely agree with that.

R4: And – and the cities will have to drive the carts on those kinds of things, so –

HH: I know what you mean mean? Allen, Plano, Addison, you know, South Lake.

R4: Yeah.

HH: Those are some cities that I really think are gonna be, you know, thinking about green because of – like you said, because of their demographic really.

R4: Mm-hmm. Well, there are three things that drive that kind of stuff. One is mandate. If the feds and the state tell us we gotta do it, guess what? We'll line right up.

HH: Yep.

R4: Two is market. If the market requires it, we will pay the premium, and if we don't – if you don't offer it, we're gonna go somewhere else. And then third is just general philosophy. You can have a city that doesn't have the mandate and the market's really not asking for it,

but the city leaders have such a – enough head space and forward thinking that they drive it that direction.

HH: Yeah. And that you see a lot in California.

R4: I would agree with that. I'm not surprised a bit.

HH: That's – it's a – the cities are like –

R4: Not surprised.

HH: Philosophy or, you know, they're philosophically based on green, and the whole city has kinda grown from even that, from – you know, there's a lot of new little towns and stuff especially suburbs of stuff that, you know, they're – they were established in 1970.

R4: Right.

HH: When, you know, this was the biggest thing, you know, in the '70s.

R4: Gotcha.

HH: So there's a lot of cities in California like that. Um, so finally –

R4: Yes.

HH: So I don't have to keep you too long.

R4: Okay.

R4: I have a couple questions on, um, planted green roofs. Um, are you familiar, obviously we've kind of talked about this, with – and it's – it's a category of them, and it's, uh, extensive green roofs?

R4: No, I'm not.

HH: Okay. So basically it's a – a planted roof with a lower soil profile or it's really not even soil. It's a growing medium, usually made up of expanded shale or, um –

R4: Okay.

HH: – fired clay; so it's not even soil. There's very little organic matter – they do put a little in it however. But, they're all propriety mixes.

R4: Mm-hmm.

HH: They are usually not accessible; so they're not roofs that you go out on – it's not a rooftop garden.

R4: Mm-hmm. I understand.

HH: Have you ever seen photos of the Ford Motor Company's headquarters?

R4: Mm-hmm. I have.

HH: There are thousands of square feet.

R4: Yeah, yeah.

HH: And that's – that only has four inches of soil.

R4: No kidding?

HH: Yeah.

R4: Is it more hydroponic or is it plant selection or –

HH: It's plant selection, and that's one of the hard things with – about – with DFW is everywhere else in the Northeast, in the Northwest, sedums are the primary plant pallet.

R4: Okay.

HH: Well, David at UTA has this experimental green roof, and he has 1,000 square feet, and he's testing, and basically every sedum he's tested has died.

R4: 'Cause of the heat?

HH: Heat. They can't take it.

R4: I understand. Sure. I understand that.

HH: Yeah. And then – so he's been testing a lot of native and near native plants, and he has found – just as the Wildflower Center in Austin – that these plants are doing much better than the sedums in the harsh Texas climate

R4: Mm-hmm.

HH: And TCU's also been doing some research, and they've found a number of plants that will absolutely work here.

R4: Okay. Very good.

HH: So going to be doable. It's just going to be a different plant pallet, which is kind of – we're used to.

R4: Sure. Exactly.

HH: Texas has had a –

R4: Yeah.

HH: – has a different plant pallet than most places, especially DFW. Um, so do you feel like a planted roof would be an ecologically appropriate, you know, sustainable practice?

R4: Clearly.

HH: Clearly?

R4: Yes.

HH: Yeah.

R4: Absolutely.

HH: Okay. Do you – um, how about environmentally?

R4: Absolutely.

HH: Okay.

R4: Certainly.

HH: Um, and then economically? And you can elaborate any that you want.

R4: Yeah.

HH: Like – and economically is probably gonna be the easiest one to elaborate one because there's – obviously it's more expensive than –

R4: Yeah.

HH: – regular roof; so –

R4: Ecologically, I mean – excuse me. Um, financially or economically.

HH: Yeah.

R4: There's – there's surely a savings, a payback over time, and how long that payback is, you know, where the curve breaks as far as what you could afford. But more importantly, to me – 'cause there's a – there's a payback and it'll be – it's – it's math. It is what it is.

HH: Mm-hmm.

R4: More importantly is where does that place you in terms of market? You know, there's a – like we talked in the class, there's a niche out there somewhere that still needs to be filled, and if – and if that's the thing, and it has all these other spin-off positives, the save the planet and save money and all that other gobbledygook. But if it's the thing that causes one major multinational to locate an island and bring all their employees and spin up the park system and spin up the stores, it's well worth it.

HH: Well worth it.

R4: So there's – there's part of it too I think.

HH: Mm-hmm.

R4: You know, environmentally, obviously it's the – it's the greening of the footprint, it's the chlorophyll and the – you know, the O_2, CO_2 cycle and all that other good stuff.

HH: Absolutely.

R4: All the biological benefits of that kind of thing. Yeah, it'd be – it'd be sharp. It'd be nice.

HH: Yeah.

R4: It'd be nice. It'd be nice to see this flat right here planted as opposed to this black lookin' ugly shit that –

HH: Absolutely. And so –

R4: – stands in water all the time.

HH: – that comes up. That brings up a point that I – there's an article, and I can forward this article from New York Times about the popularity in New York with mid-level mid-rise buildings doing it because the premium you can get from he high rises from just looking down on it.

R4: I could understand that. Absolutely.

HH: And that's kind of exactly what you say. The value you get out of the building space overlooking a green roof is kind of like the value you get having a house on green space.

R4: See, I understand.

HH: So it's market driven. You know?

R4: Yeah. You pay $50.00 more dollars a month for an apartment that faces the creek versus one that faces the – that – I never thought of that, but it makes perfect market sense.

HH: Yeah.

R4: Absolutely.

HH: And even for, you know um, uh, investors or people that own their own buildings, and, you know, it's not really a retail kind – or a rental type basis.

R4: Mm-hmm.

HH: Um, it's a good – you can kind of think of it like, there's ton of these you know this, a building, right, with a lower level, you know, like second – only two story below.

R4: Yep.

HH: And then they go really high, but then just beyond that is a sea of parking.

R4: Mm-hmm.

HH: So you're looking down on an ugly roof and ugly parking.

R4: Yeah.

HH: So if you were to at least cut that up with a little bit of green, yeah, you're taking it – you're taking – mentally, you're getting –

R4: Absolutely.

HH: So there's – there's little, not only monetary value, but also just for people, you know –

R4: Psychological.

HH: Lifestyle. Yeah.

R4: Mental health, everything. Yeah, lifestyle.

HH: So in a sense that will turn into, um, productivity, right?

R4: Yeah.

HH: You know, if people are happier at their work –

R4: Sure. Clearly.

HH: – they're gonna work better; so in a sense that even turns around to money again.

R4: Mm-hmm.

HH: So I think that, you know, there's definitely a lot of, you know – it's just long term.

R4: Mm-hmm. I understand.

HH: You know, and it's – it's not necessarily direct; so it's hard for people to grab onto especially developers. Because I've met with some developers, and they're really in the – in, you know, like – they don't know really what's going on with 'em because for them it's about money.

R4: Mm-hmm.

HH: And it's about – right now it's about building, and you know, if it's not gonna get them – if it costs more to do, they're gonna be out of it.

R4: Let me – how much – I mean how much more time do you have to complete your research?

HH: I have a couple weeks.

R4: Okay. And – and is it already preset? I mean I know a guy, a developer, Philip Williams with Montgomery Farms.

HH: No, I was gonna ask you for people.

R4: That developed all of this over here where Watters Creek. I just got off the phone with him. I can't imagine a better person for you to talk to to talk about this type of technology because Montgomery Farms is – is the one that has the – the LEED certified neighborhood and the LEED certified this and that.

[End of Audio]

RESPONDENT #5 (ARCHITECT): INTERVIEW TRANSCRIPTS

HH: So I really appreciate you meeting with me.

R5: Oh. I appreciate the opportunity.

HH: So, um, first I'm just gonna ask you a couple questions about your knowledge and perceptions on green roofs. Um, are you familiar with green roofs?

R5: A little bit, yeah.

HH: A little bit? Um, basically please describe a green roof as you understand it.

R5: It's either the, uh, at least in our country we have the intensive or extensive types of green roof, you know, extensive being the ones really we're more interested when we're dealing with remodels of buildings in the intensive ones like you'd see on the top of parking structures and large urban areas for big commercial developments and thick soil matrix with trees in it or whatever, but uh, really the, uh, extensive green roof and I'm going to a seminar this spring and kind of following what you guys are doing on the engineering buildings.

HH: Yeah.

R5: That's kind of very intriguing to me as far as urban in fill and improving our heat island effects, etc., etc.

HH: Yeah. Absolutely.

R5: Just research, just doing research on my own. I'm going to a few places to see some ladybird wildflower. They have a really nice little setup there.

HH: Yeah. Absolutely. They're doing some great research there.

R5: So I went through there last year and that was pretty cool, so I've never done one. It's definitely on the radar and that's why I've been following you guys at UTA, what works up here. It looks like you're finding some plants that can survive in pretty harsh climates.

HH: Absolutely. David is finding some plants that we didn't expect to do as well as they have and so, and a lot of things that people aren't trying that David decided to try just because he thought they might work and they're doing really, really well, you know, and it's been a year in so we're starting to really see the things that are and are not working because it's had enough time to -

R5: Run through the four seasons.

HH: Exactly.

R5: That's neat.

HH: So what would you say are the possible benefits or negatives to a green roof, and/or negatives to a green roof?

R5: Well let me get rid of the negatives right away. Um, I think one of the – with, with retrofitting just the structural implications of a green roof and the limiting factor there, or maybe even an extensive green roof wouldn't work, um, it's kind of a negative thing from the point of view of getting it done and actually doing it. A lot of our buildings have – this roof actually probably could handle it even though it's built in 1937, but it's a really strong roof.

HH: Yeah.

R5: It's amazingly durable. Um, up front costs, I think those will come down especially when using the systems, priced some of the systems. I think that'll come way down as we just get more into the green roof kind of world. For the positive side, there's just a ton of positive things. Reducing your heat island, uh, just kind of managing runoff to a certain degree.

HH: Mm hmm.

R5: Filtering the water, um, as it comes off the roof, cleaning the air, scrubbing the air out of heavy metals and other things that plants wonderfully do, especially in an urban environment where we have a lot of them floating around in the air. Um, I jotted down a few notes here. Habitat for insects and other small creatures. That's kind of nice to have another place where they can hide, not have a cat or something else going after them. [Laughing]

HH: Yeah.

R5: Of course sound and thermal insulation is really important. Especially here in Texas I can see thermal insulation being one of the most important factors here where we have so much heat. That wouldn't be as big a deal in Portland or Seattle, and, uh, I don't know, just kind of aesthetically. At a high rise looking down at a roof we're creating more usable space and certain roof conditions actually create – here we have 18,000 square feet that we don't use upstairs.

HH: Absolutely.

R5: Creating, you know, more usable urban space that's green and, uh, and aesthetically pleasing. It's hard to put a cost or a value there, but it's substantial I think.

HH: Mm hmm.

R5: So man, a lot of stuff that the green roof solves and improves. It's pretty amazing.

HH: Especially when you think of when we are thinking of the negatives and the only ones we can really think of are up front costs.

R5: Some costs and – yeah.

HH: And some installation type issues, but -

R5: Yeah. That works with existing buildings, but if you figure it into your building up front the structural issues are really minor.

HH: Yeah.

R5: It may not add much to the project cost. Be less than a percent maybe or something compared to an overall cost for the project, but it's -

HH: Have you ever used green roof technology in any of your past projects?

R5: We have not. We have not used it.

HH: Okay.

R5: We will, but we just haven't.

