

THE IMPACT OF BIOPHILIC DESIGN ON HEALTH AND WELLBEING OF
RESIDENTS THROUGH RAISING ENVIRONMENTAL AWARENESS AND
NATURE CONNECTEDNESS

by

YINGTING CHEN

(Under the Direction of Alfie Vick)

ABSTRACT

Mounting evidence shows that the disconnection between humans and nature due to the advances of the modern world have caused detrimental effects on human health and wellbeing. Among the current theories and research, the biophilia hypothesis is relatively new and the least well understood, though it contains with great potential.

This study aims to measure the impact of biophilic design on environmental awareness and nature connectedness, and prove whether this impact can enhance human health and wellbeing or not. For this purpose, a mixed-methods, concurrent triangulation approach that includes both qualitative and quantitative analysis was designed and applied in Serenbe, an intentional community of biophilic design in southwest of Atlanta.

The result demonstrated a significant positive correlation between health and wellbeing, environmental awareness, and nature connectedness. It supports the idea that the presence of biophilic features have a significant beneficial effect, and nature should no longer be neglected as an important source of health and wellbeing.

INDEX WORDS: Environmental Design, Residential Community Design, Human-Nature Relationship, Biophilia Hypothesis, Biophilic Design, Health and Wellbeing, Environmental Awareness, Nature Connectedness, Serenbe

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	x
CHAPTER	
1 INTRODUCTION	1
Impetus and Rationale.....	1
Aims of the Study	3
Significance of the Study	4
Hypothesis.....	6
Research Questions.....	6
2 LITERATURE REVIEW	8
Community Health and Wellbeing	8
The Human-Nature Relationship	11
Biophilia Hypothesis vs. other Environmental Design Theories.....	17
Summary of Current Methodology and Types of Instrument.....	30
3 METHODS	38
Theory and Rationale of the Methodology Design.....	38
Site Selection, Study Population and Sampling Strategy	40
Elements of the Study Design.....	43

Qualitative Methods.....	45
Quantitative Methods.....	51
4 THE SERENBE COMMUNITY	61
Context and History	61
Design Concepts and Master Plan Elements	63
The Culture and Nature of Serenbe	71
5 RESULTS AND DISCUSSION	77
Biophilic Design Features Survey	78
Participant Observation.....	84
The Relationship between Environmental Awareness, Nature Connectedness, and Health and Wellbeing.....	90
6 CONCLUSION.....	103
Methodological Conclusions	103
Experimental Conclusions	104
Suggestion for Future Research	109
REFERENCES	111
APPENDICES	
A OBSERVATION PROTOCOL	124
B SURVEY FOR THE SERENBE GROUP.....	128
C SURVEY FOR THE NON-SERENBE GROUP.....	136

LIST OF TABLES

	Page
Table 2.1: Preference Matrix	22
Table 2.2: Elements and Attributes of Biophilic Design	27-28
Table 2.3: 14 Patterns of Biophilic Design.....	29
Table 2.4: Comparison of the Top Five Tools of Measuring Health and Wellbeing	31
Table 2.5: Comparison of the Main Three Scales to Measure How Strongly an Individual Feel Connected to Nature.....	36
Table 3.1: Research Tools, Methods Employed and Rationale	43-44
Table 3.2: Dimension of Participant Observation and Level of Engagement of Each Dimension	49
Table 3.3: Level of Engagement and Content of Observation.....	50
Table 3.4: Description of the Biophilic Design Elements and Attributes.....	52-53
Table 3.5: Domains and Indicators of Basic Information and Relationship of the Community and Its Residents	55-56
Table 3.6: Domains and Indicators of General Community Health and Wellbeing Measurement.....	56-57
Table 3.7: Domains and Indicators of Environmental Awareness Measurement.....	58
Table 3.8: Domains and Indicators of Nature Connectedness Measurement	59
Table 5.1: Biophilic Design Features Survey	79-80
Table 5.2: Participant Observation	84-89

Table 5.3: The Serenbe Group & the Non-Serenbe Group: Demographic Data	91-93
Table 5.4: The Serenbe Group & the Non-Serenbe Group: Demographic Difference.....	93
Table 5.5: Level of Reliability and Dropped Questions	95
Table 5.6: The Serenbe Group & the Non-Serenbe Group: Correlation between the Outcomes of the NEP Scale, the CNS Scale, and Health and Wellbeing.....	96
Table 5.7: The Serenbe Group & the Non-Serenbe Group: Difference between the Outcomes of the NEP Scale, the CNS Scale, and Health and Wellbeing.....	96
Table 5.8: The Serenbe Group & the Non-Serenbe Group: Average Score and the Level of Difference of Each section of Relation with Community, Health and Wellbeing, Environmental Awareness, and Nature Connectedness	99-100
Table 5.9: The Serenbe Group: Correlation between the Length of Time Living in Serenbe and the Level of Health and Wellbeing, Environmental Awareness and Natural Connectedness.....	100

LIST OF FIGURES

	Page
Figure 2.1: Major Factors that Make a Healthier Community.....	10
Figure 3.1: Visualization of the Concurrent Triangulated Design of the Study	45
Figure 4.1: Serenbe Location.....	61
Figure 4.2: The road to the Inn at Serenbe.....	62
Figure 4.3: Serenbe Community Master Plan with Serenbe Farm (2014).....	65
Figure 4.4: Serenbe Omega Geometry.....	66
Figure 4.5: Thorburn Transect	66
Figure 4.6: Selborne Urban Courtyard.....	68
Figure 4.7: Grange Hamlet	69
Figure 4.8: Community Edible Garden.....	69
Figure 4.9: Serenbe Organic Farm.....	70
Figure 4.10: Variety of Building Types and Architectural Languages at Serenbe.....	71
Figure 4.11: Serenbe Farm.....	72
Figure 4.12: Constructed Wetlands.....	74
Figure 4.13: Green Constructions	75
Figure 4.14: Serenbe Community Events	76
Figure 5.1: Vista Views	81
Figure 5.2: Serenbe Water Features.....	82
Figure 5.3: Serenbe Trails.....	82

Figure 5.4: Serenbe Community Gardens.....82

Figure 5.5: Serenbe Animals.....83

Figure 5.6: Serenbe Biophilic Patterns & Natural Materiality83

CHAPTER 1

INTRODUCTION

Impetus and Rationale

There is substantial and ever growing evidence that living environments and daily experiences, both physical and emotional, are major factors that contribute to human health and wellbeing.^{1, 2, 3, 4, 5}

Due to advances in science, new materials and technologies, there is no doubt that modern living has significantly increased the survival and longevity of human beings. Evidence of this can be seen, for example, in the ability to build safer, more hygienic homes and communities, increase food production and improve methods of transport and preservation,^{2, 6} and in advances in healthcare and medical popularization etc.² Under the combined effect of all these changes, the global average life expectancy has more than doubled since 1900 and is now approaching 70 years. And nowhere in the world today is the life expectancy lower than the highest average expectancy in 1800.⁷

While we achieved this great feat in less than one hundred years, many researchers have noted that as survival has become less of a concern, it is now time to shift our focus

¹ Belloc, Nedra B. and Lester Breslow. "Relationship of Physical Health Status and Health Practices," *Preventive Medicine* 1, no. 3 (1972): 409-421.

² Blaxter, Mildred. *Health and Lifestyles*. (London: Routledge, 2003).

³ "About". *Center for Disease Control and Prevention*. <https://www.cdc.gov/nccdp/dch/about/index.htm> (accessed Oct.11, 2016)

⁴ Goodman, Richard A. et al. "What is 'community health'? Examining the meaning of an evolving field in public health." *Preventive Medicine*, no. 67 (2014): S58–S61.

⁵ "About WHO". *World Health Organization*. <http://www.who.int/about/mission/en/> (accessed Oct.11, 2016)

⁶ Caballero, Adrian Cerezo. "Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age." PhD diss. 2013, Yale University.

⁷ Roser, Max. "Life Expectancy." *Our World in Data*, <https://ourworldindata.org/life-expectancy/> (accessed Oct.11, 2016)

to the study of how to improve the quality of life, attain spiritual satisfaction, and reach life's full potential.^{8,9} Correspondingly, a host of research on human health and wellbeing has been developed and conducted. However, one area that has been overlooked until very recently is the role of nature. We are only beginning to become aware that the natural world might be fundamental to human health and wellbeing.^{10, 11, 12, 13, 14}

Humans are inexorably tied to the larger natural world, and the human-nature relationship is fundamental and instinctive.^{15, 16} This is the basis for the biophilia hypothesis, and by extension, a fundamental principle of biophilic design.^{17, 18} If the environment constructed with healthy and rich natural spaces benefits our basic needs and wellbeing, as the biophilia hypothesis claims, then nowhere is the need for ensuring a good and healthy connection to nature more important than in the places where people live and spend almost half of their daily lives.

This study is driven by a belief that non-human nature and a well-designed human-nature connection should play an important role in improving residents' health and wellbeing by raising their environmental awareness and nature connectedness. By testing

⁸ Ibid.

⁹ MacQueen, Kathleen M. et al., "What is community? An evidence-based definition for participatory public health." *Am. J. Public Health*, no. 91(2001): 1929-1938.

¹⁰ Caballero. "Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age."

¹¹ Kaplan, Rachel and Stephen Kaplan, *The experience of nature: A psychological perspective*. (Cambridge: Cambridge University Press, 1989).

¹² Kellert, Stephen R. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

¹³ Nisbet, Elizabeth K. et al. "Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being." *Journal of Happiness Studies: An Interdisciplinary Forum on Subjective Well-Being*, no. 12 (2011): 303-322.

¹⁴ Vining, Joanne, Melinda S. Merrick and Emily A. Price, "The distinction between humans and nature: Human perceptions of connectedness to nature and elements of the natural and unnatural." *Human Ecology Review*, no. 15 (2008): 1-11.

¹⁵ Kellert, Stephen R. and Edward O. Wilson. *The Biophilia Hypothesis*. (Washington DC: Island Press, 1993).

¹⁶ Wilson, Edward O. *Biophilia*. (Cambridge, MA: Harvard University Press, 1984).

¹⁷ Kellert, Stephen R. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

¹⁸ Kellert, Stephen R., Judith Heerwagen and Martin Mador. *Biophilic design: The theory, science, and practice of bringing buildings to life*. (Hoboken, NJ: Wiley, 2008).

this hypothesis, the study's goal is to enrich existing knowledge of the role of biophilic design in human health and wellbeing.

Given the exploratory nature of the study, a concurrent mixed-methods approach was applied¹⁹. This approach allowed for testing the hypothesis by a triangulated comparison of the results from quantitative and qualitative research tools.

Serenbe, a planned community south of Atlanta, was selected as the study site due to its well-known reputation of biophilic design. Quantitative data about residents' health and wellbeing, along with their levels of environmental awareness and natural connectedness were collected using a questionnaire survey; a general evaluation and description of the biophilic design of the site were collected by a biophilic design features survey. A variety of qualitative research tools were used to provide context and to support and enhance the analysis of the results of the survey. These tools included: literature review, photographic survey, and participant observation in activities related to the use of biophilic designs.

Aims of the Study

The primary aim of this study is to measure the impact of biophilic design on residents' environmental awareness and nature connectedness; to examine whether this impact enhanced human health and wellbeing or not; by doing so, to provide an assessment template and baseline, and a solid foundation for further research on the topic.

The broader aim of this study is to contribute to the understanding of the interrelation between residents and nature in their living environment, and to enrich the conceptual and methodological approach to measure the impact of biophilic design. This

¹⁹ Caballero. "Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age."

expanded understanding is needed to give appropriate consideration to nature in community environmental design, and thus improve the application of biophilic design as an innovative and effective way of designing the places that help enhance residents' health and wellbeing throughout their daily lives.

Significance of the Study

1> Conceptual Significance of the Study

This study expands the current understanding of the role of non-human nature in health and wellbeing. Significant knowledge will be added to the field of the human-nature relationship by providing an empirical survey to examine the role of nature in the living environment.

The study will also fill in some of the blanks of existing research on biophilic design. While it is generally accepted in that non-human nature is essential in environmental design and has a positive impact on human health and wellbeing,^{20, 21, 22, 23, 24, 25, 26} biophilic design is a relatively novel concept in environmental design. There is little research assessing how and how well biophilic design might affect community health and wellbeing. In order to address this deficiency, environmental awareness and nature connectedness were identified to be the scale for the first time.

²⁰ Kaplan, Rachel and Maureen E. Austin. "Out in the country: Sprawl and the quest for nature nearby." *Landscape and Urban Planning*, no. 69 (2004): 235-243.

²¹ Kaplan and Kaplan. *The experience of nature: A psychological perspective*. (Cambridge: Cambridge University Press, 1989).

²² Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

²³ Newman, Lenore. and Ann Dale. "Celebrating the mundane: Nature and the built environment". *Environmental Values* 22, no. 22 (2013): 401-413.

²⁴ Nisbet et al. "Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being." 303-322.

²⁵ Schultz, Paul Wesley. "Inclusion with nature: The psychology of human-nature relations." In P. W. Schmuck & W. P. Schultz (Eds.), *Psychology of sustainable development*. (pp. 62-78). (Norwell, MA: Kluwer Academic, 2002).

²⁶ Vining et al. "The distinction between humans and nature: Human perceptions of connectedness to nature and elements of the natural and unnatural." 1-11.

In addition, as stated above, the built environment constitutes a large and very significant portion of the human realm, and is believed to have a fundamental impact on health and wellbeing.^{27, 28, 29, 30, 31, 32, 33, 34} However, available data is surprisingly sparse when it comes to the effect of connection with nature in homes, neighborhoods, and communities. Given the current level of fragmentation and lack of relevant studies,^{35, 36} assessing the impact of nature in a living environment becomes particularly important and representative. The analysis of the results will offer new perspectives, advice, and suggestions for the improvement and development of the application of biophilic design in built environments.

2> *Methodological Significance of the Study*

This study is the first to discuss the impact of biophilic design on community health and wellbeing from the perspective of environmental awareness and nature connectedness. Given the exploratory and interdisciplinary nature of the study, a concurrent mixed-methods approach was designed to test the hypothesis via a triangulated comparison of the results from quantitative and qualitative research tools. By doing so, data and information

²⁷ Caballero. "Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age."

²⁸ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

²⁹ Kellert et al. *Biophilic design: The theory, science, and practice of bringing buildings to life*. (Hoboken, NJ: Wiley, 2008).

³⁰ Kellert and Wilson. *The Biophilia Hypothesis*. (Washington DC: Island Press, 1993).

³¹ Kaplan and Kaplan. *The experience of nature: A psychological perspective*. (Cambridge: Cambridge University Press, 1989).

³² Nisbet et al. "Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being." 303-322.

³³ Vining et al. "The distinction between humans and nature: Human perceptions of connectedness to nature and elements of the natural and unnatural." 1-11.

³⁴ Wilson. *Biophilia*. (Cambridge, MA: Harvard University Press, 1984).

³⁵ Gillis, Kaitlyn and Birgitta Gatersleben. "A Review of Psychological Literature on the Health and Wellbeing Benefits of Biophilic Design." *Buildings*, no. 5 (2015): 948-963.

³⁶ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

collected through different approaches would be used mutually to explain each approach's results, and so strengthen the rationality and persuasiveness of the conclusion.

More specifically, for the site, Serenbe, that was selected to conduct the survey, the study will not benefit the residents directly, but the Serenbe Institute Environmental Committee will benefit from the results of the study by having an increased understanding of the environmental awareness and attitudes of residents. This will enhance the services and opportunities offered to residents in the future. In addition, the methodology established and data collected from the study will be added to the community's database as a template and baseline for further related studies. These findings could then be applied more widely on similar sites or conditions.

Hypothesis

The study will test the following research hypotheses:

Biophilic design will produce a higher level of environmental awareness and nature connectedness (as expressed by a higher score on the environmental awareness and nature connectedness survey), which is significantly correlated to higher quality health and wellbeing outcomes of residents in the study scale.

Research Questions

Key Questions:

- Can biophilic design improve community health and wellbeing in built environments through raising environmental awareness and nature connectedness?

- Is there any difference of the level of health and wellbeing between Serenbe residents and non-Serenbe residents? If so, does the difference come from the impact of biophilic environmental design? If not, why?
- Does the level of environmental awareness and nature connectedness significantly correlate to community health and wellbeing? If so, how? If not, why?

Once the key question was resolved by quantitative data, in order to provide supportive evidence and a more contextual understanding of this complex phenomenon, the following questions were introduced:

- What attributes inform, guide or determine the current biophilic features at Serenbe – the study site?
- What is the condition of biophilic designs at Serenbe?
- How do the residents use these biophilic designs? What attitude and thoughts do they have toward these designs?
- What new and valuable insights can be gained through the survey to help improve community health and wellbeing through biophilic design?

CHAPTER 2

LITERATURE REVIEW

This review is focused on four main areas. The first explores standards set by the World Health Organization (WHO) and the Center for Disease Control and Prevention (CDC). It explores the definition and scope of community health and wellbeing, the outcomes and key factors that increase the risk of disease, and how quality is measured in community health and wellbeing settings. The second area is focused on the human-nature relationship, on what is known about the value of non-human nature in community health and wellbeing, and on why environmental awareness and nature connectedness are important approaches to realizing this value. The third area describes current environmental design concepts that aim to improve community health and wellbeing, explains why this research focuses on biophilia, and then introduces applications of the hypothesis in the principles of biophilic design. Finally, the fourth area summarizes methodologies regarding how to evaluate community health and wellbeing, and the impacts of biophilic design on environmental awareness and nature connectedness.

Community Health and Wellbeing

1> Definition of Community Health and Wellbeing

Usage of the term “community health” has a long history, and the development of definitions demonstrates the ambiguity and overly general use of the concept. The meaning and strategic significance of community health remain challenging to fully define and to clearly distinguish from related areas of public health, practice, community engagement,

or other related community development.³⁷ The need for consensus on the definition of “community” within a public health context is apparent because “the lack of an accepted definition of community health can result in different collaborators forming contradictory or incompatible assumptions about community and can undermine our ability to evaluate the contribution of community collaborations to achievement of public health objectives.”³⁸

In order to make communities healthier places to live, learn, work, and play, the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) defined “community health and wellbeing” in order to make it measurable and evaluative. Community health and wellbeing refers to “a state of complete physical, mental, emotional, and social wellness - including social connectedness, spiritual fulfillment, life satisfaction, and happiness - identified by individuals and their communities as essential for them to flourish and fulfill their potential, and not merely the absence of disease, infirmity, or poverty.”^{39, 40, 41}

³⁷ Goodman et al. “What is ‘community health’? Examining the meaning of an evolving field in public health.” S58–S61.

³⁸ MacQueen et al. “What is community? An evidence-based definition for participatory public health.” 1929-1938.

³⁹ Center for Disease Control and Prevention. “Division of Community Health (DCH): Making Healthy Living Easier.” <http://www.cdc.gov/nccdphp/dch/about/index.htm> (accessed Oct.11, 2016)

⁴⁰ “About WHO.” *World Health Organization*. <http://www.who.int/about/mission/en/> (accessed Oct.11, 2016)

⁴¹ “WHOQOL: Measuring Quality of Life.” *World Health Organization*. <http://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/> (accessed Mar. 21, 2016)

2> Aspects and Factors of Community Health and Wellbeing

WHO also points out the many factors that, if improved, can help make communities healthier places to live, learn, work, and play. Three main aspects are emphasized: health outcomes, health factors, and policies and programs. These measures are standardized and combined using scientifically-informed weights and presented in the following flowchart:⁴²

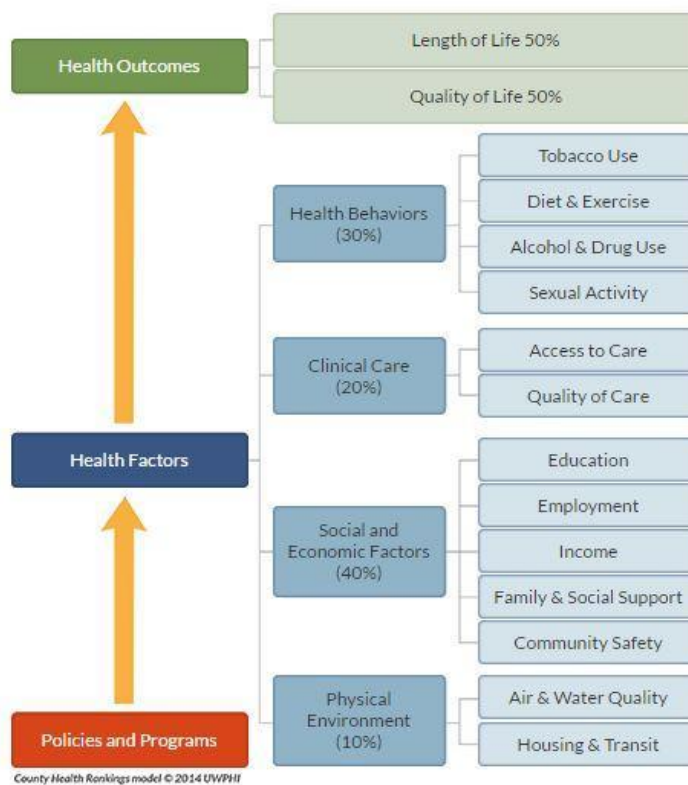


Figure 2.1: Major Factors that Make a Healthier Community (County Health Rankings and Roadmaps, 2016)

This chart served as the basis for developing methods and a list of items to measure the community health and wellbeing in this study. Further details will be presented in Chapter 3: Methods.

⁴² “Our Approach.” *County Health Rankings and Roadmaps*. <http://www.countyhealthrankings.org/our-approach> (accessed Oct.15, 2016)

The Human-Nature Relationship

I> Current Study of the Human-Nature Relationship

A growing area of research and literature is the sub-field of social ecology concerning humans and nature. Research and publication in this area was stimulated by the growing concern that disconnection from nature may have detrimental effects on human health and wellbeing, as well as contribute to an unhealthy environment.⁴³ It is generally believed that the cause of this disconnection between humans and nature is technology. Driven by the imaginative human mind, technology shapes and defines us.⁴⁴ Technological advances first allowed people to settle and farm the land, but further advances eventually made people leave the fields and villages for an unfamiliar industrial life in towns and cities. This change resulted in a lifestyle where living and working are no longer driven by the seasons and ecological context, and in which we are surrounded by a more built environment.^{45, 46, 47, 48, 49, 50, 51} Western philosophical thinking developed parallel to these lifestyle changes, seeing humans as separate from nature and dominant over it, rather than integrated within and adapted to it.⁵²

⁴³ Nisbet et al. "Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being." 303-322.

⁴⁴ Taylor, Timothy. *The Artificial Ape: How Technology Changed the Course of Human Evolution*. (New York, NY: Macmillan, 2010).

⁴⁵ Newman and Dale. "Celebrating the mundane: Nature and the built environment". 401–413.

⁴⁶ Conn, Sarah A. "Living in the earth: Ecopsychology, health and psychotherapy". *The Humanistic Psychologist* 26, no. 1-3 (1998): 179–198.

⁴⁷ Bragg, Elizabeth A. "Towards ecological self: Deep ecology meets constructionist self-theory". *Journal of Environmental Psychology* 16, no. 2 (1996): 93–108.

⁴⁸ Feral, Crystal-Helen. "The connectedness model and optimal development: Is ecopsychology the answer to emotional well-being?" *The Humanistic Psychologist* 26, no. 1-3 (1998): 243–274.

⁴⁹ Kahn, Peter H. Jr. "Developmental psychology and the biophilia hypothesis: Children's affiliation with nature." *Developmental Review* 17, no.1 (1997): 1–61.

⁵⁰ Kals, Elisabeth and Jürgen Maes. "Sustainable development and emotions." In P. Schmuck & W. P. Schultz (Eds.), *Psychology of sustainable development* (pp. 97–122). (Norwell, MA: Kluwer, 2004).

⁵¹ Kellert, S. R. *Kinship to mastery: Biophilia in human evolution and development*. (Washington, DC: Island Press, 1997).

⁵² Vining et al. "The distinction between humans and nature: Human perceptions of connectedness to nature and elements of the natural and unnatural." 1-11.

What do we know about the relationship between natural systems and human physical, mental, emotional, and social wellbeing? The truth is, not much. Various wide-ranging studies of the human experience of nature have provided only fragmented, inconsistent, unsystematic information rather than a definitive answer.⁵³ In contrast, the ways disturbed and degraded natural systems negatively affect human health and productivity, as well as how human activity damages the condition of a natural environment, have been much more widely studied.⁵⁴ Little systematic empirical investigation on positive human-nature interactions has been conducted, particularly on how the experience of nature fosters human physical and mental wellbeing, and even how beneficial human actions can actually enhance the functioning of natural systems. Yet even this scarce “positive research” has focused mostly on documenting relaxation, healing, and the restorative benefits of nature and natural settings - on nature as a recuperative mechanism, rather than as a source of wellbeing.^{55, 56, 57}

There are three theories that help elucidate the interdependency of human health and wellbeing and the natural world. First is the concept of ecosystem services, which means healthy ecosystems benefit humans by providing them with essential goods and services, like clean drinking water and the decomposition of wastes, etc., that support their basic existence.⁵⁸

⁵³ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

⁵⁴ Ibid.

⁵⁵ Mayer, F. Stephan and Cynthia McPherson Frantz. “The connectedness to nature scale: A measure of individuals’ feeling in community with nature.” *Journal of Environmental Psychology* 24, no. 4 (2004): 503-515.

