ECOLOGICAL HOUSING:

AN EXPLORATION OF SUSTAINABILITY AND COMMUNITY DESIGN

THESIS

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By

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DEDICATION

I dedicate this thesis to Loretta Marsh who would never be able to get through reading this thesis, but who would tell me how beautiful and smart I was for writing it.

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CHAPTER I

INTRODUCTION

Since the industrial revolution, the human population has expanded exponentially. Between 1950 and 2000, the global population increased from 2.5 to 6.1 billion people. By 2050, it is estimated that the world will be inhabited by no less that 8.9 billion people (Brown 2000). The Earth's natural systems are being required to accommodate not only more people, but 'larger' people that require more resources per person (Dale and Pierce 1999). Today, not only are we running out of habitable areas on the planet, but also we are using more resources than ever before (Grossa and Marsh 1996).

Another product of the industrial revolution has been the redistribution of rural populations to urban corridors. After the United States Civil War, industry moved into cities. Factories, located in the city centers, provided employment opportunities for immigrants and farmers. These city centers soon became plagued with smog from factories, deplorable living conditions (poor health and sanitation), and over-crowding. In the United States, younger cities became defined by these poor conditions (Kunstler 1994).

Because of poor city conditions, migration from U.S. city centers to the more "livable" outskirts of town occurred after World War II. Families looked toward new, "clean" developments bordering city centers (Eisner, Eisner, and Gallion

1993). These fringe developments (suburbs) were feasible due to the increased popularity of automobiles and better-developed road systems. It was possible for adults to work in the city while living in the country (Kunstler 1996). Spearheaded by planners such as Lewis Mumford, the suburbs emerged (Mumford 1954).

Today, half the human population lives in an urban environment (Dale and Pierce 1999). In the industrialized world 70% – 80 % of the population lives in cities and these city dwellers consume two-thirds of the world's output of natural resources (Grossa and Marsh 1996). About 50% of the world's fossil fuel consumption as well as 50% of the world's Chlorofluorocarbon (CFCs) production is directly related to construction of buildings and homes (Moughtin 1996). Every year, more than 1.5 million homes are built in the United States, and 80% of these homes are single-family dwellings (Du Plessis 2001).

From the late 1940s through the 1980s suburbanization remained the most popular method of creating new housing. But in the 1990s planners and communities began to reconsider this development strategy. Growing concerns about the health of the environment, inadequate road conditions, and a lack of suburban community identity, caused developers, planners, and community members to look more closely at community design (Eisner, Eisner, and Gallion 1993).

Today 20% of the United States housing development community is involved with some form of sustainability, as there is a high demand for these kinds of developments (McCormick 2001). This research investigates the current movement to reform housing developments in the United States to become more environmentally sensitive. A group of twelve housing developments, which are identified as sustainable, ecological, or conservation-oriented, provide the data for this preliminary survey.

Using a list of sustainability indictors, this research evaluates the consumption patterns of these modern, ecological housing developments. Without a standard for what qualities indicate ecological, conservation, or sustainable housing design, homebuyers, planners, and ecologically minded developers are left to create and re-interpret what a sustainable housing development entails. The goal of this research is to lay the foundation for exploring and examining factors that might be used uniformly to access “sustainable housing.”

CHAPTER II

REVIEW OF RELEVANT LITERATURE

Ecological or "strong sustainability" planning evaluates the total relationship between the human population and the environment. It considers the levels of consumption that affect the health of the natural environment by evaluating how long resources will be available given these particular consumption patterns (Roseland 1998). The term "sustainability" is subject to diverse and conflicting interpretations. This research utilizes the interpretation of sustainable development reflected in the Bruntland Report, "Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Moughtin 1996, 4).

Sustainability does not mean that a system remains static. In order to achieve sustainability, humans have to constantly change and adapt as all natural systems do (Dale and Pierce 1999). Sustainability can best be measured by looking at patterns of consumption, which lead to environmental degradation. While there might remain some uncertainty regarding exactly where environmental thresholds ultimately lie, this research uses the precautionary principle outlined by Cliff Moughtin in Urban Design Green Dimensions, by considering if development designs contain elements that are more sustainable or less sustainable (Moughtin 1996).

One method of evaluating the presence of sustainable design standards is by creating a list of sustainability indicators. Many researchers, communities, agencies, and individuals have been experimenting with developing a working list of sustainability indictors for a variety of purposes (Sustainable Measures 2002). One of the best known of these indictor lists that evaluate consumption patterns is Mathis Wackernagel and William E. Rees's "Ecological Footprint" concept (Rees and Wackernagel 1996). Unfortunately the indicators used in Wackernagel and Rees's work are not specific enough to housing for the purposes of this research. For this reason two sustainability indictor research groups that concentrate specifically on housing are used.

This research draws from Perks and Vliet's "Sustainable Community Design Features" and Mark Roseland's "Sustainable Building Blocks" (Perks and Vliet 1993; Roseland 1998). The categories for each of these lists are shown in Table 1.

Table 1. Referenced Sustainability Indicators Lists

"Community Design Features"	"Community Building Blocks"
Energy	Energy Efficiency and Renewables
Water and Sewage	Water and Sewage
Waste and Recycling	Waste Reduction and Recycling
Land Use/ Landscape Ecology	Greening the City
Transportation	Transportation Planning and Traffic Management
Building Ecology	Atmospheric Change and Air Quality
Community Design	Land Use and Urban Form
Community Management	Community Development
Economic Viability	Economic Development

(Perks and Vliet 1993; Roseland, 1998)

These two indictor lists are more complex than the one that will be used in this research, for it is beyond the scope of this research to collect data for all characteristics indicated on these lists. Sustainable community design indicators used in this research include six categories containing a total of 19 design characteristics (sustainability indicators) (Table 2). Indicator categories include energy, water, waste and recycling, transportation, building ecology, and landscape ecology.

Table 2. Sustainability Indicators Used in This Research

Categories	Qualities
Energy	Renewable Energy Sources Used Contains Passive Solar Design Energy Saving Appliances
Water	Conservation Measures in Place Protection Measures in Place
Waste and Recycling	Organic Wastes Composted Recycling Service Available Re-Use of Discarded Wastes
Transportation	Close to Work Close to Public Services Close to Public Transportation Carpooling Utilized
Building Ecology	Uses Recycled Building Materials Uses Local and Natural Materials Uses Low-Embodied Energy Materials
Landscape Ecology	Considers Local Habitat and Natural Resources Has a Community Farm or Garden Organic Food Available Locally Grown Food Available

Under the energy category, sustainability indicators include the presence of renewable energy sources, passive solar design, and energy saving appliances. Using renewable energy to fuel homes supports the movement to step away from fossil fuel dependency. Dependency on fossil fuels has had many environmental impacts including ozone layer depletion, acid rain, smog, and the increase of Carbon Dioxide (CO2) in the atmosphere (Roseland 1998). Excess CO2 is often cited as the cause for global warming. In order to stabilize levels of CO2 entering the atmosphere, society must look toward renewables (Brown 2000). In this research renewable energy includes the use of photovoltaic (solar), wind power, hydroelectric, or biomass energy sources to provide electricity (Roseland 1998, 89).