HH: Have you done any research? Have you been researching like you're looking to use them in the future or is this something that's just -

R5: I've done, I've done research, not on a project specific basis but a general basis.

HH: General?

R5: Yep, general research, just trying to figure out what's out there and systems and how these guys work with Dave a little bit. I've met them at a trade show. Look at that. It's gorgeous.

HH: Isn't that beautiful?

R5: Yeah. Chicago, they're becoming the green roof capital of the U.S. I guess.

HH: Yeah. They have more green roofs than any other city in the country.

R5: That's gonna make a difference. Over time that'll just -

HH: Yeah, and he's also, the mayor is actually writing into policy a lot of like mandates where 70 percent of a flat roof must be covered.

R5: Is it that high a percentage?

HH: Yeah.

R5: I knew that they were really getting serious about it.

HH: Which is great. I mean I think a lot of times the policy is what can really make big things happen in the city. I think we all wanna do it and clients even wanna do it, but then when it comes down to it a lot of times it gets cut at the last minute, all kinds of things can happen when it comes to the budget, but when it's in policy and when it's mandated, then those are things that become much more important. You have to do it, so -

R5: That's one of the few instances where government is good. [Laughing]

HH: Exactly. Exactly. So now I'm gonna ask a couple questions, just a few questions about sustainable building practices in general. Um, how important do you think sustainable building practices are in the decision making process?

R5: In the decision making process?

HH: Yeah.

R5: Uh, I think that's a critical first step. Any time you're taking especially a piece of land that's virgin or wild, um, trying to impact it in the least possible way is, uh, something we like to think about here.

HH: Mm hmm.

R5: Don't always. Depending on your client it really varies, but, um, and your project type. We're trying to I guess tread lightly a little bit with our build footprint. Even the site selection, which we get involved with in our municipal projects and our other oil and gas projects, um, you know, try to pick a site that makes sense from as many directions as it can. Usually community and a lot of times also environmental, and then placement of that building, orientation of the building, all the things that really what we call common sense. We refer to everything sustainable as common sense 'cause you go to any ancient culture that's the way they're built.

HH: Common sense.

R5: They wouldn't put something out in the bright sun unless they had to, unless they wanted it to be warm.

HH: Yeah.

R5: You know? And, uh, our air conditioned boxes we have all over the world doesn't matter how you orient the buildings. It's crazy. End up paying a huge price in energy, so, um, I think it's, yeah, immensely important to think sustainably.

HH: Right on. Have you, have you ever used sustainable building practices in your past projects and kind of explained maybe?

R5: Yeah. In fact we did the, um, you're familiar with lead I'm sure?

HH: Oh, of course.

R5: A number of the lead categories are based on the post office we did here in Ft. Worth about 12 years ago. We did the first green post office in the U.S. over on 8th Avenue and, uh, some of the books later on showed the floor plan of the post office and had the information on that project, so we were doing that about several years ahead of lead, so, and even before that I was into solar energy when I was in high school and looking into things like that back in the late 70's and early 80's, so, um, I think architects tend to think that way, not all architects but I'd say probably two-thirds of architects think sustainably and we have used sustainable techniques on many of our projects especially ground up, and we've had, uh, I don't know how many projects now, three or four that are in for lead certification if not lead certified. Just did the very first show in Williams store, just opened it a month ago in the county and it's lead.

HH: Right on.

R5: Gonna go for – it's lead or lead silver. Hopefully it gets lead silver. It may just fall into lead basic, but yeah. We're there.

HH: That's very cool.

R5: Yeah.

HH: Very cool. Well finally I'm gonna ask you about extensive green roofs, which you were speaking about in specifics, and their appropriateness to North Texas. So as you said before, but I'll ask again, are you familiar with extensive green roofs and if you could explain?

R5: A little bit. You know that's probably what I've done research on more on extensive, you know, trying to limit your soil depths to 4-8 inches. It doesn't become a structural issue because we do a lot of remodel work. This building for instance was a recycled building when we bought it ten years ago.

HH: It's beautiful.

R5: And it's a cool building. I think if anyone else had bought it, it was in such bad shape they would've bulldozed it.

HH: Yeah.

R5: All it needed was carpentry and electrical work and plumbing. I mean structurally otherwise it was just in perfect shape, so we saved it from the wrecking ball. But yeah, I

have, for the last couple years I've been looking, maybe longer than that, kind of studying extensive green roofs, how you layer them up. I was gonna do a gazebo in my back yard and turn that into a green roof. I ended up not doing that 'cause I have enough green already, so I'm going probably solar with photovoltaics, but, um, yeah. I know enough about 'em. I'd still have to really get into the research of putting one together, filter fabric, the details.

HH: But you have a good understanding of what extensive green roofs is.

R5: Yeah, in general what they're trying to resolve.

HH: And that's the point to this research. Well do you feel like extensive green roofs are ecologically appropriate for north Texas?

R5: I think they will be. Yeah. As we have, we just find out what will grow here on a hot, windy roof, I think absolutely, helping building performance, another thing, keeping your roof lasting longer. It's not exposed to UV and weather, hail. That could be a huge thing here really.

HH: Yeah.

R5: I think so. Yeah. Definitely.

HH: How about, um, environmentally.

R5: I think so.

HH: You think so?

R5: Just from a heat island impact, how that really affects our weather patterns. When you watch weather patterns dissipate when they hit the west side of the metroplex and peter out, but then it'll rain on the periphery or the heat really moves rain away from where we need it. I think too the other things I mentioned, habitat, storm water control, filtering water before it hits the storm sewers, things that really can add up pretty quickly when you look at the major rain we have here.

HH: Yeah, like today.

R5: We're not like Portland where it just drizzle all the time, which is beautiful in its own way, but we just have beasts. We just get three inches in two hours.

HH: Four inches in a day, you know?

R5: And it's crazy and all that water ends up in the Trinity.

HH: In the Northeast it can take 'em a whole month to get four inches of rain or two months, you know, to get -

R5: Yeah.

HH: Basically I've heard that Dallas and Seattle have the exact same amount of rainfall except -

R5: Oh, do they really?

HH: Yeah, except we get ours in like five days and they get theirs throughout the whole year, which is really interesting. Well not five days, but you may get it over 14 days out of the year compared to their 300 days.

R5: 300 days. Yeah, or they have 70 days of sunshine and we're the opposite. We have 280 days of sunshine or something. [Laughing]

HH: But when it rains it pours!

R5: Yeah, and we get these major monster events.

HH: Yeah. The Trinity is really beautiful when it rains though.

R5: Yeah.

HH: Like just the rushing. I mean there's parts of it where the trash collects just, you know, that's part of being in our environment.

R5: The river started out as the reason for development, why you put a log cabin there.

HH: Yeah.

R5: [Laughing] 'Cause they collect rain off roofs and roadways.

HH: Yeah, and we move 'em if they're in the way. Now we're moving rivers, which is – the Trinity itself.

R5: Don't get me started. We can engineer – no. [Laughing] Mother nature is a lot smarter than we will ever be. Once you realize that you'll be okay. [Laughing]

HH: That brings us right back up to sustainability practices and common sense.

R5: Yeah. It really is common sense. That's what we – some people don't wanna hear the word "sustainable" or "green" 'cause they're getting -

HH: Sick of the actual word, the verbiage.

R5: Every article in every magazine cover. You say whatever happened to this common sense, folks? And here's how we'll implement it.

HH: Yeah. I love that.

R5: Whether it's a lead project. It says here we're gonna do some things that are gonna make your building more sustainable but are gonna cost you less money in the long run.

HH: Which is still common sense. Absolutely.

R5: Make your environment a more pleasant place to work every day. Huge. There's saving money. People have less absenteeism. All that stuff's been proven now.

HH: Yeah. Absolutely.

R5: So -

HH: So the last question would be, and really we've also touched on it, but just to get a good firm answer, are extensive green roofs do you feel economically appropriate for this area?

R5: I think extensive green roofs can do that. I think they will and I know what – do you have 1,000 square feet over there at the engineering building?

HH: Mm hmm.

R5: It's about $15,000.00 that gets up through a year including some water costs and running pumps or whatever.

HH: And now they're using the air conditioner condensate, so it's really not any -

R5: Less water.

HH: Yeah.

R5: Yeah, less water usage. It's that nice fresh water, um, and I think that'll drop a lot. You've got cities like Chicago jumping on board and then you get a city like Dallas or Ft. Worth say, "Hey, we're gonna start implementing green roofs on our municipal buildings" or something like that, and then it goes to, well, you've got the people in the commercial buildings say, "Hey, let's do that. We have 20,000 square feet on the top of this building we're not using at all." Whatever. Just make it work.

HH: Absolutely.

R5: I think so. I think there will be more and more affordable like all these new technologies. Solar panels, god.

HH: Yeah.

R5: With incentives like encore and 30 percent tax it's now affordable where it wasn't a year ago. Couldn't touch it.

HH: Yep.

R5: Now I'm looking at doing one on my house for about 60 percent less than what it cost a year ago.

HH: That's amazing.

R5: That's big. Well it makes it affordable and it's something that'll pay off in 10 or 11 years, which I can live with that.

HH: Well are you familiar, um, with the, um, photovoltaics, um, what's it called there, um, optimum range of temperature for working?

R5: Mm hmm.

HH: So it's like around something like 90-95 degrees, the ambient temperature above. If you're putting it on a roof, well we tend to be at 140 so you're losing a lot of your, um -

R5: You wanna somehow cool your roof if you can.

HH: And how do you do that with a green roof?

R5: You can put a green roof on it.

HH: So that in my research, in my literature, that is the biggest benefit or direct benefit of a green roof is that it keeps that ambient temperature and it allows those photovoltaics to really work and produce lots of energy in this environment. When you take 'em, you know, you take solar panels to different climates it's not as bad because their temperatures don't get quite as high as ours do.

R5: Yeah.

HH: You know, but our temperatures on a white roof -

R5: 150 degrees.

HH: 150 degrees, you know? And if you put, uh, solar panels up there, you're gonna get, you know, they're gonna work, but they could work so much better, you know?

R5: Yeah. I've seen the curve. It drops off.

HH: Yeah. So that's, I mean again that's really not a question, but that's something that I found that I think is just super interesting if you're interested in solar panels.

R5: Yeah. I'm gonna have a cool roof seminar at 1:00 today. [Laughing]

HH: Oh, cool.

R5: This building is an experiment right now. That face and the face over here is silver, the asphalt is silver. Here and here is U.S. Ply's Cool Roof, which is white. I mean you get up there you have to wear sunglasses it's so bright, but you can put your hand on it, it's like 85 degrees. You put your hand on the silver and it'll burn your hand.

HH: Wow.

R5: As reflective as the silver is, night and day, and so we're monitoring temperatures seasonally -

HH: That's great!

R5: - inside and out and it's 3 degrees cooler inside than it is on the solar face. It's 18,000 feet. 3 degrees is big.

HH: Yeah!

R5: We're already saving money. Our air conditioning is already running a little bit less.

HH: Isn't that great?

R5: So yeah. It's a big laboratory here. [Laughing]

HH: Yeah. I love that. Yeah.

R5: I'd love to do a green roof on one section and then take temperatures and do some other experiments up there with that.

HH: If you ever – do you wanna – talk to David because he really can, especially when it comes to, you know, smaller, just more, you know, research based, if it's not fully like -

R5: Like 1,000 feet would be cool.

HH: Wouldn't that be great?

R5: 1,000 feet and just, and then see what happens.

HH: Even those tray systems too. Those tray systems are so great because you can pre-grow 'em and everything and basically you have a green roof before you even go in.

R5: Set 'em in place.

HH: Yeah. All right, man. Well I really appreciate you talking with me.

R5: You bet.

HH: It's gonna – it makes a huge, um, help. I've met with some landscape architects and now you're my first architect, so, uh, it's really good to know that you guys are, you know, have a good understanding of what extensive green roofs are, 'cause that was my fear going into this research was that people are gonna know what a green roof was but not really the difference between intensive and extensive and the goals of the two, but from what I'm finding out, people are really aware.