⁵⁶ Kaplan, Rachel. “The Nature of the View from Home.” *Environment and Behavior* 33 (2001): 507-542.

⁵⁷ Nisbet et al. “Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being.” 303-322.

⁵⁸ Millennium Assessment Panel. *Ecosystems and Human Well-being*. (Washington, Covelo, London: Island Press, 2003).

Second is the theory of biophilia which explores how people's instinctive affinity for the natural world drives them to directly interact with nature, and how activities like walking in a forest ravine, swimming or fishing in a free-flowing stream, or hiking and camping on a mountaintop, can confer a range of vital physical and mental benefits.^{59, 60} Evidence of the biophilia hypothesis lies in the popularity of outdoor wilderness activities, our relationships with animals, and fondness for natural scenery.^{61, 62, 63, 64, 65}

Third is a psychological phenomenon that "people who live in secure and familiar places are more likely to derive the benefits afforded by the natural world that tend to make their lives more satisfying and productive."⁵⁹ However, when it comes to the effect of contact with nature in people's homes, neighborhoods, and communities, surprisingly little data is available.

2> *Definition and Scope of Nature and the Human-Nature Relationship*

The most widely accepted definition of nature in the realm of environmental and social ecology was outlined by environmental psychologist Joachim Wohlwill as "vast domain of organic and inorganic matter that is not a product of human activity or intervention."⁶⁶ However, this notion is too narrow for the study of the human-nature relationship in our highly-urbanized world. If we take the deliberate products of human

⁵⁹ Gillis and Gatersleben. "A Review of Psychological Literature on the Health and Wellbeing Benefits of Biophilic Design." 948-963.

⁶⁰ Gray, Tonia, and Carol Birrell. "Are Biophilic-Designed Site Office Buildings Linked to Health Benefits and High Performing Occupants?" *Environmental Research and Public Health* 11, no. 12 (2014): 12204-12222.

⁶¹ Nisbet et al. "Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being." 303-322.

⁶² Hartig, Terry et al. "Environmental influences on psychological restoration." *Scandinavian Journal of Psychology* 37, no.4 (1996): 378-393.

⁶³ Kaplan, Stephen. "The restorative benefits of nature: Toward an integrative framework." *Journal of Environmental Psychology* 15, no.3 (1995): 169-182.

⁶⁴ Ulrich, Roger S. "Stress recovery during exposure to natural and urban environments." *Journal of Environmental Psychology* 11, no. 3 (1991): 201-230.

⁶⁵ Kellert and Wilson. *The Biophilia Hypothesis*. (Washington DC: Island Press, 1993).

⁶⁶ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

construction and creation (e.g. domesticated animals and built environments) that affect our daily lives into consideration, the world is largely dominated by three types of environments.⁶⁷ The first, the human environment, has developed a monoculture wherein one species dominates.⁶⁸ The second, the agricultural realm, as a highly-domesticated ecosystem, is dominated by homogeneous natural elements selected according to human needs. This type of ecosystem highly depends on external disturbances such as fertilization and weeding to maintain its stability and productivity.^{69, 70} The third, pristine wilderness, which is defined by the US Wilderness Act as "providing opportunities for solitude" and "not being substantively modified by humans."⁷¹ Wilderness is idealized as a place of reflection that serves a sacred function similar to a church or temple; wilderness is a place where humans meditate upon the "other".^{72, 73}

However, in an attempt to help realize the truth of the human-nature relationship and increase community health and wellbeing, what truly matters is not the artificial environment nor intact wilderness, but the blending of realms remains on the urban edge spaces where nature and culture meet. These components work together to form the urban experience of everyday interactions with the natural world, and are defined as "mundane nature"^{74, 75} or "nearby nature".^{76, 77} This is the kind of nature that will be discussed here.

⁶⁷ Ibid.

⁶⁸ Newman and Dale. "Celebrating the mundane: Nature and the built environment". 401-413.

⁶⁹ Ibid.

⁷⁰ Brereton, Finbarr, J. Peter Clinch and Susana Ferreira. "Happiness, geography and the environment." *Ecological Economics* 65, no. 2 (2008): 386-396.

⁷¹ Ashley, Peter. "Toward an understanding and definition of wilderness spirituality." *Australian Geographer* 38, no. 1 (2007): 53-69.

⁷² Ibid.

⁷³ Havlick, David. "Reconsidering wilderness: Prospective ethics for nature, technology, and society." *Ethics, Place and Environment* 9, no. 1 (2006): 47-62.

⁷⁴ Cronon, William. "The trouble with wilderness; or getting back to the wrong nature". In: Cronon, William. (ed.) *Uncommon Ground: Rethinking the Human Place in Nature*. (New York: Norton & Co 69-90, 1995).

⁷⁵ Newman and Dale. "Celebrating the mundane: Nature and the built environment". 401-413.

⁷⁶ Kaplan and Kaplan. *The experience of nature*. (Cambridge: Cambridge University Press, 1989).

⁷⁷ Kaplan and Austin. "Out in the country: Sprawl and the quest for nature nearby." 235-243.

This aspect of nature raises the question of what we mean by the “human-nature relationship”. According to Kellert⁷⁸, the human experience of nature occurs along two broad dimensions. First is the degree of closeness to nature, which ranges from a highly familiar and domesticated setting, such as pet animals and backyard gardens, to wildlife and pristine wilderness, with the middle ground occupied by, for example, zoo animals or a municipal park. Second includes the varieties of contact with the nonhuman world, which ranges from direct and indirect contact to a very subtle experience that is often easily overlooked: symbolic representation in the built environment. Direct contact involves the experience of relatively self-sustaining natural features and processes like boating on a stream, hiking in the mountains, or riding a horse in a forest. Indirect contact is most common in urban areas. This dimension refers to interactions with elements of nature that require ongoing human input, intervention, and control – for example, tending a potted plant, a manicured lawn, or a lush rooftop garden. Symbolic or vicarious contact does not involve actual physical experience of the natural world, but the symbolic or metaphorical encounter with nature, such as the mimicking of natural forms in buildings and constructed landscapes, photographs, paintings, books or videos of natural world, or even the use of floral patterns in decorative or ornamental objects. All these forms of interaction are within the scope of discussion, since all of these and more can affect people’s everyday lives, health, and wellbeing.^{79, 80}

⁷⁸ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

⁷⁹ Newman and Dale. “Celebrating the mundane: Nature and the built environment”. 401-413.

⁸⁰ Richardson, Miles, Jenny Hallam and Ryan Lumber. “One Thousand Good Things in Nature: Aspects of Nearby Nature Associated with Improved Connection to Nature.” *Environmental Values* 24, no. 5 (2015): 603-619.

3> *What are the Core Outcomes of a Positive Human-Nature Relationship?*

By reviewing evidence of how the experience of the nonhuman environment can enhance human physical, mental, emotional, and social productivity and satisfaction, I suggest the core outcomes of a positive human-nature relationship are environmental awareness and nature connectedness.

Environmental awareness is the knowledge and understanding of the fragility of our environment and the importance of its protection. It aims to “evoke the necessity and responsibility of humans to respect, protect, and preserve the natural world from its anthropogenic (caused by humans) afflictions.”⁸¹ Nature connectedness refers to the extent to which individuals include nature as part of their identity. It includes three components: (1) The cognitive component, the core of nature connectedness and how integrated one feels with nature; (2) The affective component, an individual's sense of concern for nature; and (3) The behavioral component, an individual's commitment to protecting the natural environment.^{82, 83, 84}

So, environmental awareness promotes healthy and sustainable ecosystem services and a positive feedback loop, while nature connectedness provides abundant and easy access and encourages people to interact with the natural world. By improving environmental awareness and nature connectedness, the experience of nature as a normal aspect of people's everyday lives at home, work, play, or in their neighborhoods and communities would positively affect their basic health and wellbeing.

⁸¹ “Environmental Awareness.” Pachamama Alliance. <https://www.pachamama.org/environmental-awareness> (accessed Dec.10, 2016)

⁸² Nisbet, Elizabeth K. et al. "The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior." *Environment and Behavior* 41, no. 5 (2009): 715-740.

⁸³ Nisbet et al. “Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being.” 303-322.

⁸⁴ Schultz. "Inclusion with nature: The psychology of human-nature relations." (Norwell, MA: Kluwer Academic, 2002).

Biophilia Hypothesis vs. other Environmental Design Theories

1> Definition and Development of Environmental Design

Since the Industrial Revolution of the 18th and 19th centuries, humanity's ever-expanding footprint has damaged, or even destroyed, many formerly pristine natural environments through deforestation, air or water pollution, desertification etc.^{85, 86} In the 1940s, in response to increasing levels of environmental crisis, particularly air pollution due to the emergence of large factories and the immense growth in coal consumption, a diverse scientific, social, and political movement to address environmental issues began in Europe, and quickly spread all over the world. It is known as the environmental movement (sometimes referred to as the ecology movement).^{87, 88, 89, 90}

One major achievement of the movement was the generation of environmental design theory. Broadly speaking, environmental design describes any effort to integrate the artificial built environment with the surrounding natural world in a manner that addresses the importance of environmental factors, and preserves limited resources when devising plans, programs, policies, buildings, or products. Compared with classical prudent design that may have always considered environmental factors, the environmental movement has made the concept more explicit.^{91, 92, 93}

⁸⁵ "Environmental Movement." *Pollution Issues*.

<http://www.pollutionissues.com/Ec-Fi/Environmental-Movement.html> (accessed Nov.21, 2016)

⁸⁶ "What is Environmental Design." *Regenerative Leadership Institute: Create a meaningful life doing what you love*. <https://www.regenerative.com/environmental-design> (accessed Nov.21, 2016)

⁸⁷ de Steiguer, J. Edward. *The Origins of Modern Environmental Thought*. (Tucson: The University of Arizona Press, 2006).

⁸⁸ Guha, Ramachandra. *Environmentalism: A Global History*. London: Longman, 1999.

⁸⁹ Kamieniecki, Seldon. ed. *Environmental Politics in the International Arena: Movements, Parties, Organizations, and Policy*. (Albany: State University of New York Press, 1993).

⁹⁰ McCormick, John. *The Global Environmental Movement*. (London: John Wiley, 1995).

⁹¹ Farr, Douglas. *Sustainable Urbanism: Urban Design with Nature*. (Hoboken, NJ: Wiley, 2008).

⁹² Plunz, Richard. ed. *Design and the Public Good: Selected Writings by Serge Chermayeff (1930 -1980)*. (Cambridge: MIT Press, 1982).

⁹³ "What is Environmental Design." *Regenerative Leadership Institute: Create a meaningful life doing what you love*. <https://www.regenerative.com/environmental-design> (accessed Nov.21, 2016)

Nowadays, this concept is more often used in the fields of creating the human-designed environment, including architecture, geography, urban planning, landscape architecture, and interior design.^{91, 92, 94, 95}

In more recent times, environmental design has taken on a new, urgent purpose: to enhance human health and wellbeing through the power of design.⁹⁶ There is an acknowledged need to reconnect people with nature owing to the associated benefits to human health and wellbeing, as stated above. However, as our interactions with nature will be increasingly within urban landscapes – the “mundane nature” or “nearby nature”⁹⁷ – rather than the wilderness,^{98, 99, 100} there is a need to consider how the “built environment” can be valued and provide a route for people to better interact with nature, and to better understand their connection to nature.^{99, 100}

2> *Current Major Environmental Design Theories Aiming to Improve Community Health and Wellbeing*

Of all the environmental design theories that focus on the subject of community health and wellbeing, it seems three paradigms have received the most attention. First is landscape preference, which consists of a series of hypotheses and theories that have studied which factors influence people’s attitudes and feelings toward a landscape. Second

⁹⁴ Mostafavi, Mohsen and Gareth Doherty. ed. *Ecological Urbanism*. (Cambridge: Harvard University Graduate School of Design, and Baden, Switzerland: Lars Müller Publishers, 2010).

⁹⁵ Waldheim, Charles. *The Landscape Urbanism Reader*. (New York: Princeton Architectural Press, 2006).

⁹⁶ “Design & Health Topics: Six approaches to achieving health through built environment design & policy.” *American Institute of Architects*. <http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab104538.pdf> (accessed October 4, 2016)

⁹⁷ “Mundane nature” or “nearby nature” refers to the blending of realms remains on the urban edge spaces where nature and culture meet. These components work together to form the urban experience of everyday interactions with the natural world.

⁹⁸ Dunn, Robert R. “The pigeon paradox: Dependence of global conservation on urban nature.” *Conservation Biology* 20, no. 6 (2006): 1814–1416.

⁹⁹ Newman and Dale. “Celebrating the mundane: Nature and the built environment”. 401-413.

¹⁰⁰ Richardson et al. “One Thousand Good Things in Nature: Aspects of Nearby Nature Associated with Improved Connection to Nature.” 603-619.

is sustainability, which seems to be one of the most influential, well-known and widely studied environmental design theories. The intent of sustainable design is to "eliminate negative environmental impact completely through skillful, sensitive design",¹⁰¹ and requires renewable resources, minimal environmental impact, and providing means for people to connect with the natural environment (Norton, 2005).¹⁰² The third one, biophilia hypothesis, is a rising star in the field of environmental design. It states that connection with nature is among the basic needs of human beings. And biophilic design is defined as the kind of environmental design that is able to satisfy our innate need for connection to life and its vital processes.^{103, 104, 105}

(1) Landscape Preference

Current theories state that contemporary environmental design preferences are a result of human evolution, reflecting the landscape and nature qualities that enhanced survival for humans through time,¹⁰⁶ and indicating that indeed we do possess innate, instinctive, aesthetic preference that shape our sense of beauty and influence our appreciation of art, architecture, and nature.¹⁰⁷

In any given landscape evaluation, a mixture of internal and external factors impact the attitudes and feelings of the observer. In some circumstances, external forces may dominate the response, while in others the internal ones may dominate. In other words, "in

¹⁰¹ McLennan, Jason F. *The Philosophy of Sustainable Design*. (Kansas City: Ecotone Publishing, 2004).

¹⁰² Norton, Bryan G. *Sustainability: A philosophy of adaptive ecosystem management*. (Chicago: University of Chicago Press, 2005).

¹⁰³ Grinde, Bjørn and Grete Grindal Patil. "Biophilia: Does Visual Contact with Nature Impact on Health and Well-Being?" *Int J Environ Res Public Health* 6, no. 9 (2009): 2332–2343.

¹⁰⁴ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

¹⁰⁵ Kellert, Heerwagen and Mador. *Biophilic design: The theory, science, and practice of bringing buildings to life*. (Hoboken, N.J.: Wiley, 2008).

¹⁰⁶ Ryan, Catherine O. et al. "Biophilic Design Patterns: Emerging Nature-Based Parameters for Health and Well-Being in the Built Environment". *International Journal of Architectural Research* 8, no. 2 (2014): 62-76.

¹⁰⁷ Nies, J. Dirk. "Science to Live By: Beauty and the Savanna Hypothesis." *The Crozet Gazette*. July 3, 2015. <http://www.crozetgazette.com/2015/07/science-to-live-by-beauty-and-the-savanna-hypothesis/> (accessed Oct 10, 2016)

some circumstances beauty will reside more in landscape and nature itself and in others the eye of the beholder will be more critical in influencing landscape judgements”.^{108, 109} Major theories that study these factors include the savanna hypothesis,¹¹⁰ the habitat and prospect-refuge theory,¹¹¹ the preference matrix,¹¹² and the biophilia hypothesis.¹¹³

- The Savanna Hypothesis

The Savanna Hypothesis postulates that our landscape preferences are innate and are the result of hominid evolution in East Africa where hominins moving out of the forests and onto the grasslands. Although this hypothesis has received criticism in recent years, with alternative competitive hypotheses such as rapidly fluctuating environments or the aquatic ape hypothesis, it is one of the oldest and most established hypotheses for what separated humans from the other great apes, dating back to Charles Darwin's time.¹¹⁴

Plenty of research, coupled with extensive American data, support the hypothesis that humans possess an innate preference for savanna-like settings.^{115, 116} The analysis of historic patterns of landscape design and large gardens, city parks, and estates all over the world reflects a cross-cultural preference for our savanna-like ancestral home, and reveals some striking parallels in the use and organization of certain landscape elements, such as

¹⁰⁸ Dearden, Philip. “Consensus and a theoretical framework for landscape evaluation.” *Journal of Environmental Management* 24 (1987): 267-278.

¹⁰⁹ Kaymaz, Isil Cakci. “Landscape Perception, Landscape Planning.” Dr. Murat Ozyavuz (Ed.). *InTech*. Published: June 13, 2012 under CC BY 3.0 license. <http://www.intechopen.com/books/landscape-planning/landscapeperception> (accessed Jan 25, 2017)

¹¹⁰ Orians, Gordon H. and Judith H. Heerwagen. *Evolved responses to landscapes*. Barkow, Jerome H. (Ed); Cosmides, Leda (Ed); Tooby, John (Ed). (1992). (New York, NY: Oxford University Press, 1992).

¹¹¹ Appleton, Jay. *The experience of landscape*. London: Wiley, 1975.

¹¹² Kaplan and Kaplan. *The experience of nature: A psychological perspective*. (Cambridge: Cambridge University Press, 1989).

¹¹³ Wilson. *Biophilia*. (Cambridge, MA: Harvard University Press, 1984).

¹¹⁴ Orians and Heerwagen. *Evolved responses to landscapes*. (New York, NY, US: Oxford University Press, 1992).

¹¹⁵ Nies. “Science to Live By: Beauty and the Savanna Hypothesis.” <http://www.crozetgazette.com/2015/07/science-to-live-by-beauty-and-the-savanna-hypothesis/> (accessed Oct 10, 2016)

¹¹⁶ Falk, John H. and John D. Balling. “Evolutionary Influence on Human Landscape Preference.” *Environment and Behavior* 42, no. 4 (2010): 479-493.

the random placement of trees, bushes or flowerbeds gathered in clumps and dispersed throughout an open field.^{116, 117, 118, 119}

- The Habitat and Prospect-Refuge Theory

Prospect and refuge theory was first proposed by English geographer Jay Appleton in 1975 to describe the reason why certain environments meet human needs and feel secure and relieved. One of the principle needs that identified by Appleton is the capacity to observe (prospect) without being seen (refuge).^{120, 121} It is widely used in environmental design aimed at discussing the influence of environmental features on the sense of fear or safety.

- Information Processing Theory

The Kaplans' information processing theory (1979)¹²² is among the most influential and well-known theories on landscape preferences. As leading researchers in environmental psychology, Rachel and Stephen Kaplan of the University of Michigan developed the preference matrix in 1989. The preference matrix as shown in Table 1 indicates that the more the four traits are present in a given environment (coherence, legibility, complexity, mystery), the more highly preferred this environment will be. The preference matrix is applicable to any environment, be it natural (e.g. finding one's way in a jungle) or human designed (e.g. a book).^{123, 124}

¹¹⁷ Hyams, Edward. *A history of gardens and gardening*. (London: J. M. Dent, 1971).

¹¹⁸ Jellicoe, Geoffrey Alan and Susan Jellicoe. *The landscape of man: Shaping the Environment from Prehistory to the Present Day (Third Edition, Expanded and Updated)*. (New York: Viking Press, 1975).

¹¹⁹ Newton, Norman T. *Design of the land*. (Cambridge, MA: Belknap Press, 1971).

¹²⁰ Appleton, Jay. *The experience of landscape*. (London: Wiley, 1975).

¹²¹ Dosen, Annemarie S. and Michael J. Ostwald. "Prospect and Refuge Theory: Constructing a Critical Definition for Architecture and Design". *The International Journal of Design in Society* 6, no. 1 (2013): 9-24.

¹²² Kaymaz. "Landscape Perception, Landscape Planning."

<http://www.intechopen.com/books/landscape-planning/landscapeperception> (accessed Jan 25, 2017)

¹²³ Kaplan and Kaplan. *The experience of nature: A psychological perspective*. (Cambridge: Cambridge University Press, 1989).

¹²⁴ Paxton, John. "The Preference Matrix as A Course Design Tool". Proceedings of the 6th Baltic Sea conference on Computing education research: Koli Calling (2006): 124-127.

Table 2.1: Preference Matrix (Kaplan & Kaplan, 1989)

	MAKE SENSE/UNDERSTANDING	INVOLVEMENT/EXPLORATION
2-D	Coherence: refers to scenes that have different landscape parts fitted together, providing a sense of order and assisting in directing attention.	Complexity: refers to the level of richness of a setting. It postulates the internal variation of the scenes' wealth of information and offers many different kinds of distinct elements in the scene.
3-D	Legibility: refers to landscape scenes where the elements are distinctive and easily identified.	Mystery: refers to something promising in a physical setting which could encourage people to move deeper to gain more information.

(2) Sustainability

Sustainability means a capacity to maintain an entity, outcome, or process over time. Sustainable development “meets the needs of the present without compromising the ability of future generations to meet their own needs.”¹²⁵

Sustainability consists of three components: environment, social, and economic. The environment component focuses on maintaining the earth's life support system (e.g. ecosystem services such as pollution filtering); the social component aims to maintain a community (civic) capacity that fosters effective participation and ‘equitable’ treatment of all stakeholders; and the economic component serves to maintain an economic system that provides a non-declining standard of living for present and future generations.

Currently, there are two key theories concerning sustainable environmental design – ecosystem stability and resilience,¹²⁶ and system theory.¹²⁷

¹²⁵ Brundtland Commission. *Our Common Future*. London: Oxford University Press, 1987.

¹²⁶ Mitchell, Ruth J. et al. “Ecosystem stability and resilience: a review of their relevance for the conservation management of lowland heaths.” *Perspectives in Plant Ecology, Evolution and Systematics* 3, no. 2 (2000): 142-160.

¹²⁷ Stichweh, Rudolf. “Systems Theory”. *International Encyclopedia of Political Science*. https://www.fiw.uni-bonn.de/demokratieforschung/personen/stichweh/pdfs/80_stw_systems-theory-international-encyclopedia-of-political-science_2.pdf (accessed Nov. 30, 2016)

- Ecosystem Stability and Resilience

Ecosystem stability depends on the response of ecosystems to disturbance. It can refer to types of stability in a continuum ranging from regeneration via constancy (living systems that can remain unchanged), to persistence (the variable of interest changes little in response to external pressures) to resilience (the tendency of a system to regain its functional and organizational structure after a perturbation quickly to a previous state). Within them, resilience thinking is the most frequently used concept guiding sustainable design because “change little” is very difficult, if not impossible, to achieve, not to mention “no change”. So, how to make a system return quickly to a previous state after a disturbance becomes crucial in built environments,¹²⁸ and biodiversity, along with variation from within species to across landscapes, may be crucial for the longer-term resilience of ecosystem functions and services.¹²⁹

- System Theory

System theory was developed and used by L. von Bertalanffy, a biologist, in 1968 as the basis for the multidisciplinary field of study known as “general system theory” to study “the abstract organization of phenomena, independent of their substance, type, or spatial or temporal scale of existence.”¹³⁰ It defines a system as a set of things that affect one another within an environment and form a larger pattern that is different from any of the component parts, and points out a system is always engaged in a dynamic process rather than remaining in a static balance.

¹²⁸ Norton. *Sustainability: A philosophy of adaptive ecosystem management*. (Chicago: University of Chicago Press, 2005).

¹²⁹ Oliver, Tom H et al. “Biodiversity and Resilience of Ecosystem Functions.” *Trends in Ecology & Evolution* 30, no. 11 (2015):673-684

¹³⁰ Stichweh. “Systems Theory”.

https://www.fiw.uni-bonn.de/demokratieforschung/personen/stichweh/pdfs/80_stw_systems-theory-international-encyclopedia-of-political-science_2.pdf (accessed Nov. 30, 2016)

(3) Biophilia Hypothesis

The biophilia hypothesis suggests that there is an instinctive bond between human beings and other living systems. Edward O. Wilson introduced and popularized the hypothesis in his book, *Biophilia* (1984).¹³¹ The term "biophilia" means "love of life or living systems." It was first used by Erich Fromm to describe a psychological orientation of being attracted to all that is alive and vital.¹³² Wilson uses the term in the same sense when he defines biophilia as "the urge to affiliate with other forms of life".¹³¹

Since today's "natural habitat" is largely the built environment, where we now spend 90% of our time, biophilic design, as an extension of the theory of biophilia, seeks to satisfy our innate need to affiliate with nature in the modern built environment.¹³³ Thus, the fundamental goal of biophilic design is to create an effective habitat for people as biological organisms inhabiting modern structures, landscapes, and communities.^{134, 135}

3> *Why Study Biophilia?*

In terms of the application of these theories in built environments, landscape preference theories mainly talk about the formal or abstract, compositional dimensions of the landscape, and their aesthetic impact on observers. Sustainability theory focuses more on environmental issues, especially in the areas of conservation and restoration. And certain other fragmentary environmental design theories very specifically address physical design factors aimed at ensuring or improving health and wellbeing; such factors would

¹³¹ Wilson. *Biophilia*. (Cambridge, MA: Harvard University Press, 1984).

¹³² Fromm, Erich. *The Heart of Man: Its Genius for Good and Evil*. (New York City: Harper & Row, 1964).

¹³³ Kellert, Heerwagen and Mador. *Biophilic design: The theory, science, and practice of bringing buildings to life*. (Hoboken, N.J.: Wiley, 2008).