Passive solar design integrates the orientation and location of housing structures to maximize natural solar heating, thereby reducing the need for space heating. Often homes incorporating a passive solar design position the most commonly used areas of a house facing south and incorporate high performance windows to maximize heat absorption (Edwards and Turrent 2000). By using passive solar design, a structure can reduce energy consumption used for space heating by 20% (Moughtin 1996).

Appliances such as refrigerators account for up to 2/3 of the electricity used in American homes (United States Department of Energy 1999). By replacing older appliances in existing homes or incorporating energy saving appliances in new homes, a substantial savings in energy consumption can be achieved. Commonly produced energy saving appliances include, but are not limited to, refrigerators, clothes dryers, dishwashers, and solar hot water heaters.

The second sustainable design indicator category is water. Two indicators are considered in the water category, water conservation measures and water quality protection measures. The United States populace consumes more water per capita than of any other country in the world (Roseland 1998). Housing uses over 50% of all abstracted public water supply (Edwards and Turrent 2000). When considering the total cost of transporting and piping water to houses, conservation becomes very important (Speir and Stephanson 2002).

Water conservation measures include "gray water" re-use systems, rainwater collection systems, drought tolerant landscaping, and low flow toilets, sinks, and washers (Perks and Vliet 2001). "Gray water" is defined as the wastewater produced from baths and showers, clothes washers, and lavatories. This does not include wastewater generated by toilets, kitchen sinks, and dishwashers, which is called "black water" (Austin Green Builder Program 2001). Drought tolerant landscaping requires less water than traditional (lawn) landscaping (Perks and Vliet 1993). Rainwater collection systems capture water from the roofs of buildings on residential property. Harvested rainwater can be used for indoor residential needs at a residence, for irrigation, or for both, in whole or in part (Austin Green Builder Program 2001). The use of low flow toilets, sinks, and washers can reduce the consumption of water by 245 gallons per household per day (Edwards and Turrent 2000).

Septic overflow, agriculture, industry, households, automobiles, and sedimentation from cleared land affect water quality (Roseland 1998). Much of housing's contribution to degraded water quality falls under the category of non-point source pollution. Non-point source pollution is "derived from contaminates washed off the land by stormwater run-off and carried either directly or indirectly into waterways and groundwater" (Arnold and Gibbens 1996, 243). Water quality protection measures that can reduce non-point source pollution include storm water retention ponds (or bioswales), reduction of impervious cover, and the use of constructed wetlands.

Storm water retention ponds are used to absorb some of the excess water produced by heavy rainstorms so that the street sewer system does not get overloaded (Perks and Vliet 1993). Storm water retention ponds also help prevent erosion and sedimentation that can lead to increased non-point source pollution. Reduction of impervious cover also prevents erosion and sedimentation by minimizing run-off. Impervious cover is any material that prevents the infiltration of water into the soil (Arnold and Gibbons 1996). Homes, buildings, and paved surfaces are examples of impervious cover. Constructed wetlands are shallow ponds populated with aquatic plants (Perks and Vliet 1993). They provide a natural and effective way of absorbing nitrates, phosphates, and sedimentation from wastewater (Roseland 1998).

The third sustainability indictor category is waste and recycling. In 1999 the United States produced 229.9 million pounds of municipal solid waste; of that waste 50.8 million pounds were recycled, 13.1 million pounds were composted, and 166 million pounds were discarded (United States Environmental Protection Agency 2000). Most of the waste that is discarded goes into landfills on the fringes of communities where questions regarding water quality and human health are continually linked (Roseland 1998). Waste and recycling indicators include composting, recycling and re-use.

Composting is an effective means of managing organic waste. Composting removes 13% of the solid waste, by volume, in the United States (Lyle 1994). Composting reduces costs and energy expenditures associated with waste management. Sustainable composting includes backyard composting, vermaculture (worm composting), and community organized composting (Roseland 1998).

Recycling is the re-manufacturing and re-shaping of old material into new material (Lyle 1994). Commonly recycled materials include paper, plastic, glass, and metal. In order to make recycling work, it is important to make recycling centers and drop boxes available (Lyle 1994). While recycling provides a positive alternative to disposing of wastes directly into landfills, re-use is far more efficient.

The re-use of potential waste includes, but is not limited to, re-using locally unwanted building materials and providing "drop off boxes" for unwanted household items. Many communities combine their resources by arranging swap meets or combined garage sales (Lyle 1994). Through the practice of re-use, materials do not need to be re-manufactured, thereby better conserving resources.

The fourth sustainability indictor category is transportation. Seventy-seven percent of the United States population drives a car for an average of 9870 miles a year. Driving accounts for 27% of all energy consumption in the United States (United States Department of Energy 2001). Transportation indicators include proximity of housing to work, public services, and public transportation as well as the presence of carpooling initiatives.

Proximity of housing to work, public services, and availability of public transportation are significant if they reduce community members' need to drive their cars. For distances less than 1.2 miles walking can play a tremendous role in eliminating automobile use and traffic (Roseland 1998). Many transportation planners estimate that the most successful transit-oriented (sustainable) communities are within a five to ten minute walk to these amenities (Edwards and Turrent 2000). A sentiment echoed by the many planners is stated by Moughtin in Urban Design Green Dimensions, when he writes, "The green building set in a park on the periphery of activity, served only by roads used entirely by the private motor car is a contradiction in terms" (Moughtin 1996, 27). Finally, carpooling or car co-ops allow people in a community to share access to a vehicle without accruing the full cost of ownership. In Europe there are more than sixty successful car-sharing programs (Roseland 1998).

The fifth sustainability indicator is building and ecology. There exists an ample body of literature that addresses the ways in which architects, designers, and private homebuilders may build homes more sustainably (Austin Green Builder Program 2001; Perks and Vliet 1993; Rocky Mountain Institute 1998). For the purposes of this research only the most commonly mentioned components are addressed. Building ecology indicators in this research include the use of recycled building materials, the use of natural and local materials, and the use of low embodied energy materials (Roseland 1998).