R5: I think people are picking up on it.

HH: Yep.

R5: And I think around here, I mean look at what an opportunity just in the Dallas Ft. Worth area.

HH: Huge.

R5: It's enormous.

HH: Yeah. We have actually right now a research project going on at UTA as well where they are, um, calculating the total area of DFW of flat roof.

R5: Hmm.

HH: So what is the market out there?

R5: Yeah.

HH: If we were to green roof every flat roof in DFW, like that's the, you know, size that it could be. Of course there's a piece how much is actually gonna get done, but still just to know what the availability is I think is pretty interesting, so they're using GIS and all those things to try to _____.

R5: Oh man. That's pretty neat.

HH: Isn't that interesting?

R5: I'd like to follow that a little bit.

HH: Yeah, so I'm sure someone in the next year or so's gonna be doing a thesis on it. They're just still all in the middle of collecting data right now, so -

R5: Okay. I do blogs about every other week. We always do blogs on our website. I may do a quick blog on green roof and just link you guys or something.

HH: Yeah.

R5: So people have that extra portal into what you guys are doing.

HH: That'd be awesome.

R5: I saw an article come out just yesterday, I think just yesterday on your roof and you're gonna go on the research building with I guess an intensive roof.

HH: Yep.

R5: Excellent.

HH: Yeah. They, um, it was supposed to be extensive. It was supposed to be the entire roof and you know how things go.

R5: Yeah.

HH: The saddest part about it is that they ended up doing it on the north side on the second story -

R5: That's what the article said. Yeah.

HH: - of a four-story building, so it's getting no sun.

R5: Oh.

HH: And then when it does get sun it's hot baking afternoon sun.

R5: Yeah.

HH: You know? And so they're having to irrigate it. They're having to do a lot of stuff that, you know, it's more of a presentation piece.

R5: Okay.

HH: So it started out, you know, the dreams were big, but, you know, things happened, but the next phase of the campus really is going to have, you know, a lot of different, they're bringing in different landscape architect, different, um, different consultants that are, like you said, a little more common sense aware.

R5: Yeah.

HH: So they're doing some really great things.

R5: That's not good here, but hey, let's do it here. Parking lots I think are the next thing.

HH: Yeah.

R5: You're covering shading cars with photovoltaics, little green roofs. I would love to have a – I'm from Michigan. People, you know the little grass tree papers and you can put grass in.

HH: Yeah,

R5: And that could work up there. You just have to go through it with a weed eater once in a while or just mow your parking lot. [Laughing]

HH: Yeah. Mow your parking lot.

R5: But they stay in pretty good shape.

HH: Yeah.

R5: Something in Texas, get rid of some of this parking lot.

HH: Oh my goodness.

R5: The heat impact it has. It's just brutal.

HH: Brutal.

R5: Yeah.

[End of Audio]

RESPONDENT #6 (ARCHITECT): INTERVIEW TRANSCRIPTS

HH: First, I'm just gonna ask you a couple questions about your general knowledge or perceptions of green or living roofs. Are you familiar with the green or living roof?

R6: Yes, to some extent. Not technically, but in practicality, yes.

HH: Okay, so please describe them as you understand them.

R6: Well, the primary purpose of a green roof is to, I guess – a lot of different functions, I guess. To mitigate runoff, to conserve water, cut down on radiant heating and heat loading of buildings, probably some visual, from a landscaping standpoint. But I think primarily for the conservation of water and for the carbon dioxide that it chews up and emits oxygen during the photosynthesis phase, and then, certainly, for helping cooling the building, insulating the building. I guess, for heat or cold.

HH: What do you believe are the benefits of a green roof or the negatives, could you foresee?

R6: Well, we can start with the negatives. Expense – green roofs are gonna be inherently heavier because you gotta have soil. There's gonna be water and plant material, planting boxes, etc. I'm not sure what all kind of media or containment is necessary up there, but weight certainly would be a factor. You have to build a building, probably, to be stronger to support all that up there.

The benefits being in the cutting down of urban runoff, I suppose; the generating of oxygen and the consumption of carbon dioxide and providing a pastoral setting for the occupants of the building. You make that a garden up there where people can go up and take their breaks or have their lunches or just to go up there and get away form their desk for a while. So that's an intrinsic benefit there, but certainly one that can be overlooked.

HH: Have you ever used a green roof technology in any past projects? Please explain why or why not.

R6: We've not gotten any of those in Addison, and I've been here for 20-odd years, so I've not personally seen it or we've not utilized any of that here. I've been exposed to some of the technology here through some LEED training we took, but not in personal experience.

HH: Next, I want to find out a little bit more of your perceptions on sustainable building practices in general. How important are sustainable building practices in the decision making process as you see it?

R6: Well, it's gonna become increasingly important all the time for a variety of reasons – obviously, energy conservation, the lower dependence on fossil fuels, lower electricity costs and less of an impact on natural resources. Certainly the energy packages on the building will be a lot more effective in maintaining the heating and cooling, so to the operator of the building, the owner of the building, the operation costs should be quite a bit less.

Generally, comfort in the building, using up products that come from either reused products or renewable resources, and things like that, not just fossil fuels, but also stuff like wood, stone, concrete, gravel, all the different components that go into buildings. It's a way to get fid of fly ash, mixing it with concrete. Using up what would normally be waste materials, conserving mother nature's raw materials there, energy conservation, operating of the building, comfort of the people utilizing the building, cutting down on the amount of water consumption – just any kind of impact you can possibly imagine. Some very large footprint they could remove and some much smaller.

There's a cost benefit there to how much you can put in there, but there's benefits up and down the line here, towards a sustainable planet to get in concert with the land here and in concert with the planet.

HH: Finally, I have a couple questions about extensive green roofs and their appropriateness in North-Central Texas. Extensive green roofs are a lower-profile green roof. It's anywhere from two to six inches of growing medium and very little maintenance, and they're not accessible, except for maintenance maybe once or twice a year. So they're very, very low maintenance, very low-profile, a very streamlined style of green roofs.

With that kind of – you don't have to know too much about them, but with just that kind of understanding, do you feel like green roofs would be appropriate for North-Central Texas, extensive green roofs for North-Central Texas?

R6: Yeah, certainly. It may even be a better choice than something a lot more intensive for the very things you mentioned. You've got a lot less growing media there, so therefore you don't have to build the building as stout to maintain all that weight. You don't have to have all that deep media for growing, like you say, upright vegetation, mostly turf and flowers and things like that.

But mostly, probably, non-decorative, low water consumption, buffalo grass or some other type of really heat-tolerant and draft-tolerant type of plant. So, yeah, I could see that that would certainly be a good happy medium between conventional built-up roofs that we see out there and the garden roofs that everybody really – that makes the neat pictures and publicity and all that.

HH: Yeah, the New York City rooftop garden.

R6: Exactly. Exactly. Where the prettiest place in town is on top of the biggest building. But yeah, I can see it from a practical standpoint and cost-containment for original construction, and just the practicality of it, of insulating the building.

HH: Well, you actually touched on each of the different areas that I was gonna actually go into, but we can just reiterate. Do you feel that extensive green roofs are ecologically appropriate? You kind of touched on that using some of the native grasses and using some of the native plants.

And then, environmentally, which obviously, the water consumption, all that you talked about, and then economically, obviously, it's a little bit cheaper, a little less structural support. You kind of touched on it, but is there anything else that sticks out in those three? Basically, it's ecologically, environmentally or economically.

R6: I don't know, probably expand on those just a little bit there. But, yeah, economically, obviously, if you're gonna grow a turf grass, something that doesn't need much maintenance. It doesn't require much fertilizer. It doesn't require much water. It doesn't require mowing, if at all. Who wants to have a turf that needs to be mowed on your roof?

HH: On your roof. Come on.

R6: For sure. And, obviously, for different parts of the country, you're gonna need different types of grass up there because of the rainfall that you have. Obviously, you don't want to put irrigation up there. That kind of defeats the whole purpose if you gotta add water to keep it alive. So there are different types of grass for different parts of the country. Here, probably, Bermuda or certainly a buffalo grass or some other types of native, short prairie-type grasses might work pretty well.

Ecologically, again, I don't know how much grasses, how much carbon dioxide they consume versus a lusher garden. Obviously, the more plants you have, the more carbon dioxide you're gonna consume. I would think you'd get quite the bang for the buck there with grasses as you would with trees and shrubs and a wide assortment of lush vegetation up there. But again, you've got the cost savings involved because you don't have near as much prep to get that going.

Obviously, you don't have the interactive. It's not like you're setting it up for pastoral type of uses. It's strictly for buffering for heat and cold and for energy consumption and water runoff, absorbing the water or channeling it to maybe tanks or whatever where it might be reusable in some kind of way in the building.

HH: How about if it is seen from another place, like speaking of mid-rise to high-rise buildings?

R6: Sure. Oh, sure. Yeah, there's definitely some intrinsic value there, where you're not just looking down on a rooftop air conditioning units and gravel roofs and things like that. So yeah, for mid-rise, where you've got a mix of high-rise in there, even on low-rise, two and three-story buildings. If you've got a lot of buildings around there, sure, it would be much nicer to look upon patches of green than looking down on the top of somebody's building and all the utilities. Obviously, utilities are going to have to be there, but I'm sure there's ways that those things can be decorated or positioned or otherwise camouflaged, either with living plants or with compatible materials to where they lower that visual impact.

But there was a lot of things that made tremendous sense, and can be driven from a practical standpoint by just cost savings, by absolutely, pure cost savings on construction on the front end and then, certainly, on operations, where some of these other things were the right thing to do, but they don't make as much sense from a practical, dollar-and-cents standpoint.

Absolutely, there will be a whole lot more of that, and when that becomes mandated by the various building codes, electric and plumbing, and the air conditioning and heating, and all the various codes that address building construction, materials and practices and things like that are gonna become a whole lot more mainstreamed. There's going to be cost containment there, simply because the business will be there and the suppliers will then follow.

Here's a regulation and everybody's gotta do it, and therefore, that will feed the suppliers for the people who are actually doing the building. Then these things will become mainstream because they're mandated. They'll become economical by just economy of scale – no, that's not the right word – just because the demand increases, and therefore, the supply side will increase.

HH: Yeah, basically, the market, creating a marketplace for it.

R6: Exactly.

R6: Whereas, right now, there's not really a strong marketplace for it and that's why I'm finding that there's not a lot of perception. Most people don't have a lot of knowledge about them because there's really not a market. Once the market develops, then people really start paying attention, because there's a market for it.

R6: Absolutely. I think we're gonna see it move forward in fits and starts and –

HH: Especially if this economy, right?

R6: Yeah, and it's really hard to convince somebody to do the right thing because just the intrinsic value of doing that, and they're looking at the bottom line. They've got lenders. They've got Board of Directors. They've got buyers.

HH: And they're really breathing down their neck now.

R6: Yeah, and cost-containment is a very, very specific thing right now, a very tough thing. It's a tougher sell than a weak market, but by the same token, so much of the construction standards that are out there now, if you put them all into good practice, you can get a building pretty close to silver, which, to me, doesn't mean a whole lot, but it does mean, I guess, a lot in the building community that we have a silver building or a gold building or a platinum building or whatever.

But to get to LEED silver, we've already seen a lot of things that have been done, certainly not just the envelope of the building, but with the energy packages inside, the wind units, the air conditioning and heating packages that are put in there, the materials that are used for finishing out a room, or the carpet, and the paints and things like that that don't off gas as much. All these things create a better living environment inside the building, too. We're talking about LEED. We're not talking about just the sustainability or the impact on the outside world, but the world that people are living in inside the building.