¹³⁴ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

¹³⁵ "What Is and Is Not Biophilic Design?" *Metropolis*. Published Oct 26, 2015. <http://www.metropolismag.com/Point-of-View/October-2015/What-Is-and-Is-Not-Biophilic-Design/> (accessed Dec. 10, 2016)

include features like community safety, access to medical care, healthy food options, and community spaces that encourage healthy activities. On the other hand, biophilia cares about physical, mental and social factors, looks at both humans and nature, and discusses how to benefit both sides through innate intercommunication, and in so doing build a positive human-nature relationship. Compared with other environmental design theories with similar goals, the biophilia hypothesis is relatively new and the least understood, though it contains great potential.

Additionally, although biophilic design is quickly growing as an applied concept in environmental design, and the notion that connection to nature on a daily basis reinforces the values of respect and care for the environment that are necessary for sustainable communities is widely accepted,¹³⁶ there is little research that has measured the impact of biophilic design on environmental awareness and nature connectedness, nor proof of whether this strategy enhanced human health and wellbeing or not.

4> The Biophilia Hypothesis, Biophilic Design, Health and Wellbeing

The biophilia hypothesis proposes that humans have an inherent tendency to affiliate with natural systems and processes. Kellert and Wilson (1993) propose that biophilia is the result of a process of cultural and biological co-evolution.^{137, 138} And this evolutionary process has shed light on a basic human need – ongoing connections with the natural world. Not a cultural amenity, not an individual preference, but a universal primary need.¹³⁶

¹³⁶ Heerwagen, Judith H. *Biophilia, health and well-being*. In L. Campbell, & A. Wiesen (Eds.). *Restorative commons: Creating health and well-being through urban landscapes* (General Technical Report, NRS-P-39 ed., pp. 39-45). Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station, 2009.

¹³⁷ Wilson. *Biophilia*. (Cambridge, MA: Harvard University Press, 1984).

¹³⁸ Kellert and Wilson. *The Biophilia Hypothesis*. (Washington DC: Island Press, 1993).

This insight is key in the context of health and wellbeing because it proposes that biophilia lies at the roots of our minds, our behavioral patterns, and our physiological functioning. If we are conscientious of affinity for nature, which has been adapted and refined over millions of years, we can enhance community health and wellness through the built environment, and can offer a sense of belonging and security.¹³⁸

As is the case with most other social ecology theories, the biophilia hypothesis argues against the notion that humans are separate from nature.¹³⁹ Nature is everywhere and everywhere,¹⁴⁰ however, not all nature is equally attractive or beneficial.¹³⁶ Therefore, the question is not whether people have access to nature, but rather, what is the quality of the nature they have access to? The issue then, of whether a given space is more or less natural is reformulated as whether a space could attract people to interact with it in a positive way.

This point is further elaborated by Kellert (1996)¹⁴¹ when he considers the universal basis for how humans value the natural world. Kellert (2008),¹⁴² and numerous researchers have also provided evidence to support the notion that affiliating with healthy, rich, and productive natural systems has been shown consistently to confer physical, emotional, and social benefits, which, in turn, confer sustainable positive feedback to natural systems.^{141, 143, 144, 145} Based on this evidence, Kellert (2008)¹⁴² proposes a list of biophilic design features that most impact our satisfaction with the built environment, which is intended to

¹³⁹ Caballero. "Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age."

¹⁴⁰ Kellert. *Building for Life: Designing and Understanding the Human-Nature Connection*. (Washington DC: Island Press, 2005).

¹⁴¹ Kellert, Stephen R. *The value of life: biological diversity and human society*. (Washington D.C.: Island Press, 1996).

¹⁴² Kellert, Heerwagen and Mador. *Biophilic design: The theory, science, and practice of bringing buildings to life*. (Hoboken, N.J.: Wiley, 2008).

¹⁴³ Heerwagen. *Biophilia, health and well-being*. (Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station, 2009).

¹⁴⁴ Kahn, Peter H., & Kellert, Stephen R. *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*. (Cambridge: MIT Press, 2002).

¹⁴⁵ Caballero. "Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age."

apply the concepts of the biophilia hypothesis to the context of the built environment to make it healthy, rich, and productive.

The table below is a comprehensive list of the attributes of biophilic design (based on Kellert, 2008 and Caballero, 2013).^{146, 147} This list is divided into six broad categories: environmental features (elements that capture well recognized characteristics of the natural world); natural shapes and forms (representations and simulations of the natural world); natural patterns and processes (incorporation of properties found in nature into the built environment); light and space (qualities of light and spatial relationships); place-based relationships (the integration of culture and ecology); and evolved human-nature relationship (attributes derived from Kellert's typology of environmental values).

Table 2.2: Elements and Attributes of Biophilic Design (based on Kellert, 2008 and Caballero, 2013)

1. Environmental Features	2. Natural Shapes and Forms	3. Natural Patterns and Processes
<ul style="list-style-type: none"> • Color • Water • Air • Sunlight • Plants • Animals • Natural materials • Views and vistas • Façade greening • Geology & landscape • Habitats & ecosystems • Fire 	<ul style="list-style-type: none"> • Botanical motifs • Trees & columnar supports • Animal (mainly vertebrate) motifs • Shells & spirals • Egg, oval, and tubular forms • Arches, vaults, domes • Shapes that resist straight lines and right angles • Simulation of natural features • Biomorphology • Geomorphology • Biomimicry 	<ul style="list-style-type: none"> • Sensory variability • Information richness • Age, change and patina of time • Growth & efflorescence • Central focal point • Patterned wholes • Bounded spaces • Transitional spaces • Linked series & chains • Integration of parts to whole • Complementary contrasts • Dynamic balance & tension • Fractals • Hierarchically organized ratios & scales

¹⁴⁶ Ibid.

¹⁴⁷ Kellert, Heerwagen and Mador. *Biophilic design: The theory, science, and practice of bringing buildings to life.* (Hoboken, N.J.: Wiley, 2008).

4. Light & Space	5. Place-Based Relationships	6. Evolved Human-Nature Relationship
<ul style="list-style-type: none"> • Natural light • Filtered & diffused light • Light & shadow • Reflected light • Light pools • Warm light • Light as shape & form • Spaciousness • Spatial variability • Inside-outside spaces 	<ul style="list-style-type: none"> • Geographic connection • Historic connection • Ecological connection • Cultural connection • Indigenous materials • Landscape orientation • Landscape features that define building form • Landscape ecology • Integration of culture and ecology • Spirit of place • Avoiding placelessness 	<ul style="list-style-type: none"> • Prospect & Refuge • Order & complexity • Curiosity & enticement • Change & metamorphosis • Security & protection • Mastery & control • Affection & attachment • Attraction & beauty • Exploration & discovery • Information & cognition • Fear & awe • Reverence & spirituality

Besides, theorists, research scientists, and design practitioners from Terrapin Bright Green LLC (2014) developed “14 Patterns of Biophilic Design”¹⁴⁸ to articulate the relationships between nature, human biology, and the design of the built environment so that we may experience the human benefits of biophilia in our design applications. The table below illustrates the functions of each of the 14 patterns in supporting stress reduction, cognitive performance, emotion and mood enhancement, and the body.

¹⁴⁸ “14 Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment.” *Terrapin Bright Green*. <https://www.terrapinbrightgreen.com/report/14-patterns/> (accessed Nov 2, 2016).

Table 2.3: 14 Patterns of Biophilic Design (Terrapin Bright Green LLC, 2014)

14 PATTERNS	*	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection with Nature	* Lowered blood pressure and heart rate (Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)	Improved mental engagement/ attentiveness (Biederman & Vessel, 2006)	Positively impacted attitude and overall happiness (Barton & Pretty, 2010)
	Non-Visual Connection with Nature	* Reduced systolic blood pressure and stress hormones (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)	Positively impacted on cognitive performance (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	Perceived improvements in mental health and tranquility (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)
	Non-Rhythmic Sensory Stimuli	* Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity (Li, 2009; Park et al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)	Observed and quantified behavioral measures of attention and exploration (Windhager et al., 2011)	
	Thermal & Airflow Variability	* Positively impacted comfort, well-being and productivity (Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)	Positively impacted concentration (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	Improved perception of temporal and spatial pleasure (alliesthesia) (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschong, 1979)
	Presence of Water	* Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure (Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)	Improved concentration and memory restoration (Alvarsson et al., 2010; Biederman & Vessel, 2006)	Observed preferences and positive emotional responses (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphryes et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	Dynamic & Diffuse Light	* Positively impacted circadian system functioning (Figueiro, Brons, Plitnick et al., 2011; Beckett & Roden, 2009) * Increased visual comfort (Elyezadi, 2012; Kim & Kim, 2007)	Enhanced perception and psychological responsiveness (Alvarsson et al., 2010; Hunter et al., 2010)	
	Connection with Natural Systems			Enhanced positive health responses; Shifted perception of environment (Kellert et al., 2008)
NATURAL ANALOGUES	Biomorphic Forms & Patterns	*		Observed view preference (Vessel, 2012; Joye, 2007)
	Material Connection with Nature		Decreased diastolic blood pressure (Tsunetsugu, Miyazaki & Sato, 2007) Improved creative performance (Lichtenfeld et al., 2012)	Improved comfort (Tsunetsugu, Miyazaki & Sato 2007)
	Complexity & Order	* Positively impacted perceptual and physiological stress responses (Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)		Observed view preference (Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Purcella, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE	Prospect	* Reduced stress (Grahn & Stigsdotter, 2010)	Reduced boredom, irritation, fatigue (Clearwater & Coss, 1991)	Improved comfort and perceived safety (Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)
	Refuge	* * *	Improved concentration, attention and perception of safety (Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Wang & Taylor, 2006; Petherick, 2000; Ulrich et al., 1993)	
	Mystery	* *		Induced strong pleasure response (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood & Zatorre, 2001)
	Risk/Peril	*		Resulted in strong dopamine or pleasure responses (Kohno et al., 2013; Wang & T sien, 2011; Zald et al., 2008)

The elements and attributes list and biophilic design patterns and functions can serve as the basis for developing biophilic design items that need to be investigated and recorded, and for future indicators, items, and scales regarding participant observation and measurement of environmental awareness and nature connectedness.

Summary of Current Methodology and Types of Instrument

This section describes the methodology that has been developed. It gives insight into how community health and wellbeing will be assessed, how the level of environmental awareness and nature connectedness is to be measured, and will set out the definitions used and criteria applied. It also includes a brief description of the instruments used to implement these methodologies.

1> Measurement of Community Health and Wellbeing

With interest in evaluating community health and wellbeing on the rise, the need for information about what tools are available and best suited for the task is continuously growing. There is currently a considerable volume of reviews and assessments of how these tools measure overall health, wellbeing or quality of life in community settings. Among them, Dronavalli and Thompson's review of health and wellbeing measurement tools used for evaluating community-based interventions (2015)¹⁴⁹ is the most systematic, and fits very well with the purpose of this study.

They screened 958 abstracts, extracted 123 articles, identified 96 potential tools, and then selected and conducted an in-depth evaluation of the 27 most frequently-used measurement tools published in or after 1990. Based on the composite score assessing across all domains (Cronbach's α reliability test, test-retest, validity, population norms, responsiveness, measure of health, measure of wellbeing, subjective measure used, global assessment mad, length, clarity of questions, cross-cultural use, cost, and measurement domains).

¹⁴⁹ Dronavalli, Mithilesh and Sandra C. Thompson. "A systematic review of measurement tools of health and well-being for evaluating community-based interventions." *Journal of epidemiology and community health* 69, no. 8 (2015): 805-815.

The following five tools were rated as excellent and widely used, and each has different focus:^{150, 151, 152, 153, 154}

Table 2.4: Comparison of the Top Five Tools of Measuring Health and Wellbeing

	DEVELOPER	LENGTH	FOCUS
QOLS (Quality of Life Scale)	John Flanagan	16 items	Compares individual to an ideal standard: - Happily married with children - In a fulfilling job - Engaging with the community - Having good opportunities for recreation - With material comforts - Having good friends.
PWI (Personal Wellbeing Index)	An international collaboration (headed by Professor Cummins of Deakin University in Australia)	7 items	Very broad questioning, better for wellbeing.
CWI (Community Wellbeing Index)	A collaboration organized by Professor Forjaz of the National School of Public Health in Madrid, Spain	10 items	It is purely a community connectedness tool that focuses on the fit of the individual with the surrounding community. Community rather than individual orientation.
HRQOL (Health Related Quality of Life)	An international collaboration based in Dartmouth Medical School in USA	< 5 min	Broad Picture Based Tool, useful for chronic disease.
WHOQOL-BREF (WHO Quality of Life -Brief)	A team commissioned by WHO headed by Professor Skevington of the University of Bath, UK.	26 items	It is the longest and the most widely used of the top five tools. Detailed assessment, measures activities of daily living.

¹⁵⁰ Ibid.

¹⁵¹ Burckhardt, Carol S. and Kathryn L. Anderson. "The Quality of Life Scale (QOLS): Reliability, validity, and utilization". *Health and Quality of Life Outcomes* 1:60, 2003. <https://hqlo.biomedcentral.com/articles/10.1186/1477-7525-1-60>

¹⁵² International Wellbeing Group. *Personal Wellbeing Index: 5th Edition*. (Melbourne: Australian Centre on Quality of Life, Deakin University, 2013).

¹⁵³ Romero, Martin, David Vivas-Consuelo, and Nelson Alvis-Guzman. "Is health related quality of life (HRQoL) a valid indicator for health systems evaluation?" *Springerplus* 2, no. 1 (2013): 664-676.

¹⁵⁴ "WHOQOL: Measuring Quality of Life." *World Health Organization*.

<http://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/> (accessed Mar. 21, 2016)

However, after comparing these tools with the goals of this study and the needs of Serenbe (the study site), some problems and shortcomings have been revealed. The 16 item QOLS tool scores people by how closely they fit a certain ideal standard. But it more likely reflects the expectations of the majority, since not everyone aligns with this ideal.¹⁵⁵ The PWI seems the best choice for this study. While being brief and easy to administer, it also adequately balances health, well-being, relationships, community connectedness, and future security. Furthermore, it is frequently used in many studies that require assessment of general wellbeing.¹⁵⁶ This is also what the current study aims to do. But on the other hand, with only seven items, it cannot provide more detailed information to improve understanding of which aspects of health and wellbeing the intervention has impacted or how to amplify these effects. The CWI purposely does not measure individual characteristics, but is particularly useful to assess a community as a whole. What's more, this scale was developed only very recently, and has only been used in studies in Spain; the English-language translation of the test is still in progress.¹⁵⁷ As opposed to the CWI, the HRQOL is very much focused on individuals. It attaches meaningful pictures to a Likert scale for each question, making it very suitable for low literacy respondents.¹⁵⁸ However, the sample population of this study has a relatively high average level of education. As to reliability and validity, it is mainly used in chronic disease states, which is not the subject that this study wants to explore. The WHOQOL-Brief has been used by over one thousand

¹⁵⁵ Burckhardt and Anderson. "The Quality of Life Scale (QOLS): Reliability, validity, and utilization". <https://hqlo.biomedcentral.com/articles/10.1186/1477-7525-1-60>

¹⁵⁶ International Wellbeing Group. *Personal Wellbeing Index: 5th Edition*. (Melbourne: Australian Centre on Quality of Life, Deakin University, 2013).

¹⁵⁷ Dronavalli and Thompson. "A systematic review of measurement tools of health and well-being for evaluating community-based interventions." 805-815.

¹⁵⁸ Romero, Vivas-Consuelo, and Alvis-Guzman. "Is health related quality of life (HRQoL) a valid indicator for health systems evaluation?" 664-676.

studies all over the world, and is often employed to make comparisons between populations.¹⁵⁹ It provides a detailed evaluation of the surveyed individuals and their roles in the community, but this detailed information is inevitably accompanied by discrimination – it established a certain ideal standard of the ideal enriched life, such as “being happily married with children, in a fulfilling job, engaging with the community, having good opportunities for recreation, with material comforts and having good friends”.¹⁶⁰ While this ideal life-style may be widely agreed, not everyone follows this ideal. And its length may entail a longer administration period.

In conclusion, with the purpose of collecting general health and wellbeing data along with some detailed physical and emotional information, PWI and WHOQOL-Brief are selected as suitable tools, with a combination of the two ideal.

2> Assessment of Environmental Awareness

Current assessments of environmental awareness tend to be focused on very targeted groups, such as teachers and students of primary or higher education, environment-related practitioners, areas affected by serious environmental issues and so on. And the researchers leading these studies often develop their own surveys and scales to measure the awareness, knowledge, and attitudes of a specific population. These survey instruments and scales are too specific and targeted to be used to gain a general view of the environment. However, an instrument called the New Ecological Paradigm (NEP) Scale can be used as a guide and points to fundamental domains highlighted over and over again in these targeted studies, and so can serve as a basis or reference point for researchers

¹⁵⁹ “WHOQOL: Measuring Quality of Life.” World Health Organization.
<http://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/> (accessed Mar. 21, 2016)

¹⁶⁰ Dronavalli and Thompson. “A systematic review of measurement tools of health and well-being for evaluating community-based interventions.” 805-815.

looking to develop their own evaluation scales.^{161, 162, 163, 164, 165}

The New Ecological Paradigm (NEP) Scale, in use since 1978, is the most widely used tool used for measuring the general environmental concern and environmental worldviews of groups of people.¹⁶⁶ The NEP scale is a measure of endorsement of ‘pro-ecological’ (as opposed to narrower, more specific, and less systematically “environmental”) worldviews among groups of people.¹⁶⁷ It is used extensively the United States and in many other nations in before-and-after studies of the effects of some intervention or activity, usually applied in environmental education, outdoor recreation, and other areas where differences in behavior or attitudes are believed to be explained by underlying environmental values, worldviews, or paradigms.¹⁶⁸ The scale consists of individual responses to fifteen statements ranging from ‘strongly disagree’ to ‘strongly agree.’

The NEP scale also has been critiqued on its omission of certain elements of a pro-ecological worldview, on the weak link between NEP scale results and environmental behavior, and on the number of dimensions it captures. These factors may influence its validity (does it measure the phenomena it claims to measure?) and reliability (does it

¹⁶¹ Altaher, Hossam. “An assessment of environmental awareness in an industrial city”. *Manag Environ Q Int J* 24, no. 4 (2013): 422–451.

¹⁶² Khan, Shazli Hasan. “A study of attitude towards environmental awareness in relation to certain variables among senior secondary school students”. *Global Research Analysis* 2, no. 4 (2013): 42-44.

¹⁶³ Kuhlemeier, Hans, Huub Van Den Bergh and Nijs Lagerweij. “Environmental knowledge, attitudes and behaviour in Dutch secondary education”. *The Journal of Environmental Education* 30, no. 2 (1999): 4-14.

¹⁶⁴ Sivamoorthy, M., R. Nalini and C. Satheesh Kumar. “Environmental Awareness and Practices among College Students International.” *Journal of Humanities and Social Science Invention* 2, no. 8 (2013): 11-15.

¹⁶⁵ Sharma, Neeraj Kumar. “A Study on environmental awareness of college students in relation to sex, rural- urban background and academic streams wise.” *The Online Journal of New Horizons in Education* 4, no. 2 (2014): 15-20.

¹⁶⁶ Dunlap, Riley et al. “Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale.” *Journal of Social Issues* 56, no. 3 (2000): 425-442.

¹⁶⁷ Arcury, Thomas A., Timothy P. Johnson and Susan J. Scollay. “Ecological worldview and environmental knowledge: The ‘new environmental paradigm’”. *Journal of Environmental Education* 17, no. 4 (1986): 35-40.

¹⁶⁸ Dunlap, Riley E. “The new environmental paradigm scale: From marginality to worldwide use.” *Journal of Environmental Education* 40, no. 1 (2008): 3-18.

measure the phenomena in the same way across different populations or across time?).¹⁶⁹,
¹⁷⁰ However, no other instrument has been so widely and extensively accepted as a measure of environmental worldview thus far, and the NEP scale will continue to be valuable and used in diverse settings.^{169, 170, 171} And the growing amount of data and research will provide opportunities to test and to improve the reliability and validity of the NEP scale.

Given its undoubtable and extensive degree of acceptance and utilization, the NEP scale is the best choice for assessing community environmental awareness.

3> Assessment of Nature Connectedness

The environmental awareness dimension mentioned above aims to measure individuals' primitive beliefs concerning their relationship to the natural world, while the nature connectedness dimension was designed to tap an individual's affective, experiential connection to nature. These two concepts measure from different but mutually complementary perspectives. Their combined use would provide a more comprehensive understanding of the human-nature relationship in this study than the use of either alone.

Several scales have been created to measure how strongly an individual feel connected to the natural world. The three main scales are: The Nature Relatedness Measure (NRM), the Connectedness to Nature Scale (CNS), and the Inclusion of Nature in Self Scale (INS).^{172, 173, 174, 175}

¹⁶⁹ Hawcroft, Lucy J. and Taciano L. Milfont. "The use (and abuse) of the new environmental paradigm scale over the last 20 years: A meta-analysis." *Journal of Environmental Psychology* 30 (2010): 143-158.

¹⁷⁰ Lalonde, Roxanne and Edgar L. Jackson. "The new environmental paradigm scale: has it outlived its usefulness?" *Journal of Environmental Education* 33, no. 4 (2002): 28-36.

¹⁷¹ Lundmark, Carina. "The new ecological paradigm revisited: Anchoring the NEP scale in environmental ethics." *Environmental Education Research* 13, no. 3 (2007): 329-347.

¹⁷² Mayer and Frantz. "The connectedness to nature scale: A measure of individuals' feeling in community with nature." 503-515.

¹⁷³ Nisbet et al. "The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior." 715-740.

¹⁷⁴ Nisbet et al. "Happiness is in our Nature: Exploring Nature Relatedness as a contributor to Subjective Well-Being." 303-322.

¹⁷⁵ Schultz. "Inclusion with nature: The psychology of human-nature relations." 62-78.

Table 2.5: Comparison of the Main Three Scales to Measure How Strongly an Individual Feel Connected to Nature

	DEVELOPER	LENGTH	FOCUS
NRM (Nature Relatedness Measure)	E. K. Nisbet J. A. Zelenski S. A. Murphy	21 items (6 items in brief version)	To measure how connected to nature the participants feel at a trait level.
CNS (Connectedness to Nature Scale)	F. S. Mayer & C. M. Frantz	13 items	To measure how emotionally connected people feel to the natural world, animals, and plants. It also assesses people's perceived equality between nature and themselves. It can be used both at the trait and state level. And its validity is demonstrated by its associations with other environmental scales (such as the NEP scale stated above).
INS (Inclusion of Nature in Self Scale)	P. W. Schultz	1 item (4 items in extended version)	To measure the extent that individuals include nature as part of their identity. This scale has been proved to have a positive correlation with the NEP scale. This scale can also be used to measure how connected to nature people feel in the moment (or on a general level).

Among these tools, the Connectedness to Nature Scale (CNS) seems to be the most widely used and acknowledged tool to measure an individual's connection to nature.^{176, 177, 178, 179, 180}

Given the fact that the CNS is an extension of the NEP scale, a moderate positive correlation between them could be predicted. NEP focuses more on rational, cognitive beliefs and worldviews about humans' relationship to the natural world, while CNS measures individuals' direct experiential, affective, and behavioral connections to nature.

¹⁷⁶ Dutcher, Daniel D. et al. "Connectivity with nature as a measure of environmental values." *Environment and Behavior* 39, no. 4 (2007): 474-493.

¹⁷⁷ Frantz, Cynthia et al. "There is no 'I' in nature: The influence of self-awareness on connectedness to nature." *Journal of Environmental Psychology* 25, no. 4 (2005): 427-436.

¹⁷⁸ Mayer, F. Stephen et al. "Why Is Nature Beneficial? The Role of Connectedness to Nature." *Environment and Behavior* 41 (2009): 607-643.

¹⁷⁹ Nisbet, Zelenski and Murphy. "The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior." 715-740

¹⁸⁰ Perrin, L. Jeffrey, and Victor A. Benassi. "The connectedness to nature scale: A measure of emotional connection to nature?" *Journal of Environmental Psychology* 29, no. 4 (2009): 434-440.

These two instruments perfectly complement each other and are ideal for concurrent use in the survey to help study the individual relationship with nature comprehensively.

CHAPTER 3

METHODS

This chapter provides a detailed description of the study design and the methods employed in this study. The first section will present the theory and rationale of the experimental design. And then in the second section, each of the methods and instruments will be presented along with a description of how they were employed in the study, their internal relationship and the applied analysis strategy. Special emphasis will be given to describing the design, development, and application of the survey evaluating community health and wellbeing, environmental awareness and nature connectedness.

Theory and Rationale of the Methodology Design

The study was conducted using a mixed-methods approach, and a concurrent triangulation design, which allowed for the collection of quantitative data, to test the hypothesis, and qualitative data, to provide a context and foundation in which to situate and explain the quantitative results.

1> Why a Mixed-Methods Approach?

- Lack of precedents and references

This is the first time that a living environment was assessed from a biophilic perspective. This study is among the first to consider the impact of biophilic design on community health and wellbeing through a social ecological lens (the human-nature relationship), and is also the first to suggest that environmental awareness and nature connectedness are the core outcomes of the human-nature relationship to study the effect

of biophilic environmental design. Due to this lack of precedent, it was important to use a mixed-methods approach to collect and analyze data from multiple sources to provide a solid foundation for future related research.

