RE-THINKING HIGHEST AND BEST USE: IMPLEMENTING SMART DEVELOPMENT IN SUPPORT OF SMART GROWTH. *A Case Study in Santa Fe, NM*

by

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ABSTRACT

This paper answers the questions "where to develop?", "for whom to develop?", and "what to develop?" from a double bottom line perspective of profit making and social benefit, using a 3-acre property in Santa Fe, NM as an example. The first section on where to develop gives a literature review of the costs and benefits of urban growth and generates the types of questions to ask when determining appropriate development location from a smart growth, double bottom line perspective. Using this framework it is determined that four of the top priorities for development in Santa Fe are affordable/moderate income housing, water conservation, greenhouse gas reduction, and compact/infill development. Section two considers who the best target market is for development, using demographic data and GIS maps from the 2000 Census, as well as statistics from local Santa Fe government and think tank sources, and finds that housing for the population between 100-120% of area median income is a significant unmet need. Section three begins to determine what to develop for this population, while addressing the remaining policy priorities for the city of water conservation, compact development, and greenhouse gas reduction, and presents a preliminary cost analysis for a passive solar green built house. Preliminary results reveal that the green cost premium is an additional $6,743 over the cost of a traditional house, but this does not include the associated reduction in utility bills resulting from a passive solar design. A preliminary analysis of the costs and benefits of installing a photovoltaic system is included as well, and a feasibility analysis suggests that building a passive solar adobe house with photovoltaic system is feasible if a variance is granted to put at least 3 houses on the 3-acre subject property, which is currently zoned for one house. The conclusion makes suggestions for program evaluation measures, to evaluate success at not only profit making, but the double bottom line of achieving social returns as well.

Thesis Supervisor: John Kennedy
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For Mom who taught me to love houses and communities
For my sister who taught me to love Santa Fe and how to locate my passion
For Dad who taught me to do what I love and the money will follow

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… And to Gloria Schuck for helping me make it a reality.

Most of all, to everyone above for believing I could do it, which is the greatest gift of all.

Get over your skis
Take more risk than you're comfortable with
- Hamid Moghadam

Jump in the pool
- Peter Aldrich

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INTRODUCTION

With house prices increasing, commute times lengthening, cultural diversity decreasing, natural resource depletion rising on political agendas, and concerns about global warming deepening across the country, "smart growth" has become the buzzword of the last decade to describe how cities *should* be developing in contrast to how they *are* developing. It includes many different policies and practices, and is as vague a term as "green building", defined differently for different purposes. Indeed, the definition of smart growth and green building change from one city to the next or one climate to the next, and people variously define the "growth problem" as too many cars on the road or too many roads for cars. Regardless of the specific definition, small towns like Santa Fe and large cities like Boston, environmentally oriented urban planners and economically oriented businesses, are all asking how to preserve and integrate our economy, community, and sense of place.

Books such as: 1) Natural Capitalism[1], 2) Cradle to Cradle[2] 3) The Ecology of Commerce[3], 4) The Sustainability Advantage: Seven Business Case Benefits of a Triple Bottom Line[4], and 5) Mid-Course Correction: Toward a Sustainable Enterprise, The Interface Model[5], to name a few, have emerged to argue the financial benefits of converging profit motivated businesses with environmental responsibility to create socially responsible businesses.

The goal of this project is to examine how smart growth and green building can combine with traditional development to create socially responsible, profit producing "smart development". L. Hunter Lovins from the Rocky Mountain Institute offers a great distinction:

> *Growth is an increase in size, while development is an increase in quality and diversity. Development increases the value of both public and private investments, while growth tends to require increases in these investments that may or may not increase value.*[6]

Smart growth refers to development that minimizes the costs of geographic growth and maximizes the benefits, as discussed in Section 1. Green buildings or sustainable buildings:

> *"…use key resources like energy, water, materials, and land much more efficiently than buildings that are simply built to code. They also create healthier work, learning, and living environments, with more natural light and cleaner air, and contribute to improved… health, comfort, and productivity. Sustainable buildings are cost-effective, saving… dollars by reducing operations and maintenance costs, as well as by lowering utility bills."*[7]

Combining the two means answering the typical questions that developers ask about profit creation, but also looking at how social goals and profit maximization can actually support each other. The questions are:

1. *Where to develop?* What do regional plans, development codes, and variances that were granted indicate about a city's preferences for development? An understanding of these preferences will enhance developers' relationships with city officials and planners, and developing along these lines will minimize valuable time that the developer spends negotiating with the city and delaying project implementation.

2. *For whom to develop?* Looking at what kind of housing is most socially needed in a town also reveals where the market opportunity resides. The developer then has to decide whether the costs of such development will support profit necessary for building this kind of housing.

3. *What to develop?* Green building is becoming mainstream with GM, Ford, TI, and Genzyme building LEED certified headquarters (to name a few), and several studies have been completed on the financial costs and benefits of green building. These studies, however, focus on commercial buildings. The data presented herein is for single family homes, to illustrate a starting point for how developers and homeowners can think about the tradeoffs and benefits of building green.

4. *How to finance the development?* Loans for socially responsible development are hard to come by, some developers say. Others report that low energy costs mean more reliable (and lower) monthly bills for homeowners, which makes them more stable mortgagees. Included here is a list of resources for financing green building.

5. *How to define success of the development, if it is not purely profit motivated?* Over the last decade trends in the non-profit community push organizations to financially act like for-profit organizations, carefully monitoring administrative overhead and returns to donors' "investments" while still achieving a social mission. This sector has developed strategies for how to measure success of a "double bottom line" of social returns and financial returns, that provide valuable insight into how "smart development" can be evaluated based on community development outcomes measures.

6. *Appendices*. Appendices include green building criteria for the U.S. Green Building Council's LEED rating and the Department of Energy's Energy Star rating, sample suggestions for green building specifications and suppliers in the southwest, and a construction strategy for buildings in the southwestern climate created by Building Science Corporation.

STRUCTURE AND PURPOSE OF THIS PAPER

Using my land in Santa Fe, NM as the focal point of the study, I'll examine each of the above questions. The result is a thesis which will have, for the first half, a literature review on urban growth problems and policies to provide the context, and for the second half, a cost analysis of

green-built, single family homes in Santa Fe, including market analysis and demographics for the Santa Fe area.

In the process of researching green building this year, it became apparent that there are very few sources of information on green building that clearly and concisely explain the basics of green building in plain English. Therefore, this paper is created for developers who are new to green building and want a sense of what green building means to them before diving into a full scale analysis, or for homeowners who may not have the time, inclination, or engineering degree needed to decipher the respectable instructions developed by do-it-yourself pioneers on how to design and build a photovoltaic or solar heat system (the difference between these is covered – *briefly* – in the beginning of "What to Develop".) Each section will present general concepts – in plain English – and then apply the concepts using a 3 acre piece of land and specific house design in Santa Fe as an illustrative example. Helpful written and internet resources for each topic are in grey boxes.

This project is from the standpoint of "a use looking for a site" because it is unrealistic for the scope of this project (and outside the realm of my interest) to examine all possible uses. Thus, this is not truly a highest and best use analysis, but I've titled it as such because it provides an example of how to re-think highest and best use to include both a profit motive as well as other socially-oriented development priorities appropriate for the town. In this way, developers become leaders of appropriate development and can meaningfully contribute to conversations about planning and smart growth.

The urgency of growth policy is further determined by the nature of sprawl, which is a path dependent process.[8] It is not self correcting like the economy, in which demand falls when prices rise. Rather, growth breeds more growth. The decline of central business districts causes further economic decline as the movement of people to the suburbs causes businesses, shopping, and more people to follow. Thus, it is ever more important for us to understand the stories behind growth in order to engage in meaningful dialogue about solutions.

WHAT IS NEW ABOUT THIS?

I have seen articles on costs and benefits of commercial green building (schools, office buildings, apartment buildings, etc.), but have not been able to, in the last year, locate a direct cost comparison of various components for single family houses. I have read about smart growth but not about defining smart development and how it can work with local policy. (Any recommendations for additional resources on single family green building costs and benefits would be greatly appreciated. Please send them to Balkcom@alum.mit.edu.) And lastly, I have found many extensive resources for green building written by people more well versed in it than I, but found nothing instructive, brief, and written in plain English for people who are new to the idea.

1. WHERE TO DEVELOP?

A. Introduction to the costs and benefits of urban growth
B. Problem definition and solution are location specific
C. Key federal, state, and local growth policies
D. What smart growth means for development location in Santa Fe

As David Goldberg begins in *How Do You Know if It's Smart Growth?,*[9] "Imagine … you're a profit oriented developer with a social conscience. Through market and demographic research, you've detected an unmet demand in metro Atlanta for well-designed, urban scale neighborhoods, with a mix of housing types and prices, in a village-like setting. You've absorbed the literature on green design and Smart Growth… you're confident you've got a to-die-for winner, but when you present it to the local government the reception is a tad chilly…"

The most significant question to answer, from a smart growth standpoint, is where to develop because smart growth depends first and foremost on where development takes place. In addition, it makes financial sense for a developer to identify what kind of development a town most desires from both a market and planning standpoint, because it will maximize selling opportunity and minimize entitlement (permitting, variance) difficulties.

AN INTRO TO THE COSTS AND BENEFITS OF URBAN GROWTH

An analysis of urban sprawl and growth management often brings more questions than answers, with supporters and opponents of growth management both citing studies, data, and logical arguments leading to opposing conclusions. Supporters for growth management argue that land use is becoming a bigger and bigger issue as states like Oregon and California find themselves routinely updating regional plans to accommodate ever-increasing levels of growth.[10] Growth management opponents claim that only 3% of the country is classified as "urban" and that open space is abundant.[11]

Problem definition of urban growth

There are four types of implicit assumptions made about problem definition in current analysis of urban growth debates, which must be identified in order to fully understand both the problem and proposed solutions. They include environmental ideology[12], geography[13], time horizon[14], and to these I add an underlying assumption about policy priorities. Each of these assumptions limits the kinds of costs and benefits considered in urban growth.

The ideological assumption stems from a belief in the existence value of the environment and open space. While our country's system of laws, and the laws of economics, are designed to

govern the relationship between an individual and society, many proponents of growth management implicitly consider interaction with a third participant – the environment – to be an equally important ethic.[15] The inclusion or exclusion of existence value for the environment deeply affects interpretations of economic models. Property rights advocates argue that the free market should guide decisions about land use for housing.[16] Growth management proponents, on the other hand, argue that path-dependent effects of sprawl dictate ever increasing outward expansion and inefficient use of land[17] require limits on unnecessary growth.[18] This ideological value colors any further assumptions made, most notably policy priorities.

Second, many analyses of urban sprawl and urban growth boundaries tend to implicitly prioritize various policy problems caused by urban sprawl and focus analysis of solutions on only these prioritized problems. These may include the economic decline and segregation of inner cities[19], preservation of farmland[20], protection of the environment, forests, and open space[21], the effect on the land cost and housing market[22], cost of public services[23], or all of the above.[24] To evaluate the costs of urban growth and expansion, these priorities must be identified in order to determine the appropriate costs and benefits to be analyzed.

Third, the geographic scope for cost / benefit valuation must be considered. In response to ideology and policy priorities, the geographic scope of a cost / benefit analysis may include only the central business district, the entire urban area, the county, etc. As the scope grows larger, so does the number of costs and benefits to consider. Analysis based on economic development priorities tends to focus on costs to the central city, while proponents for farmland preservation base analyses on areas outside of the city. The geographic scope of a cost benefit analysis will determine which of these areas to include.

Fourth, the temporal scope of an urban growth analysis is important and often overlooked. Analyses frequently have an implied general time horizon – i.e. today, the short term future, the long term future, or the very long term future. As time increases, the considerations of costs and benefits and also of the model design in general will change. For example, examining costs and benefits of urban growth 100 years in the future will necessarily include population projections out to that point, along with predictions about city limits and resulting densities of development. Some property rights based analyses of land values and urban sprawl take into account only costs of urban sprawl today, and do not account for future escalating costs.[25]

Together these four assumptions form the framework for a cost / benefit analysis, by defining parameters for the kinds of costs and benefits to be included.

Costs of expanding an urban area

Several scholars analyze the financial costs associated with expanding the urban land area[26], compared to potential revenue generated by newly developed land[27]. These include costs for public services[28], the cost of tearing down and rebuilding central business districts[29], and the

increasing time cost for the development approval process as land migrates from a rural to urban designation.[30] However, the costs of expanding an urban area are not purely financial. To form a complete estimate of the impact on society, the negative social benefits accrued by land and housing consumers and producers must also be considered.

These costs become apparent through examination of the market for land and housing. One of the most significant questions surrounding the urban growth debate is its impact on land and housing prices, with housing density as a mediating factor.[31] Housing prices rise as populations grow and demand for housing increases, and the rate at which they rise is determined by the rate that land prices increase in response to scarcity. The rate at which land becomes scarce is determined by the density of development.[32] The effects of land scarcity and housing density are further aggravated by land speculators who buy land with the intention of selling it once land prices rise.[33] Thus, there is less land available, without the benefit of additional housing. However, if growth management policies successfully restrict land supply and thus land prices increase, then density should also increase as developers substitute more costly land input for less costly capital input (i.e. buildings).[34] *This begs the question of ideal density[35] because there is a potential trade-off between density and land prices.* This central debate plays out in cities and towns all over the country.

Second, when an urban area expands, the value of land near the center declines while land farther away increases in value in response to pollution externality from the urban area.[36] The primary cost accrued from urban expansion into land outside the city is loss of existence value of open space, animal habitats, forests, and farmland. This loss is minimized if key environmental resources are preserved even as the boundary expands, but then these are also subject to spillover effects from the surrounding urban area. As urban size increases, so do commute distances and automobile pollution, and the buildout of cities increases flood control issues and water pollution, as concrete forms a barrier between water runoff and the soil to absorb it.[37] This detrimental effect, or externality, is not captured in market prices for land and housing. In order to assess accurately the costs of urban expansion, the value of social cost of expansion, from increased pollution, must be assessed.

The third cost that completes the components of cost / benefit analysis for urban expansion is the market for services. In close connection with fiscal analysis, scholars have debated the effects of density and metropolitan size on the cost of providing public services including schools, sewer systems, roads, and police and fire departments. The cost associated with buildout of transportation becomes essential to maintaining the accessibility goal (to open space and points within the urban boundary).

The model for these services resembles a natural monopoly, meaning that the initial capital outlay is so large that average cost per person (marginal cost) decreases as the number of people served increases. However, as distances from the capital resources (e.g. schools) in the city center increase, costs suddenly leap as more capital outlay (more schools) is required.

Studies have predictably found that, while the cost of providing services decreases with density due to economies of scale, it increases with distance from the city center.[38] Thus, as urban areas expand, the financial cost of supporting annexed land with public services increases with distance and low densities, but then decreases relative to these costs as population density in outlying areas increases.

It is important to remember that while additional property tax revenue will be created from the annexed urban land, property values of existing urban development will decline in response to increased supply, decreasing revenue from property taxes. Thus, in order to know the net costs and benefits related to public services, it will be necessary to estimate not only the costs for additional services, but the effect that land prices will have on consumer demand.

Benefits of expanding an urban area

Within this framework there are many social costs and benefits, both negative and positive, that accrue to consumers and producers of land and housing when expanding an urban area. (Negative benefits are similar to costs, but slightly different from an economic perepsctive.) These include:

- The positive benefit to urban land producers owning land that is added to the urban area, which appreciates in value in response to development potential
- The negative benefit to urban land producers who own land previously inside the urban area, which depreciates in response to an increase in supply (which is somewhat offset by a decrease in property taxes)
- The positive benefit for housing consumers of lower cost housing and land resulting from an increase in supply, which is partially offset by new residents moving into the area
- The negative benefit to residents near the original urban edge who lose views of open space
- The negative benefit of decreasing accessibility to open space as the urban edge radius grows larger and farther from the center
- The undetermined benefit of additional tax revenue from newly annexed land, which is offset by losses in tax revenues from decreasing property values in response to increasing supply; the degree of tax revenue losses is determined by consumers' responsiveness to price changes for housing and land

Problems with valuing urban growth effects

There are several challenges to measuring these costs and benefits. It may be difficult to discern whether increases in housing prices are due to urban expansion or upturns in the economy, interest rates, lower densities, and land speculation. In addition, real estate markets have a time lag, meaning they eventually respond to price but not immediately.[39] Thus, it will

be difficult to attach changes in housing prices to appropriate causes. Lastly, for owner occupants, profit is not the motive of housing or land ownership[40], and thus positive or negative benefits resulting from changes in housing prices may not apply to them and may not capture their true concerns.

There are several challenges to valuing environmental effects as well. First, estimates of value for environmental resources and open space do not account for intrinsic, existence value of resources because they estimate values based on people's interaction (directly or indirectly) with the environment. Second, people tend to discount the future benefits of environmental preservation.[41] Stated differently, people undervalue future benefits and overvalue current costs. Third, people's willingness-to-pay is constrained by income, while willingness-to-accept is not. Therefore, valuing how much farmers are willing to be paid to compensate for pollution spillover externalities will produce values that are inflated compared to farmers' willingness to pay to avoid such effects.

Questions to ask

In order to effectively apply a cost / benefit analysis there are several questions that will need to be answered by regions evaluating urban expansion. These include:

- ❒ What are the ideological environmental values and policy priorities that define the need for urban expansion?
- ❒ How is farmland valued? As a producer of revenue from agriculture or for existence value?
- ❒ How are parks, forests, and other environmental resources valued? For existence value, revenue, or recreation?
- ❒ Who should be included in voting on land use decisions and valuing willingness-to-pay and existence value? Residents within the urban area, outside of the city, or anyone affected?
- ❒ Who should pay the societal and financial costs associated with expansion?
- ❒ When should market forces be used to determine conditions for expansion, and when is regulation necessary to counteract the failures of market assessments?

A Note on New Urbanism

Because New Urbanism is becoming the prevalent form of "smart growth", it is important to note that, although New Urbanism offers strong support for higher density and mixed use development, its purpose is sometimes misconstrued by those not completely informed, to be about the human experience of neighborhood design and community creation, rather than including environmental concerns. New Urbanists are skilled at creating beautiful neighborhoods, but the distinction between smart growth and sprawl often lies in location of development. For example, a developer in Atlanta located a neighborhood 30 miles from the

city, in what was previously farmland, and touted it as "New Urbanist smart growth" because it included higher density mixed use development. The purpose of mixed use development is to reduce car trips for work and shopping. Locating a new development 30 miles from the city in the middle of farmland surrounded by low density suburbs is not an effective way to reduce car travel and has a negative effect on quality of life as people are most likely still required to commute an hour or more to work in the city center.

PROBLEM DEFINITION AND SOLUTION ARE LOCATION SPECIFIC

One of the most important steps in a cost benefit analysis is the problem definition. However, in much of the existing analysis of urban sprawl or sustainable development *solutions*, the issue of *problem* definition goes unrecognized. The authors then propose "the" solutions to "the" problem, but we need to think critically about how to attach appropriate solutions to real situations, defined by the historical context for local growth management decisions in that city. For example, it may be difficult to determine a solution to the problem of traffic congestion, when the problem is variously defined as too many cars for the highways or too many highways for cars.[42] Each side of the debate presents studies and data to back their conclusions[43], but the interpretation of the data depends on the implicit assumptions made about the components of the problem.[44]

Indeed, the differences in the definitions of the term "growth management" are illustrative of the need to apply concepts appropriately to varying situations. The term may be used in suburban areas by people whose goal is to keep property size large, population densities low, and the tax base high, which means excluding affordable housing.[45] With the rise of urban sprawl on the political agenda, however, growth management has become synonymous with just the opposite, meaning higher population densities, smaller property size, and a mix of types of housing including middle or low income, in order to decrease the rate at which open space is developed and to even the tax base and municipal services offered among regions.

The Federal government's allowance of local growth controls provide initiative for residents to move to suburbs in search of higher tax bases and better services, and then implement controls to deny affordable housing options to others.[46] As a result, statewide tax base sharing and state or regional growth strategy is one of the proposed solutions to the problem of sprawl.[47]

Cities' or states' solutions to growth vary widely depending on the resources available to each state, the attitudes of the public, the support of the state government, and the relative priority of growth management initiatives. Minneapolis began with an appointed council to oversee regional planning, while Portland's was elected.[48] Some states like Florida have direct control ("preemption") over local planning, while Georgia has a primarily voluntary, incentive based structure to promote local cooperation with regional goals.[49] While Vermont, replete with open

space, began state-wide planning legislation to protect the environment, New Jersey's strategy began with a need for affordable housing.[50]

I offer as an example a contrast between the experiences of San Francisco[51] and San Diego.[52] Both areas experienced significant population growth during the 1980s. San Francisco was affected by the rise in the high tech industry, while San Diego was supported by federal defense dollars. In response to growing populations, voters in San Diego called for a regional growth plan, while San Francisco's growth strategies remained local. Then San Francisco continued to grow during the 1990s, while San Diego entered a recession caused by the change in defense spending. San Diego was left with large numbers of relatively unskilled workers, while San Francisco was experiencing the exponential growth of the technology industry and was receiving an influx of college graduates.