Recycled building materials can be remanufactured and reused in many ways. There are economic and ecological benefits to reusing building materials as they reduce material mass in landfills and reduce extraction and refinement of resources. Some examples of recyclable and re-usable materials include dimensional lumber, doors, cabinetry, precast and prestressed concrete slabs, steel structural members and cladding, glazing, and other modular construction elements (Perks and Vliet 1993).

Natural and local materials reduce toxic contamination to the environment as well as transportation costs associated with transporting materials across regions. The use of regional resources helps to support local economies and can contribute significantly to creating a sense of place. Materials such as stone, clay, brick and wood are labor intensive rather than energy-intensive to install (Perks and Vliet 1993). Low embodied energy materials are materials, which require less total energy to extract, manufacture, transport, construct, maintain and dispose of. Some low embodied energy materials include sand, gravel, wood, concrete, sand-lime brickwork, and lightweight concrete (Perks and Vliet 1993).

The final sustainability indicator is landscape ecology. Landscape decisions made by architects and engineers, have a tremendous effect upon biodiversity and species survival. In <u>Design For Human Ecosystems</u>, John Lyle describes creating a "rich and diverse landscape design" as a step toward greater sustainability (Lyle 1, 1999). Water is always carefully considered in sustainable landscape design. As available clean water sources are not projected to be adequate for our growing human population, steps must be taken to conserve water resource (Edwards and Turrent 2000). Agricultural considerations are also important when designing landscapes. Providing or having access to natural, local, and organic food is significant to the sustainability of a community (Corbett and Corbett 2000; Perks and Vliet 1993; Roseland 1998). Indicators used in this research include the consideration of local habitat and natural resources in the landscape, the presence of a community farm or garden, and the availability of locally grown and organic foods.

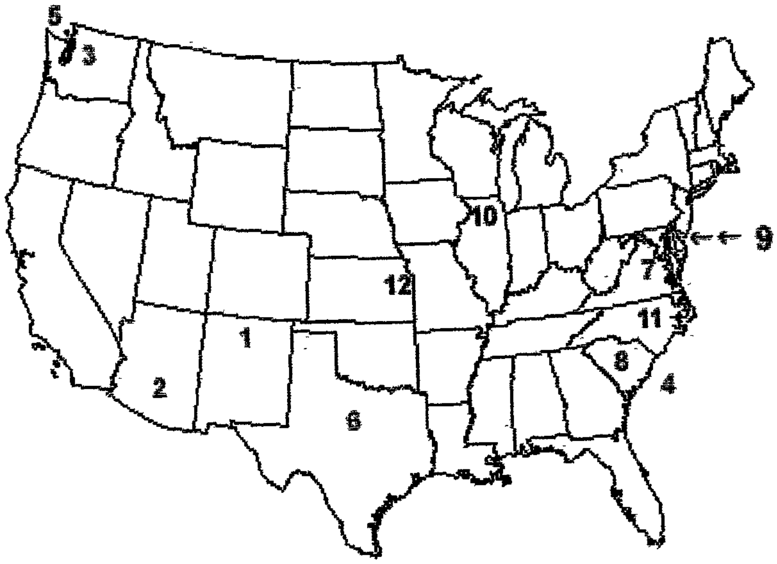
The consideration of habitat and natural resources implies that a housing community integrates its structures consciously in an effort to avoid erosional problems and habitat destruction. An on-site garden or farm and locally grown food reduce transportation and manufacturing costs of food transport. The consumption of organic food reduces the use of pesticides and soil depleting mono-cropping, which negatively affects the soil and the water supply (Perks and Vliet 1993).

CHAPTER III

INTRODUCTION TO COMMUNITIES

It is beyond the scope of this research to examine all types of "sustainable developments;" therefore developments identified as "conservation oriented", "ecological," or "sustainable" either through advertising or affiliation will be considered in this study. Communities that participated in this research include Arroyo Park (New Mexico), Civano (Arizona), The Cottage Company (Washington), Dewees Island (South Carolina), Eagle Lake (Washington), Esperanza del Sol (Texas), Haymount (Virginia), Newpoint (South Carolina), Paternal Gift Farm (Maryland), Tryon Farms (Indiana), Unahwi (North Carolina), and Shoal creek Valley (Kansas) (Figure 1).

Figure 1. Map of Community Locations



1. Arroyo Park
2. Civano
3. The Cottage Company
4. Dewees Island
5. Eagle Lake
6. Esperanza del Sol
7. Haymount
8. Newpoint
9. Paternal Gift Farm
10. Tryon Farms
11. Unahwi Ridge
12. Shoal Creek Valley

Arroyo Park is a new planned community with an emphasis on preservation and the natural environment" (Arroyo Park 2002). This community is located in Taos, New Mexico and is situated on 54 acres with 35 home sites planned. Because this community is located in a highland desert, water conservation and protection are among its primary goals (Arroyo Park 2002). At the time of this research 16 home sites have been completed.

Civano is a "solar village" in Tucson, Arizona. Civano considers sustainability a guiding principle for the community (Civano 2002). The community sits on 880 acres of which 380 have presently been developed for 170 families. Civano's community goals include: "significantly reducing energy consumption, reducing potable (drinking water) consumption, reducing internal vehicle miles, and reducing landfill destined solid waste, and Integration of working and living environments" (Civano 2002). All Civano homes are currently designed to use 50% less energy than a typical home of the same size (Civano 2002).

The Cottage Company is based in Seattle, Washington. The Cottage Company identifies itself as, "a development and construction company focused on the implementation of 'pocket neighborhoods' of cottages and small homes" (Cottage Company 2002). This research evaluates Glenwood Avenue Cottages; one of several projects the Cottage Company has developed. This development contains eight houses and fifteen people all clustered on one acre. Glenwood Avenue Cottages is in North Seattle.

The Dewees Island marina development is located on Dewees Island a few miles north of Charleston, South Carolina. There are will be 150 home sites on this 1206 acre island, leaving 65% of the land as a wildlife refuge (Center of Excellence for Sustainable Development 2002). Dewees Island Marina lists environmental preservation and respect for the environment as part of its mission statement (Dewees Island 2002). There are not any gas-powered cars or paved roads on Dewees Island: only electric cars are allowed on the island (Dewees Island 2002).

Eagle Lake is a development located on the north side of Orcas Island, Washington. The property includes 293 acres and 53 possible home sites (Eagle Lake 2002). Ninety-five percent of the land in the development is designated as open space and design guidelines set limitations for individually owned homes. Eagle Lake lists among its main goals "environmental and architectural integrity" (Eagle Lake 2002).

Esperanza del Sol is an "environmentally sensitive," "affordable" housing community located in Dallas, Texas. There are 12 homes in this small community with identical design. Esperanza del Sol incorporates active and passive solar design as well as geothermal energy use. Along with using alternative energy sources, the homes are very well insulated to reduce energy needs (Affordable Sustainability 2002).