- Limited time for research

In addition, the limited research period of a master's thesis does not allow for the creation and testing of a new method or tool. So, it is important and necessary to use multiple reliable instruments and methodological approaches that are already mature and proven in the data collection and analysis process.

- Interdisciplinary integration

The mixed-methods design aligns with the interdisciplinary nature of this study and its goal of integrating interdisciplinary concepts and methods by allowing for the use of tools and constructs from multiple disciplines.

2> *Why Concurrent Triangulation Design?*

- To strengthen the validity of the mixed-method study

Specifically, the mixed-method study relied on a concurrent triangulation design. In this study, qualitative and quantitative data are collected concurrently in order “to provide context and supporting explanations for a comprehensive, well-validated and substantiated analysis of the research problem”,^{181, 182} and “to strengthen the validity of the overall findings through congruence and/or complementarity”.¹⁸³

¹⁸¹ Tashakkori, Abbas M. and Charles B. Teddlie. *Mixed Methodology: Combining Qualitative and Quantitative Approaches*. Thousand Oaks, Calif: Sage Publications, 1998.

¹⁸² Tashakkori, Abbas M. and Charles B. Teddlie. *Handbook on Mixed Methods in the Behavioral and Social Sciences*. (Thousand Oaks, Calif: Sage Publications, 2003).

¹⁸³ Greene, John O. et al. “Planning and control of behavior during deception.” *Human Communication Research* 11, no. 3 (1985): 335-364.

- Exploratory character of this study

The exploratory nature of the study requires triangulation (using the results from one method to support the other, and to develop the next steps), initiation (offering new insights and perspectives), and expansion (extends the breadth of the inquiry).^{184, 185} In order to fulfill these demands, the comprehensive perspective provided by a mixed-methods approach is essential, while the triangulation design is necessary to organize substantial data collected through integrated research methods, thus avoiding wasted research resources and redundant data.

Site Selection, Study Population and Sampling Strategy

1> Rationale for Site Selection

Serenbe is an intentional community of biophilic design in southwest of Atlanta, Georgia.¹⁸⁶ It is a 1,000-acre community with two completed omega-shaped neighborhoods: Selborne and Grange.¹⁸⁷ It has plans for two other “hamlets,” Mado and Education. Mado is now under construction, and Education is still being planned. According to Serenbe’s website, it had over 400 residents as of February 2015. It was selected as the study site for several reasons relevant to the concepts of the study and site availability:

¹⁸⁴ Ibid.

¹⁸⁵ Caballero. “Nature Nurtures Nature: Measuring the Biophilic Design Elements in Childcare Centers as Related to the Developmental Outcomes of Children 34 to 38 Months of Age.”

¹⁸⁶ Sack, Kevin. "Outside Atlanta, a Utopia Rises." *New York Times*, February 23, 2009. <http://www.nytimes.com/2009/03/01/travel/01heads.html> (accessed Feb 20, 2017).

¹⁸⁷ Tabb, Phillip James. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

- Serenbe is famous for its New Urban and biophilic design, and is now receiving more and more attention.¹⁸⁸ Inspired by characteristics of serene urbanism, the design of Serenbe utilized the best qualities of both the natural landscape and urban amenities.¹⁸⁹
- Serenbe offers a level of social and ecological complexity comparable to larger sites in a smaller and more compacted system that is easier to study in its full complexity.
- Serenbe provides a great wealth of secondary data and information about social, economic, historic, cultural, environmental, and ecological issues.
- Serenbe is particularly suited for an explorative study of the human-nature relationship because, along with its rich sources of information, there is a concerted effort by the Serenbe Institute to help introduce this study to the residents and distribute the survey. Given the difficulty of short-term social ecological research, the interest of the institute and the very gracious support of the managers made it relatively easy to get a very detailed view of the site and receive adequate responses in a very limited timeframe.

2> *Study Population and Sampling Strategy*

The actual study population of this study consists of two groups. One group was residents of Serenbe, the other was Georgia residents who do not live in Serenbe. Adults who are older than 18 years old are eligible to participate in the survey. Data was collected in two ways: one, directly on site during Serenbe community events (such as the May Day Festival and Farm Tour); the other, creating a survey online by Survey Monkey (a popular online survey creation tool), and emailed the introduction and link to residents.

¹⁸⁸ Ibid.

¹⁸⁹ Berryman, Anne. "The sound of a bulldozer leads to a new vision." *New York Times*, October 16, 2005. <http://www.nytimes.com/2005/10/16/realestate/the-sound-of-a-bulldozer-leads-to-a-new-vision.html> (accessed Feb 20, 2017).

The total population of Serenbe is around 400.¹⁹⁰ The initial goal was to survey at least 80% of the population, and then to collect the same or approximate sample of non-Serenbe residents. The final number of Serenbe participants for the study was 130 (32.5%). While 80% response would be ideal it is unrealistic to expect that level of response. The 32.5% response rate is statistically representative since the obtained responses have a representative demographic range (see “Comparability Test” of Chapter 5: Results).

In addition, according to the standard sample size calculator,¹⁹¹ this sample size gave us a 95% confidence level with a 7% margin of error, which means we can be 95% sure that responses reflect the entire study population within plus or minus 7% accuracy.

In terms of the group of non-Serenbe residents, 50 responses were collected during Serenbe community events and 50 responses were bought from the audience pool of Survey Monkey. The parameters applied to the pool was: Georgia resident who is over 18, with an income level of \$25,000 or more. P value testing (T-test) was done to evaluate whether the non-Serenbe Group was comparable with the Serenbe group. The test used the demographic data (gender, age, marital status, race, level of education, income, employment status and upbringing) as reference points. These data were chosen because they were available within both groups, and, more importantly, they demonstrate many characteristics that could be used to define a person to some degree.

The test found no significant demographic difference between the Serenbe group and the non-Serenbe group (see “Comparability Test” of Chapter 5: Results and Discussion). Therefore, the data received from the Serenbe group and the non-Serenbe

¹⁹⁰ “About”. Serenbe Official Website. <http://serenbe.com/about> (accessed May. 30, 2016)

¹⁹¹ “Sample Size Calculator”. *Creative Research Systems*. <https://www.surveysystem.com/sscalc.htm> (accessed June 18, 2017)

group can be confidently combined for comparative purposes. It is possible that the pool of residents from Survey Monkey does not accurately reflect the average citizen of Georgia.

In conclusion, while not the most ideal representation or the most optimum sampling methods, they are nonetheless considered appropriate and acceptable for this exploratory study, which is intended to set a starting point and a baseline for future study of this topic.

Elements of the Study Design

The table below presents a description of the instruments, their experimental design, and rationale. Detailed information on application of each method will be described in 3.3 Qualitative Methods and 3.4 Quantitative methods.

Table 3.1: Research Tools, Methods Employed and Rationale

QUALITATIVE			
DOMAIN	INSTRUMENT	METHOD	RATIONALE
Site Investigation & Biophilic Design Description	Literature Review	Archival & online research	<ul style="list-style-type: none"> To provide preliminary data and information about the demographic, economic, social, cultural and historic context of the study site and population. To provide basic ideas regarding the concept of the community design, especially of the biophilic features.
	Photographic Survey	Unstructured Observation & Photo Documentation	<ul style="list-style-type: none"> To provide data and evidence about the general context of the study site. To record physical attributes, use conditions and interactions with users of the community biophilic designs.
	Participant Observation	Unstructured Observation & Casual Conversation	<ul style="list-style-type: none"> To provide data and evidence about the general context of the study site. To provide specific data about the outdoor activities of residents and use conditions of the community biophilic designs.

QUANTITATIVE			
DOMAIN	INSTRUMENT	METHOD	RATIONALE
Site Investigation & Biophilic Design Description	Biophilic Design Feature Survey	Structured observation	<ul style="list-style-type: none"> To provide data and evidence about the level of presence of biophilic design features of the study site. To provide a baseline for further study on the topic.
Community Health & Wellbeing	Personal Wellbeing Index (PWI) & WHO Quality of Life-Brief (WHOQOL-BREF)	Questionnaire Survey	<ul style="list-style-type: none"> To provide data about the health outcomes and wellbeing conditions of the study population.
Environmental Awareness	The New Environmental Paradigm (NEP)	Questionnaire Survey	<ul style="list-style-type: none"> To provide data about the level of environmental awareness of the study population.
Nature Connectedness	Connectedness to Nature Scale (CNS)	Questionnaire Survey	<ul style="list-style-type: none"> To provide data about the degree of nature connectedness of the study population.

Three qualitative research strategies were employed to collect a host of data about Serenbe: the selected study site, including basic descriptive information, history and culture, general information about the community and residents, the characteristics and conditions of biophilic design features, and the interaction among these biophilic designs and their users.

Quantitative methods included a biophilic design feature survey and a questionnaire survey. The biophilic design feature survey was used to collect data about the degree of presence of biophilic features in two completed neighborhoods (Selborne and Grange) of Serenbe. The questionnaire survey was distributed to two population groups (Serenbe residents and non-Serenbe residents) to collect data about general community information, basic demographic information, residents' attitudes toward their neighborhood and living environment, general level of health and wellbeing, and degree of environmental awareness and nature connectedness. Detailed information about the structure, content and development of the questionnaire will be described in section 3.4: Questionnaire Survey.

Finally, the qualitative and the quantitative results were “triangulated”, which means they were compared and integrated, in order to analyze and draw conclusions.

Figure 3.1 is a visualization of the experimental design of this project.

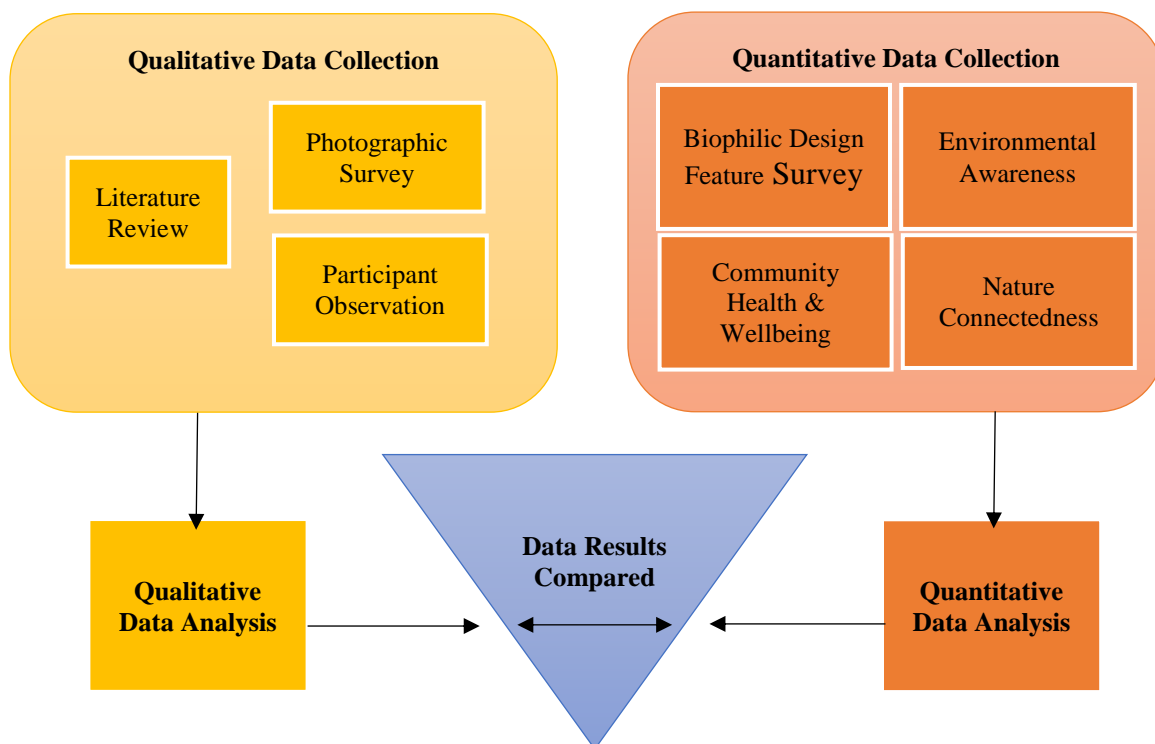


Figure 3.1: Visualization of the Concurrent Triangulated Design of the Study (based on Caballero; Tashakkori & Teddlie, 2003)

Qualitative Methods

1> Literature Review

This method integrated the techniques of media analysis and archival research. The purpose was to provide fundamental data and context to the study. Information, books, and articles were collected from the library and online resources.

The process of the literature review: first, a preliminary document survey was done to ground the study and provide fundamental information for understanding key features

of the site (demographic, economic, social, cultural and historic context), establish contacts, and design proper methods of the study. And then, a more thorough documentary survey was done to collect data and information about the biophilic concepts, design and features of the site.

The sources reviewed were: community planning documents and maps, publications of Phillip James Tabb, one of the principal designers of Serenbe, the official website of Serenbe, and a variety of materials and program information provided by the official organizations and institutions of Serenbe (the Biophilic Institute of Serenbe, the Serenbe Institute of Art, Culture and the Environment).

All the materials collected were analyzed to extract four kinds of information: socioeconomic and demographic; history and culture; health and wellbeing; and environmental design. Special emphasis was given to analyze and extract information connected in any way with community health and wellbeing, environmental and biophilic aspects of the site.

The results were presented in two ways: first, in Chapter 4: The Serenbe Community, and then throughout Chapter 5 and 6 as part of the triangulated analysis and conclusion.

2> *Photographic Survey*

Photographic surveys have made unique contributions to anthropology in three areas: the significance of bodily expression the contextual meaning of human behavior, and choreography of culture.¹⁹² The role of the photographic survey in this study is to provide data and evidence about the general context of the study site and to record physical

¹⁹² Collier, John, Malcom Collier and Edward T. Hall. *Visual Anthropology: Photography as a Research Method*. Santa Fe: University of New Mexico Press, 1986.

attributes, use conditions and interactions with users of the representative community biophilic designs.

The first photographic survey was done prior to any contact with people in Serenbe (including residents and visitors) on May 1st, 2017. The survey aimed to gain a general understanding of the physical attributes of Serenbe. Around 130 photographs were taken of significant and unique biophilic elements of the urban, sub-urban, and natural areas in the site.

A second and third survey were conducted on the May Day Festival (a community event to celebrate the spring on May 7th, 2017) and the following weekend (May 13th, 2017). The reason for conducting the surveys on holidays and weekends was to ensure adequate number of people on site. These two surveys focused on recording physical features and participants' behavior in six representative biophilic sites: the Selborne wetland trail, the Selborne urban courtyard, the Serenbe Organic Farm, the Grange Lake trail, the Grange green square, and the waterfall. An average of 10 photographs were taken for each site.

The content was analyzed at two stages of the study: first, to gain context and features of the biophilic design of Serenbe; second, to add depth to the analysis of the quantitative data. The results of the photographic survey are presented in section Chapter 4: The Serenbe Community, Chapter 5: Results and Discussion, and Chapter 6: Conclusion. Please note, all documented observations include no identifying information. Photographs were only taken with agreement of the subject, and were mainly used to record biophilic features of the community and how people interact with these biophilic designs.

3> Participant Observation

Participant observation “connects the researcher, through immersion and participation, to the hows and whys of human behavior in a particular context”,¹⁹³ and in this case is relevant to understanding how the biophilic design has involved and affected people’s daily lives. This approach would provide very helpful information because “any setting in which people have complex interaction with each other, with objects, or with their physical environment can be usefully examined through participant observation”.¹⁹³

This technique was used in this study to collect data from the six above-mentioned representative biophilic sites about the general context, physical conditions, use conditions and participant behavior within the sites. During the observations, possible casual conversations may have occurred between the researcher and participants, discussing how and how often they use the site and how they feel about interaction with the site. Beyond obtaining basic information, this approach was also used to explore possible consistencies or incongruences between what was stated in the literature review of Serenbe and the actions of the population.

The observation protocol was designed based on Patton’s five dimensions of participant observation technique.^{194, 195} Table 3.2 lists and describes these dimensions.

¹⁹³ Guest, Greg, Emily E. Namey and Marilyn L. Mitchell. *Collecting Qualitative Data: A Field Manual for Applied Research*. Los Angeles, London, New Delhi, Singapore, Washington D.C.: Sage, 2013.

¹⁹⁴ Patton, Michael Quinn. *Utilization-focused evaluation (2nd ed)*. (Newbury Park, CA: Sage, 1986).

¹⁹⁵ Patton, Michael Quinn. *Qualitative evaluation and research methods*. (Newbury Park, CA: Sage, 1990).

Table 3.2: Dimension of Participant Observation and Level of Engagement for Each Dimension (Patton, 1986 & 1990)

DIMENSION	LEVEL OF ENGAGEMENT		
Role of the observer	Onlooker: observation as outsider	Partial observation	Full participant observation
Portrayal of role to others	Covert observation: subjects do not know that observations are being made or that there is an observer	Observer's role is known by some, but not others	Overt observations: subjects know that observations are being made and who the observer is
Portrayal of study purpose	False explanation: subjects are deceived as to the study purpose	Covert explanation or partial explanation	Full explanation of real purpose to everyone
Duration of observation	Single observation: limited duration	Several observations with limited duration	Long-term multiple observations
Focus of observation	Narrow focus: Single element, component, variable	Expanded focus: predetermined set of factors or variables	Broad focus: Holistic view of the situation, setting, subjects, etc. possibly including letting variables emerge.

In this exploratory, interdisciplinary study, the observation method chosen depends on the research question, the researcher's level of involvement with the observed objects, and the time limitations. Based on these criteria, the following information and behaviors would be observed and recorded respectively at the Selborne wetland trail, the Selborne urban courtyard, the Serenbe Organic Farm, the Grange Lake trail, the Grange green square, and the water fall. See Appendix A for details about the observation protocol that was approved by the IRB.

Table 3.3: Level of Engagement and Content of Observation.

		SITE CONDITION	CHARACTERS OF PARTICIPANTS	BEHAVIORS OF PARTICIPANTS
LEVEL OF ENGAGEMENT	Role of the Observer	Onlooker: observation as outsider	Onlooker	Partial observation: casual conversation may occur
	Portrayal of Role and Study Purpose	Covert observation: subjects do not know that observations are being made or that there is an observer	Covert observation	Observer role is known by those who would be photoed or would have conversation with the researcher, but not others
	Duration of Observation	Single observation: observe for an hour	Several observations: observe respectively on weekday and weekend	Several observations: occur at the same time as the observation of characters of participants
	Focus of Observation	Expanded focus: predetermined set of factors or variables	Broad focus: holistic view of the situation, setting, subjects, etc. possibly including letting variables emerge.	Broad focus
CONTENT OF OBSERVATION		<ul style="list-style-type: none"> ● What's the function of the site? (single or multiple purpose?) ● Is it clean and tidy? ● Does it work well? ● Does it have any damages? ● Do people have easy access to it? ● Does it encourage active activities? ● Does it encourage social activities and interactions? ● Does it have any sustainable features? 	<ul style="list-style-type: none"> ● How many people are there on the site? ● Are they alone or in group? ● How is the age distribution? 	<ul style="list-style-type: none"> ● What are people doing on the site? (record all activities observed) ● Are people using the site properly? Any improper acts? <p>Questions for possible casual conversation:</p> <ul style="list-style-type: none"> ● How often do you use this place? ● What do you usually do here? ● What do you of this place? ● What aspect you think this place has impacted you or your daily life? ● Do you have any other places that you like in Serenbe? Why?

In the same manner as the photographic survey, the content of the observation and casual conversations were analyzed at two stages of the study: first, to understand the context and conditions of each site; second, to add depth to the analysis of the quantitative

data. The results of the participant observation are presented in section Chapter 5: Results and Discussion, and Chapter 6: Conclusion.

Quantitative Methods

1> Biophilic Design Features Survey

The Biophilic design features survey was conducted to provide basic information about the general condition of biophilic design in Serenbe, specifically, the degree of presence of biophilic features in Selborne and Grange, the site's two completed areas.

The selection of the final 37 study indicators, originally from Kellert (see Table 2.2: Elements and attributes of biophilic design in Chapter 2: Literature Review), was based on feasibility of measurement, redundancy and relevance in the Serenbe context. For example, some items were removed because they specifically referred to the interior space, while others were excluded because they were variations on other more suitable items. The chosen items were then categorized based on the "14 Patterns of Biophilic Design: Improving Health & Well-being in the Built Environment"¹⁹⁶ to establish the relationship between biophilic features and human health and wellbeing. Table 3.4 demonstrates descriptions and a brief definition of each indicator.

¹⁹⁶ "14 Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment." *Terrapin Bright Green*. <https://www.terrapinbrightgreen.com/report/14-patterns/> (accessed Nov 2, 2016).

Table 3.4: Description of the Biophilic Design Elements and Attributes. Based on Kellert (2008).¹⁹⁷

DOMAIN 1: NATURE IN THE SPACE		
Indicators	Definitions	
ENVIRONMENTAL FEATURES	Visual Connection with Nature	
	<ul style="list-style-type: none"> Rich colors 	Bright flowering colors, rainbows, sunsets, glistening water, blue skies, other colorful features of the natural world, natural colors (such as earth tones).
	<ul style="list-style-type: none"> Presence of water 	Presence of natural or man-made water bodies.
	<ul style="list-style-type: none"> Presence of fire 	Presence of manipulated fire (e.g. candles or fireplace).
	<ul style="list-style-type: none"> Presence of plants 	Presence of natural plants.
	<ul style="list-style-type: none"> Presence of animals 	Presence of animals: including aquaria, aviaries. Presence of some free roaming creatures (like birds). Presence of domestic animals.
	<ul style="list-style-type: none"> Preferred views & vistas 	A distant view through or along an avenue or opening
	<ul style="list-style-type: none"> Geology & landscape 	Presence of topographic change and well-designed landscape.
	<ul style="list-style-type: none"> Diverse habitats & ecosystems 	Presence of a range of habitat and ecosystem in a region (such as forest, meadow, wetland, lake etc.) .
		Non-Visual Connection with Nature
	<ul style="list-style-type: none"> Sensory variability 	Sensuous and variable environment for all senses.
NATURAL PATTERN & PROCESS	Dynamic & Organic Pattern	
	<ul style="list-style-type: none"> Age, change & patina of time 	Patina, aging elements, change over time in natural materials.
	<ul style="list-style-type: none"> Dynamic balance & tension 	The blending of varying forces often produces a quality of creative tension that transforms static forms into organic-like entities.
	<ul style="list-style-type: none"> Mimicry of organic function & process 	Designs that borrow from adaptations functionally found in nature, particularly among other species. Also known as biomimicry.
		Space & Connection
	<ul style="list-style-type: none"> Integration of parts to wholes 	Discrete parts that comprise an overall whole, especially when that whole has an emergent property comprising more than the sum of the parts.
	<ul style="list-style-type: none"> Transitional spaces 	Spaces within and between built and natural environment (include thresholds, portals, doors, bridges and fenestration).
LIGHT & SPACE	Light	
	<ul style="list-style-type: none"> Filtered & diffused light 	Modulated daylight to reduce glare.
	<ul style="list-style-type: none"> Light & shadow 	The contrast of light and dark spaces.
	<ul style="list-style-type: none"> Reflected light 	Light reflected off surfaces such as light colored walls, ceilings, and reflective bodies like water.
	<ul style="list-style-type: none"> Light as shapes & form 	Manipulation of natural light to create stimulating, dynamic, and sculptural forms.
		Space
	<ul style="list-style-type: none"> Spaciousness 	Areas that provide a feeling of spaciousness, especially as connected to smaller spaces.
	<ul style="list-style-type: none"> Spatial variability 	Multiple spaces with different sizes and proportions.
	<ul style="list-style-type: none"> Inside-outside spaces 	Spaces in the interior spaces that appear connected to the outside environment (include colonnades, porches, foyers, atriums and interior gardens).

¹⁹⁷ Kellert and Mador. *Biophilic design: The theory, science, and practice of bringing buildings to life.* (Hoboken, N.J.: Wiley, 2008).

DOMAIN 2: NATURAL ANALOGUES		
Indicators		Definitions
SIMULATION OF NATURAL FEATURES	Natural Shapes & Forms	
	• Botanical motifs	The shapes, forms and patterns of plants and other vegetative matter.
	• Animal motifs	The simulation of animal life. It can be some features (like claws or heads) rather than entire creatures.
	• Tree and columnar supports	The appearance and simulation of treelike shapes, especially columnar supports.
	• Arches, vaults, domes	Presence of arches, vaults or domes for functional or decorative purposes.
	• Shapes that resist straight lines & right angles	Shapes and forms that are sinuous, flowing and adaptive in responding to forces and pressures found in nature. Shapes that resist mechanical edges, straight lines and angles.
	Material Connection with Nature	
	• Natural materials	Presence of natural materials that age, weather, develop patina, and change dynamically over time.
	• Simulation of natural texture	Imitation of the feel, appearance, or consistency of a natural surface or substance.
	• Landscape features that define building form	Built environment that is integrated to its biophysical context.
	Complexity & Order	
	• Information richness	Amount of detail contained in a piece of textual, graphic, audio, or video information.
	• Complementary contrasts	Rendering of seeming opposites like light and dark, high and low, open and closed.
• Hierarchically organized ratios & scales	Forms that occur in hierarchically connected ways, sometimes arithmetically or geometrically related (example: golden proportion and Fibonacci ratio).	
DOMAIN 3: HUMAN-NATURE RELATIONSHIP		
Indicators		Definitions
PLACE-BASED RELATIONSHIP	Preservation & Placemaking	
	• Indigenous materials	The use of materials that are naturally and locally found in a specific place.
	• Integration of cultural & ecology	Places that integrate the history, ecology and geography of an area becoming an integral component of the individual and collective identity.
	• Spirit of place	Built environments that become life-like and serve as long-term motivational basis for stewardship and responsibility.
NATURE OF THE SPACE	Prospect & Refuge	
	• Prospect & refuge	The complementary relation between offering a secure and protected setting and the capacity to discern distant objects and habitats and horizons. Environments that meet such needs will often provide people with the capacity to observe (prospect) without being seen (refuge).
	• Exploration & discovery	Environments that contains rich information and reserved representation, which is able to arouse people's curiosity to explore and discover more.