San Diego's economic woes were becoming a dominant concern and their land use restrictions – which set impractically low levels of population density – were part of the reason they were running out of space. Therefore, the policy priorities for San Diego were defined excessive growth controls and a focus on economic vitality and education. In San Francisco, on the other hand, fragmented planning and growth controls resulted in keeping people out and driving up housing prices, creating an income disparity between those who can live in growth controlled cities and those who are forced to live outside them.

What we see in this example are two cities that went through periods of economic growth and corresponding population growth. However, the answers for each are very different according to their individual stories. San Diego needs higher densities throughout the city, and a focus on education. San Francisco's challenge is to create a regional approach to growth that evens the opportunities to live in various parts of the area and redistributes the tax base more evenly. These cities both had growth problems but required very different solutions.

The question that needs to be answered is, what causes a city to grow geographically? I.E., what causes urban sprawl and the loss of open space? A developer or homeowner needs to understand, on a local level, the causes of growth leading to development choices that reduce open space in order to gain insight into local needs for appropriate development. Here "open space" includes privately owned but undeveloped property, publicly owned parks and other land, or farmland. "Appropriate development" means development that has the smallest possible impact on open space and supports local growth management priorities.

Questions to ask

The basic tenets of societal decision making[53] suggest that, viewed within the framework of growth management, key questions include:

- *Priorities* – what are the city's dominant policy priorities?

- *Attitude* toward growth management – how does culture, determined by people's attitudes, affect the priority to control growth?
- *Ability* to control growth – to what extent does external support such as federal and state government encourage or inhibit the city's ability to control growth?
- *Motivation* – To what extent do direct economic forces (i.e. taxes) or indirect economic forces (businesses' pressure on government) affect the city's policy priorities?
- *Implementation* of growth controls – what role do local politics play (power allotted to regional planning commission, agenda of governor or mayor) in inhibiting or increasing the city's ability to implement growth controls?

KEY FEDERAL, STATE, AND LOCAL GROWTH POLICIES

Federal, state, and local level policies create a growth management context for development decisions by encouraging, limiting, or directing where and when growth takes place. An understanding of regional plans, local property tax policies, state transportation and infrastructure priorities, and federal funding processes helps the developer to predict future growth patterns, and understand future policy priorities for a city. Growth management is inherently a natural resource allocation problem beginning with land use policy, enabled by transportation policy, and restricted by air quality and environmental policy. Most current research on growth management focuses on two (often opposing) dynamics, which are economic development and urban growth management. The following analysis focuses on the latter of the two.

Federal transportation and environmental policies enable or restrict development

Urban sprawl is a recognized social problem affecting taxpayers, health, wildlife, and preservation of resources. However, one of the most challenging steps in urban sprawl policy formulation is, as stated, problem definition. It is the variance in problem definition that precludes a uniform federal solution. Again, urban sprawl issues and accompanying solutions are, by nature, a local problem, and policy goals for urban sprawl are as varied as the cities served by the policy. Interpretation of the data and appropriate solutions depend upon implicit assumptions about the problem's components.

The federal government cannot effectively implement national regulation to reduce growth, but it could seek to alleviate effects of policies that have encouraged unplanned growth, including the Federal Highway Act. While it clearly is not politically feasible to discontinue funding of highways upon which the public has come to depend, as of 2003 (the most recent year for which data is available), railway miles traveled are .165 % of miles traveled in cars or motorcycles,[54] and obviously there is much room for improvement in use of environmentally advantageous public transit. Funding for railway should be increased to encourage these more efficient options.

There are several existing policies that seek to improve urban growth and land use problems, implemented in multiple Federal departments. First, passage of the Comprehensive Environmental Response and Cleanup Liability Act (CERCLA) authorized additional funding for cleanup and development of polluted sites in and around urban areas, in order to encourage "infill" development and reduce development on new land. Second, the Federal government in recent years has increased the amount of federally owned and protected land and parks. Third, the Environmental Protection Agency (EPA) is empowered through the Clean Air Act to set National Ambient Air Quality Standards (NAAQS)[55].

The NAAQS are enforced through transportation funding, which can be withheld for areas that do not meet standards. These "nonattainment" areas, such as the Atlanta area, must then produce plans for reducing congestion and decreasing pollution. Nonattainment regions are not allowed to build roads, which has a direct effect on land use and development patterns. The Transportation Equity Act for the 21st Century passed in 1999 reauthorized and updated transportation funding and requirements that were originally enacted in 1991[56]. Requirements include attainment of air quality standards as well as minimizing harm to the environment, protection of wetlands and national parks, enhanced funding for mass transit, and Environmental Impact Statements for major potential impacts.

The procedures required of states both by the EPA through the Clean Air Act, and by the Department of Transportation to receive federal funding, define a required metropolitan and statewide planning process for receiving funding. It is through this process that environmental restrictions are enforced. The federally required transportation planning process regulates not only what is to be included in the plans, but also details how often plans should be updated, who should be involved in the planning process at state and local levels, and processes for public participation as well as environmental requirements. Furthermore, these requirements are "not reviewable by any court," meaning the Federal Department of Transportation has final approval on federal-aid programs and requirements.

- A state implementation plan (SIP), required by the EPA for states with any areas not in attainment for air quality standards, is the primary plan and requires that all other plans comply.
- State level planning is governed by the long-range transportation plan (STP), which presents long-range goals.
- The state transportation improvement program (STIP) lists and prioritizes all upcoming transportation projects that are proposed for federal-aid grants and is required by the Department of Transportation in order to receive any grants. The transportation improvement program, by nature, has a shorter-range purpose than the long-range plan[57].
- At the metropolitan level both long-range plans and transportation improvement programs are required as well. In creating metropolitan plans, metropolitan planning organizations

are required to create them "in conformity" with state plans. The State, in turn, is required to include metropolitan plans "without modification" as part of state plans[58].

These requirements touch on all aspects of urban growth, and a state's specific construction of the problem will determine where resources are focused. Transportation policy cannot be separated from urban growth policy and dynamics because transportation systems enable growth. Therefore, it is important for developers to understand and place the transportation debate within the larger framework of urban growth and development. This requires an understanding of local motivations because the primary driver of growth and development is local government competition.

Local policies focus on the revenues and expenses of development

Locally, land use policies respond to the competing forces of growth management and economic development. These competing forces cause two kinds of local growth policies that have regional impact.

- "Type I" refers to growth that benefits one locality at the potential expense of others (known in economics as a negative externality), called developments of regional impact[59]. For example, building a new office for a major employer may generate significant property taxes for a town, but may also induce 5000 additional cars to drive through neighboring towns every day, creating traffic congestion in towns that may not have the infrastructure to support the additional traffic.
- "Type II" growth refers to local governments' avoiding development that imposes local costs but has regional benefits such as high pollution power plants, unsightly waste disposal facilities, or high cost affordable housing[60]. Type I and II growth may be exacerbated by local political and industry pressures or lack of local expertise about land use decisions[61].

Local policies focus on property taxes and zoning that guide growth and development. Economic development plays a dual role of benefiting citizens by providing jobs and benefiting fiscal health by providing property taxes. Property tax policy is of central importance to local economic policy and fiscal health. It comprises 90% of total local tax revenue and 30% of local government revenue[62]. In other words, of the taxes raised independently by any of the 19,000 existing municipalities, 90% of this independently created revenue is based on property taxes[63].

Important questions that local governments face concerning tax policy include:

- How do taxes encourage urban growth? How can tax policies be changed to decrease or increase the rate of geographic growth?
- How are tax rates affected by density of development? And how is density of development affected by tax rates?

- How can land speculation, which raises land prices by creating artificial shortages, be controlled[64]?
- How can taxes be used to promote economic development? Do tax abatements work?
- How can a city maximize the amount of revenue it brings in each year (primarily through property taxes) while minimizing its costs? Will this decrease tax rates?
- How should costs for infrastructure and schools be financed through property taxes?

These questions surrounding residential, commercial, and industrial taxation reflect the evolution of tax policy to become closely correlated with land use policy and fiscal goals. To wit, the mix (zoning) of low-income and high-income housing affects tax rates[65] because high priced houses are usually taxed at a lower tax rate. Today we see incentive taxation used for denser development[66], and exclusive zoning for lower tax rates[67], tax abatement to encourage development, and tax relief (through assessment) to preserve farmland[68]. Zoning was originally created to minimize effects on neighboring communities of industrial land use, such as noise, pollution, and congestion. However, it has evolved to include uses for fiscal impacts and preservation of property values, often to the exclusion of other uses[69].

A Note on zoning in Santa Fe

When most people think of local land use policies, they think of zoning. As mentioned above it is the most direct power a city has to control or direct growth. This requires consideration of maximizing tax revenues, and minimizing infrastructure costs while maintaining the quality of life goals and policy priorities expressed by local residents. A strong example of using zoning to manage these competing priorities is given in the next section on *What smart growth means for development location in Santa Fe*, in the discussion of the Santa Fe Regional Future Land Use and Growth Management Plan.

Real world implementations of property taxation produce four primary points of controversy[70]. These include:

- Regressivity – Many argue that property taxes place a disproportionate burden on lower income households. As income level decreases, the effective property tax rate must decrease or at least stay the same for the policy to be equitable.
- Discouraging development – Taxing property may discourage investment in capital that is subject to the property tax, in response to effectively higher prices.
- Economic segregation from tax rate disparities – Since localities are able to set their own budgets and tax rates, and the resulting revenues are used to finance the budgets, richer towns pay lower taxes and have better schools.
- Poor administration – Tax assessment practices are inconsistent and faulty.

The split rate tax is being explored in several areas of the country because the traditional property tax potentially distorts investment decisions. A firm owning land will receive a larger tax bill for developing high value property on the land. Thus, the incentive is for firms to buy land and build the lowest value property possible in order to minimize assessed value of the property. In comparison, the split rate tax, which taxes land at a higher rate and property (development) at a lower rate, encourages higher value development[71]. The split rate tax may be used to bring idle land into production, prevent speculation, encourage infill development, discourage building disinvestment, restrain rising residential land prices[72], encourage higher density of development, and promote, or at least not discourage, economic development.

The critical question being asked about the split rate tax is, does it work? A study conducted by Wallace Oates and Robert Schwab on Pittsburgh's experience[73] presents compelling results. Property tax rates and the value of building permits were anayzed for two periods, before a split rate tax was implemented (1960-1979) and after (1980-1989). The authors found that rates of development rose 70% *more* in 1980-1989, after the split rate was implemented, than from 1960-1979. During the same period construction in 13 of 14 other rust belt cities fell sharply, with declines of 11% to 52%. The split rate tax allowed the city to translate a larger portion of demand into actual development and, when compared to the alternative taxes, had a net positive effect.

Local government's primary responsibility is to provide needed services to its residents, promote economic development, and support local government fiscal health. This necessarily requires competition with neighboring localities. In order to manage Type I and Type II local growth, there has been increasing interest in regional or statewide planning.

State/regional plans fill the gaps and encourage consistency

It is not effective for growth management policies to be implemented at the federal level because solutions would not be appropriate or specific enough to be relevant for various states and regions. However, it also is not effective for policies to be implemented solely at the local level because solutions will be too specific and may not consider effects on neighboring localities. State/regional policies are required to bridge the divide.

Growth policies emerged during the 1970s. Public concern for the environment and natural resources[74] spurred adoption of legislation characterized by a focus on developments of regional impact (DRI) or Type I growth[75] and rigid state mandates requiring local compliance[76]. Public concern in the 1980s broadened to include transportation and traffic congestion, and in the 1990s included additional environmental preservation goals for farmland, forest, habitat, wetlands, and rural countryside, and equitable placement of public housing[77]. As public concern has broadened, growth management policy goals have as well.

In order to manage both Type I and Type II development as well as growing public concerns, comprehensive planning has emerged as a *process* mandated of local governments by state governments. Previous regulation of DRIs did not adequately address the cumulative effects of individual local development decisions too small to fall under DRI scrutiny. Thus, comprehensive planning was initiated to "fill in the gaps between state environmental regulation, regional planning, and scattered and inconsistent local growth management efforts"[78]. State and regional growth management policy goals tend to include[79]:

- Consistency – Requiring adherence between or among state, regional or local plans, also called vertical consistency[80]
- Concurrency – Requiring infrastructure development to occur in tandem with or prior to any new physical developments[81]
- Compatibility – Requiring consistency with plans of neighboring localities, also called horizontal consistency[82]
- Compact urban growth patterns – To minimize the effects of "sprawl"[83]
- Affordable housing[84]
- Economic development considerations – Which mitigates the need for growth restrictions with the need for a healthy economy[85]
- Protection of the environment and natural resources[86]

More important than individual components, however, is how those components interact. Raymond Burby and Peter May classify 13 state planning mandates according to two dimensions: degree of persuasion through sanctions and incentives, and degree of prescription for local plans including consistency and concurrency requirements[87]. They found through their research (discussed below) that a high degree of prescription and persuasion leads to more effective policies while low degrees of either leads to less effective policies.

Combined policy components form the relationships between state, regional, and local governments. Scott Bollens offers three intergovernmental dynamics that have been formed through growth policies.

- The first is "preemptive/regulatory"[88] characterized by direct state regulatory power over local plans and development decisions.
- The second, which is emerging as the most effective intergovernmental structure today[89], is "conjoint/ planning". It ensures consistency through mandates and sanctions, and requires local plan creation and adherence to state or regional standards. These standards are much less prescriptive than state requirements in preemptive governmental structures, and enable greater local independence.

- The third structure is "cooperative/planning" which relies on incentives to induce consistency and does not mandate local planning. Cooperative approaches are less effective[90].

Does development happen according to plans?

The primary question for developers is the "extent and nature of the influence of state mandates on local plans and development management"[91]. Development management is defined as separate from planning. *The key is whether development happens according to plans, after those plans are created.* Because the end result of growth management is to effect actual development patterns, Burby and May examine whether state mandates, filtered through regional agencies, implemented by local governments, actually affect development management. The focus is on local governments who determine the end results.

An important distinction is made between growth mandates (which they call "single purpose" plans) and comprehensive planning mandates. The former refers to prescriptive standards set for specific kinds of developments such as DRIs or wetland protection. Comprehensive planning mandates, on the other hand, refer to state requirements that determine a *process* for planning, the goals of which are regional coordination and comprehensive (local) consideration of development impacts.

The research model rests on two "linchpins". The first considers states' effectiveness in making local governments create plans that include required components, and the second is whether those plans are used to guide local development. State agencies may be empowered to use financial incentives to support the costs of comprehensive planning, and/or sanctions to withhold state funding from local governments that do not comply.

Burby's and May's research finds, first, that effective state enforcement of local compliance, measured in terms of dollars spent on mandate implementation, depends on high levels of both state agency commitment and leadership. This results in more flexible, effective controls on local compliance that interpret and follow the true nature of state agencies' mandates. While the initial theory included adequate state agency *capacity* as a necessary condition for effectiveness, research showed that capacity was not important if commitment and agency leadership were strong. Low levels of commitment led to rigid enforcement and token actions to support the mandate. Second, research found that existence of both sanctions and incentives were important tools for influencing local compliance, and that those plans are of a higher quality than in states without mandates.

The second linchpin of Burby's and May's research considers whether local plans are actually used to guide local development. There are three important findings.

- First, commitment of local governments significantly affects adherence of local development to plans, but commitment is determined by local demand and is *not* affected by state mandates.
- Second, state tools to induce local planning such as sanctions, incentives, or technical assistance do not directly affect local commitment, but they do indirectly affect commitment by inducing better quality plans developed through consensus building.
- Third, these higher quality plans with clear goals, analysis, and recommendations, subsequently strengthen development management. But development management will only achieve state (regionally focused) goals if there is strong local commitment to state objectives.

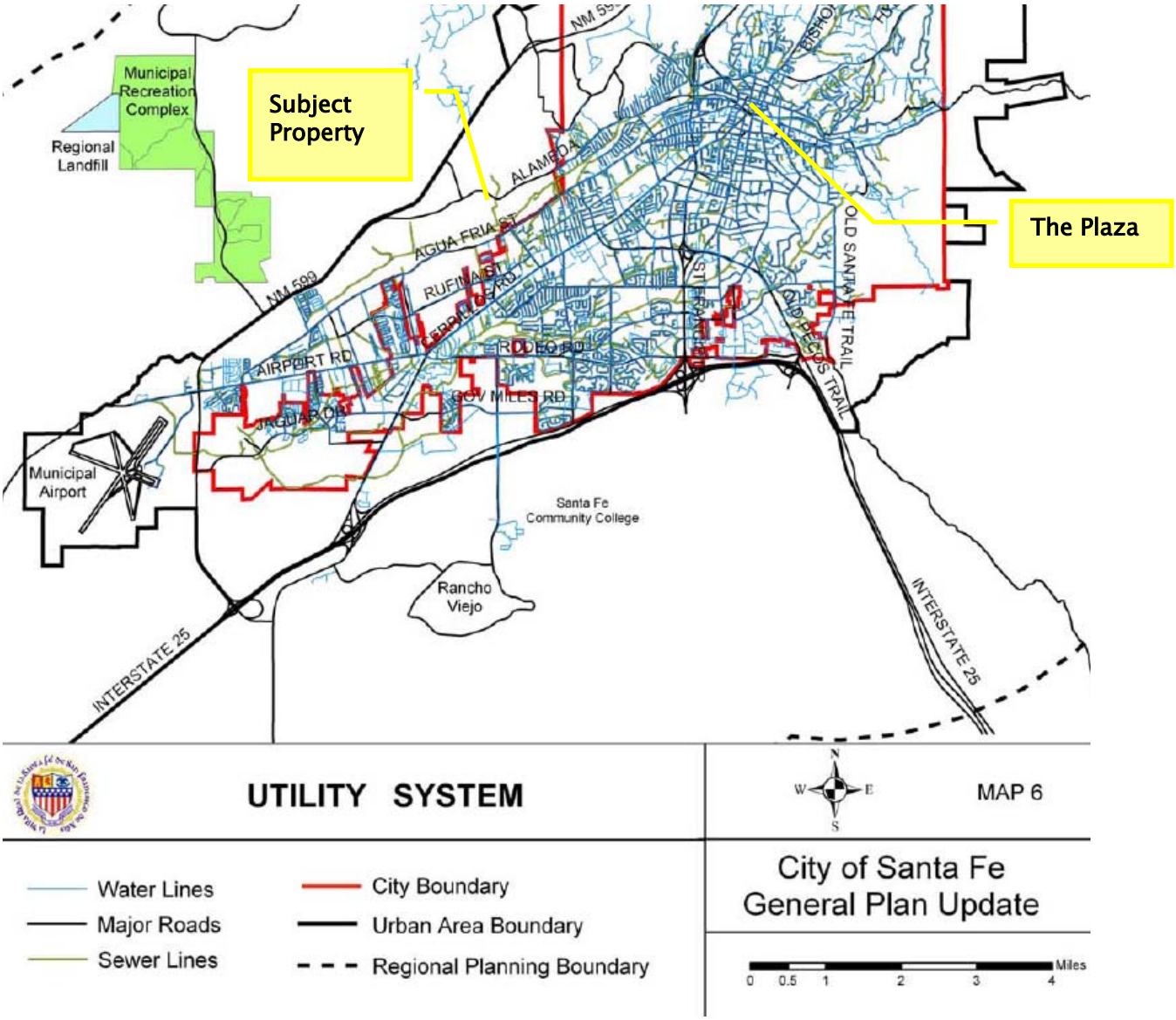
Burby and May acknowledge throughout their analysis that comprehensive planning is often argued to be too complex, too expensive and requiring significant time and technical ability. However, the authors argue that the (intensive) process of creating these plans, which includes public hearings, interdepartmental local cooperation, and generation of consensus on local goals, is critically important for enhancing local governments' understanding of larger growth policy needs and implications.