HH: Absolutely, and a person that I was interviewing, he had just written an article on the loss of the human connection to LEED, basically, how, a lot of times, LEED forgets about the human factor of it. They're so focused on the energy efficiency, all the stuff you were just speaking of and they kind of leave what you last spoke of, the human quality of life effect is a little bit lost and this article is really trying to pressure LEED to really start thinking more about the human aspect of it as well.

R6: There's definitely stuff in there, like the way you orient the building, the way you shade or not shade certain facing windows and all, trying to get more ambient light into every workspace rather than people having just artificial light. It's just so much common sense kind of stuff that's in there and it's taking all the consumptive and non-consumptive sustainability objectives and incorporate some common sense, and, like you say, to the living condition and try to meld and mesh all of these different things there to make a building that's just so much more in concert with the earth and the impact that it makes.

HH: I like that you said, "common sense." The director of our program believes that "sustainability," the word, really should just be "common sense." We just made up a word for common sense. Architects and landscape architects have been doing this since the beginning of time. It wasn't until this mass urbanization that a lot of things got forgotten, but, really, that's where architecture came from, was common sense. You put your house on a river because you needed fresh water.

R6: Exactly, but high enough out of the stream bed, so it doesn't get flooded.

HH: Yeah, and so you have room for growing plants and the fertile soil, all these different kinds of things.

R6: You put your windows in the south side to take advantage of all that sun, if you live in the northern hemisphere.

HH: Exactly.

R6: And don't put your windows on the north side where you get all that radiant cold coming in. I had a house that faced south one time and it was perfect. Now the house I have faces west and all the windows in the west and it's a nightmare. It's like solar screens and upgrade windows and Venetian blinds and curtains and all that trying to keep the heat out.

[End of Audio]

RESPONDENT #7 (LANDSCAPE ARCHITECT): INTERVIEW TRANSCRIPT

HH: First, I want to ask you a couple questions about just the perception of a green roof in general. Like are you familiar with green roofs?

R7: Yes.

HH: Please describe green roofs as you understand them.

R7: Well as I understand them there are basically two essential types. One is extensive, which ranges from maybe three to as much as six or eight inches of medium, planting medium. It's meant to maintain a low profile and a very low, um, mix of plants. Um, it's from what I understand a little bit less costly, maybe a little bit less maintenance than an intensive green roof, which is maybe as much as three feet of growth medium designed to actually provide for some depths of actual plant materials, trees, shrubs, ground covers, etc., and maybe some hard scape elements as well. I think the perception in my mind is an extensive green roof is for, uh, visual, uh, aesthetic purposes and cooling potentially for the building, and really I think the way I understand it, intensive is more for, uh, potentially giving yourself actual space for, uh, active and passive, uh, use for pedestrians.

So you might introduce shade trees, you might introduce shrubs and ground cover, you might introduce some hard scape elements, seeding, walkway spaces, etc., um, and obviously it's a heavier system, which means you need better structure for your roofs, um, as well. There's different types of systems. There's the cellular approach where you actually have trays of media that can be pre-purchased and bought by, um, different suppliers that have different proprietary mixes to their media from the amount of aggregate to the amount of lightweight, uh, heavyweight soil. Maybe some of 'em come pre-packed with irrigation, rip irrigation built in; maybe they don't. Maybe that's installed by a separate person, and then I know waterproofing is a very big, uh, component that comes in line that may or may not be done by the actual green roof contractor, and it may be done more with a specialized, uh, waterproofing system.

Again could be proprietary. Could be sold and bought with the green roof mix in system or it could be done as a separate third party installation, and regarding the actual specification of plants I know that sedums are the primary, uh, plant used in the northeast and, uh, maybe Pacific northwest because they do very well in those kinds of environments. Regarding the southwest and south from what I have under – been told, those kinds of plants don't hold up as well because of the wind and the heat. So I know there are studies and, and, uh, trials being done by the Ladybird Johnson Wildflower Center by UTB, UTA, University of Texas, to establish what particular plant species seem to be the most successful in this environment.

HH: What do you feel like the benefits or the negatives of green roofs are?

R7: Uh, the benefits are, um, reducing, uh, heat island. In other words when you've got a lot of hard scape, a lot of roof, it generates urban heat, so green roofs from what I understand

are more of a cooling, uh, device that can lessen the amount of reflected heat into the atmosphere. It also provides for insulation on top of the buildings for heating and cooling. It provides just another layer of insulation there, and then aesthetically it provides for a greener urban environment that could be interactive and could provide view, uh, make for a better view shed or view corridors out of buildings to the urban environment. So instead of seeing an asphalted green, or asphalted roof, you're seeing green park-like experience or, or, um, space from your office, from your office space.

Um, and I think it just lends itself to a more sustainable, uh, story or ethic that you're providing for not only the people in your building but for the people that are in the surrounding buildings as well. Um, it also could potentially provide habitat in the urban environment for wildlife, probably primarily obviously for birds, um, and just the pure beauty of it, providing for seasonal change throughout the year for your employees or whoever your end user is to enjoy and experience.

HH: Any negatives?

R7: Um, the negatives, uh, would be the cost of the initial installation. Um, we usually figure about $30.00 a square foot for installation, media, plants and irrigation, and that's really just a rule of thumb and ballpark. I think, you know, it ranges with any one system you use. That's what we give our clients, sort of here's a ballpark to think about. Uh, so there's the initial up front costs of the green roof. There's the ongoing maintenance costs of, um, potential irrigation, uh, any, uh, maintenance you need on the plants and really outside of those two things I don't perceive any real negatives.

HH: Have, have you guys ever used green roof technology in any of your past projects?

R7: Right. We've specified it and we've, um, researched it, but as far as having an actual green roof built, um, there may only be in Mesa maybe only one or two examples of that and they're in real small scope. Um, we've looked at them for the Parkland expansion. We'll be studying green roofs very closely as that becomes to happen with HDR Corgan. We've looked at it for Glory Park out there in Arlington, which has gone on hold or basically cratered due to the economy, but we are looking at green roofs there. Uh, we've looked at green roofs for some of our multi-family towers and it eventually becomes less of a green roof and more about pool deck or active, you know, where they've got seating, decking, pools, that sort of thing, stages, things of that nature, so the true green roof has not been I think fully vetted out in any of our projects that I know of.

HH: Okay. Now I'm gonna ask you a couple questions about sustainability or sustainable building practices in general. How, how important are sustainable building practices in the decision making process do you feel?

R7: Well I guess it depends on who's asking the question and what kind of an ethic the client has. Um, from a landscape architect's point of view, um, the main thing that, uh, I think is gonna be the most critical element is the conservation of water and how that's treated over the next 20 years especially in really draught-filled areas like the southwest. So I think if

you were gonna start with sustainability you've got to start with the protection of water and specifying low maintenance, draught tolerant native landscapes. So if the green roof effort can help that, if that can be a part of that ethic or that story that the client is telling or is, is going to be building into their building program then I think sustainability is very important.

Um, from our standpoint, uh, really reducing maintenance costs and irrigation of water use either by collecting rainwater through roof collection or like you mentioned earlier condensate collection or even collecting water off of our parking lots or hard scape surfaces, filtering it through a bio filtration system and then using that back on the irrigation is something that's gonna be real important I think in the next ten years, and how we, uh, really begin to build that into our everyday dialogue with our clients and our vernacular with our clients. So, um, sustainability is, uh, very, very critical when it comes to energy use within buildings and how they're managing and maintaining their heating and cool, which is a majority of where our energy cost goes, just the HVAC, and building in the ability to take advantage of building orientation for solar gain and providing for daylight so that you can minimize the amount of lighting. Obviously that's critical.

Um, and then the human health and welfare of sustainability, which says you as an office worker needs to have control of their environment, their thermostat, their lighting. You need to have views of nature. You need to be able to get out of the building and get a breath of fresh air and areas of respite. You need to be able to get out of the building and go on maybe a trail and exercise or at least walk during the day, um, and this idea of mass transit really, uh, maybe our particular clients don't have the ability to affect mass transit, but how do we begin to reduce our dependence on automobiles and really begin to take advantage of light rail and bus and bike to get to and from work? So, um, those are kind of the big things that I know are on the forefront of all of our clients' minds.

Um, there's thousands of topics of sustainability that are out there that are important, but really to me it's energy, it's water, it's human health and well being, it's, um, it's our, it's our ability to reduce our impacts on the land and that's being, you know, careful about how we grade a project, how we cite it, how we, uh, how we protect the resources that are there from soil to water to plants to air, and so to me those are the kind of big ideas on, um, sustainability. In fact I've just wrote an article that I'll give you, uh, for the USGBC in North Texas about connecting people to nature through air, water, and light, and using the metric of lead and the sites initiative to, to not only use that as a benchmark, but also how do we take those elements and really connect people to them in a way that's sustainable and not let the spiritual aspects of those get lost in our focus of these elements from a, from an energy standpoint or from a metric or a check off standpoint? We wanna save water because it gets us a lead point but also because connecting people to water and the touch and feel of water is just as important from a sustainable ethic than it is actually saving it.

HH: Yeah.

R7: Because it's that, um, it's that connection that we as architects and landscape architects need to really be focusing on and not just doing it because it gets us a point or because it might save us some money, but there's bigger issues at hand, and I'll give you that article.

HH: Yeah. I'd love to read that. That sounds really great.

R7: It's pretty cool.

HH: Yeah, so obviously you have, um, used sustainable building practices in a lot of your projects.

R7: Mm hmm. Right.

HH: Maybe explain some of those, or -?

R7: Sure. Sangri La, uh, Botanical Gardens is a good case study. It's a lead platinum project that we just finished in Orange, Texas, which is outside of Houston.

HH: Yeah. I've – it was in Landscape Architecture magazine and I've looked it up online, 'cause I went to, I did a semester in Vancouver and Seattle and we went to Islandwood.

R7: Yeah. That was one of the parts of the inspiration for Sangri La.

HH: Absolutely, and so that's why David suggested I go look up the site and look at that article.

R7: Okay. Well, um, let me just give you a couple here. There's a lot, but, um, we restored or are restoring a man-made lake to its, um, fully operating natural, uh, systems by collecting the water through a series of pumps and day lighting that water into new constructed wetland cells that are filled with, uh, wetland plants. It brings the, uh, nitrogen filled, phosphorous filled water at five gallons a minute into the wetland cell. The water then works its way through the system over the course of about three days and then by the time it gets to the last cell it's basically purified by the wetland plants, and then it returns back to the lake. So to take this kind of duck weed filled sick lake that's full of all these, um, nutrients and to, to kind of man-made pull it through these cells and then return it is a really neat story to tell.

HH: Yeah.

R7: And you're sort of cleaning the lake without physically, uh, having to use chemicals or, or manpower really to do it. So it's about a three-year process in order to clean this lake, which is about ten acres. Um, the, all of the rainwater is harvested off buildings done by Lake Flato in, uh, 3300-gallon cisterns, which are – there's nine of those. That collected rainwater. Then

HH: Okay. Under or above it?

R7: They're above grade. They're corrugated metal.

HH: Yeah.

R7: They, uh, collect 3300 gallons a piece. That water is then used to help flush toilets and irrigate all of the, um, landscape within the visitor's center and the parking lot. The historic garden, and this is sort of a lead loophole, in a lead gives you the ability to define your lead boundary on a site.

HH: Mm hmm.

R7: Doesn't have to be the entire property. It can be whatever you're deeming to be lead project. So the lead project really starts and stops at this pair of existing greenhouses and includes the whole visitor's center and the nature preserve, and then the historic garden that was done by Jeff Carbo's office is not considered part of the lead boundary, so none of that water is collected or restored, or, uh, sorry, harvested. It's all city water, so there's a little bit of a dividing line in the project. Um, that was kind of another big thing. Architecturally they're using PV panels, photo voltaic panels to collect sun, uh, light to power – think of what they're powering with that – I can't remember. Some degree of their electrical needs is collected through PV. We used recycled asphalt from the Texas highway.