Each of the 37 indicators received a score from 0 to 3 points. The three-point scale was designed in order to determine the level of presence of Serenbe's biophilic features: 0 for no display, 1 for apparent display, and 3 for a strong display.

As can be seen in Table 3.4, the attributes selected as indicators were grouped under their corresponding characteristics which connect closely with the factors that have been proven to have a positive impact on health and wellbeing.¹⁹⁸ The results served as subscales that allowed for a more refined analysis of the data from the questionnaire.

2> *Questionnaire*

The questionnaire was the most important component of this study. It was divided in five sections: (1) You and your community; (2) Health and wellbeing; (3) Environmental awareness; (4) Nature connectedness; (5) About you. The rationale and domain of measurement of each section will be stated below. A copy of this questionnaire is contained in Appendix B and C.

(1) Section 1: You and Your Community

This section aimed to obtain general information about the living environment, and special focus was given to the feelings of the residents and their relationships with the community. It has 38 items grouped into five domains. Table 3.5 lists the domains and their respective items.

¹⁹⁸ "14 Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment." *Terrapin Bright Green*. <https://www.terrapinbrightgreen.com/report/14-patterns/> (accessed Nov 2, 2016).

Table 3.5: Domains and Indicators of Basic Information and Relationship of the Community and Its Residents

DOMAIN	INDICATOR
1. Basic Information	1. How long have you lived in your current home?
	2. Which Serenbe community do you live in? (for non-Serenbe group, this was changed to: Urban, suburban, or rural, where do you live currently? and Single-family, multi-family, or mixed-use, which kind of community do you currently live in?)
	3. How often do you live here?
	4. Do you expect to move away from the area in the next twenty years?
1. Level of Connection with Neighborhood	5. How many of your adult relatives live within an hour drive of your home?
	6. How many of your close friends live within an hour drive of your home?
	7. Think of the ten homes closest to your own. Of those neighbors, how many have you met?
	8. How many community organizations clubs or civic groups do you belong to?
2. Reasons to Live in Your Community (Likert Scale)	Emotional Connection
	9. I've lived here all my life
	10. I grew up in the area, moved away and wanted to come back
	11. I have family and friends that live in the area
	Financial Reason & Community Resources
	12. It's a good financial investment
	13. It's a good place to raise kids
	14. I moved for job-related reasons
	15. It's an affordable place to live
	16. I enjoy the area's proximity to Atlanta
	17. I enjoy the area's proximity to airport
	Life Style
	18. I like the slow pace of life here
	19. I enjoy the recreational opportunities
	20. I enjoy the area's art and cultural programs
	21. It's a good place to get away from everyday life
	22. It's a good place to retire to
	Natural Connection
	23. I enjoy the area's natural beauty
	24. I enjoy the area's easy access to nature
	25. I enjoy the area's rural atmosphere
3. Community Ties (Likert Scale)	Interaction with neighbors
	26. I know most of the full-time residents in my community
	27. Many of my friends and family are business, church/political leaders in the area
	28. I've met most of the part-time residents in my community
	29. Other residents make me feel welcome in here
	Feelings
	30. I am very attached to my community

	31. I got more satisfaction out of being in my community than anywhere else
	32. No other place compares to my community
	33. My community means a lot to me
4. Sense of Community (Likert Scale)	34. Community events
	35. Relation with neighbors
	36. Recognize most of the people of the community
	37. Identity of community
	38. Natural environment

(2) Section 2: Health and Wellbeing

As stated in “Measurement of Community Health and Wellbeing” of Chapter 2: Literature Review, with the purpose to collect general health and wellbeing data with some detailed physical and emotional information, PWI and WHOQOL-Brief are the most suitable tools. This section used the seven domains of PWI as guides and added 24 items extracted from WHOQOL-Brief to measure how satisfied people are with their daily lives. It provided a very comprehensive window into the general community health and wellbeing. Table 3.6 lists the domains and their respective items.

Table 3.6: Domains and Indicators of General Community Health and Wellbeing Measurement (Based on International Wellbeing Group, 2013; World Health Organization, 2017; Dronavalli and Thompson, 2015)

DOMAIN	INDICATOR
	How satisfied are you with...
1. Standard of Living	
	1. Your income
	2. Your standard of material goods and necessities
	3. The quality of your built environment
	4. The quality of your natural environment
2. Personal Health	
	5. Your physical health
	6. Your emotional health
	Under this category, the following 7 items was designed to measure what factors contribute more to people’s health and wellbeing. To maintain your health and wellbeing, how frequently do you rely on ...
	7. Health care
	8. Outdoor exercise
	9. Gym exercise
	10. Healthy food
	11. Healthy products
	12. Living habits
	13. Natural environment

DOMAIN	INDICATOR
3. Achieving in Life	
	14. What you are achieving in life
4. Personal Relationships	
	15. Your relationship with your family
	16. Your relationship with your friends
	17. Your relationship with your neighbors
	18. Your relationship with your colleagues
5. Personal Safety	
	19. Your safety at home
	20. Your safety in the community
	21. Your safety around the community
6. Community Connectedness	
	22. Feeling part of your community
7. Future Security	
	23. Your life as a whole
	24. How secure do you feel about your satisfaction in the future

(3) Section 3: Environmental Awareness and Section 4: Nature Connectedness

The New Environmental Paradigm (NEP) scale and the Connectedness to Nature Scale (CNS) were chosen to measure residents' environmental awareness and nature connectedness. The reasons for the selection of these instruments were explained in "Assessment of Environmental Awareness" and "Assessment of Nature Connectedness" of Chapter 2: Literature Review.

The 15-item NEP and the 14-item CNS have been proven to support and complement each other,^{199, 200} and were very suitable to use together in this exploratory study to learn about the human-nature relationship from the perspectives of both rational, cognitive beliefs and experiential, affective feelings. Table 3.7 and 3.8 respectively list the domains and their respective items.

¹⁹⁹ Mayer and Frantz. "The connectedness to nature scale: A measure of individuals' feeling in community with nature." 503-515.

²⁰⁰ Dunlap et al. "Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale." 425-442.

Table 3.7: Domains and Indicators of Environmental Awareness Measurement (Based on Dunlap et al., 2000)

DOMAIN	INDICATOR
	Environmental Awareness
1. Reality to Limits of Growth	
	1. We are approaching the limit of the number of people the Earth can support.
	2. The Earth is like a spaceship with very limited room and resources.
2. Anti - Anthropocentrism	
	3. Humans have the right to modify the natural environment to suit their needs.
	4. When humans interfere with nature it often produces disastrous consequences.
	5. Human ingenuity will ensure that we do not make the Earth unlivable.
	6. Humans will eventually learn enough about how nature works to be able to control it.
3. Fragility of Nature's Balance	
	7. The Earth has plenty of natural resources if we just learn how to develop them.
	8. The balance of nature is very delicate and easily upset.
	9. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
4. Rejection of Exceptionalism	
	10. Plants and animals have as much right as humans to exist.
	11. Humans were meant to rule over the rest of nature.
	12. Despite our special abilities, humans are still subject to the laws of nature.
5. Possibility of An Ecocrisis	
	13. Humans are seriously abusing the environment.
	14. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
	15. If things continue on their present course, we will soon experience a major ecological catastrophe.

Table 3.8: Domains and Indicators of Nature Connectedness Measurement
(Based on Mayer, 2004; Nisbet et al., 2009; Nisbet et al., 2010)

DOMAIN	INDICATOR
	Nature Connectedness
1. Ecological Attitudes	
	1. I often feel a kinship with animals and plants.
	2. I recognize and appreciate the intelligence of other living organisms.
	3. I have a deep understanding of how my actions affect the natural world.
	4. I often feel part of the web of life.
	5. I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.
2. Lifestyle Pattern	
	6. I often feel a sense of oneness with the natural world around me.
	7. I often feel disconnected from nature.
	8. I think of the natural world as a community to which I belong.
	9. Like a tree can be part of a forest, I feel embedded within the broader natural world.
	10. When I think of my life, I imagine myself to be part of a larger cyclical process of living.
3. Real-life Decisions	
	11. I feel as though I belong to the Earth as equally as it belongs to me.
	12. My personal welfare is independent of the welfare of the natural world.
	13. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.
	14. I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.

Please note, the order of these items in both NEP and CNS scales were carefully tested and modified in the actual survey to avoid inertial thinking or misunderstanding of respondents, and thus to obtain a more objective and accurate result.^{201, 202, 203} See Appendix B and C for the actual order of the survey.

Aside from adjusting the order of questions, the score of some items were reversed as well for the same reasons. For the NEP scale, the reversed indicators are 3, 5, 7, 9, 14, 11, 6 (see Table 3.7); and for the CNS scale, the reversed indicators are 7, 12, 13 (see Table

²⁰¹ Dunlap et al. "Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale." 425-442.

²⁰² Hawcroft and Milfont. "The use (and abuse) of the new environmental paradigm scale over the last 20 years: A meta-analysis." 143-158.

²⁰³ Mayer and Frantz. "The connectedness to nature scale: A measure of individuals' feeling in community with nature." 503-515.

3.8). The overall score of each scale was calculated by averaging all items (after reverse scoring appropriate items).

(4) Section 5: About You

This section is a standard demographic survey that collected information about participants' gender, age, marital status, race/ethnicity, education level, number of adults and children in the household, income, employment status and upbringing.

This information helped evaluate the comparability between the Serenbe group and non-Serenbe group under restricted conditions. Please refer to "Study Population and Sampling Strategy" of Chapter 3: Methods for details.

(5) Quantitative Data Analysis Methods

Cronbach's α and principal components analysis was applied to each section to test instrument reliability (how items on a scale hang together). Outcomes from the Serenbe group and the non-Serenbe group were treated as a whole, and Cronbach's α tests were respectively given to health and wellbeing, environmental awareness and nature connectedness.

Then an F-test and T-test, respectively, were used to examine correlation and differences in the degree of environmental awareness and nature connectedness, health condition, and wellbeing among distinct user groups.

Apart from these standard tests, an average score comparison of the Serenbe and non-Serenbe groups and correlation analysis between length of time living in Serenbe and the level of its residents' health and wellbeing, environmental awareness and nature connectedness was given to each domain of each section to provide evidence for a more in-depth analysis.

CHAPTER 4

THE SERENBE COMMUNITY

The literature review along with site investigation of Serenbe depicts a successful environmentally sustainable model for residential land development. This section aims to share some background and context information to the creation and planning process of Serenbe, summarize the key components of the design, especially those that have contributed to community health and wellbeing through the human-nature relationship.

Context and History

Be Serene – combine the two words and you get Serenbe, a 1000-acre community that is well-known for its environmental-oriented mixed-use urban development while ensuring that at least 70 percent would remain green space.²⁰⁴

Nestled in the heart of 40,000 acres of forest in Chattahoochee Hills, but just an hour's drive from downtown Atlanta and around a 20-minute drive to the Hartsfield-Jackson International

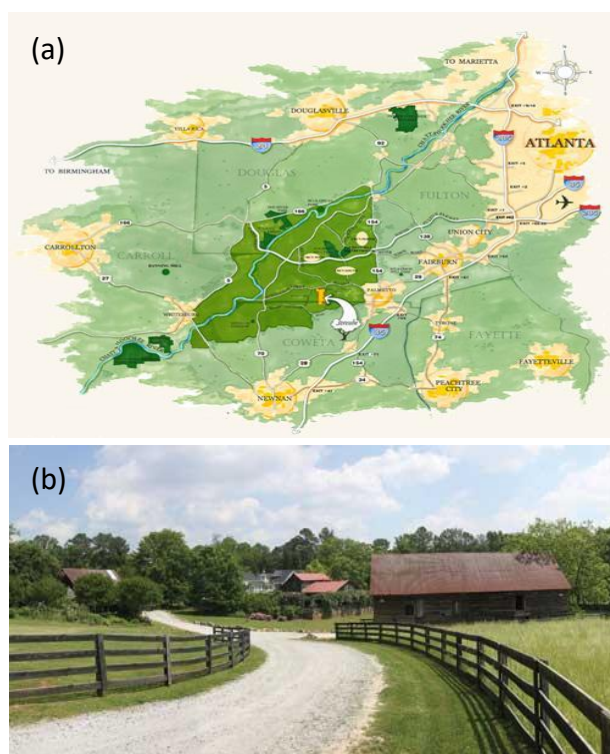


Figure 4.1 Serenbe Location:

a) Serenbe Location Map; b) The rural scene at the main entrance of Serenbe

(Source: Location map from <http://richhollenberg.blogspot.com/2011/07/paper-menus-chalk-boards-part-iii.html>; photograph by Yingting Chen)

²⁰⁴ Kimble, Megan. "Serenbe in Chattahoochee Hills, Georgia". *Terrain: A Journal of the Built + Natural Environments*. <http://www.terrain.org/2012/unsprawl/serenbe/> (accessed May. 30, 2016)

Airport – the busiest airport in US. Serenbe is connected to larger urban amenities while being in a serene rural setting.^{205, 206}

The Serenbe community's planning process commenced in 2000, but the story began with a weekend visit in 1991. Serenbe's founders, Steve and Marie Nygren, took their three daughters out to get to know the Georgia countryside,



Figure 4.2: The road to the Inn at Serenbe remains unpaved, maintaining the original property's rustic charm. (Source: photograph by Matt Hickman)

and ended up purchasing the first 60 acres of what is now Serenbe.²⁰⁷ This weekend visit transformed the life of the Nygrens: they were experiencing the serene power that seemed to be missing in their busy urban life in Atlanta. Three years later they sold their Atlanta home and relocated full-time to Serenbe.^{207, 208, 209} In the following 10 years, they purchased around 1000 acres of protected land and decided to initiate an exploratory development that has slowly grown into what Serenbe is today. The first house at Serenbe was built in 2004 and today the award-winning community is home to over 400 residents.^{206, 208}

²⁰⁵ Ibid.

²⁰⁶ Tabb. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

²⁰⁷ Kimble. *Terrain*. "Serenbe in Chattahoochee Hills, Georgia". <http://www.terrain.org/2012/unsprawl/serenbe/> (accessed May. 30, 2016)

²⁰⁸ Serenbe Official Website. <http://serenbe.com/> (accessed May. 30, 2016)

²⁰⁹ Tabb, Phillip James. "Serenbe and the Serenity of Place". Architecture, Culture, and Spirituality Symposium, 2011.

Design Concepts and Master Plan Elements

1> Development Intentions

The following original vision and goals were created during the first charrette at Serenbe, led by the Rocky Mountain Institute and documented by Georgia Tech.²¹⁰

- Focus on the essence of community formation and the interactions of people, to foster development of their potential;
- Respect for and integration of the cultural history of the surrounding area, such as agriculture;
- Preservation of permanent open space (70% was reserved for open space);
- Age diversity of inhabitants, from children to seniors;
- Economic diversity of inhabitants;
- Economic sustainability of the development effort;
- Environmental sustainability of all aspects of the development;
- High-tech, connected development to allow the integration of Serenbe with the world-at-large (at minimal environmental impact);
- Music, arts, and crafts as a theme for the development;
- The use of land trusts to achieve the desired character of the community;
- Development as a living laboratory;
- Integration of design across disciplinary, infrastructural, and philosophical dimensions;
- Inclusion of sacred geometry informing the planning process.

²¹⁰ Tabb. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

According to this list, the core factors are environmental alignment, renewable new technology, and new forms of diverse but integrated living. And understanding the concepts of environmental sustainability and their specific impacts is crucial, which determines the success of the development.

2> *Master Plan Elements – The Four Layers*

The updated master plan 2014 (Figure 4.3) illustrates the four planned mixed-use urban hamlets, and both automobile and pedestrian circulation networks. They can be categorized into four key layers:²¹¹

- **Natural Layer** – identifies generally the natural areas of the site, including: forest land, meadows, wetlands, farmland, and special features (labyrinth, wildflower hill and rock garden, the archaeological site, and water bodies such as ponds, lakes, streams and waterfalls).
- **Urbanized Layer** – the three omega-shaped hamlets and the education circle, the Crossroads cluster, commercial centers, attached housing, cottage homes, estate homes, urban greenspaces, and urban water features.
- **Circulation Layer** – automobile networks including roads, driveways, and on-and off-street parking; pedestrian networks including paths, trails, bridle paths, sidewalks, and plazas. There are about 7 miles of trails throughout Serenbe.
- **Interstitial Layer** – the transition area in between the urbanized areas, including: the forest path systems, natural waterways and features, meadows, paddocks, agriculture, recreation, archaeological sites, and special structures.

²¹¹ Tabb. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).



Figure 4.3: Serenbe Community Master Plan with Serenbe Farms (2014) (Source: Drawn by Phillip Tabb)

3> Master Plan Elements – The Omega Forms

The master plan for Serenbe calls for multiple hamlets based on English villages. Buildings were clustered along omega forms to create a greater diversity of use while reducing the need for land and disturbance (Figure 4.3). This method and arrangement provided people a face-to-face urban life, and at the same time reserved large areas of undeveloped green space at the back yard.

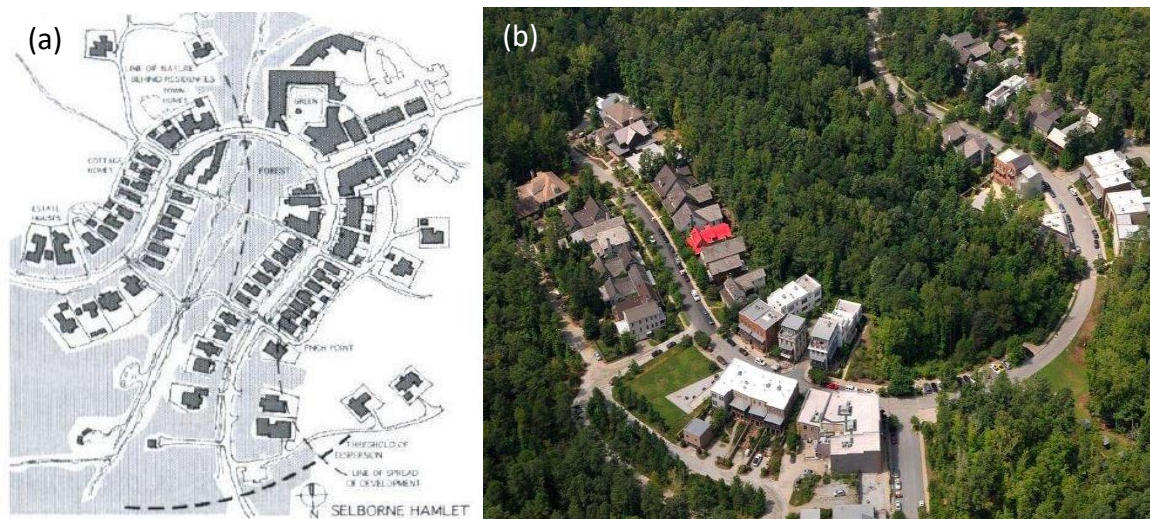


Figure 4.4 Serenbe Omega Geometry: a) Conceptual omega plan; b) Selborne omega apex (Source: Diagram drawn by Phillip Tabb; Photograph by Serenbe)

The geometry of the omega form has a very powerful presence which provides a strong sense of identity and memorable, understandable, and coherent spatial organization. A transect form called Thorburn, which was also inspired by the spatial organization of density and landscape distribution in English villages, was added to

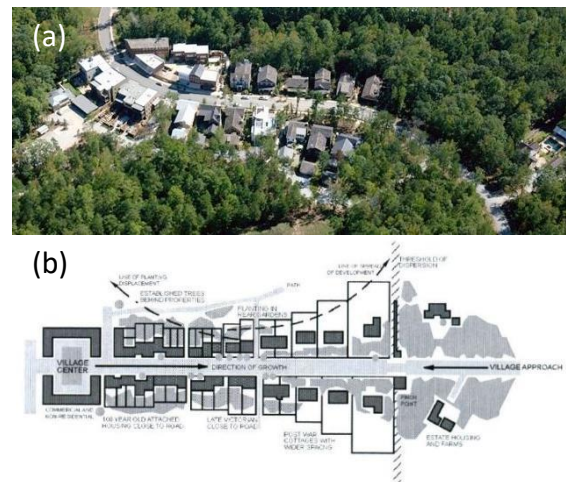


Figure 4.5 Thorburn Transect: a) Diagram of the transect; b) Transect applied to Selborne Hamlet (Source: Diagram drawn by Phillip Tabb; Photograph by Serenbe)

provide a transition from the rural character of the land to the more urban parts of the omega apex, where buildings moved closer to the road and to one another, while the landscape performed the reverse (Figure 4.4).^{212, 213}

There are five major urban design functions of this form:²¹²

- **Circle** – creating a sense of place;
- **Legs** – opening back to the community;
- **Apex** – concentrating activities at the top;
- **Open end** – connecting to the interstitial space;
- **Omega** – shaped road with varying width and functions.

4> *Master Plan Elements – The Hamlets*

The master plan of Serenbe was initially created in a three-day charrette, and then modified and refined through feedback from the owner, designers, and engineers.²¹² Derived from the natural pattern of hills and valleys, the plan was not a single massed development scheme but a constellation of four interconnected hamlet sites that were situated in the naturally defined valleys. Each of them was visually separated from one another and was paired with a distinct theme: Selborne, arts for inspiration, Grange, agriculture for nourishment, Mado, health for wellbeing, and Education, education for awareness. They work in a complementary manner to form a well-lived life and are well connected by a network of roads, paths, and greenways.^{212, 214}

²¹² Tabb. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

²¹³ Tabb, Phillip James. "Serenbe and the Serenity of Place". Architecture, Culture, and Spirituality Symposium, 2011.

²¹⁴ Berryman. "The sound of a bulldozer leads to a new vision." *New York Times*, October 16, 2005. <http://www.nytimes.com/2005/10/16/realestate/the-sound-of-a-bulldozer-leads-to-a-new-vision.html> (accessed Feb 20, 2017).

At this time, Selborne and Grange have been completed, Mado is under construction and Education is still being planned. Therefore, this study only focuses on Selborne and Grange - the two well-designed and completed hamlets. Following is a brief description of the two hamlets:

- **Selborne Hamlet** (30 acres) – The artist hamlet, with an intended focus on mixed-use activities related to the visual, performing, and culinary arts. Selborne was the first neighborhood developed, but the smallest, with around 120 dwellings.²¹⁵ The land was planned for visual art production, display, and education, and included artists' residences, live-work studio spaces, a center for art education as well as a series of supportive establishments such as a café and bake shop and some retail stores.²¹⁵ Regardless of its size, it remains the center of Serenbe today, containing the most popular urban courtyard and hosting frequent community events like the May Day Festival, the Farmers Market and the Farm Tour.