A note on the regional role

States are empowered to create comprehensive planning legislation, and local governments are responsible for implementation. In many states, regional planning agencies sit in the middle. Regional agencies may be empowered to receive federal funding or assist in oversight of local development. They also play an important part in, resolving conflict among local governments and identifying important regional resources[92]. In some states, local membership is mandated[93]. They can be funded through membership dues and state grants[94]. They have varying levels of effectiveness, and varying amounts of legal power.

WHAT SMART GROWTH MEANS FOR DEVELOPMENT LOCATION IN SANTA FE

The land under consideration for this report is 3.25 acres located on West Alameda, three miles west of the Plaza in downtown Santa Fe. The land is not improved, meaning there are no water or sewer pipes onsite, though there is a gas line across the street and electric pole at the southern edge, both of which could be extended onto the property (for a price). A well and septic system will likely be required. The land currently is zoned for one house. The plan is to apply for a variance in September to put 4-5 additional single family, green-built, water conserving, moderate income houses on the property. The following map shows existing sewer lines nearby, and water lines are a mile away.



Source: Downtown Vision: Santa Fe General Plan Update Draft

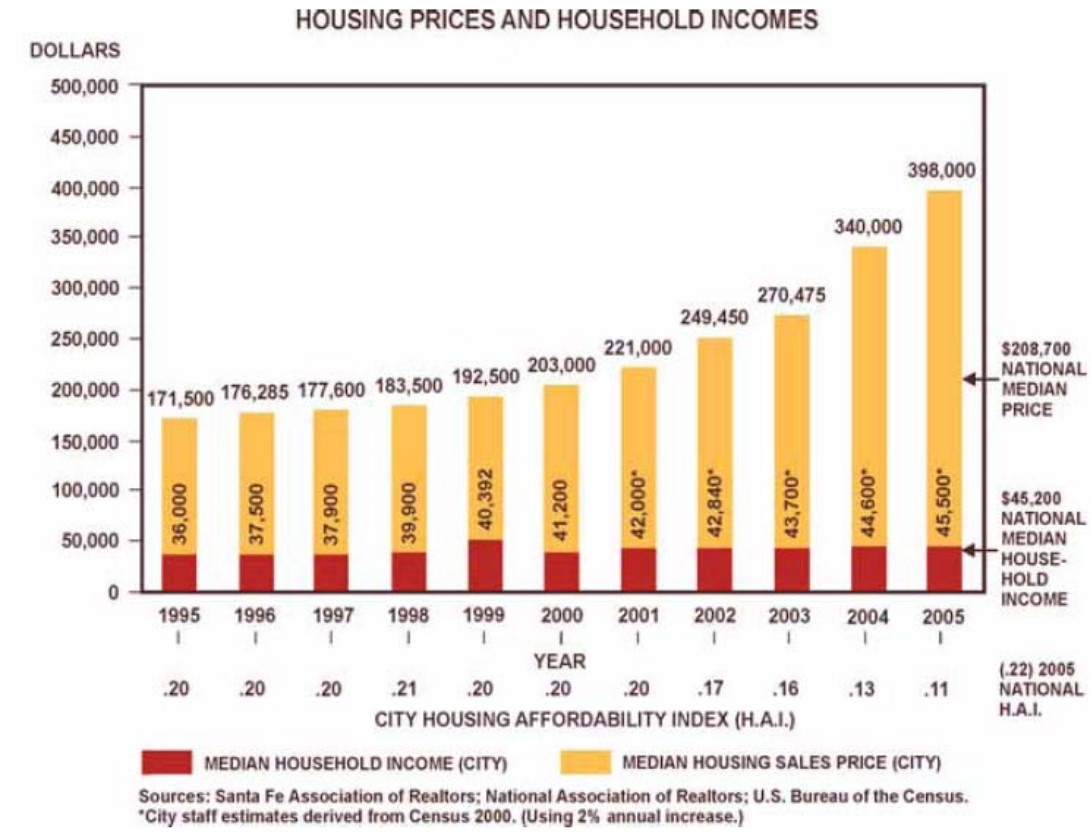
Choosing an appropriate location for land involves several considerations. Answering the "questions to ask" from above, we can begin to define what smart growth means to Santa Fe through review of city and regional plans, transportation plans, and local think tank reports on key issues such as water. It also requires a review of existing development code and consideration of public opinion. The questions to ask from the above sections are grouped below as they pertain to Santa Fe.

Local Priorities – What are the city's dominant policy priorities? What are the ideological environmental values and priorities that defined the need for urban expansion?

- ❒ Greenhouse gas emissions – When the Chicago Climate Exchange (CCX) was created as "the world's first and North America's only voluntary, legally binding greenhouse gas emission

reduction and trading program… [which] provides participants from Canada, Mexico and the United States with a forum to quantify, reduce and trade greenhouse gas emissions," New Mexico was the first state to become a member.[95]

- Water – According to Charlie Lyles, director of the National Weather Service Forecast Office, New Mexico was in drought 56% of the time between 1896 and 2003… and during a period of greater than average precipitation from the mid-1970's to the mid-1990's, many communities were also dependent on groundwater, depleting a non-renewable water supply that will be more important as the state's population grows.[96] Consuelo Bokum, Ali MacGraw, and Stewart Udall created High and Dry: Drought in New Mexico, a documentary that was aired three times on KNME-TV in April, 2005.[97] Invest New Mexico, Governor Richardson's infrastructure investment plan released on December, 2003, states that 90% of New Mexico relies on groundwater for drinking water, and called for $2.17 billion in water related infrastructure investment.



Source: Santa Fe Trends, 2006. City of Santa Fe, Planning and Land Use Department

- Affordable Housing – House prices have doubled in the last 5 years as shown on the preceding graph, while income increased only 10%. "High Priority Needs"[98] include 2-4 bedroom housing units for extremely low and low income families and affordable housing and home ownership opportunities for those of low and moderate income. Tierra Contenta

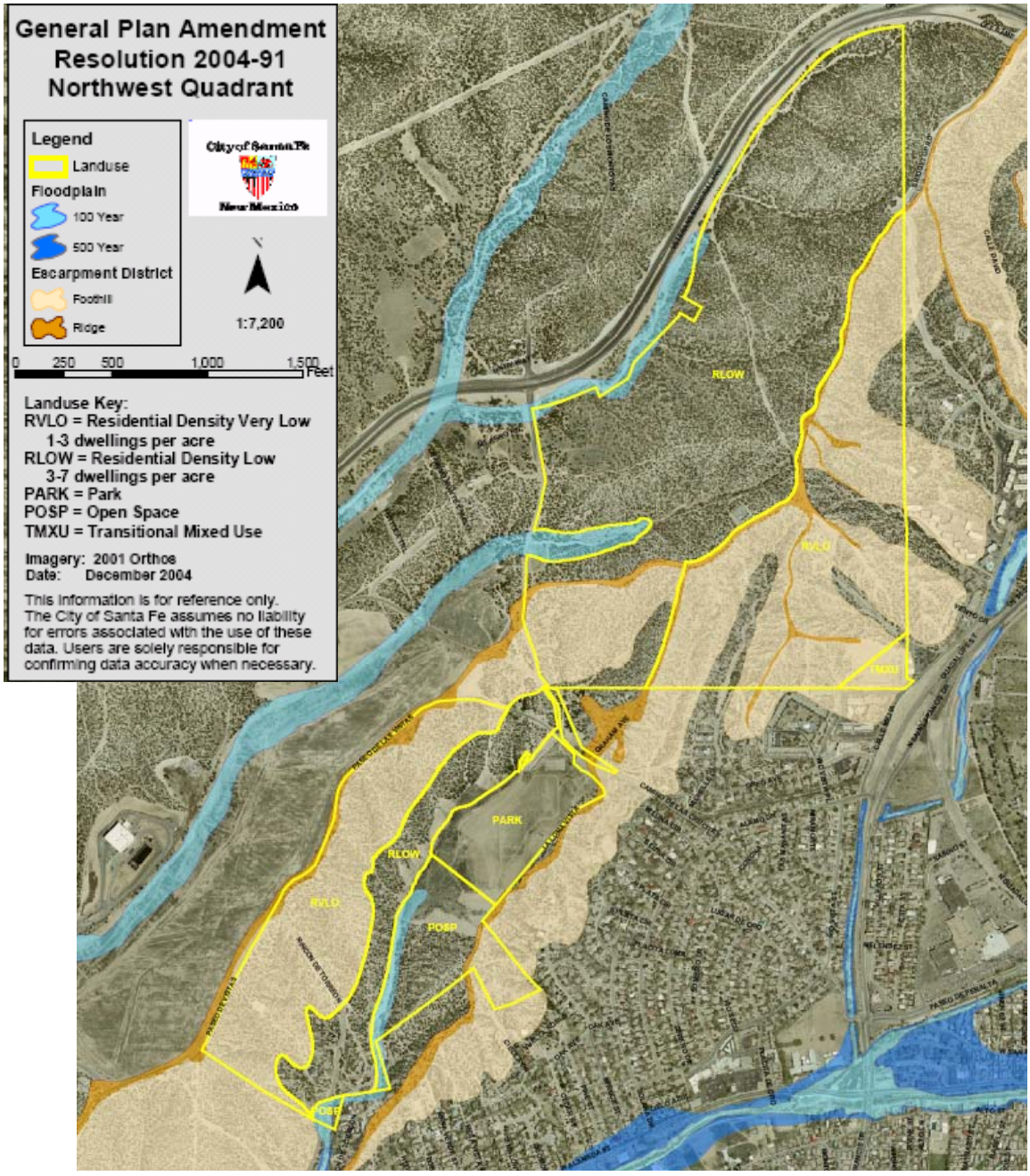
has approximately 2,500 housing units remaining, and approximately 1,000 units (40%) will be affordable. In Nava Ade, 35% of all units (180 of the 513 master-planned homes) and in Carlos Rey del Sur, 19% of all units (13 of the 67 total units) will be affordable.[99] Policy #9 of the General Plan Update Draft is to "increase affordable housing opportunities by maximizing appropriate potential infill sites by supporting changes to higher densities."[100]

- House specifics – Because much of the housing market in Santa Fe is dominated by large vacation homes or second homes, the General Plan Update Draft also highlights a need for new construction of smaller homes and smaller lots.[101]
- Historic Preservation – *The Downtown Vision: Santa Fe General Plan Update Draft* now under discussion highlights historic preservation in the downtown area, allowing residential uses on second and upper floors for all downtown buildings, returning the Plaza area to a more locally-serving commercial core to balance its current tourist orientation.
- Growth management – Strategies in the *General Plan Update Draft* highlight infill, compact urban form, the need for regional planning, and reviewing the water budget ordinance annually.[102]
- Transportation – *The Santa Fe General Plan Update Draft* priorities emphasize public transit and people over cars.[103] Following is an excerpt from the 2006-2011 Transportation Improvement Program (TIP) for the Santa Fe Metropolitan Planning Organization. We see that, in fact, there are many improvements to the local bus system called Santa Fe Trails, and that there is a commuter rail line being implemented.

	FY 2006								FY 2006	
Control Number in STIP	Project Name	Termini	Proposed Work	Lngth miles	Total Funding Amount	Federal $	State $	Local *Match* $	Funding Source	Comments
	Roads (New and Reconstruction) State and Other Funded; Local (continued)									
C5G73	Airport Rd and Constellation Intersection Lead Agency: CITYof SANTA FE		Road Improvements		$ 25,000		$ 25,000	$ -	*SGF*	State General Fund
C5G71	Camino Alire Bridge Lead Agency: CITYof SANTA FE	West Alameda to Alto St	Road Improvements		$ 25,000		$ 25,000	$ -	*SGF*	State General Fund
C5S35	Camino Alire Bridge Lead Agency: CITYof SANTA FE		Road Improvements		$ 75,000		$ 75,000	$ -	*SST*	State Severance Tax
	TOTALS				$ 495,000	$ -	$ 495,000	$ -		
	Transit Projects: w/Continuing Programs (Santa Fe Trails)									
	Commuter Rail: Albuquerque to Santa Fe Lead Agency: STATE	ABQ to Santa Fe	Implementation of Commter Rail		$ 4,600,000	$ -	$ 4,600,000	$ -	*SST*	State Severance Tax
	Sections 5307 & 5340 Lead Agency: CITYof SANTA FE Santa Fe Trails		Fixed route/ paratransit-operating		$ 5,705,587	$ 1,115,859	$ -	$ 4,589,728	*FTA GRT*	Local match GRT 'Quality of Life'; req'd: $974,229 overmatch: $3,615,499
	Section 5316 Lead Agency: CITYof SANTA FE Santa Fe Trails		Access to jobs - operating		$ 292,464	$ 146,232	$ -	$ 146,232	*FTA GRT*	FTA funded w/local match GRT 'Quality of Life'
	Section 5317-New Freedoms Lead Agency: CITYof SANTA FE Santa Fe Trails		Disabled transportation - operating		$ 103,534	$ 51,767	$ -	$ 51,767	*FTA GRT*	FTA funded w/local match GRT 'Quality of Life'
	Section 5309 Lead Agency: CITYof SANTA FE Santa Fe Trails	Santa Fe to Eldorado	Santa Fe/Eldorado Rail Link-preliminary design		$ 1,125,000	$ 900,000	$ -	$ 225,000	*FTA GRT*	FTA funded w/local match GRT 'Quality of Life'
	Section 5308 Lead Agency: CITYof SANTA FE Santa Fe Trails		Bus/Bus Facilities		$ 556,875	$ 445,500	$ -	$ 111,375	*FTA GRT*	FTA (Clean Fuels Capital Program) w/local match GRT 'Quality of Life'
7293	Santa Fe Ridefinders Lead Agency: CITYof SANTA FE Santa Fe Trails		Ride Sharing		$ 107,390	$ 61,912	$ 25,000	$ 20,478	*STP GRT*	FHWA/STP TPO-7749(8) local overmatch: $5000
	TOTALS				$ 12,490,850	$ 2,721,270	$ 4,625,000	$ 5,144,580		

Source: 2006-2011 Transportation Improvement Program (TIP) for the Santa Fe Metropolitan Planning Organization

- Northwest Quadrant Development – This area contains 2,800 acres of mostly vacant land. The City owns 2,500 acres, and previous land use plans for this area proposed at least 2,000 housing units. The city is considering the development of approximately 700 homes, many in the affordable range, on a portion of the Northwest Quadrant, but plans to develop only 178 acres of the entire NW Quad 2,560-acre tract. Requirements for developers are to produce: 37% "affordable" homes with $146,000 maximum price (3-bedroom), 32% "moderately-priced" homes with $273,000 maximum price (3-bedroom) with no requirement for certifying buyers' incomes, to make a $10,000 contribution for each lot sold for a higher-priced home, and to bring water rights.[104]



The Regional Plan and Solving the Land Use / Water Dilemma

The Santa Fe Regional Future Land Use and Growth Management Plan created jointly by the City and the County lists 5 primary principles including (in this order): affordable housing, water, infrastructure and services, character, and employment and economic development. The most difficult issue facing the city is the competing priorities of water and land use. The easiest way to solve the water shortage problem is to limit density of development, which in the area of the West Alameda property is currently one house per every 2 ½ acres. However, this creates a land use problem from a smart growth perspective to develop at such low densities, causing loss of community, expensive infrastructure, and high traffic pollution from driving long distances, among other problems. The regional plan is a great example of using zoning to balance multiple priorities for a city.

The Santa Fe Regional Future Land Use and Growth Management Plan Executive Summary states:

The amount and type of growth shall relate to future water supply. The regional water supply remains a limited resource; therefore, growth should occur in accordance with available, sustainable sources.

The linkage between land use and water occurs by directing the timing and phasing of development. In order to build a relationship between development and water supply, the plan recommends a "directed" choice for future growth. The plan suggests that growth be directed to those areas that potentially provide the greatest community benefit according to regional principles. This is meant to encourage orderly and timely development as well as direct future water to areas of preferred development. …This process identifies common areas of overlapping frequency where the regional goals may be achieved according to underlying land uses and infrastructure…

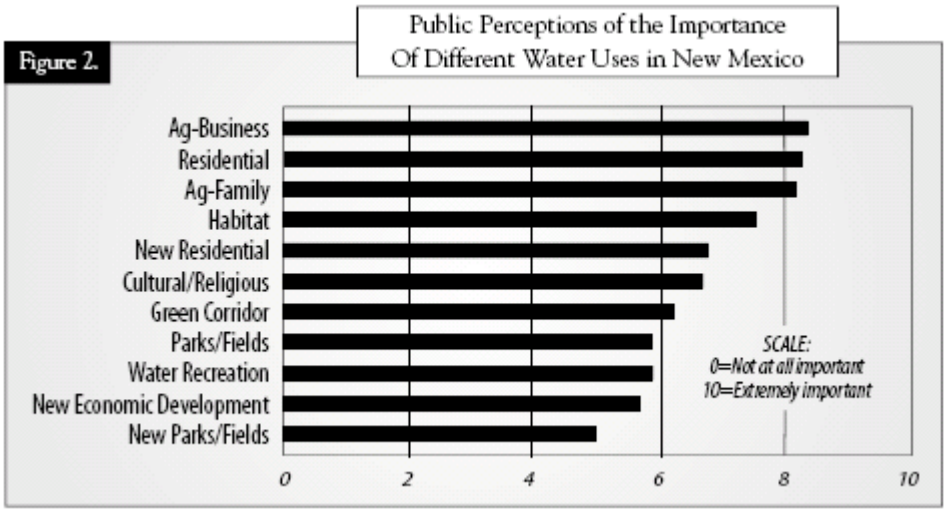
In order to direct growth to these growth priority areas, water delivery areas have to be determined according to potential water sources. Identification of those sources is to be in accordance with related water service delivery agreements or contracts, or other water utility plans, which identify known water sources. These areas then serve as the basis for cooperative water delivery/service areas in accordance with those agreements.

Attitude toward growth management – how does culture, determined by people's attitudes, affect the priority to control growth? How are parks, forests, and other environmental resources valued? For existence value, revenue, or recreation? How is farmland valued? As a producer of revenue from agriculture or for existence value?

- A recent letter from a resident to the Santa Fe Review states: "Infill, supposedly a tool for fighting urban sprawl, has no valid application in any historic district, and has turned into nothing more than a tool for rapid subdivision, with highly destructive effects…

Architectural designs should fit in contextually with already existing traditional architecture… There should be a Moratorium on new Condos in the Historic Districts. This is the worst type of infill of all… If we lose the views of the mountains downtown, the Santa Fe we know will be lost. Our mountain views are what people love about Santa Fe. The best way to preserve mountain views is not only to limit height but require significant setbacks on second or third stories… I am worried that rapid change caused by economic pressures will make downtown Santa Fe unrecognizable within just a few short years. The city's policy ought to be to put the brakes on. We have too much to lose, and decisions made quickly by governmental bodies are usually ill-advised. All Master Plans, "Vision Plans," should be viewed with suspicion, especially when assisted by outside consultants. The plans now before us constitute a blueprint for ruining the downtown.

- The Governor's Task Force Report called "Liability!" (January, 2005) states that New Mexicans "value healthy, cohesive communities where people can interact easily in the course of their daily activities—working, shopping, going to school, and enjoying themselves. While it is counter-intuitive, New Mexico has the longest urban history of walkable communities in the country, starting with the Anasazi towns, Pueblos…"
- The following chart from 1,000 Friends of New Mexico's annual newsletter on water shows public preferences for water uses. [105] Water for parks and fields is rated lowest, while water for agriculture is rated highest. However, this does not necessarily imply a low value placed on open space, which is abundant in New Mexico. The state is a desert, which means all open space is brown and thus green grassy parks often look out of place. At the same time New Mexico has the 42nd lowest average annual income and highest poverty rate of any state in the country (additional discussion below), and thus prioritizing water for agriculture is not surprising. Transferring water from agriculture to meet increasing municipal demands is controversial, leaving water conservation as one of the most viable policy options.[106]



- The General Plan states: "This plan defines 'growth management' as: Identifying the proper geographic location of various land uses for future growth; Determining the appropriate scale and intensity, or density, of future growth; and Establishing an appropriate rate, pace, or phasing of future growth, based on natural and financial resources required to sustain that growth." (Page 4-4)
- As discussed above, there is a strong push from regional and city planning for affordable housing, infill development, water conservation, and historic preservation and community character, which are sometimes at odds with affordable housing and infill development when it takes the form of more modern, or taller, buildings or condos.

Ability to control growth - to what extent does external support such as federal and state government encourage or inhibit the city's ability to control growth?

Implementation of growth controls - what role do local politics play (power allotted to regional planning commission, agenda of governor or mayor) in inhibiting or increasing the city's ability to implement growth controls?