Haymount, located in Caroline County, Virginia, 50 miles south of Washington D.C., is referred to as a green development with environmental goals (Center of Excellence For Sustainable Development 2002). There are 4000 residential home sites in this 1708 acre development (town). Among the listed goals and principles for Haymount are accepting environmental responsibility for the development and designing with sustainable objectives (Rocky Mountain Institute 1998).

Newpoint is a development in Beauford, South Carolina, that refers to itself as a "walking neighborhood" (Newpoint 2002). The development sits on 54 acres and houses 86 families. Among some of the development's amenities is accessibility to the community green space that is within a ten minute walk of all homes in the development (Newpoint 2002).

Paternal Gift Farm is a "Rural Conservation Development" located in Howard County, Maryland. This community contains 30 houses, 123 acres and 90 people. By using cluster housing, Paternal Gift Farm preserves over 60% of the acreage as open-space farmland and for equestrian uses (Mid-America Regional Council 2002).

Tryon Farm is a development one hour north of Chicago in Michigan City, Indiana. Of the 170 acres owned by the Tryon Farms development, three quarters of it will be preserved as open space (Tryon Farms 2002). When the project is complete there will be around three hundred people living in this development. Tryon Farm's goals include: saving farmland, establishing wetland habitats, and managing wastes (Tryon Farms 2002).

Unahwi is an eco-development located in Jackson County, North Carolina. The property is about 600 acres of which 500 acres are preserved as a nature preserve; the remaining 100 acres are being developed (Unawhi Ridge 2002). Among the community goals listed on the Unahwi website are, "to provide for the long-term protection of the natural beauty, biodiversity, and ecosystems present on the property" and "to develop sustainable business and agricultural opportunities that support the needs and enjoyment of the residents" (Unahwi 2002). The property includes an organic farm and ample nature trails for residents (Unahwi Ridge 2002).

Shoal Creek Valley is a master-planned community located in Kansas City, Kansas. The Community sits on 1708 acres and 20% of this area will be preserved as natural habitat (Shoal Creek Valley 2002). Shoal Creek Valley lists," preserving the site's natural features and scenic qualities," as, "an opportunity to add to resident's 'quality of life'" (Shoal Creek Valley 2002). The community has a well developed system of paths and trails and will include a 200 acre gold course (Shoal Creek Valley 2002).

CHAPTER IV

METHODOLOGY

The methods used to collect and evaluate the sustainability indicators include collecting data from communities through a written survey and evaluating responses using descriptive analysis. This research utilized the “Dillman method” for all survey mailings (Dillman 1994). First, an introductory letter was distributed to 30 housing communities by mail (Appendix A). A week later another letter (Appendix B) and a survey (Appendix C) were sent relating to each of the sustainability indictors. Finally reminder post cards were sent the following week (Appendix D).

Data was collected from twelve different housing communities of twenty-eight who received surveys. Responses to the nineteen design questions were correlated and graphed using a nominal scoring system with the Statistical Package for Social Sciences (SPSS) ©. Data attributed to consumption rates was compared to national averages using Microsoft EXCEL.

Data were collected from both private and public sources. Public sources include the United States Department of Energy (DOE), the Environmental Protection Agency (EPA), and the United States Geological Survey (USGS). Private sources include all of the housing communities participating in this research. A variety of other data sources (Edwards and Turrent 2000; Moughtin

1996; Perks and Vliet 1993; Roseland 1998) were used to define certain questions listed in the survey itself.

The survey includes six categories and 19 design questions (Table 3). Three additional questions were compared directly to known quantitative data supplied by the US government sources listed above (See Appendix D, questions A-1, B-1, and C-1). Governmental data obtained from the DOE of overall household energy consumption come from a survey conducted in 1997 (United States Department of Energy 1999) that evaluates overall United States household energy consumption. The study provides statistics for energy consumption for single- family dwellings, and this research uses statistics for single-family dwellings only. Specifically, primary household electricity consumption averages for single family households will be compared to electricity consumption of single-family suburban housing communities participating in the survey.

Table 3. Community Indicator Matrix

Category	Indicator	Yes = 1	No = 0
Energy			
	Renewables Used?		
	Passive Solar?		
	Energy Saving Appliances?		
Water			
	Conservation Measures?		
	Protection Measures?		
Waste and Recycling			
	Composting?		
	Recycling?		
	Re-use?		
Transportation			
	Close to Work?		
	Close to Public Services?		
	Close to Public Transportation?		
	Carpooling?		
Building Ecology			
	Recycled Building Materials?		
	Local and Natural Materials?		
	Low Embodied Energy Materials?		
Landscape Ecology			
	Local Habitat and Natural Resources Considered?		
	Community Farm or Garden?		
	Organic Food?		
	Locally Grown Food?		

Governmental data obtained from the EPA's Department of Solid Waste come from a study conducted in 1999 (United States Environmental Protection Agency 2000). The study evaluates overall residential municipal solid waste production in the United States. The research conducted in this paper uses statistics comparing the average national waste production standard per household to the waste produced by communities participating in the survey.

Governmental data obtained from the USGS come from a report providing statistics of the estimated water use per capita in the United States, for 1995 (United States Geological Survey 2001). This research compares the national average of public water consumption to public water consumption for the communities participating in the survey.

CHAPTER V

RESULTS

Twelve surveys were received from the twenty-eight communities and the responses are listed below. Tables 4 through 9 show the design question responses. Table 10 shows the results of the water consumption question that received some responses. As none of the respondents answered the quantitative question regarding energy consumption or waste production, there are no tables for those questions. In the interest of maintaining anonymity, due to the commercial nature of these housing developments, the specific names of the communities participating in this research are omitted in the results. If a community displayed a sustainability indicator as previously defined, indicated by an "x" in the tables that follow, it was counted as having an indicator "present."

In the Energy category, eight out of twelve communities use renewable energy sources, ten out of twelve incorporate passive solar design, and nine of twelve use energy saving appliances. In other words 27 out of 36 possible indicators were present over all of the communities which responded to that section of the survey. All communities were represented by at least one indicator in the energy category. One participant did not complete the energy section on the survey (Table 4).