Figure 4.6 Selborne Urban Courtyard: a) Retail and Blue Eyed Daisy Bakeshop (photo by Yingting Chen; b) The May Day Festival and wish field (Photo by Serenbe)

²¹⁵ Tabb. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

- **Grange Hamlet (50 acres)** –

The farm hamlet, has associative amenities such as edible sidewalk community gardens (Figure 4.8), Serenbe Farm (Figure 4.9), the



Figure 4.7 Grange Hamlet: The aerial view demonstrates the commercial center, the Grange Lake and Serenbe Organic Farm (Source: photograph by Serenbe)

equestrian center, and a farmer's market. At the center of the hamlet is a commercial center with a bookstore, a restaurant and some retailers, and opposite to it is a green open space with a pavilion and mail collection boxes, which serves as an urban gathering place.²¹⁶ Two of the hamlet's best features are a 5-acre lake, which provides a focus on outdoor activities and a tranquil view, and the Serenbe Farm. By using drip irrigation to minimize water usage and three kinds of organic farming methods (composting, cover cropping, and crop rotation), the 30-acre certified organic farm breeds 350 varieties of vegetables, herbs, flowers, fruit, and mushrooms. It serves the local farm-to-table restaurants, general stores, Serenbe residents, and even the nearby neighbors and farm cooperative.²¹⁶

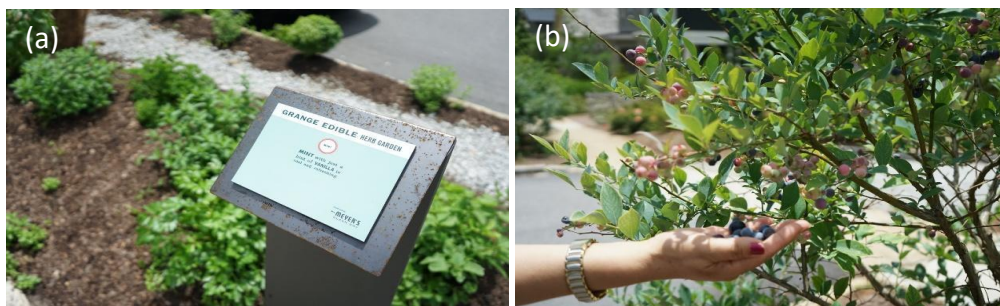


Figure 4.8 Community Edible Gardens: a) Herb Garden; b) Blueberries on sidewalks. (Source: Photograph by Yingting Chen)

²¹⁶ Serenbe Official Website. <http://serenbe.com/> (accessed May. 30, 2016)

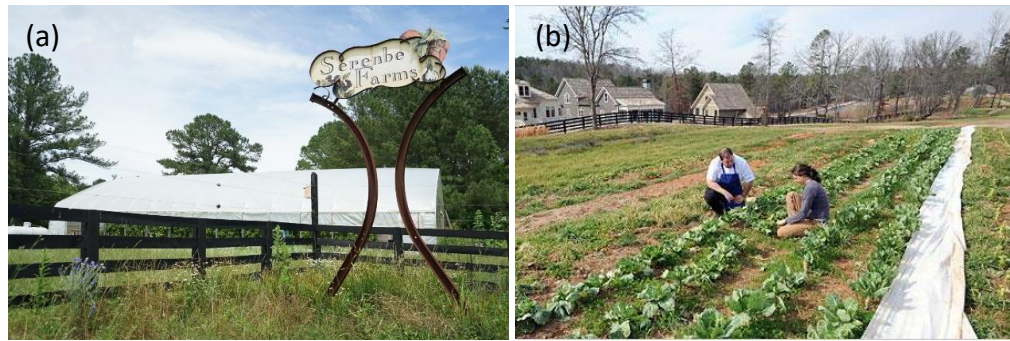


Figure 4.9 Serenbe Organic Farm: a) Farm sign at the gate (photo by Yingting Chen); b) Nick Melvin, left, chef at the Inn at Serenbe, and Paige Witherington, farm manager, at Serenbe Organic Farms (photo by Erik S. Lesser for The New York Times <http://www.nytimes.com/2009/03/01/travel/01heads.html>)

5> *Architecturalizing the Plan*

“If you want to change the world, you should start in your own backyard.” This is what Serenbe founders Steve and Marie Nygren believe and the motivation for Serenbe’s founding.²¹⁷ The initial intention for Serenbe was to create an environmentally sustainable community (as opposed to the suburban sprawl model) that is different from normal New Urbanism developments, where individual personality is less tolerated. While adopting set guidelines to ensure the “green” design and sustainability (such as construction quality, design integrity, the use of an appropriate range of materials etc.), Serenbe honors individual rights of personal expression. Residents were given enough space and freedom to decide their own architectural and landscape design.^{218, 219} The variety of building types as well as architectural languages also become one of the most charming characteristics of Serenbe.

²¹⁷ Ibid.

²¹⁸ Sack. "Outside Atlanta, a Utopia Rises." *New York Times*, February 23, 2009. <http://www.nytimes.com/2009/03/01/travel/01heads.html> (accessed Feb 20, 2017).

²¹⁹ Tabb, Phillip James. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

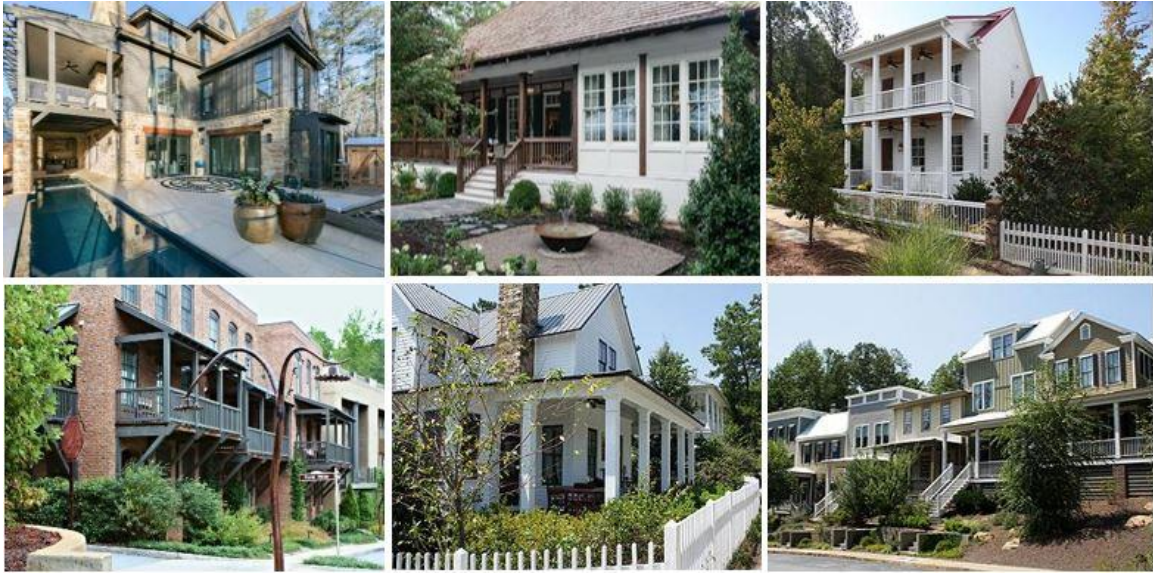


Figure 4.10: Variety of Building Types and Architectural Languages at Serenbe (Source: Photo by Yingting Chen)

The Culture and Nature of Serenbe

The human-nature cultural dimension of Serenbe is important not only for sustainable objectives, but also for community health and wellbeing. In many ways, it has come to be regarded as the most important accomplishment achieved by the development.

Sustainability and biophilia are the two major theories applied at Serenbe to create a place of growth and restoration—a place to foster deep connections and connect with living systems. The sustainable and biophilic approaches employed at Serenbe follow both recommendations for sustainable urbanism and green architecture.²²⁰ In 2008, the Urban Land Institute Inaugural Sustainability Award was awarded to Serenbe to recognize the following categories in which it has built beneficial connections between humans and the natural world:

²²⁰ Ibid.

1> Land Preservation and Integrated Agriculture

As stated previously, Serenbe preserved 70 percent of its land for open spaces, agriculture, forest land, and other natural features. These spaces are a valuable amenity to residents and visitors, providing easy access to interactions with nature, recreation, and exercise-serene experiences.^{221, 222}

Except for the natural world, the farm-to-table concept is another iconic sustainable feature of Serenbe. Approximately 2.5 acres were allocated for Serenbe Organic Farms, of which 2 acres adjacent to Mado Hamlet were planned for resident allotment gardening. One of the largest and most wide-reaching goals at Serenbe Farms is to empower all generations with hands on experience and skills to build a positive food future. It is “a source for local organic food, a place for nurture and nature, a place to get your hands dirty, a place of inspiration and reflection, a place to celebrate the seasons and their bounty, a farm to create and sustain the future”.²²³



Figure 4.11 Serenbe Farm: a) Farm Tour on every Saturday; b) Apprenticeship Program - We Grow Farmers; c) Volunteers are helping in the farm (Source: Serenbe Farm website <https://serenbefarms.com/education>)

2> Density and Mixed-Use

The zoning code for Chattahoochee Hills allows Serenbe to have a maximum of 1,000 dwellings (1 unit per acre). However, Serenbe applied for a much more condensed

²²¹ Ibid.

²²² Serenbe Official Website. <http://serenbe.com/> (accessed May. 30, 2016)

²²³ Serenbe Farms website. www.Serenbefarms.com/ (accessed June 13, 2017)

plan – to distribute 900 dwelling units on 300-acre of land (3.3 units per acre).²²⁴ This high-density approach created more beneficial open spaces with correspondingly more compact development that optimizes the utilization of resources and energy. On the other hand, living closer also increases interaction and engagement among residents, and therefore enhances community ties and vitality.

3> *Networks and Infrastructure*

The hamlets are connected with both automobile roadways and pedestrian path networks; the former tend to be curvilinear while the latter is more gridded and leads into the nearby woods and meadows. Parking is along one side of the road and in small remote lots scattered in the interstitial spaces of the hamlets.²²⁴

The monthly water usage for Serenbe as a community is 25 percent lower than the national average because Serenbe employed an innovative water-waste system – the constructed wetland – to treat and recycle water on site.²²⁵ Gray and black wastewater are collected in individual cisterns located on each residential property. Then, after a series of treatments to separate solids and send only water into the constructed wetlands, vegetation, soil, bacteria and other organisms work together as a biofilter system to remove pollutants. The treated water is then piped to irrigate nearby farms and meadows (Figure 4.12).^{224, 226}

²²⁴ Tabb, Phillip James. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

²²⁵ Kimble, Megan. “Serenbe in Chattahoochee Hills, Georgia”. *Terrain*. <http://www.terrain.org/2012/unsprawl/serenbe/> (accessed May. 30, 2016)

²²⁶ Todd, Nancy Jack and John P. Todd. *From Eco-Cities to Living Machines: Principles of Ecological Practice*. (Berkeley, CA: North Atlantic Books, 1993).



Figure 4.12 Constructed Wetlands: a) Conceptual section diagram; b) Boardwalk; c) Vegetated wetlands; d) Turtles in wetlands (Source: Diagram drawn by Phillip Tabb; Photograph by Yingting Chen)

4> Green Architectures

There is abundant evidence of sustainable architectural at Serenbe. These architectural features respond to phenomenal causes rather than static formal effects. Contemporary architecture, modeled according to vernacular styles and climate-driven features, is a representative model for many of the homes at Serenbe. They are built to respond to environmental effects (such as temperature, precipitation, wind, and solar energy), rather than according to a predetermined appearance that is reliant on the past.²²⁷

²²⁷ Tabb, Phillip James. *Serene Urbanism: A biophilic theory and practice of sustainable placemaking*. (Abingdon, UK: Routledge, 2016).

These green constructions tie daily life closely with nature. They encourage people to adjust to the natural environment and seasonal changes, rather than separate from nature and create a completely contrasting indoor environment.



Figure 4.13 Green Constructions: a) Photovoltaic installation; b) Building with solar panels on the roof; c) HGTV Green Home; d) Bosch Net-Zero House; e) & f) Blue Eyed Daisy Bakeshop and its LEED certification (Source: a) Photograph by Phillip Tabb; b) to f) Photograph by Yingting Chen)

5> Community Culture and Programs

Serenbe is a friendly place with many social activities and opportunities. A full range of events unfold throughout the year (such as Serenbe farmer's and artist's markets, Farmer's Markets, Farm Tours, Trails Tours, Camp Serenbe, the Serenball, the Serenbe Films, the May Day Festival etc.). Most of these are hosted outdoors to bring people together in nature, to enjoy interactions with fellow neighbors and visitors, and to enhance the instinctive bond between humans and other living systems.



Figure 4.14 Serenbe Community Events: a) Serenball Dinner under the stars; b) Serenbe Playhouse – Robin Hood; c) Camp Serenbe; d) Yoga in the great outdoors at Serenbe; e) Weekly Farmer's Market (Source: Serenbe Events website <http://serenbe.com/events>)

CHAPTER 5

RESULTS AND DISCUSSION

In this chapter the data obtained with the questionnaire was used to address the hypothesis that “Biophilic design will bring a higher level of environmental awareness and nature connectedness (as expressed by a higher score in the environmental awareness and nature connectedness survey), which is significantly correlated to higher quality of health and wellbeing outcomes of residents in the study scale”. And to answer the three key questions of this study:

- **Key question 1:** Can biophilic design improve community health and wellbeing in built environments through raising environmental awareness and nature connectedness?
- **Key question 2:** Is there any difference of the level of health and wellbeing between Serenbe residents and non-Serenbe residents? If so, does the difference come from the impact of biophilic environmental design? If not, why?
- **Key question 3:** Does the level of environmental awareness and nature connectedness significantly correlate to community health and wellbeing? If so, how? If not, why?

The study relied on a mixed-methods approach and a concurrent triangulation design, which consists of both qualitative and quantitative data. Therefore, qualitative and quantitative results were presented concurrently and triangulated in this chapter to fully explore the following experimental questions:

- What attributes inform, guide or determine the current biophilic features at Serenbe?
- What is the condition of biophilic designs at Serenbe?
- How do the residents use these biophilic designs? What attitude and thoughts do they have toward these designs?
- What new and valuable insights can be gained through the survey to help improve community health and wellbeing by biophilic design?

Biophilic Design Features Survey

As discussed above, biophilic design fosters a direct connection to nature and the natural process. Table 4.1 shows the level of presence of biophilic design features at Selborne and Grange (see Table 3.4 in Chapter 3: Methods for definition of each indicator). Representative features include an intense engagement with nature, framed views and easy access to the woods, water features, diverse habitats and ecosystems, and stone and wood building materials appropriate to rural and more natural settings etc.

Table 5.1 Biophilic Design Features Survey: The presence of biophilic features at the Selborne and the Grange

Legends: √ Selborne ○ Grange 3 – Strong, 2 – Apparent, 1 – Not Displayed				3	2	1
NATURE IN THE SPACE	Environmental Features	Visual Connection with Nature	• Rich color	√ ○		
			• Presence of water	○	√	
			• Presence of fire		√	○
			• Presence of plants	√ ○		
			• Presence of animals	√ ○		
			• Preferred views & vistas	○		√
			• Geology & landscape	○	√	
			• Diverse habitats & ecosystems	√ ○		
			Non-Visual Connection with Nature	• Sensory variability (sight, smell, hearing, touch, vision)	○	√
	Natural Pattern & Process	Dynamic & Organic Pattern	• Age, change & patina of time		√	
			• Dynamic balance & tension	√	○	
			• Mimicry of organic function & process	√		○
		Space & Connection	• Integration of parts to wholes	√ ○		
			• Transitional spaces	√ ○		
	Light & Space	Light	• Filtered & diffused light	√ ○		
			• Light & shadow	√ ○		
			• Reflected light	○		√
			• Light as shapes & form		√	○
		Space	• Spaciousness	√ ○		
			• Spatial variability	√ ○		
			• Inside-outside spaces	√ ○		

Legends: √ Selborne ○ Grange 3 – Strong, 2 – Apparent, 1 – Not Displayed				3	2	1		
NATURAL ANALOGUES	Simulation of Natural Features	Natural Shapes & Forms	• Botanical motifs		√ ○			
			• Animal motifs		√ ○			
			• Tree and columnar supports	√	○			
			• Arches, vaults, domes	√	○			
			• Shapes that resist straight lines & right angles	√ ○				
		Material Connection with Nature	• Natural materials	√ ○				
			• Simulation of natural texture	√ ○				
			• Landscape features that define building form	√ ○				
		Complexity & Order	• Information richness	√ ○				
			• Complementary contrasts	√ ○				
			• Hierarchically organized ratios & scales	√ ○				
		NATURE OF THE SPACE	Place-Based Relationship	Preservation & Placemaking	• Indigenous materials	√ ○		
					• Integration of cultural & ecology	√ ○		
• Spirit of place	√ ○							
Evolved Human-Nature Relationship	Prospect & Refuge		• Prospect & refuge	√ ○				
			• Exploration & discovery	○	√			

The biophilic design features at Serenbe occur in fairly obvious ways. In this survey, both Selborne and Grange demonstrated a high level of presence of biophilic design features. The most representative ones are:

- Physical and visual connections to nature;
- Natural thermal and airflow variability;
- Presence of plants, animals and water;
- Dynamic and diffused light;
- Diversity of habitats and ecosystems;
- Preferred views and vistas;
- Biomorphic patterns;
- Vernacular natural materiality;
- Places of refuge and protection for exploration and discovery.



Figure 5.1 Vista Views: a) Serenbe horse farm;
b) Serenbe meadows
(Source: <http://serenbe.com/community>)

Each omega creates an urban place of refuge, with constant visual and physical connection to woods, wildflower meadows, and water bodies. Along with the diffused light and natural shading, breezes are captured and directed into individual dwellings to create a comfortable microenvironment. Plants and animals, domestic and wild, are seen throughout Serenbe. The air is filled with the sweet aroma of gardenia, the sounds from birds and horses, the whispering from streams and falling leaves, and the laughter from the crowds. Mint, rosemary, blueberry, peach, and loquat are waiting to mature on sidewalks and in front yards. Architectural materials are mostly natural or rural in character, marked with the traces of the flow of time. Everyday passage from the residential cluster to the commercial areas provides an encounter with the natural world.



Figure 5.2 Serenbe Water Features: a) Stream at Selborne; b) The Grange Lake; c) The waterfall
(Source: Photograph by Yingting Chen)



Figure 5.3 Serenbe Trails: a) Wetland trail; b) Woodland trail; c) The path leading to the Grange Lake
(Source: Photograph by Yingting Chen)



Figure 5.4 Serenbe Community Gardens: a) Community edible garden; b) & c) Peach trees and blueberries on sidewalk at Grange; d) & e) A front yard landscape (Source: Photograph by Yingting Chen)



Figure 5.5 Serenbe Animals: a) Wild pollinator; b) Squirrel on Georgia pine; c) Swans in Grange Lake; d) Farm horses; e) Mother goat and her kid (Source: a) to c) Photograph by Yingting Chen; d) & e) photograph by Serenbe)





Figure 5.6 Serenbe Biomorph Patterns & Natural Materiality: a) Sprout-like Light Post; b) Wood and stone building with facade greening and oil lamp; c) Stone wall and wood fence; d) Peacock statue; e) Piglet stone paint statue (Source: Photograph by Yingting Chen)

Participant Observation


Observations were conducted three times (one on May 7, the May Day Festival; one on May 18, a normal weekday; one on May 20, a normal weekend) in six representative biophilic sites – the Selborne wetland trail, the Selborne urban courtyard, the Serenbe Organic Farm, the Grange Lake trail, the Grange green square, and the waterfall – to study the hows and whys of human behavior in a particular context, which in this case is to what extent the biophilic design has penetrated and affected people’s daily lives (see Appendix A for observation protocol). Table 4.2 listed the integrated results from each site from the three observations.


Table 5.2 Participant Observation: Participants’ behavior and general physical condition of the six representative biophilic sites of Serenbe

1. SELBORNE WETLAND TRAIL						
Users			Condition			
Number of Users	Alone or in Group	Age	Function	Condition	Accessibility	Iconic Biophilic Features
Resident – 2 Visitor – 5	Alone – 0 Group – 6	Child – 2 Adult – 5 Elder – 0	- Walking trail; - Water treatment	Good	Good, but a bit far from the urban/commercial area	- Wetland; - Water treatment; - Mimicry of organic function & process; - Preferred views & vistas
Opinions and Comments from Users						
<ul style="list-style-type: none"> ● Use frequency: average once or twice per month ● Use purpose: to walk for exercise; to let their child to contact and get to know nature ● Other thoughts: - good opportunities to see wildlife. - too many bugs, especially when it gets dark. - shading is not good. 						
Related Photo Records						
						
Source: Photograph by Yingting Chen						


2. SELBORNE URBAN COURTYARD						
Users			Condition			
Number of Users	Alone or in Group	Age	Function	Condition	Accessibility	Iconic Biophilic Features
Resident – 9 Visitor – varied, more than 50	Alone – 3 The remaining were in groups	Child – varied, more than 10 Adult – varied, more than 50 Elder – 7	- Visual art production, display, and education; - Artists' residence; - Live-work studio space; - Café and bake shop and some retails	Very good	Very good	- Rich information; - Sensory variability; - Natural materials; - Green building; - Good greening and landscaping; - Physical and visual connection to nature; - Presence of plants, animals, fire, water - Biomorphic patterns - Integration of culture and ecology
Opinions and Comments from Users						
<ul style="list-style-type: none"> ● Use frequency: average three to four times per week; some daily attendance ● Use purpose: to have breakfast/lunch/dinner; to shop; for community services; to gather with families or friends; to participate in community events ● Other thoughts: - good gathering place; - enjoyable food and events; - nice shading and temperature with ample seating. 						
Related Photo Records						
						
Source: Photograph by Yingting Chen						

3. SERENBE ORGANIC FARM						
Users			Condition			
Number of Users	Alone or in Group	Age	Function	Condition	Accessibility	Iconic Biophilic Features
Resident – Varied, more than 10 Visitor – varied, more than 50	Alone – 5 The remaining were in groups	Child – more than 20 Adult – more than 50 Elder – 8	The farm: - Production - Education The green space: - Gathering space - Community events such as farmer’s market, the May Day Festival etc.	Good	Very Good	- Natural materials; - Open green space; - Organic farming; - Farm-to-table; - Integration of culture and ecology - Spirit of place
Opinions and Comments from Users						
<ul style="list-style-type: none"> ● Use frequency: average three to four times per week ● Use purpose: to let their child have contact with nature in a safe open space; to do outdoor exercise; to gather with family or friends; to participate in community events ● Other thoughts: - good open green space. - good opportunities to see wildlife, such as squirrels and sometimes deer. - may become muddy after rain. - the lawn is not very well maintained. 						
Related Photo Records						
<p>Source: Photograph by Yingting Chen</p>						

4. THE GRANGE LAKE TRAIL						
Users			Condition			
Number of Users	Alone or in Group	Age	Function	Condition	Accessibility	Iconic Biophilic Features
Resident - 6 Visitor - 2	Alone - 2 Group - 6	Child - 0 Adult - 8 Elder - 0	- Swimming; - Fishing; - Boating; - Relaxing; - Gathering space	Good	Good, close to the residential area, connected via small paths.	- Lake habitats; - Presence of water, plants and animals; - Preferred views & vistas; - Sensory variability; - Light & shadow; - Natural and diffused light; - Reflected light; - Geology & landscape; - Prospect & refuge
Opinions and Comments from Users						
<ul style="list-style-type: none"> ● Use frequency: average once or twice per month (more frequent during summer) ● Use purpose: to do outdoor exercise such as walking and yoga; to do water-related activities such as fishing, boating, swimming; to relax in nature; to let their children have contact with and get to know nature ● Other thoughts: - good opportunities to see wildlife <ul style="list-style-type: none"> - good place to enjoy nature - not safe for children to play here on their own - lack of supportive facilities for water-related activities 						
Related Photo Records						
						
Source: Photograph by Yingting Chen						

5. THE GRANGE GREEN SQUARE						
Users			Condition			
Number of Users	Alone or in Group	Age	Function	Condition	Accessibility	Iconic Biophilic Features
Resident – 3 Visitor – 4	Alone – 0 Group – 7	Child – 3 Adult – 4 Elder – 0	- Green open space; - Gathering space	Good	Good, opposite to the commercial center of Grange	- Natural materials; - Green open space; - Light & shadow
Opinions and Comments from Users						
<ul style="list-style-type: none"> ● Use frequency: average once or twice per week ● Use purpose: to let their children have contact with and get to know nature; to gather with family or friends ● Other thoughts: good green open space with pavilion, cabin and stables 						
Related Photo Records						
						
Source: Photograph by Yingting Chen						

6. THE WATERFALL						
Users			Condition			
Number of Users	Alone or in Group	Age	Function	Condition	Accessibility	Iconic Biophilic Features
Resident – 3 Visitor – 0	Alone – 0 Group – 5	Child – 0 Adult – 2 Elder – 1	- Gathering and relaxing space	One of the connecting bridges to the residential area was damaged by storm, but was already under repair	Good, although a bit far from living area, but there are clear way-finding signs	- Preferred views & vistas; - Presence of water and plants; - Stream habitat where precious rock outcrops grow; - Sensory variability; - Light & shadow; - Natural and diffused light; - Reflected light; - Geology & landscape; - Prospect & refuge

Opinions and Comments from Users
<ul style="list-style-type: none"> ● Use frequency: average once or twice per month (more frequent during summer) ● Use purpose: to let their children have contact with and get to know nature; to relax and enjoy the cool water with family or friends (most of them love the feeling of stepping into water) ● Other thoughts: - very cool and interesting place <ul style="list-style-type: none"> - the best place to get away from everyday life - the trail is need of maintenance (perhaps because the Mado hamlet is still under construction) - they've never paid attention to the rock outcrops here, and were surprised to discover they are so valuable.
Related Photo Records
 <p>The collage consists of six photographs arranged in two rows of three. The top row shows a dirt path through a forest, a wooden structure made of branches, and two people sitting on a rock by a stream. The bottom row shows a waterfall, a field of white flowers, and a dense bush of white flowers.</p>
<p>Source: Photograph by Yingting Chen</p>

All these biophilic sites are in a good condition, have effective accessibility and are used and maintained properly. Among these six sites, the most popular ones are the Selborne urban courtyard and the Serenbe Farm open space, where a variety of community events are often held. Both Serenbe residents and visitors like gathering in this place; some residents come here every day while some visitors drive an hour from Atlanta with their families to spend the weekend here. The Selborne wetland trail, as the trail closest to the Selborne urban courtyard, seems much more popular than the Grange Lake trail. Compared

with Selborne, the Grange is more peaceful and quiet, and most users are residents and their close friends. The organic farm and the lake are the crown jewel of this neighborhood, and provide an intimate connection with the natural world that benefits residents' daily lives. The waterfall has the least visitors, but there is no doubt it is the most numinous place at Serenbe, a place where visitors can communicate with nature through all their senses, get away from everyday life and find inner peace.