- The General Plan states that "Both the city and county general plan updates propose changes to the existing development patterns to decrease sprawl and create affordable housing serviced in a more cost-effective way by existing infrastructure. The city's policy of using infill to produce a more compact urban form and the county's policy of directing growth to new communities can not achieve what both intend unless there is collaboration between the two jurisdictions. Without city/county cooperation, these policies will simply mean more growth rather than directed growth." (Page 4-1)
- It more specifically states: "Beyond the Urban Area boundaries, the Plan does not advocate large expenditures of money for utility extension or road building, nor does the Plan advocate large amounts of new development. The creation of a separate county water system and the extension of water lines outside the Urban Area may undermine the goal of a well-defined compact urban form." (Page 4-4)
- Between 1980 and 2000 the city absorbed just 50% of all population growth and 70% of all housing growth within the urban area,[107] requiring others to live outside the city.
- The *Downtown Vision - Santa Fe General Plan Update Draft* states that "the plan's most important contribution is that the City and County have done it together. This process has clearly demonstrated an ability to work together now and in the future to overcome regional challenges and achieve common goals."

Motivation - To what extent do direct economic forces (i.e. taxes) or indirect economic forces (businesses' pressure on government) affect the city's policy priorities? Who should pay the societal and financial costs associated with expansion? When should market forces be used to determine conditions for expansion, and when is regulation necessary to counteract the failures of market assessments?

- Average annual income of New Mexicans is forty second among the states, and the poverty rate in New Mexico is the highest in the nation. New Mexico ranks highest among the states in the number of working poor and ranks lowest among the states in the provision of health coverage for workers.[108] (The following section on "For Whom to Build" discusses further the demographics of Santa Fe.) This puts extreme pressure on Santa Fe to accept growth and support development of businesses and jobs.
- The general plan states that "Growth management also involves providing an appropriate balance between residential growth and growth in employment opportunities. This is of particular concern in Santa Fe where the cost of housing has out-paced the income of many residents." As shown above, median income increased 10% from 2000-2005 while housing prices *doubled.*
- In August, 2005 Santa Fe passed the most restrictive inclusionary zoning ordinance in the country, requiring 30% of all new development to be affordable for developments with greater than 6 units.

There is a clear intent that part of the cost of growth should be borne by developers. Given the above discussion about water issues in New Mexico, there is also a clear intent to use regulation to restrict the pace and location of development to a level that is sustainable, or to have developers locate their own water sources through water rights or paying for wholesale supply.

Development location priorities for Santa Fe

Given the city's competing resource problems of land and water, historic preservation and economic development, how can a developer support these while also making a profit?

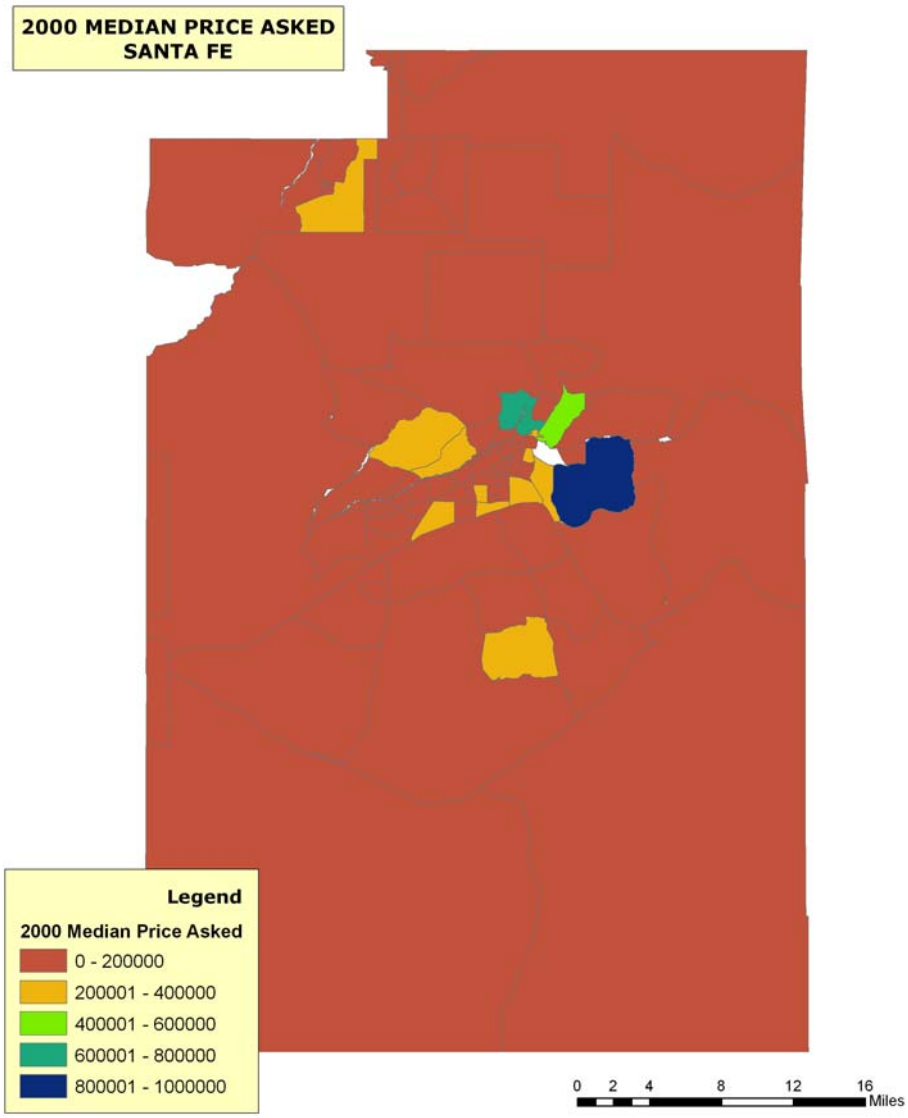
The location determines availability of water through pipes or well (while "What to Build" determines how much water is used). The property is located ¼ mile from the river, and as such, a well is a good option here. However, because this reduces the water table for the surrounding land, this does not preclude the need for water conservation which will be addressed in the "What to Build" section. Currently water pipes are a mile away, but as the following map shows, the land surrounding West Alameda is due to be annexed by the city, which may build water pipes out to service this area.

Greenhouse gas emissions are reduced through public transportation, so locating near the bus system is a priority. The first bus line created in Santa Fe over 10 years ago was on West Alameda, which continues today but does not extend as far as the subject property.

Compact urban form implies developing within the planned urban area. The *Santa Fe General Plan Update Draft* (page 26, 29) and City Council Annexation Plan (shown on page 33) show the West Alameda property due to be annexed into the city in 2010, with zoning changed to 1-3

dwelling units per acre, allowing 3-9 units on the subject property which currently is zoned for 1 unit. The General Plan calls for compact urban form and denotes the land shown on the map (including future annexation) as the developable area.

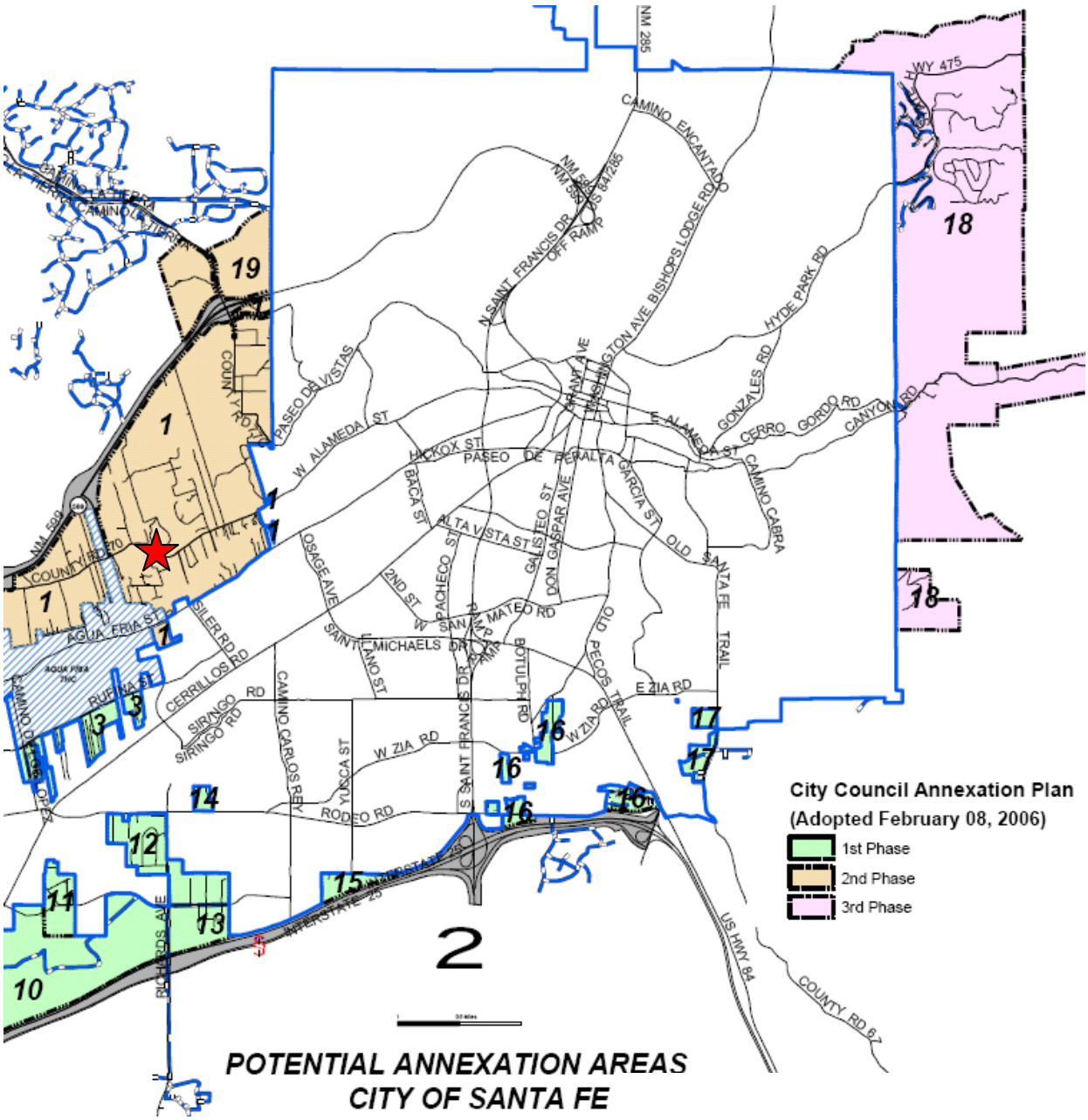
Finally, the price of land affects ability to put moderate or affordable housing on it, both of which are priorities for the city. A 1 ½ acre property in near the center of town is zoned for 32 units, but it is more likely to be won by a developer who will build luxury condos on it and thus can pay more for the land, unless the city grants a further increase in density in exchange for building moderate income housing. However, this is likely to draw animosity from residents who want to preserve the historic character and small town feel of the city. There were 2 one-acre plots of land available one mile toward town from the West Alameda property, each priced per acre at *three times* the cost. This is likely because they are both very close to water lines. Lastly, there was a one acre property available in a finished subdivision on the east (upper income) side of town for a per acre price that was *twenty times* the price of the subject property.



The map shown of median home prices as of 2000, the most recent year for which GIS data is available from the Census Bureau, shows by census block which areas of town were most and least expensive as of 2000. As will be discussed in the next section, house prices have risen exponentially since that time, but the general pattern of relatively high or low prices in town is still the same.

The property chosen is within the planned urban area and thus is not contributing to sprawl, at a

price that allows moderate income housing to be built on it, in an area that is likely to have water pipes extended after it is annexed by the city in 4 years (which again, does not preclude the need for conservation as discussed later). Because it is not yet annexed, does not yet have water pipes, is currently zoned for only one house, and thus was priced accordingly, the low price provides strong opportunity for profit, while supporting multiple development goals of the city.

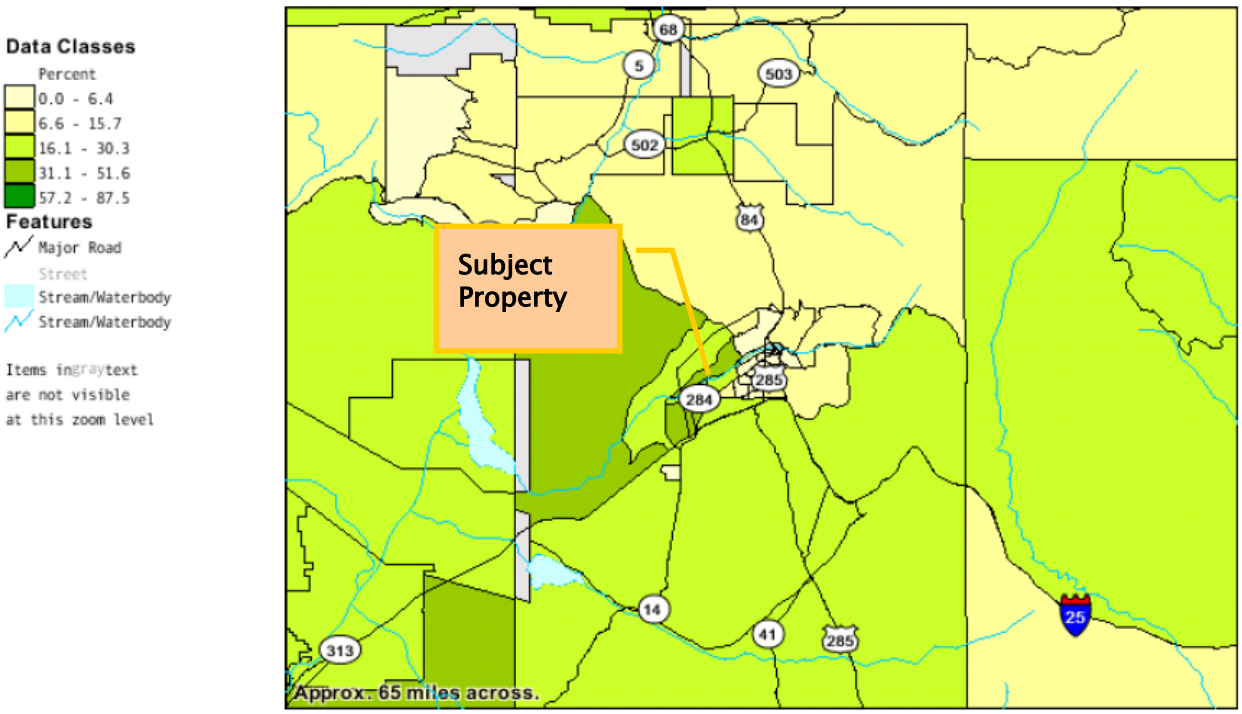


Source: GIS Division, City of Santa Fe

This kind of development is risky and will require a successful variance application to begin building now, but the chances of success of the variance are maximized by plans to meet multiple local policy and planning priorities of moderate income housing, water conservation, and solar power. Generally it is not difficult to guess where the next development boom will take place as a city expands, usually by locating a neighborhood that is a) in transition, and b) as close to town as possible. The map below shows that there is a large percentage of development occurring 4 or 5 times farther from town than where the West Alameda property is located, and, all else equal, being closer to town makes a property more valuable. If development is sited in a less glamorous and thus lower priced neighborhood close to the city, within the planned urban expansion area rather than 20 miles out causing sprawl, then smart growth and profit making are both supported while leaving financial room to address local policy priorities.

	ACRES	CENSUS 2000 POPULATION	CENSUS 2000 HOUSING UNITS	ADDITIONAL WATER DEMAND AT BUILDOUT (afy)	ANNUAL NET COST ($)
	4,173.22	14,219	4,970	1,601	2,151,235
	3,616.11	1,550	659	613	253,790
	2,761.87	228	138	30	34,975
TOTAL	10,551.20	16,297	5,767	2,244	2,500,000

% OF HOUSING UNITS BUILT 1995-2000



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2. FOR WHOM TO DEVELOP?

A. Intro to Santa Fe
B. Home sales 2005 and 2006
C. Santa Fe market trends – Census 1990 to 2000
D. Sizing the competition
E. Sizing the market

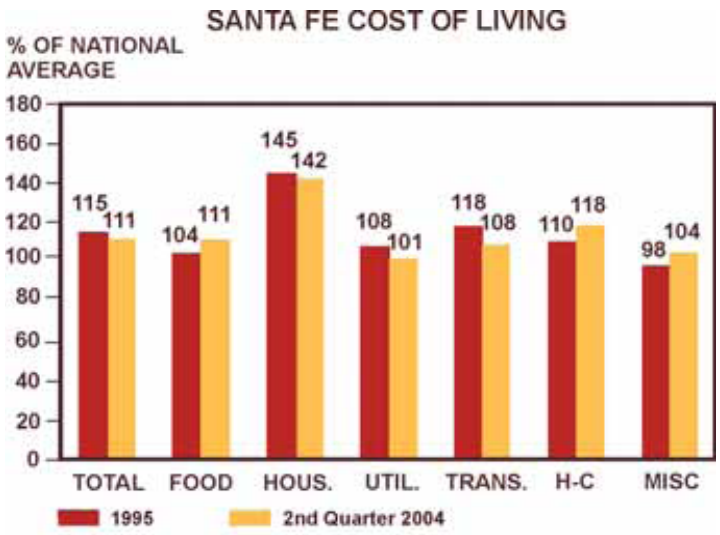
INTRO TO SANTA FE

The Spanish colony of Santa Fe was established between 1605 and 1610. It became part of Mexico in 1821 when Mexico won its independence from Spain and was captured by the U.S. in 1846. New Mexico became a territory of the U.S. in 1850 and finally became a state in 1912.[1] Today it is one of the top 3 states with the largest nonwhite populations, including Hawaii (76.7%), New Mexico (56.5%), and California (55.5%).[2] The population of Santa Fe is small and has grown 6% since the 2000 Census. The City currently has 66,500 residents.

Santa Fe Population	US Census 2000	Jan. 1, 2006 (Estimates)
City	62,203	66,500
Urban Area (includes city)	79,100	84,000
Central Region	104,192	115,000
County	129,292	144,000

Source: Santa Fe Trends 2006. City of Santa Fe, Planning and Land Use Department.

However, for a city this size, the cost of living is very high, partially due to the tourism and vacation home industry. With skiing in Taos 90 minutes away, the Santa Fe ski basin 20 minutes from town, and 3 miles to the opera, housing costs for Santa Fe in 2005 were driven to 145% of the national average. In 2000, 22% of houses with a mortgage also had a second mortgage or home equity loan, and 20% had monthly owner costs that were above 40% of their income[3]. Transportation, health care, food, and utilities are all higher than national average as well.



Source: Santa Fe Trends 2006. City of Santa Fe, Planning and Land Use Department.