Uh, they pulled up a highway and crushed the product and we used that for our parking lot and driveway sequences, so all the product was recycled, um, for the parking lot, and then I'm trying to think of what other fun things you can talk about. Um, the parking lot runoff water is channeled through – it's channeled over land through the forest and into collection bio swells that allow the water to be purified over land for some distance before it's collected in these, um, bio swells, and then – iris filled bio swells, and then they're directed to a collection point that then takes the water underneath the roadway and it spills out into an existing, um, wetland basically.

HH: Oh, cool.

R7: So it daylights into bayou water and then that water works its way down to the bayou and then out to the ocean, so we're trying to cleanse the water before it leaves the site.

HH: Right on. All right. Yeah. That's cool. Um, and the finally, um, you talked in the beginning about extensive green roofs, so you had knowledge of that, so my first question, are you familiar with extensive green roofs, which you fully explained, um, so I guess my questions now kind of move more to do you feel like extensive green roofs are ecologically appropriate in north central Texas? Kind of explain why or why not.

R7: Yeah. That's a good question. Um, [pause] I think the way Mesa, the ethic at Mesa that we would prefer to see is restoring habitat and restoring native plants. Can that be done in extensive roof? I don't know. Can it be done in 6-8 inches of soil? I don't know. I think that what's ecologically appropriate is a mix of plants that respond to the native indigenous adaptive planting that's here, so does a field of sedums, is that ecologically responsible? I don't know.

I think the answer is probably not if your ethic is to restore it to some native point, so Mesa's response would be, "We wanna encourage anyone doing a green roof to do it in an

ecologically sound way through a variety and native mix of plants, and that probably includes ground covers, shrubs, um, trees, ornamental trees. It doesn't make sense to have a low profile soil medium with certainly not even lawn because you've got a lot more water you've got to throw on it, turf is extremely aggressive in its water use. In fact, if you're trying to eliminate water use you don't plant turf.

HH: Exactly.

R7: So to have a green roof of turf is not right.

HH: Yeah. Exactly.

R7: You're missing every reason you would do it other than you're trying to provide an open, flexible use space for your employees and, you know, the only place to do it is on top of the roof. Maybe that's part of your programming as an office, but if you're just purely doing it for some, uh, ethic, uh, ethical stewardship, I think you would focus more on a higher profile of plants, uh, higher depth of soil, and a more variety of things.

HH: Absolutely. Now same question but environmentally. Are extensive green roofs environmentally appropriate?

R7: Extensive?

HH: Extensive.

R7: Um, I think that if you're trying to reduce heat island, if you're trying to save energy and further insulate your building then they have their place. Yes.

HH: Cool. Um, and then finally or economically.

R7: Right.

HH: Saved the hard question for last.

R7: That's a tough question. That's just so hard to say. Again it depends on who's asking the question. What is appropriate? Is it appropriate to spend more money to reduce heat island and to save energy and to provide green views? If you're, uh, thinking about this from a sustainable aspect then yes it's appropriate. Is it appropriate if your budget is tight and you've got other things that you can spend your money on that can also offset energy use? It's tough to say. Uh, it just depends on what your budget is and what your, what your story is you're trying to tell your employees and how much use is it gonna get, or how much visual purpose does it have.

Does it make sense to spend $30.00 a square foot extra to put a lawn on top of your building if nobody ever sees it and it requires more maintenance over time? Then of course not, it doesn't make sense, but if it's part of your programming, if it's getting use, if

it's uh, um, part of the ethic that you're telling your employees or your end user, then yeah I think it makes some sense financially. Yes. But there's a lot of variables there in any of those, um, economically or environmentally or even financially that you'd have to weigh in order to really answer that.

HH: Right on. Well I really appreciate it. I think this is gonna be a huge help.

R7: GooD

[End of Audio]

RESPONDENT #8 (LANDSCAPE ARCHITECT): INTERVIEW TRANSCRIPTS

HH: So basically, first I'm going to ask you a couple of questions about sustainability in general, and how important is sustainability in the decision-making process for you?

R8: I think – well, the way I look at it, I mean obviously it's become such a kind of – it gives the phraseology now. Actually, it's becoming marketable; so therefore, people are really jumping on the bandwagon, even just from a marketing standpoint.

HH: Yup.

R8: So inherently, I would always like to believe that as landscape architecture we've always been doing this. I mean it's nothing new to us. It's just now that there's systems, point systems, organizations. Everything is kind of putting a name to it. I think, again going into a project as landscape architecture, we should already inherently be in tune sustainability and good building practices, and this whole new idea that they put a word to it, as the green industry and all that.

I mean that shouldn't be anything new to us. Unfortunately, it is to some landscape architects, but good landscape architects it shouldn't be something new. It always starts out as, I think, whether it's a decision-making element or really a pragmatic element, it does play a big part, I think, in anything from residential into just massive master planning undertakings. It should be a pretty big part of that.

Whether the client specifically says, "This is part of my program," or you educate the client – I do think it's our responsibility to educate them on all aspects of trying to create a more holistic project. If I start veering off here –

HH: No, you're good. Perfect, this –

R8: Listening to other good landscape architects speak, and then just from my own kind of I guess, desire to, again, on any scale approach a project more holistically, it really is much more of this team-building effort to really create a really sustainable project. I mean you've got to know about other professionals that can lend to your project. You've got to be talking to foresters, arborists, soils experts, learning how to deal with civil engineers, educating architects.

I mean you really will value the collaborative process with really good people that get it that understand everybody's role. The project is just much better. I like to think that, again, part of that decision-making process is immediately saying, "I want to get an arborist out here, and this is who I recommend. It's somebody with a fat set of credentials too." This is, again, trying to educate a client because you know as well as I do that a lot of times landscape architects aren't always brought in from the beginning, and we should be in there long times before even architects have been chosen. That's not always how it happens.

HH: Yup.

R8: The whole idea of prime on our project I think is now starting to turn a little bit more to where you'll see landscape architects as primes now more so than just the architect. So they're kind of putting the team together depending on the project, but all of those decisions should be made up front. A lot of it is going to be educating the client. I mean, very rarely do you always get an educated client that knows, "Man, before I touch anything on this site, I've got to talk to an arborist, a landscape architects, soils people, water people, oh and an architect by the way."

HH: Yeah.

R8: I think –

HH: The first they think is architect.

R8: Right, exactly. I see that becoming much easier I guess even if it is now at the expense of the idea of sustainability and green purely from their view as a marketing piece. Somehow or another, it's starting to fuse all the – whether it's development, residential, commercial. Everything at least, I guess because it's becoming a marketing or profitability piece, and they are like, "Well, I guess we do need to talk to so and so." So I guess in a way, that's still positive, but to bring that all back as landscape architects, I mean that should just be something that we were educated to do I guess.

HH: Yeah, absolutely, but Pat calls it common sense.

R8: Yeah, I mean that's part of our toolbox.

HH: The better word is common sense. He said, "That's what architects and landscape architects have been doing since we've been in existence."

R8: Right, and even good architects and good contractors, good building practices are common sense, and they really mesh with leads and all these other point systems.

HH: Absolutely.

R8: I mean you know as well as I do that when we're involved in a lead project, I mean we get like two or three points out of all the points. It's like –

HH: Really.

R8: Just stuff like plants, water-sensitive plants. Well, we do that anyway.

HH: Yeah.

R8: I know that there are ASLA and some other organizations. I mean they're rewriting and trying to, I guess, redistribute how some of these points systems and that accreditation programs work, but it's funny. It's like I always look at our checklist for leads and it's like, "Okay whatever." I mean that's a given.

HH: On green roofs, kind of what this interview is about, you maybe get two or three points –

R8: Right.

HH: – for a massive amount of green space and biomass.

R8: But it's also a very expensive part of it too, which is always a tough hurdle.

HH: Yup.

R8: Which I'm sure we'll get into, but rainwater collection and green roofs and all these can become very expensive pieces of the entire program.

HH: Yup, absolutely. What are some of the sustainable building practices that you've used in past projects if you can explain why or why not?

R8: Again, I'm kind of going back to its common sense. I'd almost have to sit here and look at how – I mean maybe someone classifies that, but for me, I mean obviously just existing site conditions are such a big piece of the project. What's here? What's native? What's invasive? How are all these mature trees doing? Immediately, just kind of jumping in from there to this whole kind of almost defense mechanism of, "Okay, we're about to start construction. Here's the realities. Here's the pros and cons. Here's what we can do." Immediately start.

Again, if the client brings you in early, these decisions are so much easier. So we're doing anything and everything to mitigate for the upcoming construction process, again commercially or residentially. Can we move these trees? You kind of weigh the pros and cons of – because obviously it all comes down to money. Everything still has a price tag associated with this, but you weight the pros and cons. Is it worth moving these two trees that are in the construction zone? It's funny, I'm on a lead project we're doing at a private school.

We're moving three 16inch trees, but there's no lead point for that, right? I mean the client is spending a lot of money, and there may be – I can't remember – some kind of little sidebar that you can kind of write. I think it's called creativity or something, points for creativity.

HH: Yeah, mm-hmm.

R8: The client is spending a lot of money to move three very mature trees, and we're keeping them on site, but there's no checkbox for that!

HH: No.

R8: That's a pretty significant piece.

HH: Yeah.

R8: So I guess, to me, it's common sense to try to move that. That layers into that's a very sustainable thing to do, and the fact that you can educate and get your client and architect and whole team to want to, let's say relocate trees or even invest money in subsurface root pruning, aerospading, things like this where the building is going to impact existing trees. Making those decisions is very sustainable, and okay yeah they affect the bottom line, but I think as a landscape architect, you have to say, "It's important to me to absorb all that money in my budget, and then figure out ways to still get you a complete project. It's important enough to me to move those trees, and then find the money elsewhere to do something else."

HH: Yeah.

R8: Because budget is still always budget.

HH: Yup.

R8: I guess again on projects of different scales. It's just the continual learning process and gaining experience from working with a lot of contractors. I mean that's another hurdle is getting them on board with using the landscape and existing site and where you can go, where you can't go, how parking under trees, and how this and this affects the site; because you know when they're gone you may or may not see physical damage for three to five years of any existing trees.

That, to me, is always a challenge. If you get with good contractors, and everybody has buy-in, it just makes the project that much better, so that's another big hurdle because again, when they're looking at the leads points and all that, I mean there are check boxes. Again, they may or may not care about the rest of the site or what it looks like.

HH: Yeah.

R8: As long as they get their checkboxes and as long as this is sewn up at the end of the project and they move on, good to go.

HH: Yeah, absolutely.

R8: So responsibility, accountability, trying to get everybody to buy off on this kind of holistic approach to the whole site, entire site is challenging. When it works out, it is awesome.

HH: Right on. Have things, maybe like permeable paving, is that something that you've done or greywater recycling?

R8: We haven't done as much with greywater, and that's really it's not that things aren't proposed. When you say greywater, I assume you mean from the building, not rainwater.

HH: Yeah.

R8: The biggest hurdle with that or challenge with that is cities aren't up to the level where they even know how to inspect, approve. There's sometimes certain people in the city that obviously get it. They're not there as far as – I mean it becomes a liability issue in their mind.

HH: Mm-hmm.

R8: What do we do with this? How do we protect our water system? It's challenging.

HH: Yeah.

R8: I have yet to see much of that in some of the stuff we're working on. Rainwater is different, but the greywater is tough. It's just going to continually be an issue because of the underlying liability of it's even hard to convince people to use certain types of greywater for irrigation.

HH: Yeah.

R8: All of the sudden, someone in the crowd or in a committee or something will raise up their hand and, "Well, what if our kids are out there playing and are going to get staph, a staph infection?" I'm like – I mean you know. You try not to be a smart ass about it. You're like, "Well, I mean you could get that anywhere, the likeliness of that."

HH: Do they play in the rain?

R8: Right, exactly. Do they go into a public restroom? Do they go anywhere? Do they go into a hospital? I mean, you know. So it's a tough one, I think. From the couple times we've encountered it or tried to do it, it's gotten squashed.