Table 4. Design Results for the Energy Category

Communities	Renewable Energy	Passive Solar Design	Energy Saving Appliances
1. Community A	1	1	0
2. Community B	0	1	1
3. Community C	1	1	1
4. Community D	1	1	1
5. Community E	1	1	1
6. Community F	1	0	1
7. Community G	0	1	1
8. Community H	x	x	x
9. Community I	0	1	0
10. Community J	1	1	1
11. Community K	1	1	1
12. Community L	1	1	1
Total	8	10	9

1 = Indicator present   0 = Indicator is not present   x = Respondent left question blank

In the water category, eight out of twelve communities incorporated water conservation measures and eleven out of twelve incorporated water protection measures in their design. Nineteen of twenty-four possible indicators were present in the set of communities which responded to this section. Eleven of twelve participants responded to this section (Table 5).

Table 5. Design Results for the Water Category

Communities	Water Conservation Measures	Water Quality Protection Measures
1. Community A	1	1
2. Community B	0	1
3. Community C	1	1
4. Community D	x	x
5. Community E	1	1
6. Community F	1	1
7. Community G	0	1
8. Community H	1	1
9. Community I	1	1
10. Community J	1	1
11. Community K	1	1
12. Community L	0	1
Total	8	11

1 = Indicator present 0 = Indicator is not present x = Respondent left question blank

All participants answered the Waste and Recycling design questions. Organic wastes are composted at seven of the twelve communities, recycling services are available at eight out of twelve communities, and re-use of discarded waste is present at ten of the twelve communities. Twenty-five out of 36 possible Waste and Recycling indictors are present among the participating communities (Table 6).

Table 6. Design Results for the Waste and Recycling Category

Communities	Organic Wastes Composted	Recycling Services Available	Re-Use of Discarded Wastes
1. Community A	0	0	0
2. Community B	1	1	1
3. Community C	1	1	1
4. Community D	0	1	1
5. Community E	1	1	1
6. Community F	0	0	0
7. Community G	1	1	1
8. Community H	1	1	1
9. Community I	1	1	1
10. Community J	1	0	1
11. Community K	0	1	1
12. Community L	0	0	1
Total	7	8	10

1 = Indicator present 0 = Indicator is not present x = Respondent left question blank

All of the participants answered the Transportation Design questions. Two out of twelve communities were within a ten minute walk of 50% of community members' place of work, eight out of twelve communities were within a ten minute walk to public services, and six out of twelve communities were within a ten minute walk to a public transportation depot or stop. Four out of nine communities promote or utilize carpooling strategies. Twenty out of a possible forty-eight of the transportation indicators are present among the participating communities (Table 7).

Table 7. Design Results for the Transportation Category

Communities	Close To Work	Close To Public Services	Close To Public Transportation	Carpooling Utilized
1. Community A	0	0	1	0
2. Community B	0	1	1	0
3. Community C	0	1	1	0
4. Community D	0	1	1	1
5. Community E	1	1	1	1
6. Community F	0	1	0	1
7. Community G	0	1	0	0
8. Community H	0	1	1	0
9. Community I	0	0	0	0
10. Community J	0	0	0	1
11. Community K	0	0	0	0
12. Community L	1	1	0	0
Total	2	8	6	4

1 = Indicator present 0 = Indicator is not present x = Respondent left question blank

All of the participants answered all of the Building Ecology questions. Recycled building materials are used in seven out of twelve communities. Local and natural building materials are used at nine out of twelve communities. Low-embodied energy materials are used at nine out of twelve communities. Twenty-five out of 36 possible Building Ecology indicators are present in participating communities (Table 8).

Table 8. Design Results for the Building Ecology Category

Communities	Recycled Building Materials	Local and Natural Materials	Low - Embodied Energy Materials
1. Community A	0	1	1
2. Community B	0	0	0
3. Community C	1	1	1
4. Community D	1	1	1
5. Community E	1	1	1
6. Community F	0	0	1
7. Community G	0	0	0
8. Community H	1	1	1
9. Community I	1	1	1
10. Community J	1	1	1
11. Community K	1	1	1
12. Community L	0	1	0
Total	7	9	9

1 = Indicator present 0 = Indicator is not present x = Respondent left question blank

All of the participants answered most of the Landscape Ecology questions; one participant left one question blank. All twelve communities considered local habitat and natural resources in their community design. Seven out of twelve communities have a farm or garden on site. Five out of nine communities grow their food organically. Ten out of the twelve communities have locally grown foods available. Thirty- four out of a possible 48 Landscape Ecology indicators are present in the participating communities (Table 9).

Table 9. Design Results for the Landscape Ecology Category

Communities	Considers Local Habitat and Natural Resources	Organic Farm or Garden	Food Grown Organically	Locally Grown Food Available
1. Community A	1	0	0	1
2. Community B	1	0	0	x
3. Community C	1	1	1	1
4. Community D	1	0	0	1
5. Community E	1	1	1	1
6. Community F	1	0	0	1
7. Community G	1	1	0	1
8. Community H	1	1	1	1
9. Community I	1	1	1	1
10. Community J	1	1	1	1
11. Community K	1	0	0	0
12. Community L	1	1	0	1
Total	12	7	5	10

1 = Indicator present 0 = Indicator is not present x = Respondent left question blank

Only two participants responded to the quantitative question in the water category. None of the participants responded to the quantitative questions in the energy category. While nine of the twelve participants answered the question about what volume of waste they produced, none answered how many pounds of waste they produced. It was discovered that volume calculation of estimate weight of garbage is not accurate enough to use for analysis. Of the two communities, which responded to the quantitative water, question Community I used more water per month (770 Gallons) than the national average and Community K used less (-1770 Gallons) (Table 10).

Table 10. Comparison of Community Water Consumption to National Average

Community Name	Community consumption of domestic freshwater per person per month	Average domestic freshwater consumption per month per person (national average)	Difference between community consumption of domestic fresh water per month between study community and national averaoe
Community I	3800 Gallons	3030 Gallons	770 Gallons
Community K	1350 Gallons	3030 Gallons	-1770 Gallons

(Average domestic water usage derived from United States Geological Service 2001)

CHAPTER VI

DISCUSSION OF RESULTS

This research evaluates if consumption patterns in ecological housing communities may be accessed through looking at the distribution and the presence of sustainability indicators. Additionally, this research hopes to determine if the presence of these indicators might aid in measuring the over-all sustainability of a community or group of communities. Lastly this research seeks to ascertain whether this list of sustainability indicators may provide guidelines for homebuyers, planners, and ecologically-minded developers in planning for sustainability.

The responses from survey participants illustrate an uneven distribution of indicators present in over-all community designs (Figure 2).