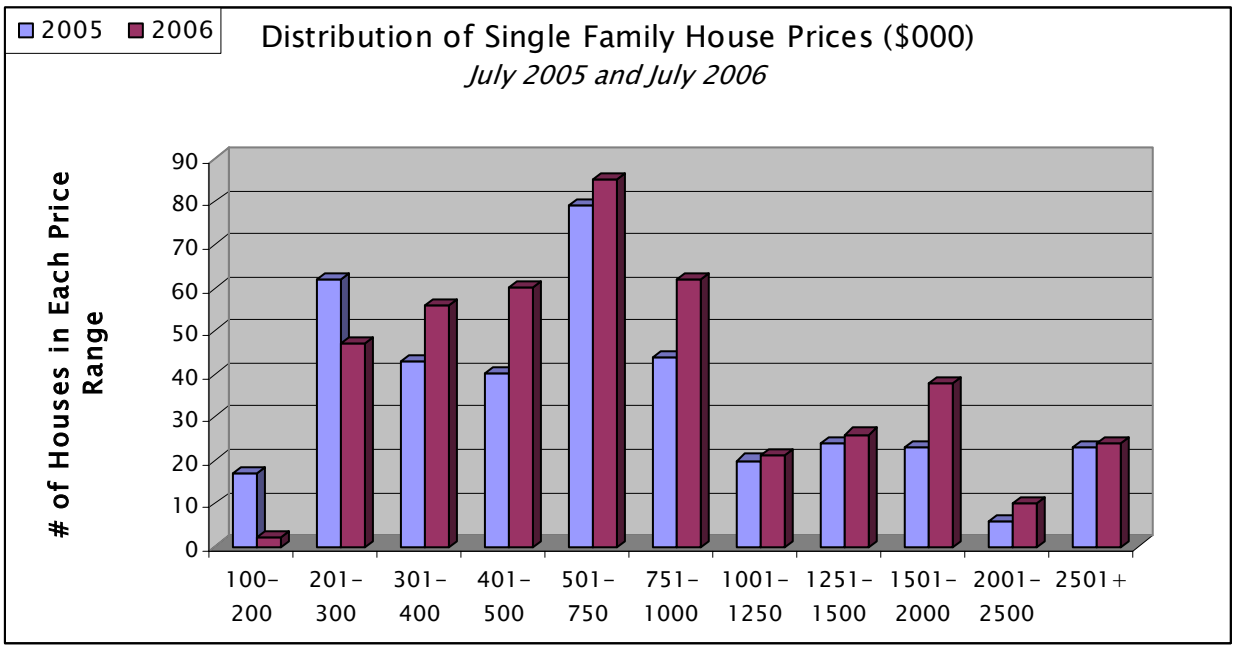
The New Mexico Department of Labor reports jobs by county, estimating that there are 61,100 jobs located in Santa Fe County. Jobs by leading sectors include: Government (fed., state, local) = 17,400 (28%); Retail/Wholesale = 9,500 (16%); Accommodation/Food Service = 8,000 (13%); Health Care/Social Assistance = 6,140 (10%); Construction = 4,600 (8%).[4]

Finally, it is worth noting that as of 2000, of the workers 16 years old or older, only 1% take public transit to work, 3.6% walk, and 7.3% work at home.[5]

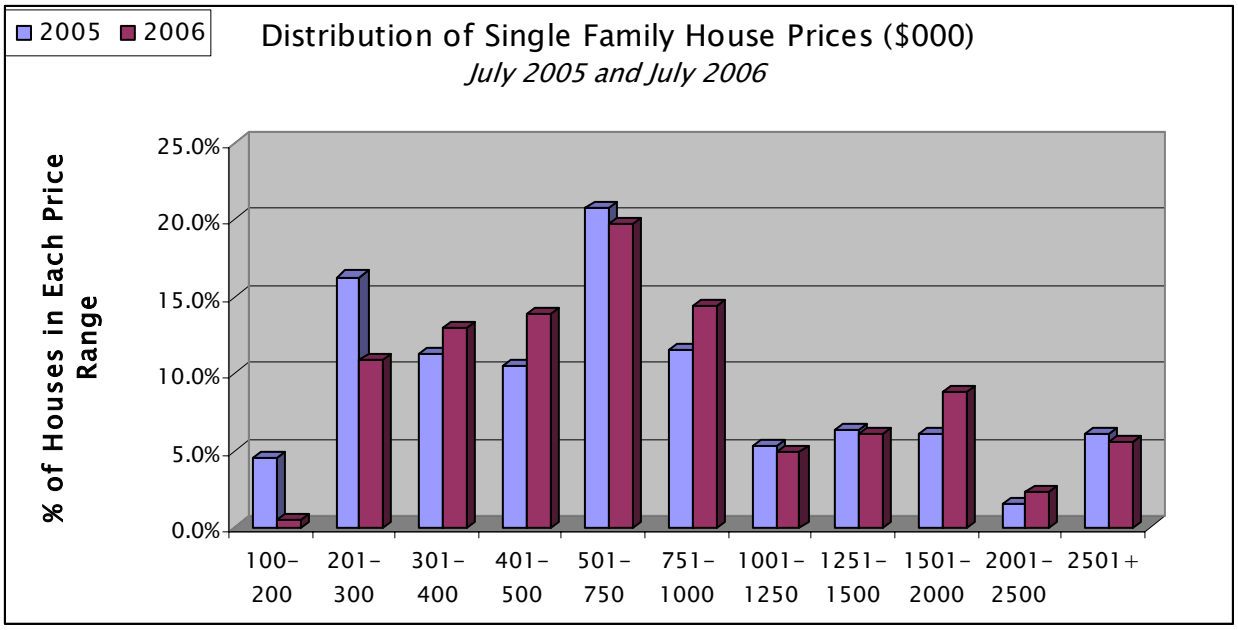
HOME SALES 2005 AND 2006

The clearest signals about the target market for development come from the current housing market in Santa Fe. Following is a comparison of the 381 and 431 houses on the market in the City of Santa Fe on July 6, 2005 and July 12, 2006, respectively. Appendix A includes the July, 2006 listing in entirety to make it very apparent why the city has such a policy focus on affordable housing. The city's definition of affordable housing means the payments for a home should not exceed 30% of that household's gross income, for a family earning 80% of the area's median household income.[6]

We see below that the number of houses priced at the lowest end of the spectrum is decreasing…



… despite the fact that the overall number of houses on the market increased by 13% in 2006.



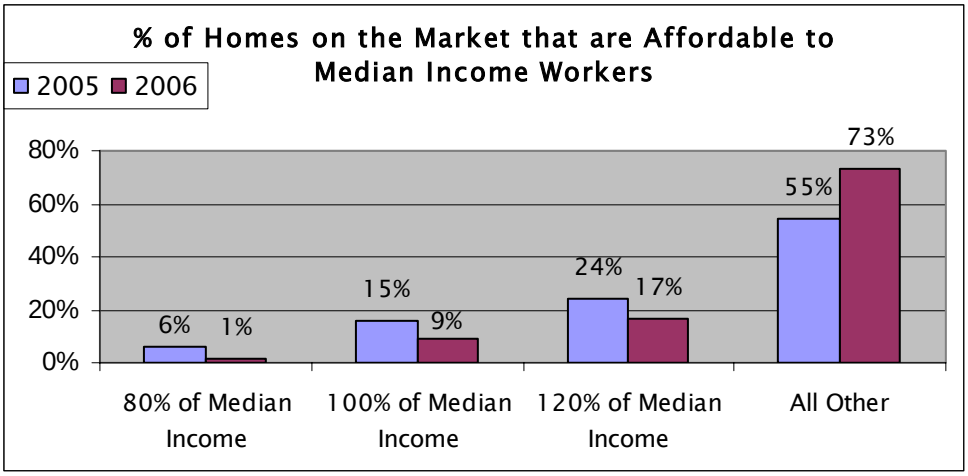
Source: Multiple Listing Service

Each year HUD establishes median incomes by household size for all areas across the country, and these incomes are widely used for many kinds of housing programs. For 2005 HUD determined the area median income (AMI) in Santa Fe for a 4-person household to be $66,000, and in 2006 it remained the same. The "moderate income" level is generally considered to be 80% - 120% of AMI. The maximum that a family of 4 with income of 120% of median can pay for a house is $327,000.

	*3-Person HH***	*Max. Home Price**	*4-Person HH***	*Max. Home Price**
80% AMI	$47,520	**$ 196,000**	$52,800	**$ 218,000**
100% AMI	$59,400	**$ 246,000**	$66,000	**$ 273,000**
120% AMI	$71,280	**$ 295,000**	$79,200	**$ 327,000**

* Based on a 30-year loan at 7% interest.
** Median incomes for 2005 and 2006 are the same.

A family of 4 at 100% of AMI can purchase 9% of houses on the market, down from 15% last year. A family of 4 with 120% of median income has 17% of homes on the market available to them.

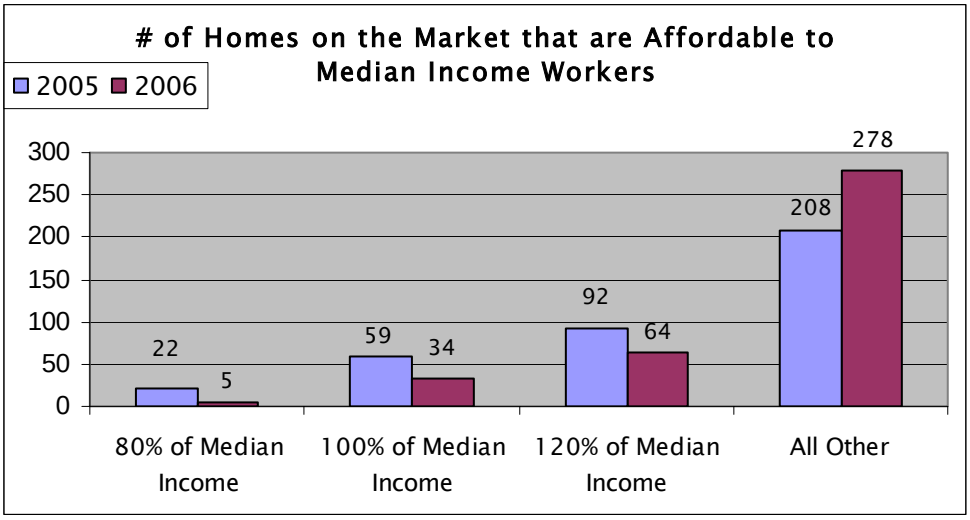


Source: Multiple Listing Service

However, median income, by definition, means that 50% of people make less. Therefore, 50% of the Santa Fe population are potential customers for 9% of houses on the market.

This means that 33,500 people have 34 houses to buy.

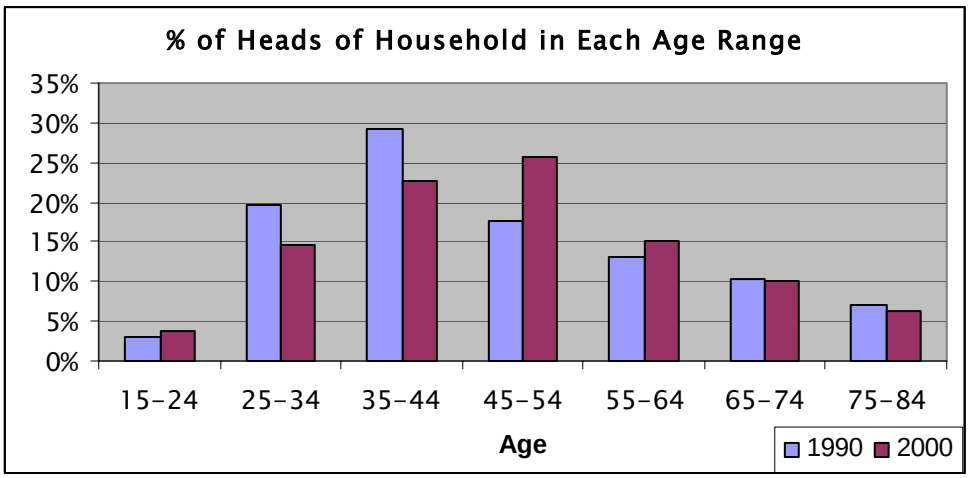
Though Census 2000 data is old and less relevant given that housing prices have doubled since 1999, anecdotal evidence suggests that some trends still continue today.



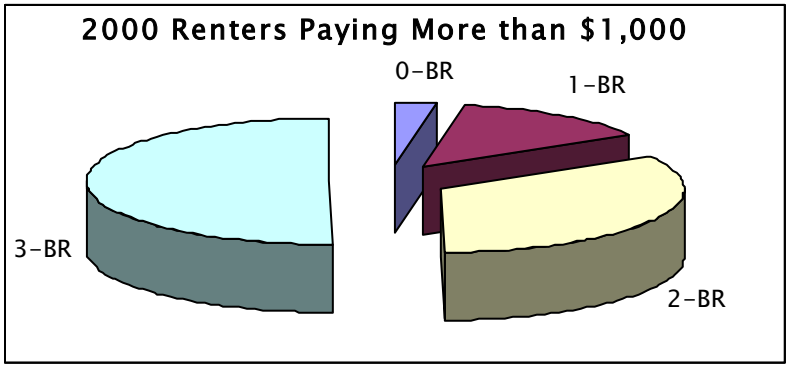
Source: Multiple Listing Service

SANTA FE MARKET TRENDS – CENSUS 1990 TO 2000

15% of households have a head of household aged 25-34, down from 19% in 1990. Households in general are aging.



There were 2,465 renting households paying more than $1,000 in rent in 2000, though this may overrepresent the current renter conversion market for moderate income houses which today will require $1,500 – $1,800 a month in mortgage costs.



Source: U.S. Census Bureau

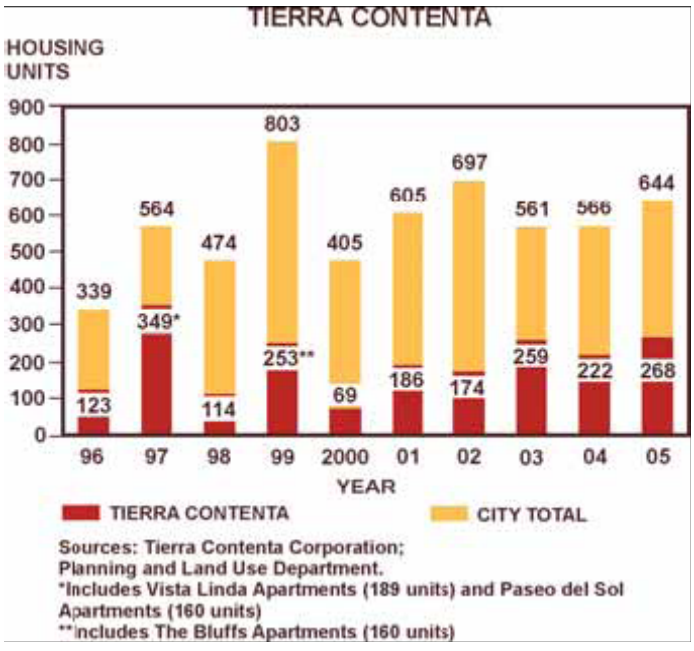
The following pages show GIS mapping of U.S. Census data from 1990 and 2000.

- Maps 1 and 2 – From 1990 to 2000 AMI increased the most in the north and southeast parts of town, which coincides with new home construction from 1995-2000 shown on page 34.
- Maps 3 and 4 – In 2000, 4-6% of people who worked in Santa Fe lived near Albuquerque – a one hour drive- which hadn't changed much in 10 years. However, when the inclusionary zoning ordinance was passed in August of last year, the talk at the City Council meeting was about the relatively inexpensive prices of housing in Rio Rancho, a large new subdivision outside of Albuquerque, so it will be interesting to see the trends in the next Census.
- Map 5 – In 2000, most of the outlying areas in Santa Fe County were 60-80% families (as opposed to non-families) while most of the areas close to town were 20-60% families.
- Map 6 – In 2000 most of the mortgaged housing units with owner costs equal to $1,500-$1,999 (which paid for a house at median price to 150% of median price) were in many of the same areas that are still considered expensive today.
- Maps 7 and 8 – People paying more than 40% of their income for housing costs are potential customers for a moderate income priced house with high energy efficiency and lower utility bills. The regions to the east and northeast are primarily comprised of higher income people who can afford to pay high percentages of their income for housing. The areas to the south and southwest are a likely target market.

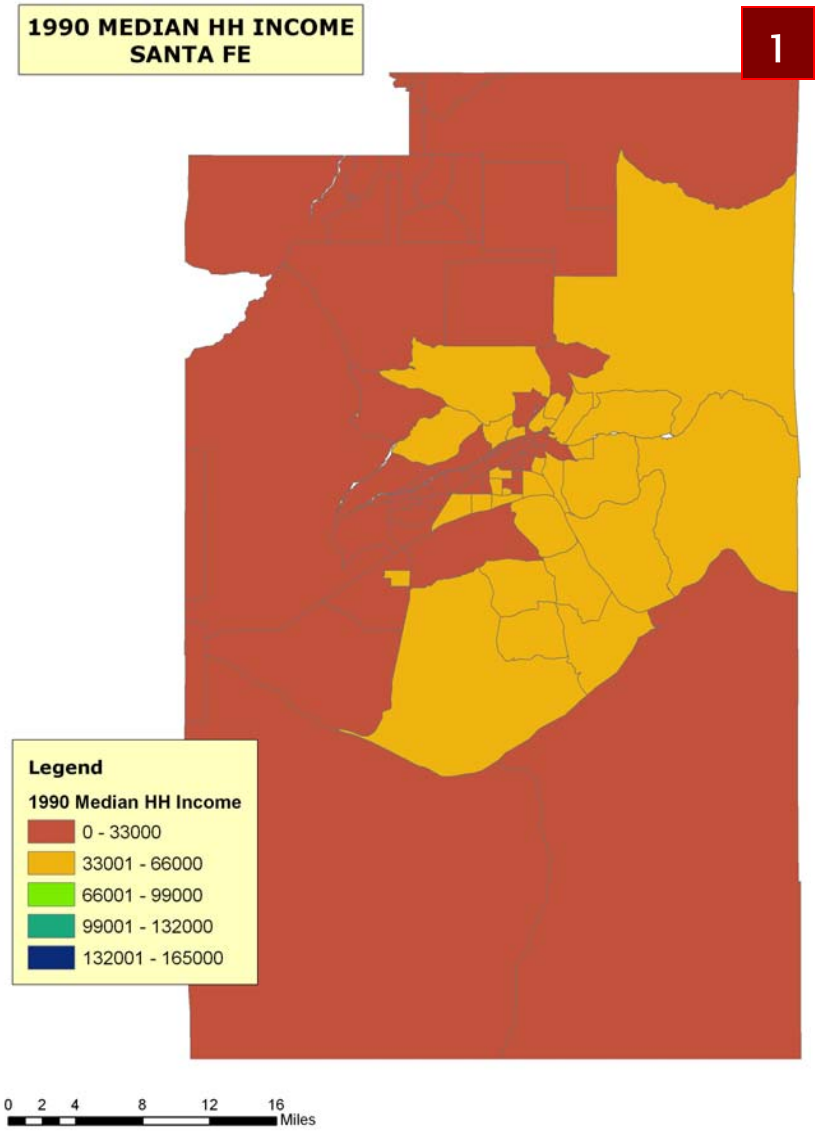
Tierra Contenta

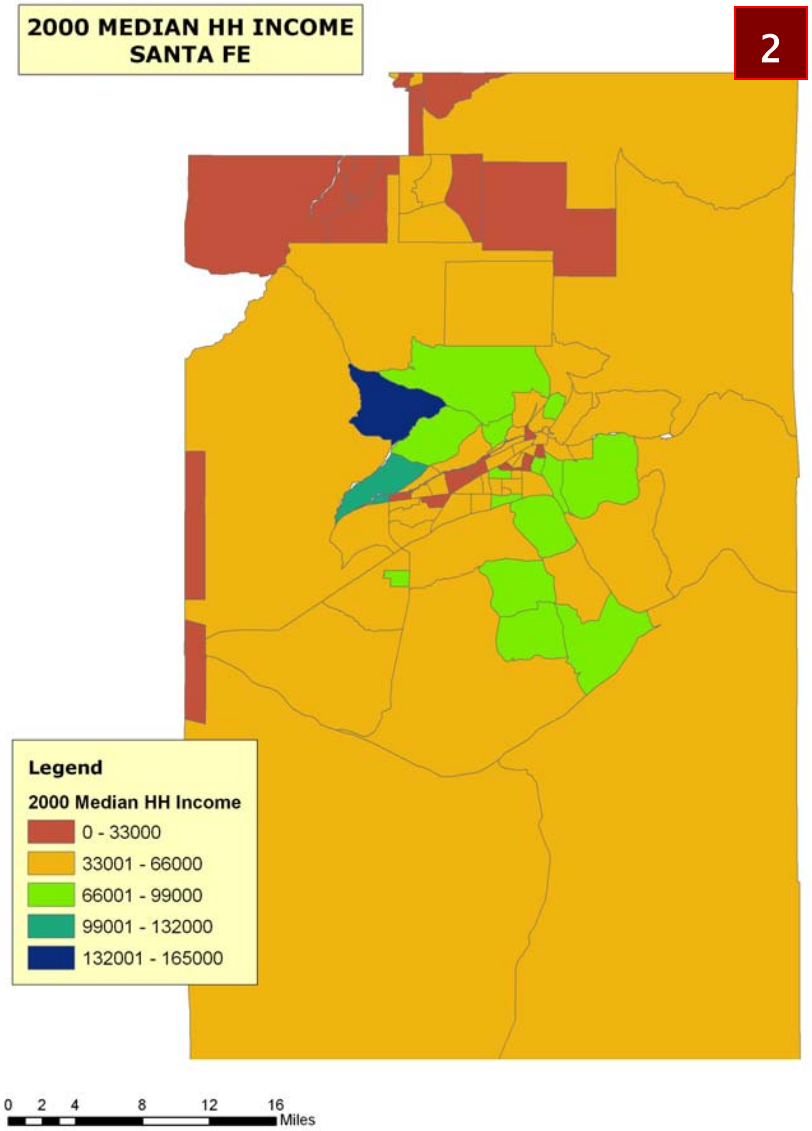
It is important to note that there are several large, lower priced housing developments that are just outside the city limits and thus not included in the housing data presented above, which are mentioned in the affordable housing discussion on pages 24-25.