The Relationship between Environmental Awareness, Nature Connectedness, and Health and Wellbeing

This section presented and discussed the quantitative data collected through the questionnaire. First of all, due to the limitation of the sample size and sampling methods stated previously (see “Study Population and Sampling Strategy” in Chapter 3: Methods), P value testing was conducted on the demographic data of both groups to see whether there was a significant difference and thus to prove whether these two groups were comparable. Then, Cronbach's α test was conducted to test whether these questions could accurately represent the category. Based on the results, a few questions were dropped in order to raise the representation to an acceptable level. After that, the residuals were tested by F-test to examine correlation between environmental awareness, nature connectedness, and health and wellbeing outcomes. At last, a descriptive percentage distribution analysis was given to each domain of each section, along with the qualitative and quantitative evidence stated above, to support a more in-depth analysis and discussion on the outcomes, findings and insights.

1> Comparability Test

Although it has been proved that the data collected had statistical significance such that we could be 95% sure that the true percentage of the population was between 43% to 57% (see “Study Population and Sampling Strategy” of Chapter 3: Methods), the small sample size (32.5% of the total Serenbe population) and non-random sampling method significantly influenced representation of the data, so a delimitation test was necessary and crucial. In this study, the Welch two sample T-test was chosen to evaluate whether the Serenbe population was comparable with the non-Serenbe group. The demographic data was an ideal reference, since it was available in both groups and was widely accepted as representative of many characteristics that could be used to define a person to some degree.

Table 5.3 The Serenbe Group & the Non-Serenbe Group: Demographic Data

<i>Serenbe Demographic Index</i>	Percentage Distribution	Median	Mean	SD	n
<i>(A) Gender</i>	Female – 59.23% Male – 40.77%	Female		0.49	(130)
<i>(B) Age</i>	84 – Max 25 – Min 36 – 10.94% 43 – 8.59% 33 – 6.25%	43	47.51	14.13	(128)
<i>(C) Marital Status</i>	Married – 60.63% Living with partner – 26.77% Divorced – 7.09% Never married – 3.15% Separated – 2.36%	Married		1.31	(127)
<i>(D) Race</i>	Caucasian – 90.63% Asian – 4.69% African American – 2.34% Hispanic/Latino – 2.34%	Caucasian		0.96	(128)
<i>(E) Education</i>	Bachelor – 38.76% Masters – 22.48% Attended college but no degree – 18.60% Some graduate work – 21.97% Associate’s or vocational degree – 3.10% PHD – 1.55% High school or GED – 0.78%	Bachelor		1.55	(129)

<i>(F) Members in House Hold</i>	<i>Adults</i>	3 – 73.23% 2 – 17.32% 1 – 7.09% 4 – 2.36%	3	2.71	0.63	(127)
	<i>Children</i>	0 – 42.52% 1 – 33.07% 2 – 17.32% 3 – 5.51%	1	0.91	1.01	(127)
<i>(G) Income</i>		\$150,001 to \$250,000 – 41.46% \$75,001 to \$150,000 – 28.46% \$250,001 or more – 24.39% \$50,001 to \$75,000 – 2.44% \$25,001 to \$50,000 – 1.63% \$25,000 or less – 1.63%	\$150,001 to \$250,000		1.00	(123)
<i>(H) Employment</i>		Full-time – 71.65% Retired – 12.60% Part-time – 9.46% Self-employed – 5.51% Stay at home parent/caregiver – 0.79%	Full-time		0.79	(127)
<i>(I) Upbringing</i>		Medium-sized city – 29.23% Metropolitan city – 28.46% Small city – 18.46% Small town – 16.92% Very small town – 4.62% Rural – 2.31%	Medium-sized city		1.31	(130)
Non-Serenbe Demographic Index						
		Percentage Distribution	Median	Mean	SD	n
<i>(A) Gender</i>		Female – 51.04% Male – 48.96%	Female		0.49	(96)
<i>(B) Age</i>		65 – Max 26 – Min 30 – 10.75% 34 – 9.68% 32 – 8.60%	35	38.35	8.76	(93)
<i>(C) Marital Status</i>		Married – 65.93% Never married – 17.58% Living with partner – 10.99% Divorced – 3.30% Separated – 2.20%	Married		1.95	(91)
<i>(D) Race</i>		Caucasian – 73.68% Asian – 11.58% African American – 9.47% Hispanic/Latino – 5.26%	Caucasian		1.39	(95)
<i>(E) Education</i>		Masters – 55.21% Bachelor – 29.17% Some graduate work – 6.25% Attended college but no degree – 5.21% High school or GED – 3.13% Associate's or vocational degree – 1.04%	Masters		1.37	(96)

<i>(F) Members in House Hold</i>	<i>Adults</i>	2 – 69.23% 1 – 16.48% 3 – 10.99% 4 – 3.30%	2	2.01	0.64	(91)
	<i>Children</i>	0 – 67.78% 1 – 16.67% 2 – 11.11% 3 – 4.44%	0	0.52	0.86	(90)
<i>(G) Income</i>		\$50,001 to \$75,000 – 34.44% \$75,001 to \$150,000 – 21.11% \$150,001 to \$250,000 – 17.78% \$25,001 to \$50,000 – 16.67% \$250,001 or more – 7.78%	\$50,001 to \$75,000		1.24	(90)
<i>(H) Employment</i>		Full-time – 85.26% Part-time – 7.37% Retired – 5.26% Unemployed – 2.11%	Full-time		0.94	(95)
<i>(I) Upbringing</i>		Medium-sized city – 32.29% Metropolitan city – 23.96% Small city – 18.75% Small town – 17.71% Very small town – 5.21% Rural – 2.08%	Medium-sized city		1.29	(96)

Median: the median value of a range of values;

Mean: an average;

SD: the standard division, which is used to quantify the amount of variation or dispersion of a set of data values;

n: the number of responses.

Table 5.4 The Serenbe Group & the Non-Serenbe Group: Demographic Difference

<i>Demographic Index</i>	Mean		t	n	
	Serenbe	Non-Serenbe		Serenbe	Non-Serenbe
<i>(A) Gender</i>	1.41	1.49	1.22	(130)	(96)
<i>(B) Age</i>	47.51	38.35	-5.93***	(128)	(93)
<i>(C) Marital Status</i>	1.76	2.16	1.74	(127)	(91)
<i>(D) Race</i>	1.28	1.72	2.62*	(128)	(95)
<i>(E) Education</i>	5.12	5.96	4.27***	(129)	(96)
<i>(F) Members in House Hold</i>					
<i>Adults</i>	2.71	2.01	-7.97*	(127)	(91)
<i>Children</i>	0.91	0.52	-3.06*	(127)	(90)
<i>(G) Income</i>	4.80	3.59	-7.59***	(123)	(90)
<i>(H) Employment</i>	1.31	1.29	1.31	(127)	(95)
<i>(I) Upbringing</i>	4.53	4.46	0.36	(130)	(96)

***p<.001, **p<.05, *p<.10.

There were no differences between the Serenbe group and non-Serenbe group with regards to gender, marital status, employment status, or upbringing ($p>0.1$). Differences existed in race and members of the household, but these differences were not significant ($p>0.05$). Significant differences emerged in age, level of education and income, which were consistent with expectations.

Most residents of Serenbe are Caucasians, while the number of African Americans and Asians in Georgia is considerable. Age, education, and income level had the most significant as well as the most predictable differences since Serenbe is known as a wealthy community, where the average price for one house is around \$400,000.²²⁸ Generally speaking, income is positively correlated with age and level of education, based on Table 4.3, and so it is obvious that respondents of the Serenbe group have a higher education level (22.48% hold master's degrees, 1.55% hold Ph.D. degrees) and are older ($M = 47.51$, $SD = 14.13$) than those of non-Serenbe group (38.55% hold a bachelor's degree or lower; age $M = 38.35$, $SD = 8.76$).

To conclude, except for a few inevitable differences that were unique to the Serenbe and non-Serenbe groups, there were no significant demographic differences between the two populations. That is to say, the Serenbe group and non-Serenbe group can be confidently combined for comparison and the results were representative.

2> *Reliability Test*

When analyzing quantitative results from a questionnaire survey, a reliability test is a standard step which is usually conducted at the very beginning. The purpose of this step is to test whether the questions developed can represent corresponding categories or

²²⁸ *Serenbe Farms website*. <http://www.Serenbefarms.com/> (accessed June 13, 2017)

not.^{229, 230} In this test, the Serenbe and non-Serenbe groups were combined, then a Cronbach's α test was respectively given to health and wellbeing, environmental awareness, and nature connectedness.

The reliability of the initial CNS scale was acceptable ($\alpha=0.73$) (an acceptable level is $\alpha\geq 0.7$), and the reliability of the health and wellbeing scale ($\alpha=0.78$) and the NEP scale was fairly high ($\alpha = 0.81$). In order to raise the level of reliability to an ideal level ($\alpha\geq 0.8$) as much as possible while avoiding sacrificing too many items, the three questions that yielded the worst inter-item correlations were dropped (two concerning health and wellbeing, one for the CNS scale). The final results and dropped questions:

Table 5.5: Level of Reliability and Dropped Questions

Scale	Cronbach's α	Dropped Questions
<i>Health and Wellbeing</i>	0.8	Personal Health <ul style="list-style-type: none"> • How much do you rely on gym exercise to maintain your health? • How much do you rely on health products to maintain your health?
<i>NEP Scale</i>	0.81	None
<i>CNS Scale</i>	0.75	Lifestyle Pattern <p>How much do you agree with...</p> <ul style="list-style-type: none"> • I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.

3> Correlation Test between Environmental Awareness, Nature Connectedness, and Health and Wellbeing Outcomes

This is the core section of this study, which provides statistical evidence to test the hypothesis of this study. A series of questions with a 5-point scale were devised to assess

²²⁹ Dunlap et al. "Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale." 425-442.

²³⁰ Mayer and Frantz. "The connectedness to nature scale: A measure of individuals' feeling in community with nature." 503-515.

the level of environmental awareness (15 items), nature connectedness (original – 14 items, revised – 11 items), and health and wellbeing (original - 24 items, revised - 23 items). Three sets of items were averaged together for an index of corresponding categories.

Then a F-test was conducted within the Serenbe group and between the Serenbe and non-Serenbe group to see whether biophilic design has produced a higher level of environmental awareness and nature connectedness, which is significantly correlated to higher quality of health and wellbeing. In addition, we conducted partial correlations to determine the extent to which the variance (the seven sub scales) in the health and wellbeing could be explained by the NEP or the CNS.

Table 5.6 The Serenbe & the Non-Serenbe Group: Correlation between the Outcomes of the NEP Scale, the CNS Scale, and Health and Wellbeing

Health and Wellbeing	NEP	CNS	CNS^a	NEP^b
<i>As a Whole</i>	9.87***	36.82***	28.76***	11.50***
<i>Consider Sub Scales:</i>				
<i>(A) Standard of Living</i>	3.51*	21.84***	18.81***	4.89**
<i>(B) Personal Health</i>	9.19**	3.81**	0.42	8.82**
<i>(C) Achieving in Life</i>	12.53***	15.25***	8.28**	14.34***
<i>(D) Personal Relationship</i>	0.16	0.03	0.09	0.12
<i>(E) Personal Safety</i>	0.06	17.18***	25.25***	0.17
<i>(F) Community Connectedness</i>	18.30***	5.97**	0.92	15.76***
<i>(G) Future Security</i>	15.74***	20.99***	12.79***	14.69***

***p<.001, **p<.05, *p<.10.

CNS^a: CNS as the major factor, taking the effects of NEP into consideration.

NEP^b: NEP as the major factor, taking the effects of CNS into consideration.

Table 5.7 The Serenbe Group & the Non-Serenbe Group: Difference between the Outcomes of the NEP Scale, the CNS Scale, and Health and Wellbeing

Index	Mean		t	n	
	Serenbe	Non-Serenbe		Serenbe	Non-Serenbe
<i>Health & Wellbeing</i>	3.95	3.54	-8.99***	(119)	(93)
<i>NEP (Environmental Awareness)</i>	3.88	3.28	-9.71***	(124)	(94)
<i>CNS (Nature Connectedness)</i>	3.64	3.37	-4.63***	(123)	(92)

***p<.001, **p<.05, *p<.10.

These two tests demonstrated that:

- The level of health and wellbeing, environmental awareness and nature connectedness of the Serenbe group were all significantly higher than the non-Serenbe group ($p < .001$);
- Both the NEP and the CNS were positively significantly correlated with health and wellbeing ($p < .001$);
- When taking into account the effect of the NEP, the CNS was positively significantly correlated with health and wellbeing ($p < .001$);
- When taking into account the effect of the CNS, the NEP was positively significantly correlated with health and wellbeing ($p < .001$);
- Consider the seven sub-scales of health and wellbeing, most items of the NEP and the CNS were positively significantly correlated with the sub scales. The differences emerged in: (1) either the NEP scale nor the CNS scale is significantly correlated with personal relationship; (2) the NEP scale has no correlation with personal safety; (3) the correlation between the CNS and personal safety remained significant when controlling for NEP, while the correlation between the NEP and health and wellbeing were not significant when controlling for CNS. However, when it comes to community connectedness, the result was exactly opposite.

Not surprisingly, for either the NEP scale and the CNS scale, both were positively significantly correlated with community health and wellbeing. It also proved the argument that the NEP and the CNS are measuring different things (this was also observed by Mayer

and Frantz in 2004),²³¹ and provided evidence for the discriminant and convergent validity of using NEP and CNS concurrently.

4> The Impact of Biophilic Design on Environmental Awareness, Nature Connectedness, and Health and Wellbeing

Although the significant positive-correlation between the NEP, the CNS, and health and wellbeing was demonstrated above, a new critical question emerged: was the high level of health and wellbeing, environmental awareness and nature connectedness the outcome of biophilic design and a good connection with nature of Serenbe, or did these people chose to live in Serenbe because they have a higher level of health and wellbeing, environmental awareness, and nature connectedness?

Combined with the findings from the qualitative and quantitative data analyses, the following discussion aims to find out whether this correlation came from the impact of biophilic design and a connection with nature. Table 4.8 presents a summary of the differences between the Serenbe group and the non-Serenbe group based on the average score in each domain of each section. And table 4.9 is the result of a regression F-test for the Serenbe group to examine whether there is a correlation between the length of time living in Serenbe and the other three scales.

²³¹ Mayer and Frantz. "The connectedness to nature scale: A measure of individuals' feeling in community with nature." 503-515.

Table 5.8 The Serenbe Group & the Non-Serenbe Group: Average Score and the Level of Difference of Each Section of Relation with Community, Health and Wellbeing, Environmental Awareness, and Nature Connectedness

		Serenbe	Non-Serenbe	Comparison	t
RELATION WITH COMMUNITY	Reasons to Live in Current Community				
	Emotional Connection	1.70	2.34	-	-7.22***
	Financial Reason & Community Resources	2.62	2.56	+	-3.61*
	Life Style	3.05	2.35	+++	-2.78***
	Natural Connection	3.40	2.73	+++	-3.46***
	Community Ties				
	Interaction with Neighbors	3.01	2.61	++	-2.24**
	Feelings	3.57	2.72	+++	-5.51***
	Sense of Community				
		4.03	3.36	+++	-8.98***
HEALTH AND WELLBEING	Standard of Living				
		3.78	3.23	+++	-7.22***
	Personal Health				
	Physical Health	3.87	3.51	++	-4.67**
	Emotional Health	4.02	3.5	+++	-4.23***
	Reliance on certain factors to maintain health				
	Health care	3.07	3.04	+	-7.99
	Outdoor exercise	4.03	3.73	++	-9.71***
	Gym exercise	3.57	3.64	-	-4.20*
	Healthy food	4.33	3.99	++	-9.12***
	Healthy products	3.02	3.31	-	-4.63**
	Living habits	4.02	3.86	+	-2.02**
	Natural environment	4.12	3.77	++	-3.88***
	Achieving in Life				
		3.88	3.46	++	-3.78***
	Personal Relationships				
		3.90	3.80	+	-3.51***
	Personal Safety				
		4.05	3.84	+	-2.24***
	Community Connectedness				
		4.08	3.06	+++	-8.58***
	Future Security				
	4.08	3.47	+++	-6.98***	

	Serenbe	Non-Serenbe	Comparison	t
ENVIRONMENTAL AWARENESS	Reality to Limits of Growth			
	3.58	3.26	++	-2.92**
	Anti-Anthropocentrism			
	3.71	2.99	+++	-8.49***
	Fragility of Nature's Balance			
	3.73	3.13	+++	-6.35***
	Rejection of Exceptionalism			
	4.23	3.61	+++	-6.89***
NATURE CONNECTEDNESS	Possibility of An Ecocrisis			
	4.18	3.48	+++	-7.01***
	Ecological Behavior			
	3.84	3.43	++	-5.61***
	Lifestyle Pattern			
	3.53	3.41	+	0.64
Real-life Decisions				
	3.53	2.96	+++	-6.35***

Serenbe > non-Serenbe: + (difference>0); ++ (difference≥.3); +++ (difference≥.5)

Serenbe < non-Serenbe: –

***p<.001, **p<.05, *p<.10.

Table 5.9 The Serenbe Group: Correlation between the Length of Time Living in Serenbe and the Level of Health and Wellbeing, Environmental Awareness and Natural Connectedness

<i>Intercept – Length of Time Living in Serenbe</i>	t Stat	F	n
<i>Health and Wellbeing</i>	1.41	2.00	(119)
<i>NEP (Environmental Awareness)</i>	3.54	12.57***	(124)
<i>CNS (Nature Connectedness)</i>	3.91	15.27***	(123)

***p<.001, **p<.05, *p<.10.

Findings:

- Although Serenbe was built in 2000, most respondents of the survey have lived here no more than 5 years. So, memories or nostalgia contributed very little to their choice to live in Serenbe. What matters to them is the healthy and sustainable lifestyle and connection to the beautiful natural world.

- The financial benefits and living, working or education resources (such as financial investment, affordability, kids raising, proximity to Atlanta or airport etc.) are not the primary reasons residents live in Serenbe.
- As expected, Serenbe hosts many community events to promote interaction and communication among residents, which has proven to produce positive sentiment and significantly enhanced connectedness and a sense of community.
- For both physical or emotional health, the Serenbe group scored significantly higher than the non-Serenbe group. This positive influence is even more apparent in the domain of emotional health. With its rich recreational opportunities, farm-to-table programs and easy access to nature, the people of Serenbe rely much more than non-Serenbe residents on outdoor exercise, healthy food and natural environments to maintain their health.
- The rural context of Serenbe can be seen as both a strength and weakness. On one hand, it imbues Serenbe with the serene power that seems to be missing in busy urban life; on the other hand, two thirds of Serenbe residents think that proximity to the urban resources of Atlanta and the airport is still important to them.
- The Serenbe group has a significantly higher score than non-Serenbe group in every domain of environmental awareness and nature connectedness. However, this trend was slightly less when it came to connectedness to nature. The score for the lifestyle pattern which measures the feeling of oneness with the natural world was consistent with the non-Serenbe group even though they absolutely have better and easier connections with nature overall. This inconsistency is

worth more in-depth study in order to deepen our understanding of the human-nature relationship, and to improve the application of biophilic design.

- The length of time living in Serenbe has no significant influence on residents' health and wellbeing, however Serenbe residents are significantly healthier than the comparison group. It is very interesting to find that a positive correlation emerged in the other two scales. It seems that the longer people live in Serenbe, the higher their environmental awareness and nature connectedness will be.

To conclude, the opportunities of connecting and interacting closely with nature, which is provided by the biophilic designs, has significantly contributed to community health and wellbeing. So far, the hypothesis of this study has been proved to be correct: biophilic design has brought a higher level of environmental awareness and nature connectedness, which is significantly correlated to a higher quality of health and wellbeing outcomes of residents in the study scale.

CHAPTER 6

CONCLUSION

Methodological Conclusions

Based on the inter-rater reliability and the statistical analysis presented in Chapter 5: Results and Discussion, it can be concluded that the health and wellbeing scale, the NEP, and the CNS have a valid internal structure. In addition, the NEP and the CNS are appropriate and recommended to use together due to their high correlation and the functional complementarity. Therefore, from a statistical perspective, the survey developed by this study can be considered an adequate instrument to document and analyze the impact of biophilic design on community health and wellbeing. However, due to the limitations of sample size and sampling methods (see “Study Population and Sampling Strategy” in Chapter 3: Methods), this conclusion is tentative.

In addition, the length of the questionnaire was questionable. For the Serenbe group, 38% of the total responses were collected from onsite visits with a face-to-face request (which was considered a bit “forced”). Even before distributing the survey, the Environmental Committee of the Serenbe Institute conducted talks that many of the residents had attended to introduce this study, but only 87 responses (22% of the total population of Serenbe) were collected through the online survey while 10% of them stopped half way through (so only 79 of them were considered useful). Therefore, even though all data collected are meaningful, it is necessary to discuss the hierarchy of questions and reduce length by one-third to ease the process of data collection.

The responses from the Serenbe group were mostly positive. While there is no specific reason to doubt the accuracy of these responses, it must be acknowledged that there is a possible bias that Serenbe residents may have over-scored items that they thought would make Serenbe look good. To build confidence in these results, future studies should include residents of additional communities with a range of urban, suburban and rural contexts. Presumably, any individual is slightly biased toward reporting positively about their own community so a direct comparison to another community rather than a control group of ‘non-Serenbe residents’ would help to equalize that possible bias.

Experimental Conclusions

1> Answers to Key Hypothesis and Questions

- **Hypothesis:** Biophilic design will bring a higher level of environmental awareness and nature connectedness (as expressed by a higher score in the environmental awareness and nature connectedness survey), which is significantly correlated to higher quality of health and wellbeing outcomes of residents in the study scale.
- **Key Question 1:** Can biophilic design improve community health and wellbeing in built environments through raising environmental awareness and nature connectedness?
- **Key Question 2:** Is there any difference in the level of health and wellbeing between Serenbe residents and non-Serenbe residents? If so, does the difference come from the impact of biophilic environmental design? If not, why?
- **Key Question 3:** Does the level of environmental awareness and nature connectedness significantly correlate to community health and wellbeing?

By integrating the statistical analysis and qualitative results, the findings fully support the hypothesis that a higher level of environmental awareness and nature connectedness is significantly correlated to a higher quality of community health and wellbeing.

And this result significantly, if not fully, comes from the impact of high quality of biophilic design. The encouragement and fulfillment of our innate tendency to seek connections with nature and other forms of life was proven to significantly benefit community health and wellbeing through positively influencing physical fitness, stress reduction, cognitive performance, and emotion, mood and preference.

2> Answers to Sub-Questions

- **Sub-Question 1:** What attributes inform, guide or determine the current biophilic features at Serenbe – the study site?

The literature review and site investigation have both proven that the environmental design of Serenbe follows the elements and attributes of biophilic design developed by Kellert (2008) and the recommendations from owners and developers for sustainable urbanism and green architecture. In a nutshell, the environmental design of Serenbe is informed, guided and determined by both biophilia hypotheses and sustainability theory. These two aspects are not mutually exclusive, but complement and promote each other to create a place to grow and restore, a place to integrate serene nature and vital urbanism, a place to foster our intimate bond with other living systems, and a place where we are more human with an ineffable higher presence.

Representative biophilic patterns at Serenbe:

- Physical and visual connection to nature;
- Natural thermal and airflow variability;
- Presence of plants, animals and water;
- Dynamic and diffused light;
- Diversity of habitats and ecosystems;
- Preferred views and vistas;
- Biomorphic patterns;
- Vernacular natural materiality;
- Places of refuge and protection for exploration and discovery.

Representative sustainable features at Serenbe:

- Land preservation (70% of its land was preserved for green space while only 30% was used for development);
- High density and concentration of built form;
- Mixed of use;
- Integrated agriculture;
- Innovative water-waste systems;
- Adequate automobile and pedestrian networks and circulation create nice connection between the hamlets as well as the urban life and the natural world;
- Efficient architectural designs and construction practices.

- **Sub-Question 2:** What is the condition of biophilic designs at Serenbe?

As reported above, both qualitative and quantitative data support that biophilic designs at Serenbe have a considerable density, good accessibility, and are well-maintained

and in good condition. But there are also some deficiencies that influence the user experience, such as the smell and bugs of wetlands, the erosion and ponding problem of meadows and woodlands, the lack of maintenance of the trail and inability to repair damages in a timely manner, among other issues.

- **Sub-Question 3:** How do the residents use these biophilic designs? What attitude and thoughts do they have toward these designs?

During the multiple site visits, all adults and children were using the biophilic sites as expected and no improper behaviors that may cause damage were observed. Based on casual conversations, the top three reasons for using the sites are: (1) To do outdoor exercises; (2) To let their children have with contact and get to know nature; (3) To get away from everyday life.

It is worth noting that most of the biophilic sites were not utilized daily by the residents interviewed, and more than half of the users are visitors rather than Serenbe residents. The questionnaire survey also revealed that environmental awareness and nature connectedness have little effect on personal relationships (see Table 4.6), and the abundant community events that are held frequently seem more attractive to visitors. These observations are worth further in-depth study in order to improve the applications of biophilic design. But from another perspective, this phenomenon also proved the irresistible tendency of human beings to seek connections with nature and other forms of life even if they need to drive many miles away.

- **Sub-Question 4:** What new and valuable insights can be gained through the survey to help improve community health and wellbeing through biophilic design?

Except for the personal relationship stated above, another noticeable discrepancy is the relatively low, although still positive, response regarding the feeling of oneness with nature, even though residents strongly agreed with anti-anthropocentrism, rejected exceptionalism, and deeply realized the limits of growth, the fragility of nature's balance, and the possibility of an ecocrisis. It seems like residents of Serenbe care deeply about the natural world and they try not to harm it, but they do not feel they are an integral part of it as a tree in the forest. Based on observations and conversations, some possible elements arose that may have overshadowed nature as priority in a living environment: fear of allergies, disease, and injury. The closer you are to nature, the more serious these negative effects would be. Although these issues are not irresolvable, it would require more time and effort than is sometimes unavailable.