Figure2. Design Indicators Present in All Communities

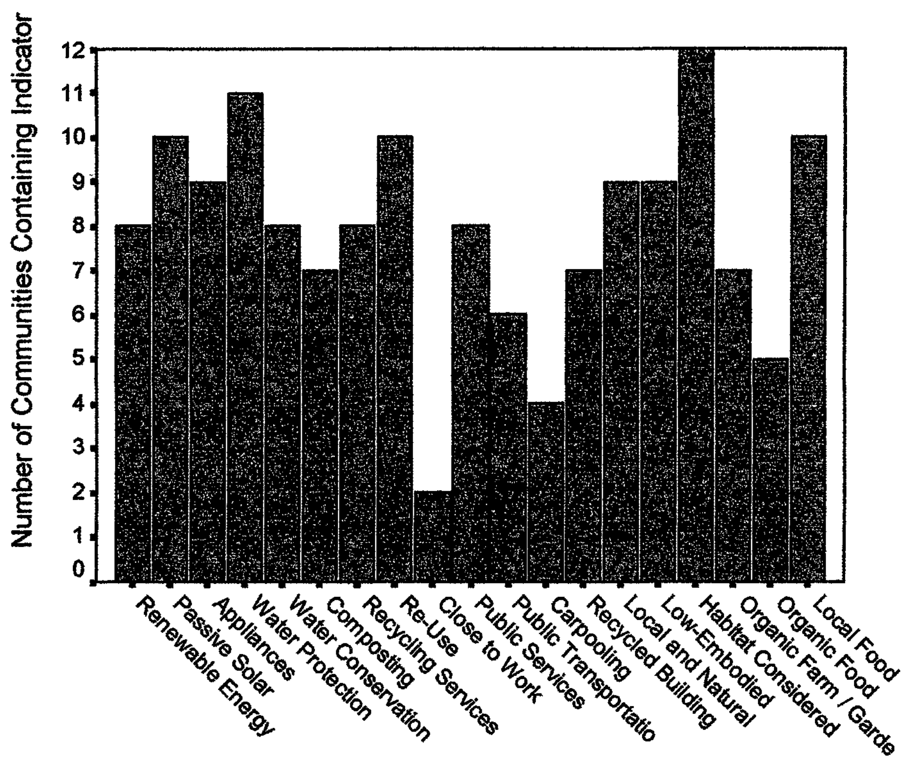


Figure 2 helps identify which indicators are well represented, in the sample communities, and which are not. For example, only two communities out of the twelve participating are designed to be in close proximity to work whereas all but one of the communities considered water protection measures.

It is also important to consider the distribution of the indicator categories. The over-all percentage of indicators present in each category can help to illustrate where a community is weak in its community design (Figure 3).

Figure 3. Percentage of Indicators Present Per Category in All Communities

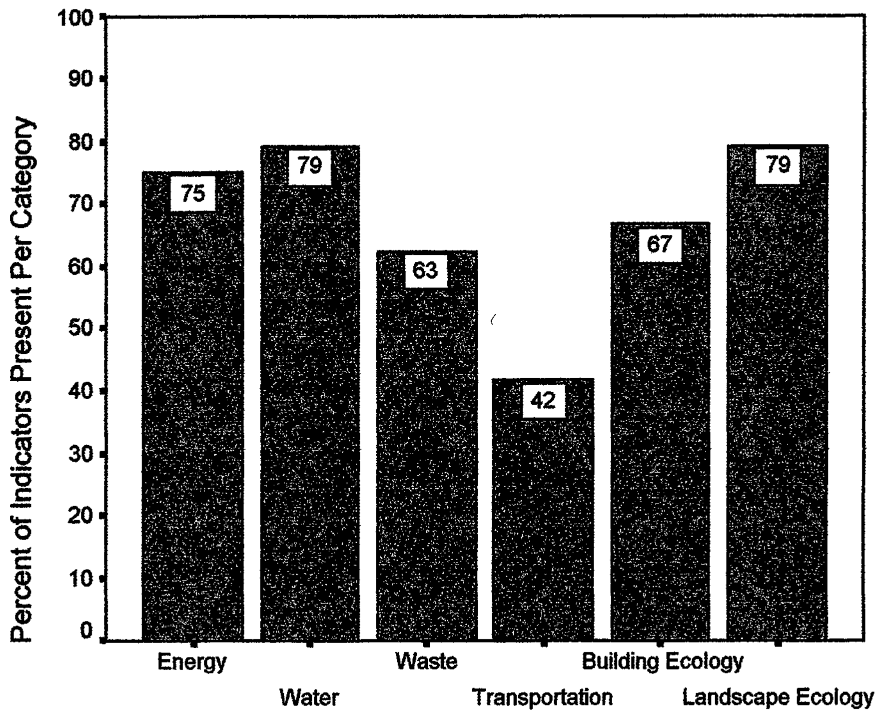


Figure 3 shows that the Transportation category is the most weakly represented and that Water and Landscape Ecology categories are the most strongly represented categories of the six.

One might measure the over-all sustainability of a community or group of communities by considering calculating the proportion of indicators present and by checking to see if all categories are represented. For example, 150 indicators were present in the participating communities out of a possible 228. This proportion (150/228) indicate the presence of sixty-six percent of all possible indicators. This group of communities scores a 6.6 out of ten.

This research could provide a guideline for homebuyers, planners, and ecologically-minder developers who wanted to determine what design changes might be needed to increase the level of sustainability for a specific project or a group of projects. In this research, for example, an ecologically-minded developer (such as the participants in this study) may access their community plan's sustainability by looking at which indicators their community did not contain and which categories were most or least represented (Tables 4 through 9).

Six of the questions were left blank throughout the surveys returned. Community H did not answer the questions in the Energy category (Table 4), Community D did not answer the Water category questions (Table 5), and Community B did not answer the last question in the Landscape Ecology category (Table 9). It is possible that these questions were simply over-looked, as each of the communities in question answered the remainder of the questions in the survey. If a community does not respond to all of the indicator questions, their over-all sustainability cannot be completely estimated.

The questions in the survey regarding specific consumption rates in the Energy Water, and Waste and Recycling categories (Appendices C, B-1, C-1, D-1) were not successful in helping to test the strength of the indicators. Only two people answered question B-1 (the community monthly water usage) and none of the communities answered questions A-1 (community monthly energy usage) or C-1 (pounds of garbage produced a month). Comments made by participants in the survey indicated that many communities did not know the answers to these questions, as the averages had not been calculated for the whole community.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

This research found that sustainability indicators may be used to evaluate consumption patterns in community design, and concludes that the presence of sustainability indicators may help in measuring over-all sustainability. Finally, sustainability indicators listed in the survey may together create guidelines for future homebuyers, planners, and ecologically-minder developer's projects. This research determined that the quantitative questions presented in the survey did not succeed in testing the strength of the indicators.