Tierra Contenta is a city-initiated master planned community of 1,400 acres, approved for a total of 5,800 housing units. The chart below shows how many total housing units (owner-occupied and rental) have been constructed in Tierra Contenta since the first homes were built in 1995. Tierra Contenta's growth is compared to the city's total growth in new units. Since its beginning, 2,045 new housing units have been built or permitted for construction in Tierra Contenta. This represents 41%, or nearly half of all new homes built in the city since 1996. In 2005, a total of 268 new units were permitted for construction in Tierra Contenta, or 42% of the city's 644 new housing units.

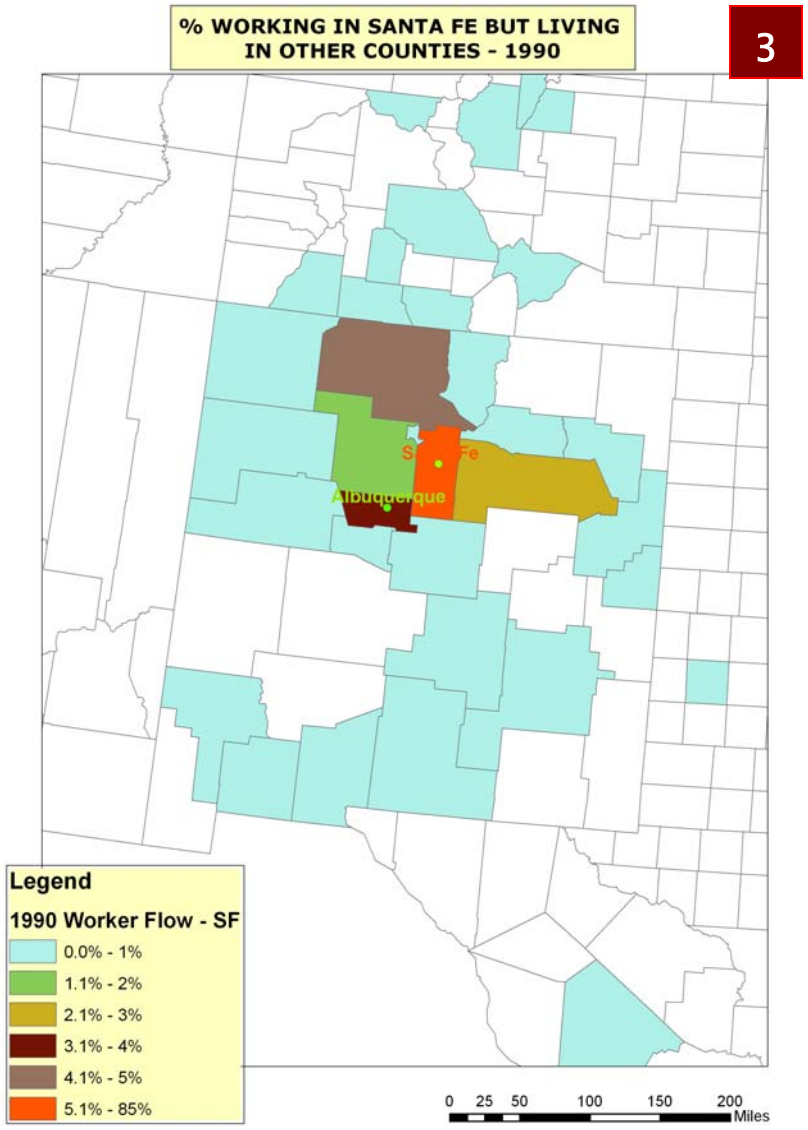


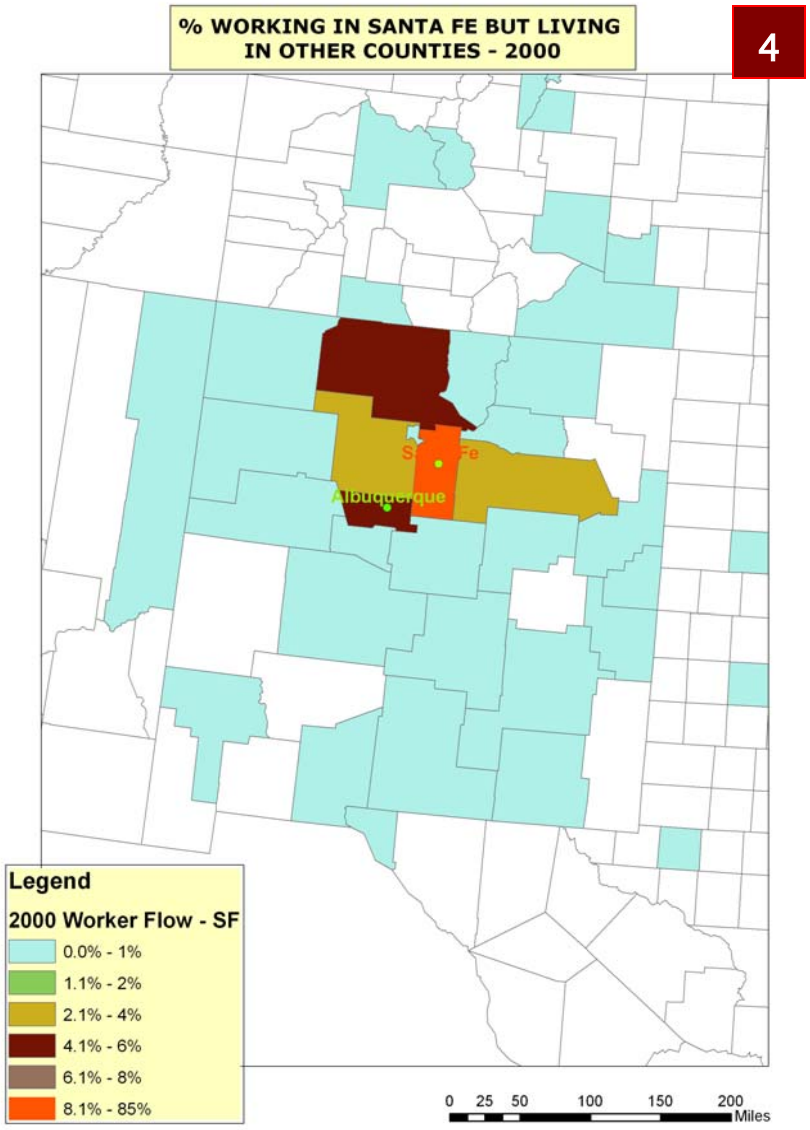
Source: Santa Fe Trends 2006.





Data Source: U.S. Census Bureau





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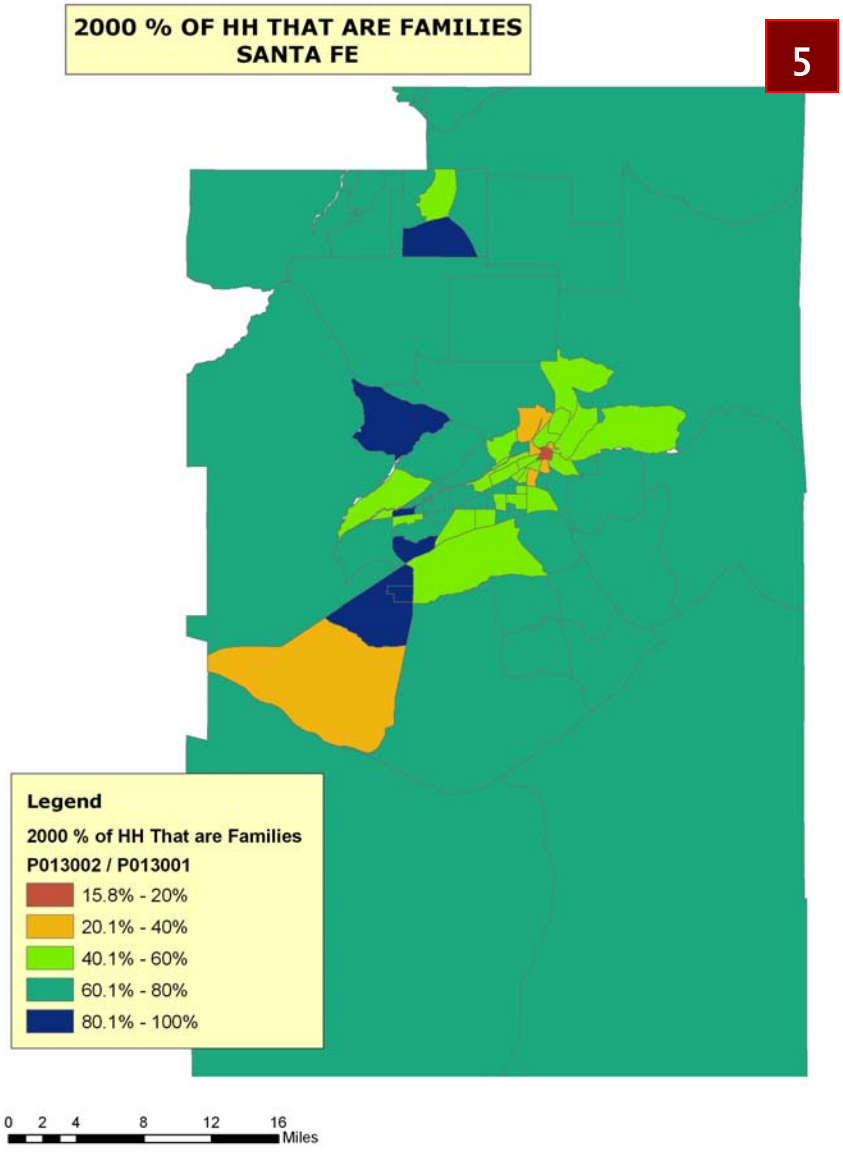
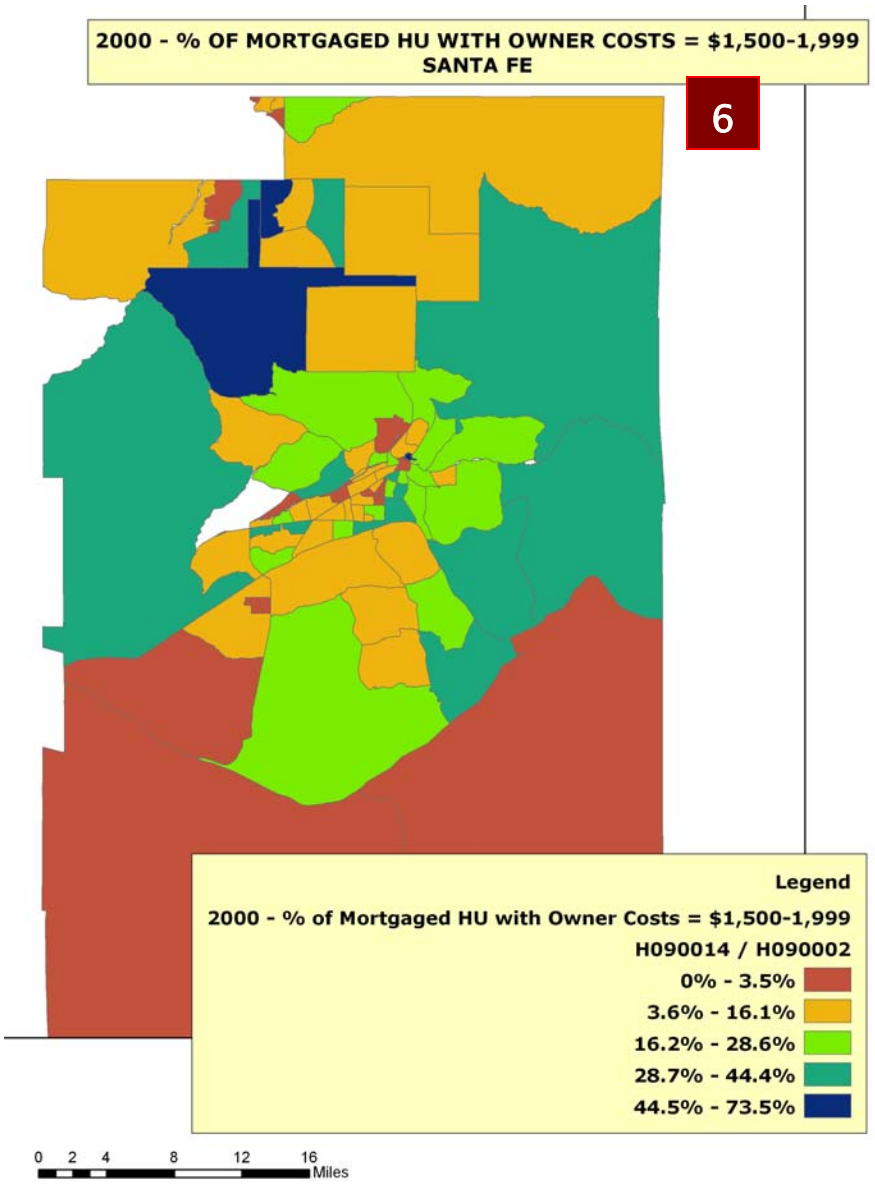
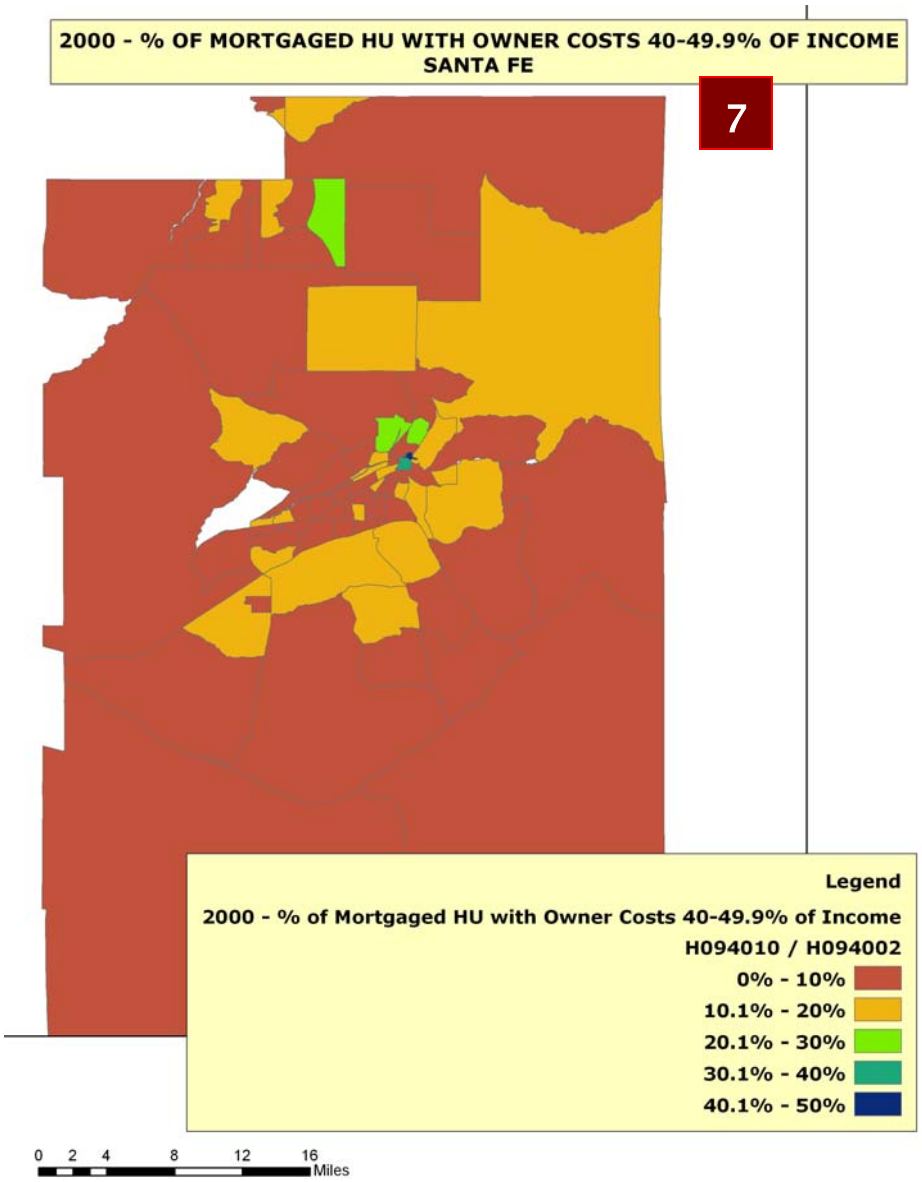
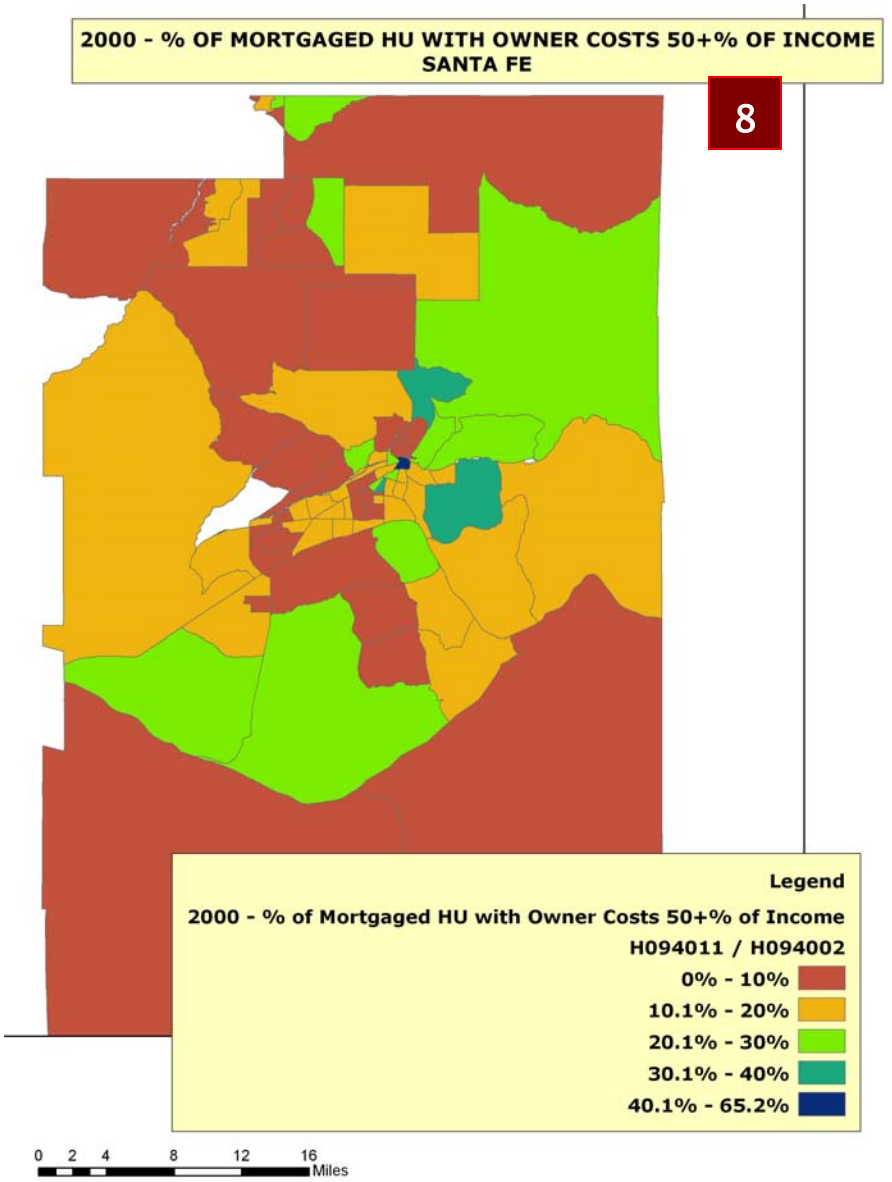




Data Source: U.S. Census Bureau





Data Source: U.S. Census Bureau

Because the houses on the West Alameda property will be priced near $275,000 – $300,000 (to be discussed in Section 3), this will require a minimum of 100% of AMI for a 4-person household, 110% of AMI for a 3-person household, 125% of AMI for a 2-person household, or 144% of AMI for a 1-person household, at 7% interest. These numbers are close enough to the upper limit of 100% of median income for inclusionary zoning, that it is possible there could be some overlap of potential customers in the upper tier.