HH: Do you think there are some things that are just, kind of going back to the common sense of it, but have become more standard like permeable paving or like –

R8: Oh yeah. On the permeable paving, I think that's becoming an easier sell. Again, where you run into issues with that, not as much residentially as you would commercially is usually cost. It's not always cheaper than just paving.

HH: Absolutely.

R8: It's definitely becoming – certain systems are becoming a much easier sell. Crushed aggregates and gravels and things like that are becoming a pretty easy sell now that decomposed granite or certain size mixed aggregates are ADA compliant, you're seeing a lot more of that.

HH: Yup

R8: You're not always seeing it done very well, but at least it's getting there. I guess, it's an easy sell because people I think are becoming more accustomed to the look and the aesthetic.

They get the permeability aspect. The biggest hurdle again with that is the whole maintenance. "Well, how is that compared to concrete?" and all that. It's like, "Well it doesn't." I mean you know it's different.

HH: Mm-hmm.

R8: The aesthetic and the long-term permeability is a bigger payoff than everything.

HH: Yeah.

R8: So again, it's just getting through that kind of education process, but yes, permeable surfaces are becoming an easier sell. Usually, the city is becoming more accustomed to seeing that on projects. They'll sign off on it if an engineer signs off on it. Then they're like, "Fine. We don't care." So it's becoming a better deal. Usually the biggest issue is – because there's so many really interesting and great products, then it comes down to cost.

HH: Yeah.

R8: I don't think it's that hard to sell somebody on the idea or even the aesthetic, but when the numbers come in, that's where it gets hard or it's vlaue engineered pretty quickly.

HH: Yeah, absolutely. That's kind of leading us right into the same kind of thing with green roofs. Everybody is right on board with it, if you try to sell it to a client or something, but then the cost of it just seems to be, you know.

R8: Yeah, it along with rainwater collection are usually ever present now I would say in program requirements or, "We'd really like to do this." Again, even residentially and commercially, but they are always the first items to get value engineered out. Green roofs especially, and then depending on the amount of water collection just because water is a cheap commodity here. Nobody sees the payback in it other than the sustainability or it's kind of the right thing to do, or even more often than not, again people are using these as big marketing tools.

HH: Yeah.

R8: So if they can't justify the payoff in their mind, it gets value engineered.

HH: Yeah.

R8: So next, I'm going to ask you a couple of questions about green roofs specifically, green or living roofs specifically. Are you familiar with green roofs?

R8: Yes, and is this specific to Dallas or is this specific – are these generalities?

HH: It's going to be get specific to Dallas, yeah.

R8: Okay.

HH: Please describe them as you understand them?

R8: My understanding of a green roof would be – well, actually I guess I'd probably use the term more, the living roof term. Basically, a vegetated roof structure, and actually purely probably from almost an aesthetic approach; not even getting into the pragmatic piece of how much depth is there? Is this a tray system? Is this a true living roof?

I always think of the image of almost like a buried house. So, to me, aesthetically it's this living roof element. Usually, in my mind I think of them as accessible in some manner too, but that's not always the case.

HH: Mm-hmm. What are some of the benefits or negatives you could foresee of green roods?

R8: To me, the benefits are the aesthetics. In Texas, it's so – again, it just seems so – again, if you look at a lot of either kind of original settler homes, the whole sod roof, the sod buster type approach, not only does it provide protection, but really the insulative factor. It's just a no-brainer to me that if you have a certain amount of mass above you that you're very well protected from the elements and heat in general here.

HH: Hail storms.

R8: Yeah, I mean all that. I mean Texas is a crazy place weatherwise. I mean this month I've spent many phone calls on projects explaining to clients, and trying to almost mitigate between contractors and clients. I mean we've had whatever in the past two months like 14 inches of rain, very little sun. All these are kind of like record-breaking or really top 10 type conditions we've had. Then all of the sudden it turns and it's 70 degrees again. I mean we're just a really strange – I mean I call it fairly hostile, back to the original grasslands.

The negatives are just – I personally because I like them, I have very few negatives and seem to be able to rationalize any con somebody else brings up. It's like with anything, you can create pros and cons based just on your own assumptions, but I personally think they have a very high aesthetic value. I think that they just provide – I mean again selfishly, they provide another place to plant. Then they have all the benefits associated with the insulation factors, and I guess they lower – this could be incorrect nomenclature, but you are kind of lowering your, I guess, carbon footprint.

HH: Yup.

R8: You are not producing this – even though reflectivity is another actually benefit, you're just not producing that, to me, which is another benefit.

HH: Mm-hmm.

R8: The possibility of having an accessible element to a project is another benefit in my mind. If the footprint of whatever the structure is, there's very little land associated with it below, but vertically you can provide more of a garden, I mean obviously that's a huge benefit; even the

fact that it could be something that does produce and is more of a true garden. All of those things are benefits.

As urban areas are getting tighter and we're looking more vertical and all that, obviously all of the – there's been a lot of technology that is being put into these green roofs whether it's a system or just dirt on a roof. Then you're planting that out. I mean there's quite a few different ways now. We have quite a few different technologies at our fingertips to try and make this work.

HH: Yeah. Have you ever used green roof technology in other past projects?

R8: This is where kind of the rubber meets the road. We've designed and had it proposed on multiple projects, and don't have anything yet built. They've gotten value engineered out. We do have upcoming projects where I think this will work. I would say we have used some trays on some roofs, but from conception I would say the most intensive green roof type applications that we've proposed and designed were not built.

HH: I'm finding that a lot, so that's, yeah.

R8: Well, I can imagine.

HH: Almost every person, architect, landscape architect that I've talked to has proposed, and been

R8: Yeah, we've gotten through CDs on plenty, and it just doesn't make the cut. I would say that – and again, this may be more regional. I mean this is here in Dallas or regional, we'll just say Texas regionally because we've had some proposed and stuff in Austin, but regionally it's been tough. For a while it was very tough to actually even get contractor buy in a well, finding people who were willing to. Again, to me, it's common sense. It's systematic how this stuff works. People are just so deathly afraid of leaks.

HH: Yup, putting water on a roof.

R8: Yeah, they're like, "You're doing the opposite of what we're trying to do." It's like, "Well, not really." Again, to me it's very basic and simple in the idea of it, but regionally it's tough. I think all the beautiful pictures you see of these massive green roofs are coming out of the Midwest or probably California.

HH: Mm-hmm, and Seattle, Portland, Chicago.

R8: Yeah, much different. Again, the ecosystem there, the weather is probably more conducive to really good success. Here, I think that's an issue. We're seeing pictures from these areas, and if landscape architects aren't really good plantsman, they're trying to recreate something that doesn't work here.

HH: Absolutely.

R8: That's another problem.

HH: That's a huge problem.

R8: Right.

HH: David has extensive green roof on the Life Science building.

R8: Okay.

HH: He has 1,000 square feet, and 500 is tray systems and 500 is a monolithic system.

R8: Right.

HH: Soil mix and everything is all proprietary. It's a company that came in and did it all for them and everything, but all the Chicago, the Seattle, Portland, all these roofs are seedum-based. Everything is sedum-based.

R8: Yeah, sure, right.

HH: Well, not one seedum has survived for him.

R8: That doesn't surprise me.

HH: They're not going to survive here. He explains it as they can handle hot-dry and they can handle cold-wet, but they can't handle hot-wet.

R8: Yeah.

HH: When that hot water hits them, it just for some reason –

R8: It's the hot water. It's the humidity. It's funny. I mean it is a plant that can take extremes, but we have – we're a very weird – that's why I say Texas. I mean especially we're in Dallas.

HH: North central Texas.

R8: Yeah, north central Texas.

HH: Yeah.

R8: We can just to extremes. We're not xeric. We go through droughts, but we get 34, 35 inches of rain a year, which is a lot. I mean it's like it confuses the plants. So I mean to me, that comes back to, you've gotta start seeing what works. A green roof here is probably going to be a gnarly mess.

HH: It's going to look completely different.

R8: Which again aesthetically to me is okay.

HH: Yup.

R8: Everybody else is seeing these beautiful sedum roofs, and they're also seeing the idea of the beautiful zoisia lawn on the roof, you know?

HH: Mm-hmm.

R8: I'm sure through all your research and interviews, you're coming up with the same conclusion of that doesn't work. It's a very easy sell. Someone sees that picture, "Oh yeah, why would I not do that?"

HH: Yeah, you see the Ford headquarters?

R8: Yeah, Ford headquarters, exactly.

HH: You're like, "Come on, yes I want to do that. That's beautiful!"

R8: Exactly, unbelievable impossible here.

HH: City lawn in Chicago, amazing.

R8: Of course, anything in Chicago, not here. Here it's going to be – I mean I know the wildflower center put out some research on this, which I'm sure you've seen.

HH: Mm-hmm.

R8: They're consistently doing trials, but our green roof really will be a mix of annuals, perennials. I'm talking about wildflowers, but annual and perennials and certain grasses.

HH: Grasses, yeah.

R8: Short grasses. You can probably get some level of stylized design within those parameters, but that's what it's gonna be.

HH: You know Wooly Stemodia?

R8: Mm-hmm.

HH: That's one of the best plants that – that's the number one plant on David's roof. It's doing so, so well.

R8: Did he seed it or plant live?

HH: He's doing plugs.

R8: Yeah?

HH: Yeah. He got – they were plugs from – I can't think of where, but they came in a box. He said 400 plugs came in a UPS box, yeah UPS box, and he was like, "Are you kidding me?" but they've done really, really well. It's been up there for a full year, and I guess he's going into his fifth season or however that works, so he's really starting to see what lasts and what's not. There's one seedum that has done fine, but all of the others have died.

R8: Yeah, I've seen seedum or flexum do decently here, but again it's not always in a roof application, but other than that it's pretty tough.

HH: There's so much more even to consider when you're going two, three, four levels up.

R8: Yeah, wind.

HH: The wind gets so much more intense.

R8: Oh yeah.

HH: So they have to be able to take a lot. I mean it's definitely –

R8: Has he planted a spineless prickly pear or any other kind of cacti?

HH: He has done yucca.

R8: Do you know which yucca?

HH: Red yucca.

R8: Yeah.

HH: The one that a lot of people are doing.

R8: Right.

HH: Because what he's also doing is trying to use plants that are available for trade.

R8: Oh yeah, that's a whole other – we're really chained to the nursery industry.

HH: What you get, yeah.

R8: In a sense.

HH: Yeah, you can have things grown, and there's definitely things you can do, but again that's cost. That's adding cost.

R8: Oh yeah. Time, cost.

HH: It's easy to say, "Okay, we won't do that.:

R8: It's very easy.

HH: It's very easy. Add another so much on this. Whatever that didn't cost, if we do have some leftover, we can use it over here.

R8: Yeah, right.

HH: It's real easy for that to happen.

R8: Right.

HH: So an extensive green roof, are you familiar with the term extensive green roof?

R8: Mm-hmm, extensive and intensive and all that.

HH: Yeah.

R8: Mm-hmm.

HH: So that's really kind of my question is looking at extensive green roofs, so trying to create the low profile, less than six inches of soil.

R8: Right.

HH: So you can do a lot of retrofitting. You can do a lot of – it doesn't take a lot of structural hoopla to get it up there.

R8: Right, correct.

HH: So I guess you're familiar with extensive greenroofs.

R8: Yeah, uh huh.

HH: So do you feel like extensive green roofs would be appropriate for north central Texas?

R8: I think so. Now, what's the mid range between extensive and intensive?

HH: There's a semi-intensive, which would be from between –

R8: I think everybody understands that if you go to a full intensive approach, and you have this massive amount of structure, you can grow anything.

HH: Anything.

R8: That, to me, is not really a green roof application. That's basically a rooftop garden.

HH: That's exactly what it is.