Surveys were sent to thirty housing communities. All mailings were conducted using the "Dillman Method" as outlined in Dillman and Sallant's, How To Conduct Your Own Survey (Dillman and Sallant 1994). Communities who received surveys were referred to as "ecological," "conservation-based," or "sustainable" online, in books, and in journals. Twelve communities of twenty-eight participated in this study. Data from surveys returned were evaluated and graphed using SPSS © and Microsoft Excel ©.

All sustainability indicators were represented at least once by at least one community. Some indicators, such as proximity of community to work and the use of carpooling, were not well represented in the participating communities. Transportation, Waste and Recycling were the categories with the lowest proportion of indicators present and Water and Landscape Ecology presented the most indicators.

From this preliminary study, this research concludes that the participating "ecological," "conservation-based," or "sustainable" housing communities are incorporating aspects of sustainable design. While all of the indicators are represented at least marginally, some indicators are well represented. This research cannot conclude that sustainable community design implies a reduction in overall resource consumption compared to traditional housing communities, as few communities answered any of the quantitative questions. Finally, this research suggests that sustainability indicators may be used to guide homebuyers, planners, and ecologically-minded developers in designing future homes and communities.

The respondents did not report any difficulty understanding the design questions in the survey; however many respondents reported difficulty in answering the quantitative questions. As each house in a housing community may be different from its neighbors, and as few communities question residents as to their consumption levels, it is recommended that specific consumption questions be omitted from this kind of survey. It is further recommended that future researchers look for studies that specifically calculate quantitative consumption rates and apply that to his/her results.

There are many in ways to build upon this research. A researcher might survey different kinds of communities to see if consumptions patterns vary between different types of housing. By including different kinds of communities such as multi-family housing, co-housing, and intentional communities, a researcher could assess if and how sustainable design indicators are present in one type of housing versus another. A researcher could collect more surveys so that statistical significance testing is possible. Further research might also include the incorporation of more indicators to more specifically assist communities to identify their consumption patterns and their sustainability. Additional categories for sustainability that could be included might be economics and quality of life. By including more indicators, a researcher may attain more specific design information by which to assess the sustainability of different communities.

It was a goal of this research to test the suggestion that sustainability indicators, which may be used to evaluate and analyze the consumption patterns and sustainability of communities, can assess the degree to which ecological principles are realized in design. It is hoped that this research may make planning for sustainability more easily definable. This research may aid future communities to develop a more sustainable footprint thereby utilizing less resources to live.

APPENDIX A

INTRODUCTORY LETTER

Hi,

My name is Alex Marsh and I am currently working on my Masters degree in Geography at Southwest Texas State University. During this spring, I am attempting to complete my thesis, but I need your support!

I am very interested in how communities, whose guiding principles include conservation and sustainability, are designed. I am also interested in how some aspects of community and home design contribute to overall energy consumption, water use, and garbage production.

I know that your community identifies itself as ecological, conservation-based, or sustainable. You have received this letter because I have already read about your community on-line or in an article and your community has a good foundation and a good reputation. My hope is to have several communities participate in my study.

In a week I will be sending you a survey, which should only take about 30 minutes to complete. The survey asks about your housing community's building design, energy use, transportation, water use, and garbage production. If you participate in my study, I will provide you with my results and what I have learned when I complete my thesis. It might be informative and fun for you to see how others are approaching creating more sustainable communities.

I am not sending very many of these letters out because very few communities fit my criteria. Consequently your participation is very important to me.

I am currently living in Portland, Oregon. If you have any questions, please feel free to contact me at:

alexblissmarsh@yahoo.com or
(503) 284-6172 or
944 NE Emerson
Portland, Oregon 97211

Thank you for your time, Alex Marsh

APPENDIX B

SECOND LETTER

April 22, 2002

Hi again,

I am the graduate student interested in different community's approaches to conservation design. A week ago I sent you a letter letting you know that this survey was coming. The survey contains six categories of conservation design including energy, water conservation and quality control, waste and recycling, transportation, building ecology, and landscape ecology. Questions are either "yes/no" or "fill in the blank".

It is okay if your community design does not consider or contain all of the characteristics listed in the survey. This research attempts to seek what currently is out there and to learn from all projects whether they are strong in one category or all six categories. In other words, don't be disheartened if your community does not consider any of my transportation questions, for example. I expect a wide variety of responses.

Remember, I will be providing all communities who participate with my results. If you have any questions you may contact me at:

am1031@swt.edu or (503) 284- 6172.

I am looking forward to learning more about your communities!

Alex Bliss Marsh
Graduate Student
Southwest Texas State University

APPENDIX C

SURVEY

The purpose of this survey is to see which sustainability indicators are present in ecological, conservation-based or sustainable developments and to if the presence of these indictors is reflected in the overall consumption of energy and water resources and production of waste.

*To assist you, a glossary is included at the end of the survey. Words found in the survey, that can be found in the glossary are marked in **bold**.*

If you have any additional information or materials that might clarify your answers to the questions below, please feel free to include them with your response.

Thank you for taking the time to fill out this survey!

A. General

1. How many acres are there in your housing community?

   ____

2. How many people live in your housing community? ____________________
3. How many structures are present in your housing community?

   ____

B. Energy

1. What is the average monthly energy usage in Kilowatt-hours per household? _______________.

Energy use is indicated on each home's monthly utility bill

2. Are renewable energy sources being used for central heating/cooling, water heating or lighting?

Yes ☐

No ☐

Renewable energy sources may include, but are not limited to, active solar, hydroelectric, geothermal, and methane.

If you are using any renewable energy sources listed or not listed here, please describe.

____

____

____

____

3. Are the housing units incorporating **passive solar design**?

Yes ☐

No ☐

4. Are energy saving appliances employed?

Yes ☐

No ☐

Energy saving appliances include, but are not limited to refrigerators, clothes dryers, dishwashers, and solar hot water heaters.

If you are using any energy saving appliances listed or not listed here please describe.

____

____

____

____

Comments (*Feel free to add any comments relating to these energy questions, that you feel are applicable*)

____

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____

C. Water Conservation and Quality Control

1. How many gallons of water are used on the average per household monthly? ______________

2. Are water conservation measures in place?

   Yes ☐

   No ☐

   Water conservation measures may include, but are not limited to, ***gray water re-use, rainwater collection****, Drought tolerant landscaping, and low flow toilets and sinks.*

   If you are using one or more of these conservation measures, please indicate which ones you are using. If you are using something not listed here, please describe.

   ____

   ____

   ____

   ____

3. Are water quality protection measures in place?

   Yes ☐

   No ☐

   Water quality protection measures may include, but are not limited to, ***storm water retention ponds****,* ***permeable surfaces****, and* ***constructed wetlands****.*

   If you are using one or more of these protection measures, please indicate which one(s) you are using. If you are using a water quality protection measure not listed here, please describe.