	Median Income	*Income Needed to Buy a 275,000 House*	*AMI Multiplier*
1-person household	$46,200	$66,500	144 %
2-person household	$52,800	$66,500	125 %
3-person household	$59,400	$66,500	110 %
4-person household	$66,000	$66,500	100 %

Inclusionary zoning

The inclusionary zoning ordinance passed last August, which is the most restrictive in the country, requires 30% of all new development to be affordable to people at or below 100% of AMI, and it has a small but present potential to compete with moderately priced houses for 4-person households near 100% of AMI who will have a choice of inclusionary zoning houses or houses on the open market. Inclusionary zoning requires that 10% of all new development be available to people below 65% of AMI, 10% for people below 80%, and 10% for people below 100%. Households making close to 100% of AMI will not be eligible to buy houses in lower priced tiers. Returning to the chart on page 44, we see that 376 (=644-268) housing units were built in the city in 2005, which adds a maximum of 111 units built through inclusionary zoning (conservatively, assuming they're not already included in the MLS listing), for purchase by 28,000 households. One third of these or 38 units will be available for people at 80-100% of AMI. *Thus, the potential competition from inclusionary zoning for the West Alameda property is 4-person households near 100% of AMI who may have interest in these 38 units.*

Sizing the competition for 80-100% of AMI

The charts on page 41 represent only the houses on the market today and do not consider the number of houses for sale during the rest of the year. There were 455 houses listed on MLS between July, 2005 and July, 2006,[vii] including those that sold and those that are still listed. (Of the 431 listed in Appendix A, 394 were listed within the past year.) This suggests that there were 9% x 455 = 41 houses affordable to people at or below median income. There are currently 29 houses on the market affordable to people between 80%-100% of AMI, with an annual estimate of (9%-1%) x 455 = 36. Market prices are rapidly increasing, and we can assume that as of next year this number will decrease, with a greater percentage being provided by the inclusionary zoning ordinance.

If the level of 376 total housing units built this year (=644-268 from the chart on page 44) is repeated next year, then the total units available to people at 80-100% of AMI include 10% or 38 units through inclusionary zoning, plus market units. Returning to the chart on page 42, we see that in July, 2005 there were 15-6=9% of houses in the open market for the 80-100% of AMI range, and in July, 2006 there were 9-1=8% in this range. Continuing this trend, if we assume 7% of 455 annual listings, this implies 32 houses on the open market in the 80-100% of AMI range, plus 38 through inclusionary zoning = 70 units available to people between 80-100% of AMI next year. If we assume that all houses built through inclusionary zoning are reflected in the MLS listing, then the estimated number of houses in the 80-100% range for next year is 32.

Sizing the competition for 100-120% of AMI

This market is much more straightforward because it is not covered by inclusionary zoning. In 2005 there were 24-15=9% of houses priced for this income range, and in 2006 there were 17-9 = 8%. Continuing this trend we can assume that next year there will be 7% of 455 annual listings, or 36 houses on the market annually in the 100-120% of AMI range. *Therefore, the size of the competition for the West Alameda property is 60 units in the 100-120% range, plus the potential overlap with 32-70 units in the 80-100% of AMI range for 4-family households near 100% of AMI. There is no overlap for 3- or 2- or 1-person households.*

A note on Appendix A

The analysis of homes above based on Appendix A includes single family homes only and does not include condos. The condo market in Santa Fe is extremely small (though growing). Single family homes will be built on the subject property, and thus this list is an accurate representation of the competition with the caveat that it does not include homes in the county, such as Tierra Contenta or Nava Ade.

The West Alameda property is about one mile outside of city limits and is a 7-minute drive to the Plaza in the center of town. It is relevant that Appendix A and the associated analysis does not include Tierra Contenta and other low cost developments farther outside of the city, which inflates the median price given in Appendix A of $639,000. The median house price reported in newspapers in January of $400,000 is more accurate. However, this is still twice the median price of 5 years ago and leaves a considerable affordability gap. More importantly, as seen on the maps on pages 33 and 34, the subject property is located so close to town that it is due to be annexed into the city, and particularly at a $300,000 price range it more likely competes with other properties in that part of town, than further out in the county which is primarily comprised of large subdivisions.

While the population of Santa Fe has grown 7% in the last 5 years, or about 1.4% per year, the housing market includes an unusually large percentage of people buying second homes, which is not reflected in the population growth numbers. It is these second homes that are driving up home prices as builders' time and land prices are focused on mansions rather than smaller homes for locals. As illustrated by the graph on page 24 (and with a little math), five years ago the median income in Santa Fe could buy the median priced house. Today 33,000 people or an estimated 28,000 households in Santa Fe are potentially chasing after 34 houses.

Thus, while the map (#4) above shows only 4-6% of Santa Fe workers living as far away as Albuquerque in 2000, the trends are rapidly changing now that there is at least a $200,000 gap between the median home price and what the median income can buy. The West Alameda property is one mile outside of city limits, and the maps on pages 33 and 34 show that it will soon become part of town, and already feels close to town, giving it a significant location advantage.

The question is, how many of the 28,000 households are potential buyers? In 2000 there were 7,386 households with heads of household between the ages of 25 and 34, who would likely be first time homebuyers. There were 3,743 households with either a home equity loan or second mortgage on their homes who may benefit from a lower cost house with lower utility bills. And there were 3,966 housing units with owner costs at or above 40% of income. However, without knowing the relative income ranges of each of these groups, it is not possible to calculate the fraction that represents the target market. The clearest available markets are:

- ❒ High cost homeowners – There were 610 households with income between $50,000 and $75,000 who were paying more than 35% of income for homeowner costs. (Given that median income has risen only 10% since 2000, this is an appropriate income range.)
- ❒ Rental Conversion – There were 2,465 renting households paying more than $1,000 in rent in 2000. Though this may overrepresent the current renter conversion market for moderate income houses which today will require $1,500 – $1,800 a month in mortgage costs, this suggests a house design with a rentable room to capture the rental conversion market.

This suggests a minimum target market of 3,075 households for 98 units available per year. While there are 28,000 households with only 9% of housing currently available to them, the new inclusionary zoning law passed will make 30% of all new housing available to this population.

Who are these 3,075+ households?

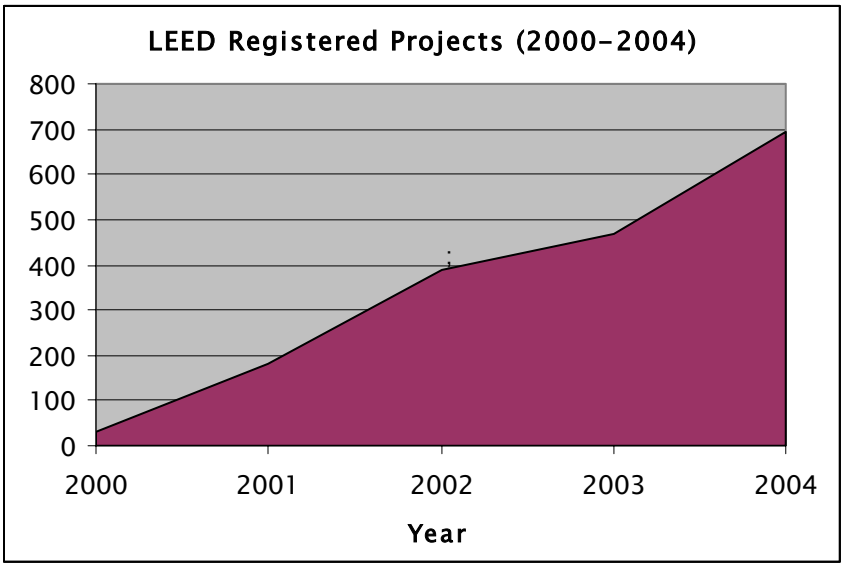
The map on the following page shows where the high rent census blocks are located, in dark green and blue. The bar graphs give an idea of how many of these high rent units there are in each area. These are both important because some census blocks have very few rental units and

are mostly owner occupied homes. A block with median rent of $1,000 but only 3 rental units in the block is less relevant than a block with 40 high rent units. Most areas at the bottom of the map, south of town, do not have strong rental conversion potential. These neighborhoods are rural with wide open views, and it is likely that people who live there intentionally live farther out and would not want to move closer to town.

- According to map #5 above, many of the blocks highlighted in the map on the next page are comprised of 40-60% families, which also implies they are also 40-60% non-families.
- 56.5% of New Mexico is non-white and statistically the same is likely true for Santa Fe.
- 75% of the population works in government, retail/wholesale, accommodation/food service, health care/social assistance, or construction.

A Note on Environmental Interest

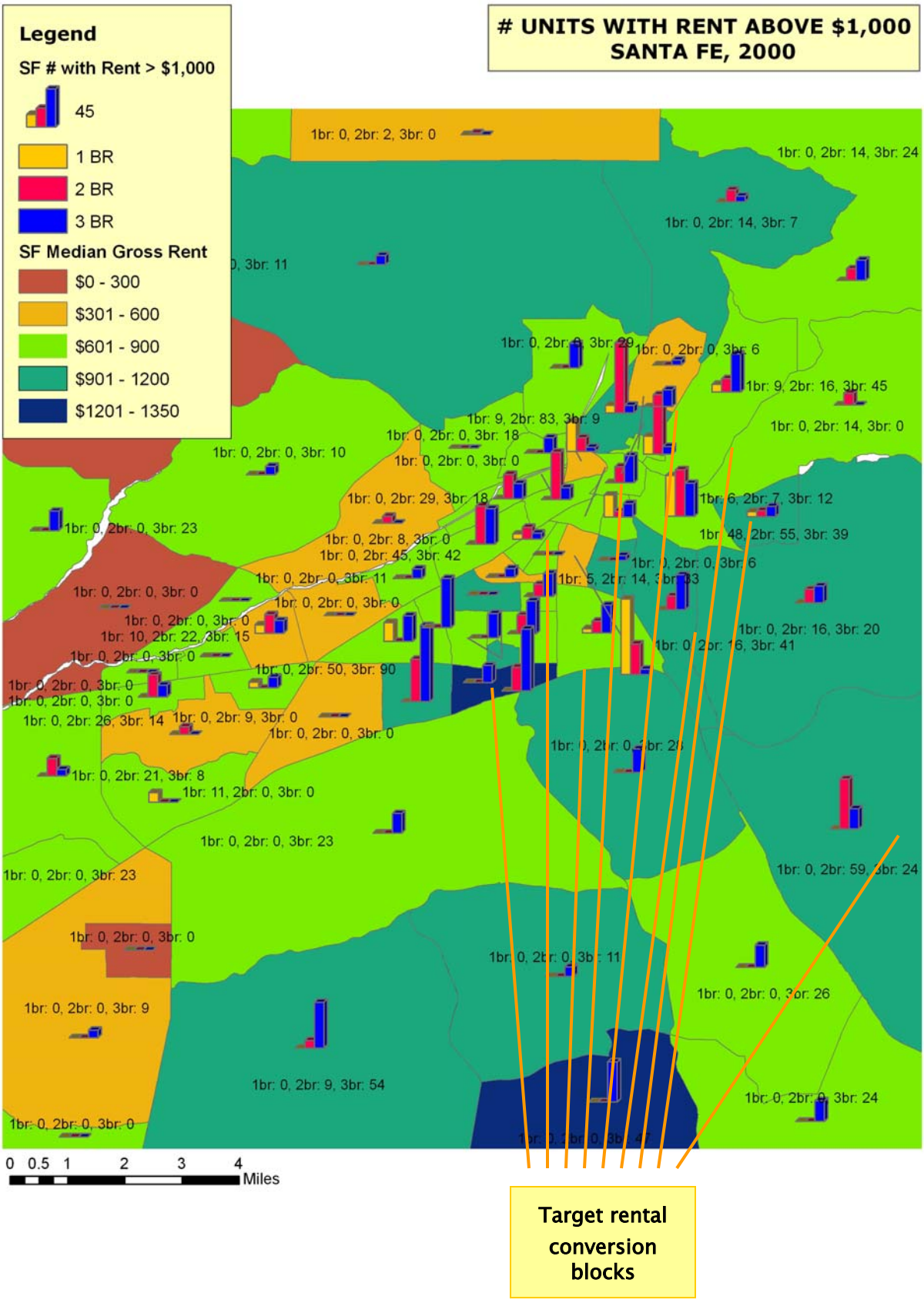
Nationally, the interest in green building is growing exponentially. According to the 2006 Green Building Smart Market Report from McGraw-Hill Construction Research and Analytics, as of 2004 the US Green Building Council had almost 700 LEED (Leadership in Energy and Environmental Design) registered projects and 70% of leading companies in the architect/ engineering/ design and owner communities "report perceived sales growth related to green building."



Reproduced from: Green Building Smart Market Report, 2006. McGraw-Hill Construction Research and Analytics.

While there are no data available to indicate the level of environmental interest in the Santa Fe area, there are several anecdotal pieces of evidence:

- The state has a history of adobe houses and alternative building materials that dates back several hundred years
- There are at least 10 builders in town who are familiar with rastra, pumice-crete, adobe, and ecrete (AAFs) (to be discussed further in Section 3)


Legend
SF # with Rent > $1,000
45
1 BR
2 BR
3 BR
SF Median Gross Rent
$0 - 300
$301 - 600
$601 - 900
$901 - 1200
$1201 - 1350
UNITS WITH RENT ABOVE $1,000
SANTA FE, 2000
1br: 0, 2br: 2, 3br: 0
1br: 0, 2br: 14, 3br: 24
1br: 0, 2br: 14, 3br: 7
1br: 0, 2br: 0, 3br: 6
1br: 9, 2br: 16, 3br: 45
1br: 0, 2br: 14, 3br: 0
1br: 9, 2br: 83, 3br: 9
1br: 0, 2br: 0, 3br: 18
1br: 0, 2br: 0, 3br: 10
1br: 0, 2br: 0, 3br: 0
1br: 0, 2br: 29, 3br: 18
1br: 6, 2br: 7, 3br: 12
1br: 0, 2br: 0, 3br: 23
1br: 0, 2br: 8, 3br: 0
1br: 0, 2br: 45, 3br: 42
1br: 0, 2br: 0, 3br: 11
1br: 0, 2br: 0, 3br: 0
1br: 0, 2br: 0, 3br: 0
1br: 10, 2br: 22, 3br: 15
1br: 0, 2br: 16, 3br: 20
1br: 0, 2br: 16, 3br: 41
1br: 0, 2br: 50, 3br: 90
1br: 0, 2br: 26, 3br: 14
1br: 0, 2br: 9, 3br: 0
1br: 0, 2br: 0, 3br: 0
1br: 0, 2br: 21, 3br: 8
1br: 11, 2br: 0, 3br: 0
1br: 0, 2br: 0, 3br: 23
1br: 0, 2br: 0, 3br: 23
1br: 0, 2br: 59, 3br: 24
1br: 0, 2br: 0, 3br: 0
1br: 0, 2br: 0, 3br: 9
1br: 0, 2br: 0, 3br: 26
1br: 0, 2br: 9, 3br: 54
1br: 0, 2br: 0, 3br: 24
1br: 0, 2br: 0, 3br: 0
0 0.5 1 2 3 4
Miles
Target rental conversion blocks

- There are at least 3 builders who have been building with pumice-crete for 15 years or more
- There is a pumice quarry for pumice-crete 20 miles north of town which is almost completely depleted from use
- New Mexico, Arizona, Nevada, and Colorado have more peak solar hours than anywhere else in the country, and have become early adopters of solar technology
- Due to an extreme necessity for water conservation, New Mexico and Santa Fe have developed a strong base of knowledge for water related technologies and strategies
- Ed Mazria, who wrote the seminal book on passive solar design, has lived and worked in Santa Fe for 30 years
- There are at least 4 companies that design and install solar power systems in Santa Fe, and several more in Albuquerque
- There are 3 organic food stores in Santa Fe
- There is a much higher proportion of off-grid houses in Santa Fe compared to the rest of the U.S., out of necessity in rural areas

ENDNOTES

[1] City of Santa Fe General Plan. (1999). City of Santa Fe, Planning and Land Use Department, p.2-3.
[2] (Unknown). Trends and Transitions, State Legislatures, February, 2006. p. 6.
[3] U.S. Census Bureau, 2000 Census.
[4] Santa Fe Trends, 2006. City of Santa Fe, Planning and Land Use Department.
[5] U.S. Census Bureau. 2000 Census.
[6] Santa Fe Trends, 2006.
[vii] MLS data provided by a prominent Santa Fe realtor.

3. WHAT TO DEVELOP?

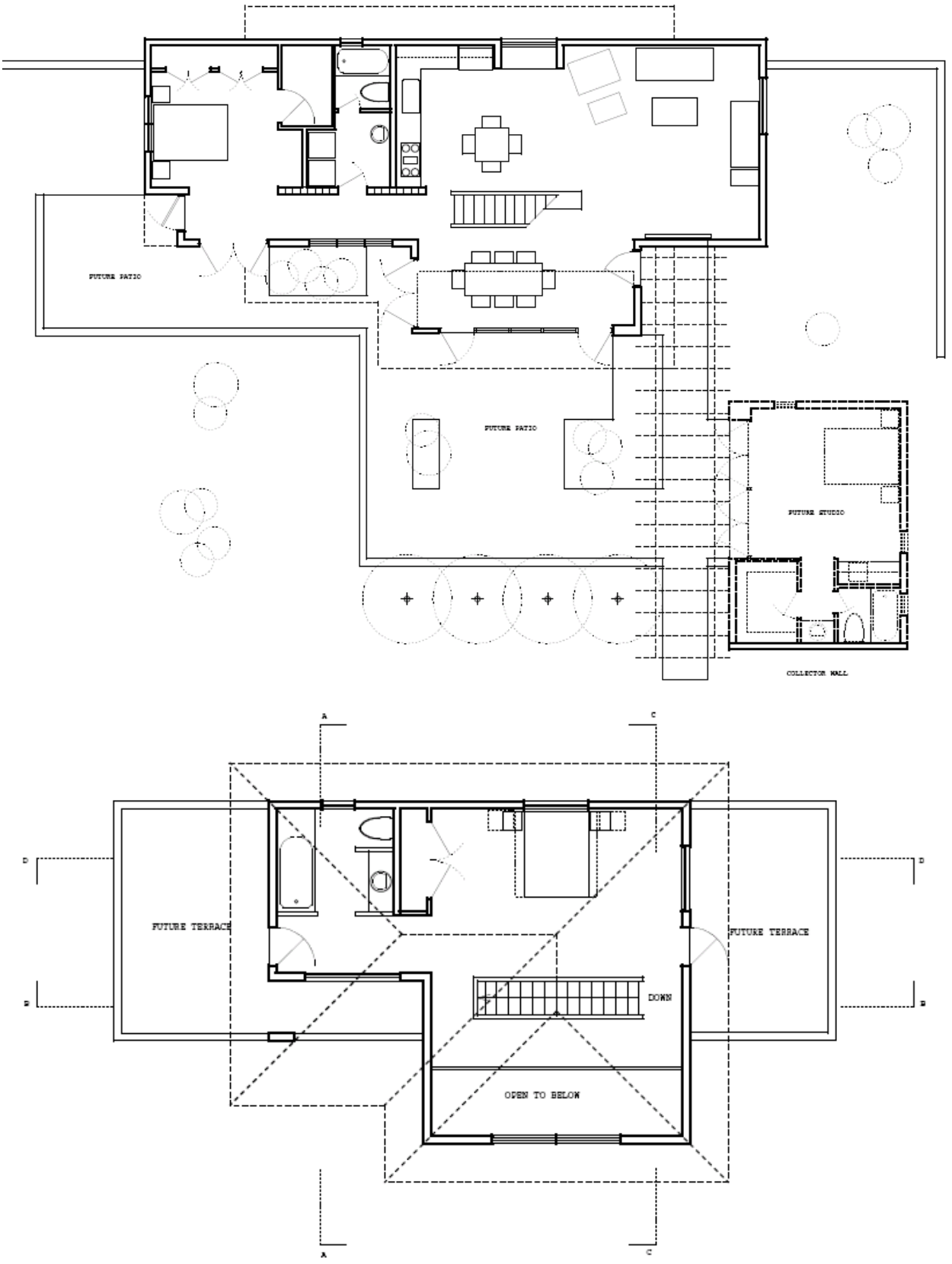
A. Feasibility analysis
B. Green building components and specifications in plain English
C. Costs and benefits of building green
D. Revised feasibility for a green built house in Santa Fe
E. A note on financing

FEASIBILITY ANALYSIS

The first step is an estimated or back-of-the-envelope calculation to determine if further analysis and research is warranted. While this generally is done before the land is purchased, in order to work backwards to determine a price that the land is worth based on the estimated costs and selling prices of what will be built on the land, I was new to town and knew this analysis would take months to complete. Because the land was priced well below other properties on the market, I bought the land before analysis was completed.