R8: You see plenty of them in Dallas, and they're planted with totally inappropriate stuff, and they look good, whatever.

HH: Yeah, they're fine.

R8: They kind of treat them almost as planters, so they always are good.

HH: Some people don't even know that they are a roof.

R8: Right.

HH: Sometimes you have no clue you're waking above a garage.

R8: Yeah, so there's massive – I mean that's basically a roof deck, roof garden. You're going into it knowing that that has a certain cost or price tag with it. So what you're saying is more of this extensive almost like a sod roof or this green roof application.

HH: Mm-hmm.

R8: I'm always an optimist, so I think done right with the right plant material, yes I think there is. What that looks like is going to be – again, it's not going to be that perfect tiff turf that people may associated with some kind of grass roof. I think, and basically most of the ones that we designed that still didn't get built were based on more of an extensive approach with I'd say anywhere from – I do think you have to have a minimum of six inches of soil.

HH: Yeah.

R8: I'm sure you're right with all your research.

HH: David's doing four.

R8: I mean I'm just – that's great.

HH: Yeah, and Ford Motor Company?

R8: Yeah.

HH: Two.

R8: Oh, that's pretty awesome, but that is, you know. I just think, I just always going into designing for six inches of some kind of soil medium.

HH: Which is a great number actually.

R8: Which is what if you're gonna start to look at, again, from my little research and kind of just even really observations and other landscapes, I mean you're going to start looking at that with short grasses, and trying to get them accustomed to that six inches. Obviously, they can go deeper, but if you're using Buffalo grass, gramma grasses, things like that, I think you could have a pretty good success.

Now again, what that ends up looking like might be a combination of some kind of – there's still some kind of lytic mulch on top or stone mulch, and all this planting coming up out of it. It will obviously do well in there depending on how much light and everything. You're going to have to really plug in site-specific plants, which again create a much different matrix than that whole even turf look that again, I think is stuck in people's minds. It sounds like that's what David is obviously really looking into.

HH: Yeah, as well as there are students at TCU that are doing bio mimicry.

R8: Really?

HH: They're taking actual plant community from native to north central Texas, and they're trying to mimic that on a roof. Basically, it's the rocky barren. I'll have to look it up, but they're basically looking at plants that actually do only grow in four to six inches of rocky soil.

R8: Well sure, yeah, yeah.

HH: Then taking those and putting them on the roof because they're trying not to water at all.

R8: Well sure.

HH: See now, with an extensive roof, the idea would be to not water at all, but here in Texas –

R8: It's just like everybody the first question is, "I want low water use, low maintenance." Well, okay we plant primarily native plant material. I mean you're gonna have a certain level of water use and maintenance associated with that that may be very similar in the beginning if you'd planted a bunch of azaleas, but where that one season two season thing starts to establish, obviously that disappears.

HH: Yeah.

R8: But the idea of not watering, and then also to me you have to meet everybody's expectations, and expectations are different, but more than likely to keep something within I guess a range of acceptable expectations means you're supplementally watering.

HH: Yeah.

R8: Yes, that native plant will survive drought once it's established, but it may look like hell.

HH: Right.

R8: Because it goes into defense mechanism.

HH: Dormancy, yeah.

R8: Defense mechanisms and dormancy, and then it pulls out.

HH: Yeah.

R8: Most people if you just supplementally water it, it won't do that. You saw that looking at landscape, so that's an expectation.

HH: David's roof is that he turned the water off for two weeks and plants started going into dormancy. They would still be alive.

R8: Of course.

HH: They would still be alive, but he would have a brown roof, not a green roof.

R8: Of course.

HH: We want, people want, like you said, expectations.

R8: Right.

HH: People want a green roof.

R8: Right. As long as you're mimicking some rainfall and giving it that supplemental water, I think you can really – that helps push it into a pretty acceptable measure, I think, to get that extensive roof. Again, I guess I was talking about the soil. I mean I always just use that six inches. I think it's great if you can get that soil profile down more, but architects are the worst about sometimes, their visuals and things will show something that, "Oh you have a lawn up on top of a four inch roof profile, structure and everything?" I was like, "Yeah." Or they'll show a tree coming up out of this really weird four inches of roof. I'm like, "That's alive. Pretty picture, but it won't work."

HH: Yeah.

R8: So I think that's coming into some of these tray systems. I think so much of it goes into the soil or really, I guess, what are they even calling it. I mean it's a medium. It's not necessarily –

HH: Yeah, it's a growing medium.

R8: Yeah. So if all that meets the requirements, it works pretty well.

HH: It's a proprietary soil mix is what they call it.

R8: Right.

HH: They are not gonna tell you what's in it for their own reasons, but basically it's expanded shale or fired clay.

R8: Right.

HH: If you're thinking sustainable, neither one of those things are not truly sustainable.

R8: That's true.

HH: So there's all kinds of issues with you know, but they're doing that, and they are in the beginning putting a little bit of organic matter.

R8: So there's like what, a slight layer of organic matter on top and then it's basically expanded shale?

HH: Yeah. That organic matter breaks down within the first year, and it's gone.

R8: Yeah. Well, again, that's where I mean field trials and stuff are important because I guess again, we're talking about trying to grow short grasses and things like that, I mean that's going to be tough to do in just expanded shale.

HH: Mm-hmm. No fertilizer.

R8: No fertilizer, organic, and then no _____ water. Obviously, if you have kind of a continual water drip on something in expanded shale it does really well, but it's tough. I mean it's finding what that mix is for all that.

HH: Mm-hmm.

R8: Like some of the stuff he's growing up there because obviously you can walk around the city and see weeds and certain things or what's classified as a weed growing in the crack of a highway sound wall.

HH: Yeah absolutely.

R8: You're just like, "How? That looks cool. That might work here."

HH: Yeah.

R8: So I mean, again kind of summing that up, yes I think you can do it, but it's what are the aesthetics, and what are people's really vision of that?

HH: Yeah.

R8: Because I believe I would say that the benefits of it, whether it looks like a weedy mess or it's a perfect lawn, you're still getting the same benefit to the building and insulative factors and all that. It's just a lot of meeting people's expectations to the end product.

HH: Yeah. Do you think that they'd be economically appropriate? Do you think that we could find a way to make them affordable in this area, in north central Texas? It seems beneficial when you're not having to irrigate. In other areas, in other regions, the benefit is a little more right out there before you because it's not so cost prohibitive.

R8: Yeah. Most of the pricing we've done on anything we've designed is using some kind of built up system or you're building up on structure.

HH: Yup.

R8: You're using bridged insulation. You're using – I mean everything is built up. It's just a layered system.

HH: Yeah.

R8: That's gonna give you a pretty good soil profile, but still extensive application.

HH: Mm-hmm.

R8: The cost for that is easily doubled just doing a membrane roof or something. So right now it is more expensive. The whole kind of tray system idea is less expensive, I think. The problem, you're still having to get all the irrigation up there. The issue for that with me is you see some great imagery of all these different systems and the ones that grow together, but they start off as trays. All this stuff, the whole idea of the pre-planted ones, well everything that is pre-planted that comes to us, doesn't work. People think it does because they are primarily seedums, I believe.

HH: Yeah.

R8: The tray system is just going to be hard, I think, to do here, and it may just be that I've never seen a good one.

HH: Yeah.

R8: I don't know that you have on any projects around Dallas?

HH: There's not any around Dallas, in north central Texas. The first one that's gone in is at North Haven College, is it North Haven?

R8: Oh really?

HH: Yeah, they just –

R8: In Irving? Oh no, that's North Lake, North Haven. Where's North Haven?

HH: No, it is North Lake.

R8: Oh, North Lake, okay.

HH: Yeah, yeah, North Lake, sorry.

R8: Yeah.

HH: They just put in, I think, 6,000 square feet.

R8: Really?

HH: Yeah, it's a tray system.

R8: Do you know what they planted it with?

HH: Seedums.

R8: Oh yeah. Who did that? Did they just internally?

HH: GSR Architects, GSR Granada.

R8: I don't know who that is. I think the trays are a brilliant idea, and I think they can be used in a retrofit aspect. I believe my understanding is you can use them. They have very little weight associated with them.

HH: Yeah, very little.

R8: So from that aspect, the technology and everything about them makes it great. I haven't seen that look good as far as here.

HH: Yeah. University of Texas at Al Paso also put one in that's a really nice tray system.

R8: Seedums might work out there.

HH: Yeah, but David's tray system is actually – it started out where the monolithic was doing a lot better.

R8: Right.

HH: The one big bed basically compared to the trays, but now the tray systems are actually doing really well, and this is a year and a half into it.

R8: Do both of them have the same soil profile?

HH: No. They are each different.

R8: So the trays are like four inches or less or something?

HH: Same depth, but just made up of different things. One is expanded shale, and one is fired clay.

R8: Oh.

HH: So different companies did the two.

R8: Right okay.

HH: It's their own soil mix, and the only reason we know is David reached, you reach down there, and you know what it is.

R8: Sure. Again, the whole idea of these pre-planted trays and stuff working here, they're just not – none of the ones that are marketed are pre-planted with anything that works here.

HH: Works here, absolutely.

R8: So I guess if you started doing your own trays, and you could get let's just say buffalo grass or even some of these other hybrids, buffalo grass or something, I mean –

HH: Ground covers, frog fuit.

R8: Yup.

HH: That's another one that's done really well for David.

R8: Has it?

HH: Four nerve daisy also.

R8: Has horseherb grown up on his roofs at all?

HH: I'll have to look at the plant list.

R8: Okay. I'd be curious –

HH: It's not one that sticks out in my mind.

R8: Again, frog fruit –

HH: Yeah, I can send you it.

R8: Frog fruit does very well, but again it has more water. It's more thick. If it's more xeric, it tends to – you really want to mix it with other stuff. Horseherb does really well if probably I would say in a little bit more protected part, but again, most everything is deciduous or semi-deciduous. That's another issue I'm sure with people's perception.

HH: Yeah.

R8: I mean that's just an issue with native landscape.

HH: Period.

R8: People are like, "Well, is that evergreen?" "Well, no."

HH: I want a yard that's evergreen that uses no water.

R8: Yeah, go to the Hamptons.

HH: (Laughter)

R8: I mean again, this is Texas. It's a gnarly environment for truly stuff that's gonna survive. I don't know. I'm consistently curious about how these tray systems work. Again, everything behind it – honestly a bunch of the applications, which probably will get built that we're working on are not necessarily on a house or a building, but more of a pavilion type application or an arbor.

HH: Yeah.

R8: It's a steel box with a built up system and you can almost – like a big planter.

HH: Yeah.

R8: That's a great way to experiment, and that one will probably get built. It's been built out, and they have okayed that, but –

HH: That'd be cool. It's like an arbor?

R8: Yeah, it's like a big steel structure, and we're going to plant it out. I think our soil profile there is that we allow for about nine inches of soil medium, just because we could.

HH: Yeah, of course.

R8: I mean it's easier to build it there. That's going to allow a lot of wildflowers and grasses and things like that. Again, I think I'd like to come see David's trials out there because – again, it goes back to the aesthetic. They probably look more wild and wooly than pristine.

HH: Oh, that's the thing. The people that have come to visit, he says it's very interesting. They think they're coming to see something, and they walk up, and some people are like, "Oh, this is great." Some people are like, "What is this?"

R8: I'll be honest. I guess my statement would be, I'm a bigger fan if you can design an extensive roof as a monolithic system, that I think is more preferable and the direction I would rather go than using the tray systems.

HH: Yeah, absolutely.

R8: I think the tray systems work exactly how they designed them, and they don't work as well here.

HH: Yeah, it absolutely is. So, cool. I appreciate your help with my research. You're awesome.

R8: No problem, I'm looking forward to seeing what you find out.