These considerations raise the issue of how to incorporate advanced techniques and concepts to realize the goals of integration and emergence in design. The quality of a space is not just the density and amount of the natural elements, but also of the coherent integration and harmonious relation of these elements.

Another valuable insight is the discovery of a tendency that the longer people live in Serenbe, the higher their environmental awareness and nature connectedness will be. This is strongly suggestive evidence in favor of the notion that a high level of environmental awareness and nature connectedness is due to the impact of biophilic design, which also significantly benefits the residents' health and wellbeing. However, because the

survey lacks precedent and has not been fully tested, there is no definite way to determine if what seems like a high score or quality is actually high, or if this is indeed a standard, if not lower, score compared with similar communities that emphasize the role of nature in human life.

It is interesting that the length of residency did not have a statistical impact on health and well-being, although Serenbe residents score significantly higher on the overall measures of health and well-being. One explanation is that the benefits of living in close proximity to nature are immediate – showing up in both new and long-term residents. Another explanation could be that the type of people that are attracted to purchase homes in Serenbe are already healthier and more active people. Future study will help to resolve these questions.

The rapidly growing concern regarding lack of connection to nature, as well as the increased knowledge of the living environment that has arisen from biophilic design, might mean that the results of a related study in this area might provide more insights or even be very different in a few years. In any case, the finding of this study supports the idea that the presence of biophilic features has a significant beneficial effect, and nature should no longer be neglected as a significant source of health and wellbeing.

Suggestion for Future Research

Once again, due to the lack of precedents, the exploratory nature of this study, the complexity of this phenomena, and the bias and confusing discrepancy discovered during the analysis, while the results look very promising, it is necessary to test this study with larger samples in a longer duration to obtain more definitive conclusions. With an attempt to help realize the truth of the human-nature relationship and increase community health

and wellbeing, following are some possible and important directions that is worth considering in future research:

- (1) Increasing the sample size and research duration to obtain more reliable and representative responses.
- (2) Using more targeted control groups with a contextual range from urban, suburban to rural for comparison, rather than randomly selecting respondents in Georgia.
- (3) The amount, order and phrasing of questions of the questionnaire survey should be carefully retested and adjusted to obtain adequate, reliable and objective responses.
- (4) Details about the degree of closeness to nature and the type of contact of nature, as well as the correlation between the length of time living in Serenbe and the degree of health and wellbeing, environmental awareness and nature connectedness are worth well studying. Which would help explain some irrational results, and could be a strongly convincing evidence on whether the positive results come from the impact of biophilic design, or it just because of the positive nature of the respondents.
- (5) Repeat the survey on a regular interval to collect long-term trends.
- (6) Survey individuals before and after moving to Serenbe in order to determine the impact and timing of living in a biophilic context on health and wellbeing.

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APPENDIX A

OBSERVATION PROTOCOL

Study Area and Frequency

The design for Serenbe Community is a constellation of four interconnected hamlet sites – Selborne, Grange, Mado and Education. Each hamlet is visually separated from one another, and is paired with a distinct theme: arts for inspiration, agriculture for nourishment, health for wellbeing and education for awareness. The Selborne and Grange hamlets are completed, Mado is currently under construction, and the education hamlet is still being planned. Based on this master plan, the site investigation and observation would be conducted respectively in these three existing well-defined areas.

Three times of observation were conducted. One on May 1st, 2017. The survey aimed to gain a general understanding of the physical attributes of Serenbe. A second and third survey will be conducted on the May Day Festival (a community event to celebrate the spring on May 7th, 2017) and the following weekend (May 13th, 2017). These two surveys focused on recording physical features and participants' behavior in six representative biophilic sites: the Selborne wetland trail, the Selborne urban courtyard, the Serenbe Organic Farm, the Grange Lake trail, the Grange green square, and the waterfall. An average of 10 photographs were taken for each site.

Biophilic Design Features Survey

The following form would be use to record biophilic design features of the Selborne and the Grange.

Legends: 3 - Strong, 2 - Apparent, 1 - Not Displayed				3	2	1
NATURE IN THE SPACE	Environmental Features	Visual Connection with Nature	● Rich colors			
			● Presence of water			
			● Presence of fire			
			● Presence of plants			
			● Presence of animals			
			● Preferred views and vistas			
			● Facade greening			
			● Geology and landscape			
			● Diverse habitats and ecosystems			
			● Easy access to nature			
	Non-Visual Connection with Nature	● Auditory Variability				
		● Haptic Variability				
		● Olfactory Variability				
		● Gustatory Variability				
	Natural Pattern & Process	Dynamic & Organic	● Growth, change and patina of time			
			● Dynamic balance and tension			
		Space & Connection	● Integraion of parts to wholes			
			● Transitional spaces			
Light & Space	Light	● Filtered and diffused light				
		● Light and shadow				
		● Reflected light				
		● Light as shapes and form				
	Space	● Spaciousness				
		● Spacial variability				
		● Inside-outside spaces				

Legends: 3 - Strong, 2 - Apparent, 1 - Not Displayed				3	2	1
NATURAL ANALOGUES	Simulation of Natural Features	Natural Shapes & Forms	● Botanical motifs			
			● Tree and columnar supports			
			● Animary motifs			
			● Shells & Spirals			
			● Egg, oval and tubular forms			
			● Arches, vaults, domes			
			● Shapes the resist straight lines and right angles			
			● Biomorphy and biomimicry			
		Material Connection with Nature	● Natural materiality			
			● Simulation of natural texture			
Complexity & Order	● Information richness					
	● Complementary contrasts					
	● Hierarchically organized ratios and scales					
HUMAN-NATURE RELATIONSHIP	Place-Based Relationship	Preservation & Placemaking	● Indigenous materials			
			● Landscape features that define building form			
			● Integration of cultural and ecology			
			● Sustainability			
			● Spirit of place			
	Involved Human-Nature Relationship	Prospect & Refuge	● Security and protection			
			● Mastery and control			
			● Affection and attachment			
		Mystery & Risk/Peril	● Attraction and beauty			
			● Curiosity and enticement			
● Exploration and discovery						
● Fear and awe						
● Reverence and spirituality						

Participant Observation

Participant observation demonstrate the hows and whys of human behavior in a particular context, which in this case is how much the biophilic design has involved and affected people's daily life.

The observation would be conducted in six representative biophilic sites – the Selborne wetland trail, the Grange Lake trail, the Serenbe Organic Farm, the waterfall, the Selborne urban courtyard, and the Grange green square.

The following information and behaviors would be observed and recorded.

		SITE CONDITION	CHARACTERS OF PARTICIPANTS	BEHAVIORS OF PARTICIPANTS
LEVEL OF ENGAGEMENT	Role of the Observer	Onlooker: observation as outsider	Onlooker	Partial observation: casual conversation may occur
	Portrayal of Role and Study Purpose	Covert observation: subjects do not know that observations are being made or that there is an observer	Covert observation	Observer role is known by those who would be photoed or would have conversation with the researcher, but not others
	Duration of Observation	Single observation: observe for an hour	Several observations: observe respectively on weekday and weekend	Several observations: occur at the same time as the observation of characters of participants
	Focus of Observation	Expanded focus: predetermined set of factors or variables	Broad focus: holistic view of the situation, setting, subjects, etc. possibly including letting variables emerge.	Broad focus
CONTENT OF OBSERVATION		<ul style="list-style-type: none"> ● What's the function of the site? (single or multiple purpose?) ● Is it clean and tidy? ● Does it work well? ● Does it have any damages? ● Do people have easy access to it? ● Does it encourage active activities? ● Does it encourage social activities and interactions? ● Does it have any sustainable features? 	<ul style="list-style-type: none"> ● How many people are there on the site? ● Are they alone or in group? ● How is the age distribution? 	<ul style="list-style-type: none"> ● What are people doing on the site? (record all activities observed) ● Are people using the site properly? Any improper acts? <p>Questions for possible casual conversation:</p> <ul style="list-style-type: none"> ● How often do you use this place? ● What do you usually do here? ● What do you like/dislike of this place? ● What aspect you think this place has impacted you or your daily life? ● Do you have any other places that you like in Serenbe? Why?

APPENDIX B

SURVEY OF THE IMPACT OF BIOPHILIC DESIGN ON COMMUNITY HEALTH
AND WELLBEING, ENVIRONMENTAL AWARENESS AND NATURE
CONNECTEDNESS - SERENBE GROUP

SECTION 1: YOU AND YOUR COMMUNITY

We would like to ask you a few questions about your community. Please remember all answers will be kept confidential and anonymous.

1. How long have you lived in your current home in Serenbe?

_____ Years

2. Which Serenbe community do you live in? **(Select ONE)**

Selborne Grange Crossroads Mado Other:

3. Why have you chosen to live in Serenbe? Please select **the ONE response** that best indicates how important each of the followings was to your decision.

	Not at all Important	Slightly Important	Important	Very Important	Not Applicable
I've lived here all my life	1	2	3	4	N/A
I grew up in the area, moved away and wanted to come back	1	2	3	4	N/A
I have family and friends that live in the area	1	2	3	4	N/A
It's a good financial investment	1	2	3	4	N/A
I like the slow pace of life here	1	2	3	4	N/A
It's a good place to raise kids	1	2	3	4	N/A
I moved for job-related reasons	1	2	3	4	N/A
I enjoy the recreational opportunities	1	2	3	4	N/A
I enjoy the area's natural beauty	1	2	3	4	N/A
I enjoy the area's easy access to nature	1	2	3	4	N/A

	Not at all Important	Slightly Important	Important	Very Important	Not Applicable
I enjoy the area's rural atmosphere	1	2	3	4	N/A
I enjoy the area's art and cultural programs	1	2	3	4	N/A
I enjoy the area's proximity to Atlanta	1	2	3	4	N/A
I enjoy the area's proximity to airport	1	2	3	4	N/A
It's an affordable place to live	1	2	3	4	N/A
It's a good place to get away from everyday life	1	2	3	4	N/A
It's a good place to retire to	1	2	3	4	N/A
Other (please explain)					

4. Which of the following best describes you? **(Select ONE)**

- I live here year-round
- I live here more than three months per year
- I live here for 1-3 months per year
- I live here for a total of less than one month per year

5. Do you expect to move away from the area in the next twenty years? **(Select ONE)**

- Definitely will move Probably will move
- Probably will **NOT** move Definitely will **NOT** move

6. How many of your adult relatives live within an hour drive of your home?

_____ (enter number)

7. How many of your close friends live within an hour drive of your home?

_____ (enter number)

8. Think of the ten homes closest to your own. Of those neighbors, how many have you met?

_____ (enter number 1-10)

9. How many community organizations clubs or civic groups do you belong to?

_____ (enter number)

10. Community ties

The following statements describe how you interact with others in your community. Please use the Strongly Disagree-Strongly Agree scale to indicate your personal assessment of each one.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I know most of the full-time residents in my community	1	2	3	4	5
Many of my friends and family are business, church/ political leaders in the area	1	2	3	4	5
I've met most of the part-time residents in my community	1	2	3	4	5
Other residents make me feel welcome in here	1	2	3	4	5
I am very attached to my community	1	2	3	4	5
I get more satisfaction out of being in my community than anywhere else	1	2	3	4	5
No other place compares to my community	1	2	3	4	5
My community means a lot to me	1	2	3	4	5

11. Please indicate how **MUCH** you think these factors contribute to your sense of community.

	Not at all	A little bit	Not too much	Much	Very much
Community events	1	2	3	4	5
Relation with neighbors	1	2	3	4	5
Recognize most of the people of the community	1	2	3	4	5
Identity of community	1	2	3	4	5
Natural environment	1	2	3	4	5

Please answer each of the following questions in terms of the way you generally feel. There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

SECTION 2: HEALTH AND WELLBEING

Please indicate how **SATISFIED** are you with the following items concerning your daily life.

	Completely Dissatisfied	Somewhat Dissatisfied	Neutral	Quite Satisfied	Completely Satisfied
Your income?	1	2	3	4	5
Your standard of material goods and necessities?	1	2	3	4	5
The quality of your built environment?	1	2	3	4	5
The quality of your natural environment?	1	2	3	4	5
Your physical health?	1	2	3	4	5
Your emotional health?	1	2	3	4	5
What you are achieving in life?	1	2	3	4	5
Your relationship with your family?	1	2	3	4	5
Your relationship with your friends?	1	2	3	4	5
Your relationship with your neighbors?	1	2	3	4	5
Your relationship with your colleagues?	1	2	3	4	5
Your safety at home?	1	2	3	4	5
Safety in the community?	1	2	3	4	5
Safety around the community?	1	2	3	4	5
Feeling part of your Community?	1	2	3	4	5
Your life as a whole?	1	2	3	4	5
How secure do you feel about your satisfaction in the future?	1	2	3	4	5

Please indicate how **FREQUENTLY** you rely on the following factors to maintain your health and well-being.

	Never	Rarely	Occasionally	Often	Always
Health care	1	2	3	4	5
Outdoor exercise	1	2	3	4	5
Gym exercise	1	2	3	4	5
Healthy food	1	2	3	4	5
Health products	1	2	3	4	5
Living habits	1	2	3	4	5
Natural environment	1	2	3	4	5

SECTION 3: ENVIRONMENTAL AWARENESS

Please use the **Strongly Disagree -Strongly Agree** scale to indicate your personal assessment of each one concerning the environment.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
We are approaching the limit of the number of people the Earth can support.	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
When humans interfere with nature it often produces disastrous consequences.	1	2	3	4	5
Human ingenuity will ensure that we do not make the Earth unlivable.	1	2	3	4	5
Humans are seriously abusing the environment.	1	2	3	4	5
The Earth has plenty of natural resources if we just learn how to develop them.	1	2	3	4	5
Plants and animals have as much right as humans to exist.	1	2	3	4	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5
Despite our special abilities, humans are still subject to the laws of nature.	1	2	3	4	5
The so-called "ecological crisis" facing humankind has been greatly exaggerated.	1	2	3	4	5
The Earth is like a spaceship with very limited room and resources.	1	2	3	4	5
Humans were meant to rule over the rest of nature.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

SECTION 4: NATURE CONNECTEDNESS

Please use the **Strongly Disagree -Strongly Agree** scale to indicate your personal assessment of each one concerning your connection with nature.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I often feel a sense of oneness with the natural world around me.	1	2	3	4	5
I think of the natural world as a community to which I belong.	1	2	3	4	5
I recognize and appreciate the intelligence of other living organisms.	1	2	3	4	5
I often feel disconnected from nature.	1	2	3	4	5
When I think of my life, I imagine myself to be part of a larger cyclical process of living.	1	2	3	4	5
I often feel a kinship with animals and plants.	1	2	3	4	5
I feel as though I belong to the Earth as equally as it belongs to me.	1	2	3	4	5
I have a deep understanding of how my actions affect the natural world.	1	2	3	4	5
I often feel part of the web of life.	1	2	3	4	5
I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.	1	2	3	4	5
Like a tree can be part of a forest, I feel embedded within the broader natural world.	1	2	3	4	5
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.	1	2	3	4	5
I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.	1	2	3	4	5
My personal welfare is independent of the welfare of the natural world.	1	2	3	4	5

SECTION 5: ABOUT YOU

At the end of the survey, we need to ask you some questions about you and your background. Your responses in this section will be kept strictly confidential.

1. What is your gender? Female Male
2. What is your age? _____ Years old
3. What is your marital status?
 - Married, living with spouse Living with partner Separated
 - Widowed Divorced Never married
4. What is your race/ethnicity? **(Check ALL that apply)**
 - White or Caucasian Black or African American American Indian
 - Hispanic/Latino Asian Other: _____
5. What is the highest level of education you have completed? **(Select ONE)**
 - Did not finish high school High school or GED Attended college but no degree
 - Associate's or vocational degree College Bachelor's degree Some graduate work
 - Graduate degree or Masters PHD Other: _____
6. How many adults in your household? _____ Children? _____
7. Please indicate your total household income range before taxes last year. **(Select ONE)**
 - \$25,000 or less \$25,001 to \$50,000 \$50,001 to \$75,000
 - \$75,001 to \$150,000 \$150,001 to \$250,000 \$250,001 or more
8. Please indicate your employment Status. **(Select ONE)**
 - Employed full-time Employed part-time Retired
 - Stay at home parent/caregiver Unemployed Other: _____
9. How big was the community you spent most of your childhood (up to age 18)?
 - Rural Very small town (<2,500 population) Small town (2,500 – 5,000 population)
 - Small city (5,000 – 25,000 population) Medium-sized city (25,000 – 100,000 population)
 - Metropolitan city (over 100,000 population)

This is the end of the survey, thank you again for your time.

APPENDIX C

SURVEY OF THE IMPACT OF BIOPHILIC DESIGN ON COMMUNITY HEALTH

AND WELLBEING, ENVIRONMENTAL AWARENESS AND NATURE

CONNECTEDNESS - NON-SERENBE GROUP

SECTION 1: YOU AND YOUR COMMUNITY

We would like to ask you a few questions about your community. Please remember all answers will be kept confidential and anonymous.

1. How long have you lived in your current home?

_____ Years

2. Where do you live currently? **(Select ONE)**

Urban Suburban Rural Other: _____

3. Which kind of community do you currently live in? **(Select ONE)**

Single-family Multi-family Mixed-use

4. Why have you chosen to live in your community? Please select **the ONE response** that best indicates important each of the followings was to your decision.

	Not at all Important	Slightly Important	Important	Very Important	Not Applicable
I've lived here all my life	1	2	3	4	N/A
I grew up in the area, moved away and wanted to come back	1	2	3	4	N/A
I have family and friends that live in the area	1	2	3	4	N/A
It's a good financial investment	1	2	3	4	N/A
I like the slow pace of life here	1	2	3	4	N/A
It's a good place to raise kids	1	2	3	4	N/A
I moved for job-related reasons	1	2	3	4	N/A
I enjoy the recreational opportunities	1	2	3	4	N/A

	Not at all Important	Slightly Important	Important	Very Important	Not Applicable
I enjoy the area's natural beauty	1	2	3	4	N/A
I enjoy the area's easy access to nature	1	2	3	4	N/A
I enjoy the area's rural atmosphere	1	2	3	4	N/A
I enjoy the area's art and cultural programs	1	2	3	4	N/A
I enjoy the area's proximity to Atlanta	1	2	3	4	N/A
I enjoy the area's proximity to airport	1	2	3	4	N/A
It's an affordable place to live	1	2	3	4	N/A
It's a good place to get away from everyday life	1	2	3	4	N/A
It's a good place to retire to	1	2	3	4	N/A
Other (please explain)					

5. Which of the following best describe you? **(Select ONE)**

- I live here year-round
- I live here more than three months per year
- I live here for 1-3 months per year
- I live here for a total of less than one month per year

6. Do you expect to move away from the area in the next twenty years? **(Select ONE)**

- Definitely will move
- Probably will move
- Probably will **NOT** move
- Definitely will **NOT** move

7. How many of your adult relatives live within an hour drive of your home?

_____ (enter number)

8. How many of your close friends live within an hour drive of your home?

_____ (enter number)

9. Think of the ten homes closest to your own. Of those neighbors, how many have you met?

_____ (enter number)

10. How many community organizations clubs or civic groups do you belong to?

_____ (enter number)

11. Community ties

The following statements describe how you interact with others in your community. Please use the Strongly Disagree-Strongly Agree scale to indicate your personal assessment of each one.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I know most of the full-time residents in my community	1	2	3	4	5
Many of my friends and family are business, church/ political leaders in the area	1	2	3	4	5
I've met most of the part-time residents in my community	1	2	3	4	5
Other residents make me feel welcome in here	1	2	3	4	5
I am very attached to my community	1	2	3	4	5
I get more satisfaction out of being in my community than anywhere else	1	2	3	4	5
No other place compares to my community	1	2	3	4	5
My community means a lot to me	1	2	3	4	5

12. Please indicate how **MUCH** you think these factors contribute to your sense of community.

	Not at all	A little bit	Not too much	Much	Very much
Community events	1	2	3	4	5
Relation with neighbors	1	2	3	4	5
Recognize most of the people of the community	1	2	3	4	5
Identity of community	1	2	3	4	5
Natural environment	1	2	3	4	5

Please answer each of the following questions in terms of the way you generally feel. There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

SECTION 2: HEALTH AND WELLBEING

Please indicate how **SATISFIED** are you with the following items concerning your daily life.

	Completely Dissatisfied	Somewhat Dissatisfied	Neutral	Quite Satisfied	Completely Satisfied
Your income?	1	2	3	4	5
Your standard of material goods and necessities?	1	2	3	4	5
The quality of your built environment?	1	2	3	4	5
The quality of your natural environment?	1	2	3	4	5
Your physical health?	1	2	3	4	5
Your emotional health?	1	2	3	4	5
What you are achieving in life?	1	2	3	4	5
Your relationship with your family?	1	2	3	4	5
Your relationship with your friends?	1	2	3	4	5
Your relationship with your neighbors?	1	2	3	4	5
Your relationship with your colleagues?	1	2	3	4	5
Your safety at home?	1	2	3	4	5
Safety in the community?	1	2	3	4	5
Safety around the community?	1	2	3	4	5
Feeling part of your Community?	1	2	3	4	5
Your life as a whole?	1	2	3	4	5
How secure do you feel about your satisfaction in the future?	1	2	3	4	5

Please indicate how **FREQUENTLY** you rely on the following factors to maintain your health and well-being.

	Never	Rarely	Occasionally	Often	Always
Health care	1	2	3	4	5
Outdoor exercise	1	2	3	4	5
Gym exercise	1	2	3	4	5
Healthy food	1	2	3	4	5
Health products	1	2	3	4	5
Living habits	1	2	3	4	5
Natural environment	1	2	3	4	5

SECTION 3: ENVIRONMENTAL AWARENESS

Please use the **Strongly Disagree -Strongly Agree** scale to indicate your personal assessment of each one concerning the environment.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
We are approaching the limit of the number of people the Earth can support.	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
When humans interfere with nature it often produces disastrous consequences.	1	2	3	4	5
Human ingenuity will ensure that we do not make the Earth unlivable.	1	2	3	4	5
Humans are seriously abusing the environment.	1	2	3	4	5
The Earth has plenty of natural resources if we just learn how to develop them.	1	2	3	4	5
Plants and animals have as much right as humans to exist.	1	2	3	4	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5
Despite our special abilities, humans are still subject to the laws of nature.	1	2	3	4	5
The so-called "ecological crisis" facing humankind has been greatly exaggerated.	1	2	3	4	5
The Earth is like a spaceship with very limited room and resources.	1	2	3	4	5
Humans were meant to rule over the rest of nature.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

SECTION 4: NATURE CONNECTEDNESS

Please use the **Strongly Disagree -Strongly Agree** scale to indicate your personal assessment of each one concerning your connection with nature.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I often feel a sense of oneness with the natural world around me.	1	2	3	4	5
I think of the natural world as a community to which I belong.	1	2	3	4	5
I recognize and appreciate the intelligence of other living organisms.	1	2	3	4	5
I often feel disconnected from nature.	1	2	3	4	5
When I think of my life, I imagine myself to be part of a larger cyclical process of living.	1	2	3	4	5
I often feel a kinship with animals and plants.	1	2	3	4	5
I feel as though I belong to the Earth as equally as it belongs to me.	1	2	3	4	5
I have a deep understanding of how my actions affect the natural world.	1	2	3	4	5
I often feel part of the web of life.	1	2	3	4	5
I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.	1	2	3	4	5
Like a tree can be part of a forest, I feel embedded within the broader natural world.	1	2	3	4	5
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.	1	2	3	4	5
I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.	1	2	3	4	5
My personal welfare is independent of the welfare of the natural world.	1	2	3	4	5

SECTION 5: ABOUT YOU

At the end of the survey, we need to ask you some questions about you and your background. Your responses in this section will be kept strictly confidential.

1. What is your gender? Female Male
2. What is your age? _____ Years old
3. What is your marital status?
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 - Widowed Divorced Never married
4. What is your race/ethnicity? **(Check ALL that apply)**
 - White or Caucasian Black or African American American Indian
 - Hispanic/Latino Asian Other: _____
5. What is the highest level of education you have completed? **(Select ONE)**
 - Did not finish high school High school or GED Attended college but no degree
 - Associate's or vocational degree College Bachelor's degree Some graduate work
 - Graduate degree or Masters PHD Other: _____
6. How many adults in your household? _____ Children?
7. Please indicate your total household income range before taxes last year. **(Select ONE)**
 - \$25,000 or less \$25,001 to \$50,000 \$50,001 to \$75,000
 - \$75,001 to \$150,000 \$150,001 to \$250,000 \$250,001 or more
8. Please indicate your employment Status. **(Select ONE)**
 - Employed full-time Employed part-time Retired
 - Stay at home parent/caregiver Unemployed Other: _____
9. How big was the community you spent most of your childhood (up to age 18)?
 - Rural Very small town (< 2,500 population) Small town (2,500 – 5,000 population)
 - Small city (5,000 – 25,000 population) Medium-sized city (25,000 – 100,000 population)
 - Metropolitan city (over 100,000 population)

This is the end of the survey, thank you again for your time.