   ____

   ____

   ____

   ____

Comments (***Feel free to add any comments relating to these water questions that you feel are applicable)***

____

____

____

____

D. Waste and Recycling.

1. Please answer either "a" or "b"
   a. About how many pounds of waste does each household generate a month? ________________ or
   b. How large are the average garbage containers used for weekly curbside pick-up?

      20 Gallon ☐

      32 Gallon ☐

      Community Dumpster ☐

      Other ________ ☐

2. Are organic wastes composted on site?

   Yes ☐

   No ☐

3. Are recycling drop boxes present in the community or are "curbside pick-up" recycling services available to community members?

   Yes ☐

   No ☐

4. Are there local efforts to re-use discarded waste?

   Yes ☐

   No ☐

Re-Use of waste includes, but is not limited to, saving and re-using locally discarded building materials or providing a "drop off box" for locally unwanted household items such as old computers, clothes, and toys.

If you are using one or more of these re-use measures, please indicate which one(s) you are using. If you are using a re-use measure not listed here, please describe.

____

____

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Comments (*Feel free to add any comments relating to these waste and recycling questions, that you feel are applicable)*

____

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____

____

E. Transportation

1. Is the housing community located within a ten-minute walk from 50% or more of community members' place(s) of work?

   Yes ☐

   No ☐

2. Is the housing community located within a ten-minute walk to any public services?

   Yes ☐

   No ☐

   *Public services include stores, **restaurants**, schools, libraries, etc.*

3. Is the housing community located within a ten-minute walk from a public transportation depot?

   Yes ☐

   No ☐

4. Is carpooling being utilized or promoted?

   Yes ☐

No ☐

Comments (*Feel free to add any comments relating to these relating to these transportation questions, that you feel are applicable)*

____

____

____

____

F. Building Ecology

1. Were recycled building materials used in the construction of the homes or facilities?

Yes ☐

No ☐

If yes, please explain.

____

____

____

____

2. Were **local materials** used in the construction of the homes or facilities in the housing community?

Yes ☐

No ☐

If yes, please explain

____

____

____

____

3. Were **low embodied energy building materials** used in the construction of the homes or facilities in the housing community?

Yes ☐

No ☐

If yes, please explain.

____

____

____

____

Comments *(Feel free to add any comments relating to these relating to these landscape and building ecology questions, that you feel are applicable)*

____

____

____

____

G. Landscape Ecology

1. Does the community design consider local habitat and natural resources?

Yes ☐

No ☐

If yes, please explain.

____

____

____

____

2. Is there a farm or community garden on site?

Yes ☐

No ☐

If yes, how is it organized?

3. Are on-site foods grown organically?

Yes ☐

No ☐

4. Are locally grown foods available to community members?

If yes, please explain how.

Comments (***Feel free to add any comments relating to these relating to these Landscape Ecology questions, that you feel are applicable)***

Glossary

1. **Constructed Wetland:** Sewage sludge settles to the bottom of the pit and decomposes anaerobically. Shallow ponds are populated with water hyacinths and bull rushes aid natural processes filtering bacteria present in the waste. The plant material can remove great volumes of nitrogen and phosphorus, as well as drawing up toxins such as phenols and heavy metals into their plant biomass (Perks and Vliet, 1993).

2. **Graywater:** Graywater is defined as the wastewater produced from baths and showers, clothes washers, and lavatories. This does not include wastewater generated by toilets, kitchen sinks, and dishwashers, which is called "black water" (Austin green builder program, 2001).

3. **Harvested Rainwater:** Harvested Rainwater is rainwater that is captured from the roofs of buildings on residential property. Harvested rainwater can be used for indoor needs at a residence, irrigation, or both, in whole or in part (Austin green builder program 2001).

4. **Local Materials:** Local materials such as stone, clay (brick), and wood can be used in most forms of smaller scale (residential) construction. These materials are labor-intensive rather than energy-intensive and can reduce the life-cycle costs of a building as well as transportation costs (Perks and Vliet 1993).

5. **Low embodied energy building materials:** Low embodied energy materials require less total energy to extract, manufacture, transport, construct, maintain and dispose of. Some low embodied energy materials include Sand, gravel, wood, concrete, sand-lime brickwork, and lightweight concrete (Perks and Vliet, 1993).

6. **Passive Solar Design:** Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. In this approach, the building itself or some element of it takes advantage of natural energy characteristics in materials and air created by exposure to the sun (Austin green builder program, 2001).

7. **Permeable surfacing:** Permeable surfaces include, but are not limited to, gravel roadways and pads, or turfstone (concrete blocks with spaces to allow for vegetation to grow through). Permeable surfaces allow for water from run-off to soak back into the Earth. Impermeable surfaces include concrete, asphalt or built structures (Perks and Vliet, 1993).

8. **Solar Hot Water Heater:** Solar hot water systems provide warm water for showers and baths, swimming pools, hot tubs, and space heating (Roseland, 1999, 89).

9. **Storm Water Retention Pond:** Storm water retention ponds are utilized primarily as a way of easing the pressure on the street sewer drain system during a heavy rainfall. The ponds typically hold water throughout the year, collecting water during a storm and releasing it slowly after the peak flow has subsided. This slow release, typically over a period of days, (rather than hours or minutes) reduces the need for storm sewers to be sized for maximum potential peak flow, which reduces infrastructure costs. This water can be used for irrigation, but also serves to provide urban habitat for migrating waterfowl (Perks and Vliet, 1993).

APPENDIX D

POSTCARD

Hi again,

I am sending this postcard to remind you about the the community design survey I sent to you last week. I would love to get the surveys back by mid-May so I can complete my thesis before summer. Please contact me if you have any questions. Your participation is very important to me.

Alex Bliss Marsh

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VITA

Alex Bliss Marsh was born in Texas on September 16, 1973. She lived in Texas until she was twelve years old when she moved with her father and brother to Maui, Hawaii where she attended high school. After high school, Alex attended Antioch College in Yellow Springs, Ohio, where she received a Bachelors Degree in History in 1995.

After graduating from Antioch, Alex traveled extensively throughout the United States, Mexico, and Europe. During this time, she sold flutes at Renaissance fairs, mapped beaver dams, worked as a wrangler, took teenagers backpacking, read electric and water meters, volunteered for nature preserves and parks, and sought out beautiful places to visit and enjoy. After spending a year in Arcata, California, taking Natural Resource Planning Classes at Humboldt State University, Alex enrolled in Southwest Texas State University in 2000 where she pursued her Master's Degree in Geography and Planning. Alex currently lives in Portland, Oregon.

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This thesis was typed by Alex Bliss Marsh.