[End of Audio]

APPENDIX C

FAMILIARITY WITH, OPINION, AND EXPERIENCE WITH GREEN ROOFS

C.1 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: Developer One

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	Yes	No
Extensive Green Roofs	No	Yes	No

C.2 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: Developer Two

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	No	No
Extensive Green Roofs	No	Yes	No

C.3 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: City Planner One

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	No	No
Extensive Green Roofs	No	Yes	No

C.4 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: City Planner Two

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	Yes	No
Extensive Green Roofs	No	Yes	No

C.5 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: Architect One

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	Yes	No
Extensive Green Roofs	Yes	Yes	No

C.6 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: Architect Two

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	Yes	No
Extensive Green Roofs	No	Yes	No

C.7 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: Landscape Architect One

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	Yes	Yes
Extensive Green Roofs	Yes	Yes	No

C.8 Familiarity, Opinion of Appropriateness, an Experience with Green Roofs: Landscape Architect Two

	Respondent is familiar with the technology	Respondent viewd as appropriate for North Texas	Respondent's has used this technology in Noth Texas
Green Roofs	Yes	Yes	Yes
Extensive Green Roofs	Yes	Yes	No

REFERENCES

American Society of Landscape Architects. Mission. http://www.asla.org/AboutJoin.aspx (accessed September 10, 2009).

American Socitey of Landscape Architects. "Statement on Climate Change." ASLA.org. November 15, 2008. http://www.asla.org (accessed September 10, 2009).

Baumann, N. "Ground-Nesting Birds on Green Roofs in Switzerland: Preliminary Observations." Urban Habitats, 4, 2006: 37–50.

Calkins, Meg. "Strategy Use and Challenges of Ecological Design in Landscape Architecture Landscape and Urban Planning 73, no. 1 (August 2005): 29-48." Landscape and Urban Planning 73, no. 1, 2005: 29-48.

Cantor, Steven L. Green Roof in Sustainable Landscape Design. New York: W.W. Norton & Company, Inc., 2008.

Colbond Inc. "Case History - NO. 0407." Calbond-USA.com. 2 2008. http://www.colbond-usa.com/App_Documents/CH0407_GreenRoofR0208.pdf (accessed September 19, 2009).

Conrad, P. Prairie Visions: The Life and Times of Solomon Butcher. New York: HarperCollins Publishers, 1991.

Dunnett, N., and N. Kingsbury. Planting Green Roofs and Living Walls. Portland: Timber Press, Inc., 2008.

Dunnett, Nigel, Ayako Nagase, Rosemary Booth, and Philip Grime. "Influence of vegetation composition on runoff in two simulated green roof experiments." Urban Ecosystems, 2008: 3-12.

Environmental Protection Agency. Heat Island Effect: Green Roofs. http://www.epa.gov/hiri/strategies/greenroofs.html (accessed September 15, 2009).

FLL. Guidelines for the Planning, Execution and Upkeep of Green-Roof Sites. Germany: Research Society for Landscape Development and Landscape Design, 2004.

Frith, M., and D. Gedge. Green roofs: Ecological design and construction. Atglen, PA: Schiffer Books, 2005.

Getter, K. L., and D. B. Rowe. "The role of extensive green roofs in sustainable development." Hortscience, 41(5), 2006: 1276-1285.

Green Roofs for Healthy Cities. Green Roof Benefits. August 12, 2009. http://www.greenroofs.org/index.php/about-green-roofs/green-roof-benefits (accessed September 15, 2009).

Greenroofs.com. The Greenroof Projects Database. 2006. http://www.greenroofs.com/projects/plist.php (accessed September 20, 2009).

Greenroofs.org. Green Roof Benefits. August 12, 2009. http://www.greenroofs.org/index.php/about-green-roofs/green-roof-benefits (accessed September 15, 2009).

Herman, R. "Green roofs in Germany: yesterday, today and tomorrow." Greening Rooftops for Sustainable Communities, May 29-30, 2003: 41-55.

Hopman, David D. "Ecologically Performative Landscapes and Water Management." Peer reviewed lecture for The Association of Collegiate Schools of Architecture (ACSA) southwest regional conference "Just Add Water". Austin, TX, 2007.

Hopper, Leonard J. Landscape Architectural Graphic Standards. Hoboken, NJ: John Wiley and Sons, 2007.

Johnson, Bill. "Letter From The Editor." Landscape Architecture Magazine, August 2009: 11.

Kadas, G. "Rare Invertebrates Colonizing Green Roofs in London." Urban Habitats, 2006: 66-86.

Kaplan, S., J. F. Talbot, and R. Kaplan. Coping with daily hassles: The impact of nearby nature on the work environment. Project Report No. 23-85-08, North Central Forest Experiment Station: USDA Forest Service, 1988.

Kaufman, Andrew, Linda J. Cox, Tomoaki Muira, and Dawn Easterday. FEASIBILITY STUDY OF GREEN ROOF TECHNOLOGIES IN URBAN DISTRICTS IN HAWAII. Honolulu: University of Hawaii, 2006.

Kula, R. "Green roofs and the LEED green building rating system." Proc. of 3rd North American Green Roof Conference: Greening rooftops for sustainable communities. Washington, D.C., 2005. 4-6.

Larson, D.W., U. Matthes, P.E. Kelly, J.T. Lundholm, and J.A. Gerrath. The Urban Cliff Revolution. Toronto: Fitzhenry & Whiteside, 2004.

Lee, Taesoo. "Modeling Best Management Practices in a Small Watershed Using Process Based Modeling Approaches and GIS: The Cases of Row Cropping, Filter Strip, and Grassed Waterway". Ph.D. dissertation, State Universtiy of New York at Buffalo." ProQuest Dissertations and Theses. 2008. http://www.proquest.com/, publication number AAT 3320416 (accessed September 15, 2009).

Liesecke, H. J., and H. Borgwardt. "Abbau von luftschadstoffen durch extensive dachbegrünungen (Degradation of air pollutants by extensive green roofs)." Stadt und Grün, 46, 1997: 245-251.

Lstiburek, Joseph W. "Why Green Can Be Wash." ASHRAE Journal, 2008: 28-36.

Mendler, Sandra, and William Odell. The HOK Guidebook to Sustainable Design. New York: Wiley, 2000.

Oberlander, Cornelia Hahn. "Letters to the Editor." Landscape Archtitecture Magaizne, October 2009: 12-18.

Oberndorfer, E., et al. "Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services." BioScience, 2007: 823-833.

Osmundson, T. Roof Gardens: History, Design, and Construction. New York: W.W. Norton & Company, 1999.

Partnow, P.H. The Seal Islands: Fur Seal Rookeries National Historic Landmanr, the Pribilof Islands Focus: St. GeorgeIsland. 2004. http;//www.alaskool.org/native_ed/curriculum/st_george/

st_george_curric.html (accessed September 15, 2009).

Peck, S. W., M. Kuhn, CMHC, and Ontario Association of Architects. Design Guidelines for Green Roofs. Report for Ontario Association of Architects, Ontario: CMHC, 2003.

Peck, Steven W., Chris Callaghan, Monica E. Kuhn, and Brad Bass. Greenbacks From Green Roofs: Foraging A New Industry In Canada. Status Report, Ontario: Canada Mortgage and Housing Corporation, 1999.

Philippi, Peter M. "HOW TO GET COST REDUCTION IN GREEN ROOF." Fourth Annual Greening Rooftops for Sustainable Communities: 2006 Conference Proceedings. Boston: Green Roof Service, LLC, 2006. 5-6.

Pledge, Earth. Green Roofs: Ecological Design and Construction. Atglen: Schiffer Publishing Ltd., 2005.

Porsche, U., and M. Kohler. "Life Cycle Cost of Green Roofs: A Comparison of Germany, USA, and Brazil." Rio, 2003: 1-5.

Rogers, Everett M. Diffusion of Innovations. 5th ed. New York: Free Press, 2003.

Simmons, Mark T., Brian Gardiner, Steve Windhager, and Jeannine Tinsley. "Green Roofs are not created equal: the hydrologic and thermal performance of six different extensive green roof and reflective and non-reflective roofs in a a sub-tropic climate." Urban Ecologist, 2008: 339-348.

Stein, Taylor Verne. ""Understanding How Rural Community Stakeholders Value and Benefit from Natural Landscapes". Ph.D. dissertation, Universtiy of Minnesota." ProQuest Dissertations and Theses. 1997. http://proquest.com/, publication number AAT 9815074 (accessed September 12, 2009).

Stormwater Manager's Resource Center. "Glossary". 2008. http://www.stormwatercenter.net/ (accessed September 12, 2009).

Tarquinio, J. Alex. "A Green Amenity Above It All." New York Times, September 30, 2009: B7.

The United Nations Department of Economic and Social Affairs. World Urbanization Prospects: The 2003 Revision. New York: United Nations, 2004.

Thompson, J. William, and Kim Sorvig. Sustainable Landscpae Construction: A Guide to Green Building Outdoors. Washington DC: Island Press, 2000.

U.S. Census Bureau. Table A1: Interim Projections of the Total Population for the United States and States: April 1, 2000 to July 1, 2030. April 21, 2005. http://www.census.gov/population/projections/SummaryTabA1.pdf (accessed September 16, 2009).

Ulrich, R. S., and R. F. Simons. "Recovery from stress during exposure to everyday outdoor environments." Paper presented at the Proceedings of 17th EDRA. Washington, D.C., 1986.

United Nations. "Report of the World Commission on Environment and Development." United Nations. December 11, 1987. http://www.un.org/documents/ga/res/42/ares42-187.htm (accessed September 12, 2009).

United States Green Building Council. LEED Rating Systems: What is LEED? http;//www.usgbc.org/DisplayPage.aspx?CMSPageID=222 (accessed September 15, 2009).

USGBC. United States Green Building Council. 2009. http;//www.usgbc.org/DisplayPage.aspx?CMSPageID=222 (accessed September 15, 2009).

Van Woert, N., D. Rowe, j. A. Anderson, C.L. Rugh, and L. Xiao. "Water regime and gree roof substrate design affect Sedum plant growth." HorthScience, 2005: 1-6.

Weiler, Susan K., and Katrin Scholz-Barth. Green Roof Systems: A Guide to the Planning, Design, and Construction of Landscapes over Structures. Hoboken: John Wiley & Sons, Inc., 2009.

Werthmann, Christian. Green Roofs: A case Study. New York: Princeton Architectrual Press, 2007.

Woodward, Lauren. "Green Roofs Over Texas." Texas Architect, November 7, 2005: 19, 59.

Yeang, Ken. Ecodesign: A Manual for Ecological Design. London, UK: Wiley-Academy, 2006.

Yok Tan, P., and A. Sia. "A pilot green roof research project in Singapore." Proc. of 3rd North American Green Roof Conference: Greening rooftops for sustainable communities. Washington, DC, 2005. 4–6.

BIOGRAPHICAL INFORMATION

Born and raised in Dallas, Texas, Matthew Heath House grew up as a competitive gymnast and had drive to succeed from a very young age. After receiving a cheerleading scholarship and attending Florida State University, in 1998, he graduated with a Bachelors of Science in Fashion Merchandising. He was then hired as a buyer at Saks Fifth Avenue in New York City. This position led to an advertising sales and marketing position at Esquire Magazine and then to an independent outdoor travel magazine, Blue. However, on September 11th, he was walking to his lower Manhattan office, when he personally witnessed the tragedy that took place that day. It was at this point that he decided this was his chance to make a change, do something that makes the world a better place. Following months of training at the Sivinanada Yoga Ashram, he began teaching yoga classes, private workshops, and celebrity clientele in New York City and Los Angeles. After six years of helping people, he discovered landscaping could also have a positive impact on the physical world around him. Over time this interest became a passion and eventually led him to the landscape architecture program at The University of Texas at Arlington in 2006. In addition to the three years of graduate school studies required, he completed an internship for Peter Walker & Partners in Berkeley, CA. where he gained invaluable working knowledge and experience. He will graduate with a Masters Degree in Landscape Architecture in December 2009.