I had preliminary schematics drawn for a house (which is a work in progress and is not yet complete) to use as a baseline for discussions with builders. The design is included on the following page. The house as drawn is 1,500 square feet including the studio, 1,200 square feet with just the main house first floor (which, with a couple minor modifications, can have 2 bedrooms), or 1,750 square feet including the second floor.

Source: Design drawn by Hugh Driscoll at Chord Architecture, Santa Fe, NM



Source: Design drawn by Hugh Driscoll at Chord Architecture, Santa Fe, NM

There are two constraints set for the feasibility analysis, examples of which are illustrated on the following page for 1 and 6 houses. First, assuming a variance is granted, the maximum number of allowable houses on the property is 6 due to a code limiting the number of septic systems to one system per ½ acre, and to ask the county to accept a variance containing innovative solutions for both water conservation and septic systems is too aggressive and not feasible at this time.

Second, the maximum selling price of houses is $300,000 in order to correspond to what customers in the moderate income range of 100-120% of AMI could afford, the reasons for which were discussed in Section 2. It is possible that by the time construction is completed, a selling price of $325,000 will be feasible based on increases in area median income. But to err on the conservative side for budgetary purposes, $300,000 is currently set as the maximum price. In addition, a Santa Fe realtor, native New Mexican, and urban growth specialist noted that he could easily sell 1,200 square foot houses priced at $275,000, and thus $300,000 is already extending this limit.

Findings are based on a 1,200 square foot model. The feasibility analysis begins by subtracting site costs, consultant costs, utility costs, and taxes that are unaffected by the size of the house. The final results of the analysis give maximum possible psf building costs for the house itself. As shown in the following chart, a construction cost of $175 or $150 per square foot appears infeasible. A construction cost of $125/sf requires at least 3 houses to share the site costs, and a cost of $113/sf (see note 15 to follow) requires at least 2 houses, though 2 houses at $113/sf will not allow for a developer fee. Thus, the feasible options are: 3 houses or more at a cost of $125/sf or less, or reducing site or architectural costs to make $150/sf feasible for 6 houses.

Maximum Selling Price Does not Vary by # of Houses Built	1	2	3	6
Cost for 1,200 sf @ $113/sf	$300,000	$300,000	$300,000	$300,000
Cost for 1,200 sf @ $125/sf	$300,000	$300,000	$300,000	$300,000
Cost for 1,200 sf @ $150/sf	$300,000	$300,000	$300,000	$300,000
Cost for 1,200 sf @ $175/sf	$300,000	$300,000	$300,000	$300,000

Construction Budget Varied by # of Houses Built	1	2	3	6
Cost for 1,200 sf @ $113/sf	$374,329	$295,963	$271,870	$247,776
Cost for 1,200 sf @ $125/sf	$388,729	$310,363	$286,270	$262,176
Cost for 1,200 sf @ $150/sf	$428,729	$350,363	$326,270	$302,176
Cost for 1,200 sf @ $175/sf	$447,529	$370,363	$346,270	$322,176

Profit Varied by # of Houses Built	1	2	3	6
Cost for 1,200 sf @ $113/sf	$ (74,329)	$ 8,074	$ 84,391	$ 313,342
Cost for 1,200 sf @ $125/sf	$ (88,729)	$ (20,726)	$ 41,191	$ 226,942
Cost for 1,200 sf @ $150/sf	$ (128,729)	$ (100,726)	$ (78,809)	$ (13,058)
Cost for 1,200 sf @ $175/sf	$ (147,529)	$ (140,726)	$ (138,809)	$ (133,058)

FEASIBILITY/ SENSITIVITY ANALYSIS FOR WEST ALAMEDA PROPERTY

Adapted from ADC Referral, Elements of Southwest Design and Energy Efficient Building class, Santa Fe, NM.

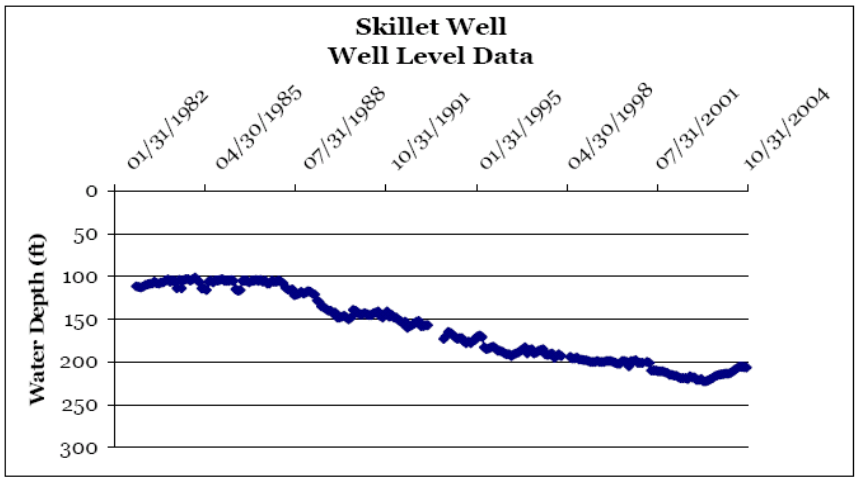
# Houses on property			1	# Houses on property			6
Selling price per house		$	300,000	**Selling price per house**		$	300,000
Land cost		$	140,000	**Land cost**[5]		$	23,333
Total budget		$	160,000	**Total budget**		$	276,667
Less Taxes and Fees				**Less Taxes and Fees**			
Less NMGRT		$	9,408	Less NMGRT[6]		$	16,268
Less Fees (permit, impact)		$	10,000	Less Fees (permit, impact)		$	10,000
Total Taxes and Fees		$	19,408	Total Taxes and Fees		$	26,268
Subtotal		$	140,592	Subtotal		$	250,399
Less contingency	5%	$	7,030	**Less contingency**	5%	$	12,520
Subtotal		$	133,562	Subtotal		$	237,879
Less Legal/Arch/Eng				**Less Legal/Arch/Eng**			
Total architectural[†1]	8%	$	11,411	Total architectural[7]	6%	$	16,600
Geotechnical engineer[†]		$	2,500	Geotechnical engineer[8]		$	1,225
Legal		$	5,000	Legal		$	833
Total A&E		$	18,911	Total A&E		$	18,658
Subtotal		$	114,651	Subtotal		$	219,220
Infrastructure/Utilities				**Infrastructure/Utilities**			
Well[†]		$	13,429	Well[9]		$	2,238
Electricity[†2]		$	5,159	Electricity[10]		$	860
Gas[†3]		$	4,192	Gas[11]		$	699
Septic[†4]		$	7,000	Septic		$	7,000
Greywater/ rainwater		$	7,000	Greywater/ rainwater		$	7,000
Driveway/ utility trenches[†]		$	10,000	Driveway/ utility trenches[12]		$	7,000
Total Utilities		$	46,780	Total Utilities		$	24,797
Subtotal		$	67,871	Subtotal		$	194,424
Misc Costs				**Misc Costs**			
Garage/carport		$	–	Garage/carport		$	–
Portal/ porch		$	3,000	Portal/ porch		$	3,000
Patio/ courtyard		$	–	Patio/ courtyard		$	–
Fences/ walls		$	2,000	Fences/ walls		$	2,000
Landscaping		$	2,000	Landscaping		$	2,000
Total Misc Costs		$	7,000	Total Misc Costs		$	7,000
Subtotal		$	60,871	Subtotal		$	187,424
Land Financing Costs[†13]		$	9,600	**Land Financing Costs[†13]**		$	9,600
Constr. Financing[14]		$	16,800	**Constr. Financing[14]**		$	29,050
Construction (heated spaces)		$	51,271	**Construction (heated spaces)**		$	148,774
			Buildable sf				*Buildable sf*
Divided by $100/ sf			513	Divided by $100/ sf[16]			1,488
Divided by $125/ sf			410	Divided by $125/ sf[16]			1,190
Divided by $150/ sf			342	Divided by $150/ sf[16]			992
Divided by $175/ sf			293	Divided by $175/ sf[16]			850
				Cost for 1,200 sf @ $113/sf[15]		$	247,776
				Cost for 1,200 sf @ $125/sf[15]		$	262,176
				Cost for 1,200 sf @ $150/sf[15]		$	302,176
Not within budget – not feasible				**Cost for 1,200 sf @ $175/sf[15]**		$	322,176

Notes for the above analysis are:

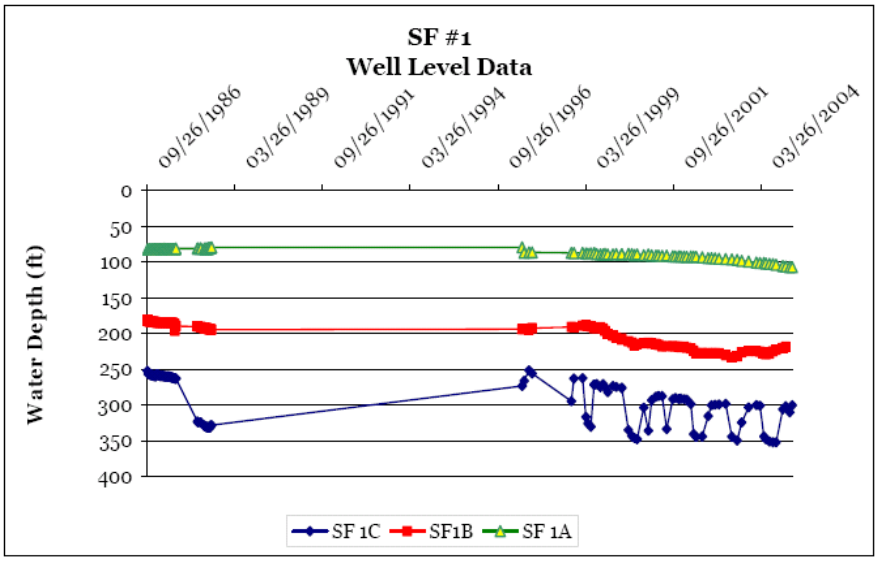
† These are actual costs or estimates received from builders/ architects

1. Two design/build firms price design services at $3,000 and $7,000 respectively, which they offer as a service to get the construction business. It is unknown whether additional costs for design services are subsequently "hidden" in other line items in the budget.
2. Above ground, with a new pole.
3. To put a box on the property line – does not include service from property line to the house.
4. Pirhana, MultiFlow, or similar water treatment/recycling unit.
5. Divided by the number of houses.
6. Does not change.
7. Assumed to be slightly less if houses are similar, but not the same.
8. Assumed to be 50% less if all houses are built together and in the same vicinity/ land characteristics.
9. Assumed that the county will only allow one, regardless of the # of houses.
10. The cost to bring service onto the site is split by all houses.
11. The cost to bring service onto the site is split by all houses.
12. Assumed that there will be some areas in common for all houses, and other areas at a lower price if the work is done at once.
13. Land financing costs are calculated for 2 years at $400/month actual value.
14. Construction finance costs are calculated for an 18 moth, 7% interest only loan.
15. There is a discrepancy between the numbers I have received from builders, which makes it unclear how to estimate a reasonable per square foot building cost for heated spaces here. Builders and developers in Santa Fe cite the cost of building per square foot at $110 psf (from Developer 1) for the least expensive affordable housing, $400 psf for luxury housing (Developer 2), and most mid-range housing around $175-$225 psf (Developer 3 and various others). However, it is unclear which development components these numbers include (design, permitting, landscaping, utility infrastructure, fences, etc.) Thus I have isolated from the schedule of values only the components related to construction of heated spaces. The cost received from Developer 4 is $113 psf, and the cost received from Developer 5 is $140 psf. These each include different assumptions about yard walls (included in the latter), costs for cabinets, etc. but give a ball park estimate of expected costs.
16. These costs per square foot are exclusive of $16/sf costs for A&E and $48/sf costs for taxes and fees, infrastructure and utilities, and miscellaneous costs.

Now that we know, at first glance, that moderate income housing on the West Alameda property may be financially feasible for 6 houses, we return to the discussion in Section 1. During the review of development priorities for Santa Fe, not only did appropriate location emerge, but the most needed type of development also became clear, and it is affordable or moderate income housing that conserves water and helps reduce greenhouse gases. These again intersect with profit making opportunity because it would be politically treacherous to design a house that was not water conserving, and politically advantageous to design a house with significant water saving strategies since this will be the primary issue driving a positive decision on an application for a variance. The following graphs for wells used to measure the depth of the water table in Santa Fe show increasing well depth needed to access water, meaning that water is being used faster than it is being replenished.



Second, because Santa Fe gets more peak solar hours than anywhere else in the country, and the power company is paying local residents for solar power generation if they are tied to the grid, it is strategically prudent to at least investigate the financial feasibility of solar power generation for the house design.



Source: Water Update, City of Santa Fe, Spring Quarter 2005

Third, if solar heat and/or photovoltaics (PV) are found to be cost effective, they have the added financial benefit of dramatically reducing costs for utilities, which allows home buyers to qualify

for a larger mortgage due to reduced monthly costs. While not all banks are familiar with this concept, it is becoming more common. Ideas for financing sources are given in Section 4.

Lastly, interest in green building is escalating nationally. Not only did the number of LEED registered projects increase from 3 in 2000, to 700 in 2004,[1] but articles on the topic are appearing in every newspaper and building related publication. GM's and Toyota's new headquarters are built green, and Ford earned LEED certification for their green facilities in 2001. Within the last few years Genzyme completed the first LEED platinum rated office building in Cambridge, MA. The convention center in Pittsburgh is now the world's largest green building. Texas Instruments built their new headquarters green – for $180 million less than their last factory built 7-10 years ago.[2] S.C. Johnson, Goldman Sachs, CalPERS, The PNC Financial Group, and Conde Nast all have green facilities.[3]

In an article in the June, 2006 issue of the Harvard Business Review titled "Building the Green Way", Charles Lockwood states that "The owners of standard buildings must act now to protect their investments" and that "building owners will make green renovations of their standard buildings a major trend in the near future." Turner Construction released a Market Barometer report titled "2005 Survey of Green Building Plus Green Building in K-12 and Higher Education." Fortune magazine carried a 14-page advertising section for the US Green Building Council. An article titled "Remodeling green goes mainstream" appeared on the front page of the real estate section of the Chicago Tribune (May 26, 2006). In North Carolina, the magazine Carolina Living included a 6-page article on green building in the May, 2006 issue. Even airline magazines are carrying articles about green building (Home Economics: With energy prices on the rise, it makes sense to build smaller and greener. Southwest Airlines Sprit, April 2006).

In May, 2006 the New York Times carried a special *12-page section* titled "The Business of Green," saying:

> *Green is in fashion – the new black, the must-have, this decade's version of business imperatives like "total quality management" or "management by objectives"… Business is going green for many reasons, not just the obvious one, public image. There is also a competitive advantage. "You don't just compete on cost or quality of new products; you can also compete on environmental performance," said Donald B. Rosenfeld, a senior lecturer at the M.I.T. Sloan School of Management.*
>
> (Matthew Wald, What's Kind to Nature Can Be Kind to Profits, p. E1)

Much like the emergence of the internet e-commerce business strategy in the 1990s, green building is a new field where there are a few people who know a lot about green building and a lot of people who know a little about it. Verifiable, detailed information is moderately available for 100-unit apartment buildings in downtown San Francisco, or large office complexes, but is hard to come by at the small project level of single family houses. However, due to Santa Fe's

policy priorities, an escalating national interest and rapidly growing market, and depending on your beliefs about global warming, perhaps an ethical imperative, a full consideration of smart development in support of smart growth necessarily will require an analysis of green building alternatives.

Before the costs and benefits of green building are considered, it is necessary to clarify concepts and terms in order to inform the discussion because, for example, solar heat generation is less effective and requires a larger (more expensive) system if the house does not have high R-value windows, a passive solar design, or sufficient mass to retain heat. These concepts and other relevant terms are explained succinctly in the following discussion.

General concepts of green building rating systems

The basic concepts and definition of green building are similar everywhere, but the specifics vary from one program or rating system to another. Following is a summary of green building certification programs specifically for houses, from the U.S. Green Building Council which is pilot testing a scorecard for houses, Built Green Colorado which has been in effect since 1995, Energy Star, and the National Association of Home Builders Model Green Homebuilding Guidelines released in 2006. These illustrate the general categories of design or construction techniques that comprise green building. Each rating system may interpret the categories slightly differently, but there are many similarities in general concepts.

The most common certification for green building is through the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) program[4]. LEED-H, a certification for houses and currently in the pilot program stage, includes the following. The checklist for LEED-H, along with the checklist for LEED-NC for new construction of commercial buildings, is included in entirety in Appendix B.

- ❒ Site selection and location
- ❒ Site stewardship and sustainability
- ❒ Water efficiency
- ❒ Indoor air quality
- ❒ Energy conservation
- ❒ Homeowner education
- ❒ Innovation

Introduced in 1995, Built Green Colorado was created by the Home Builders Association of Metro Denver (HBA), The Governor's Office of Energy Management and Conservation (OEMC), Xcel Energy, and E-Star Colorado. According to the web site, it is the largest green building program in the nation, with over 100 builder members across the state, 45 sponsor members, and 8 members of the Built Green Industry Leaders group[5]. The checklist is 12 pages long and thus is *not* included in Appendix B. Denver's Built Green program includes measures for:

- ❒ *Energy efficiency* – site design and orientation, renewable energy, foundation systems, thermal envelope, windows and doors, low energy cooling strategies, mechanical heating and cooling system, HVAC distribution systems, water heating, appliances, lighting

- *Site protection*
- *Health and safety* – improved indoor air quality, moisture management
- *Material resource efficiency* – foundation, framing, sub-floor, roofing, insulation, windows and doors, exterior wall finishes, interior finish floor, cabinetry and trim, materials reduction and re-use, construction waste reduction and recycling
- *Resource conservation* – water

The Energy Star program and rating system, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy[6], is exclusively focused on energy. A description from the web site is included in Appendix B. The rating system includes:

- Effective insulation
- High performance windows
- Tight construction and ducts
- Efficient heating and cooling equipment
- Lighting and appliances
- Third party verification

National Association of Home Builders released NAHB Model Green Homebuilding Guidelines in 2006, after "an extensive review of the existing local green home builder programs," saying "The purpose of these guidelines is to highlight ways in which a mainstream home builder can effectively and holistically weave environmental concerns into a new home and to provide a tool for local associations to create a green home building program." It's list of criteria is 46 pages long and thus it is not included in Appendix B, but a summary of components is:

- *Lot Design, Preparation, and Development* – Select the Site, Identify Goals With Your Team, Design the Site, Develop the Site, Innovative Options
- *Resource Efficiency* – Reduce Quantity of Materials and Waste, Enhance Durability and Reduce Maintenance, Reuse Materials, Use Recycled Content Materials, Recycle Waste Materials During Construction, Use Renewable Materials, Use Resource-Efficient Materials, Innovative Options
- *Energy Efficiency* – Implement an Integrated and Comprehensive Approach to Energy-Efficient Design of Building, Site, Building Envelope, and Mechanical Space, Conditioning Systems, Performance Path, Prescriptive Path, Renewable Energy/Solar Heating and Cooling, Innovative Options
- *Water Efficiency* – Indoor/Outdoor Water Use, Innovative Options
- *Indoor Environmental Quality* – Minimize Potential Sources of Pollutants, Manage Potential Pollutants Generated in the Home, Moisture Management (Vapor, Rainwater, Plumbing, HVAC), Innovative Options
- *Operation, Maintenance, and Homeowner Education* – Provide Home Manual to Owners/Occupants on the Use and Care of the Home, Optional Information to Include in the

Home Manual, Provide Education to Owners/Occupants in the Use and Care of Their Dwellings, Solid Waste, Innovative Options

- *Global Impact* – Products, Innovative Options

The Santa Fe Area Green Building Guidelines produced in 2002 by the Santa Fe Area Home Builders Association and Sustainable Communities, Inc. lists 160 criteria and is too long to reproduce in entirety here. It includes the following sections:

- *Site Guidelines* – Preservation, site use
- *Water Management* – Fixtures, appliances, outside the house
- *Energy Efficiency* – Building envelope, building landscape, heating and cooling
- *Materials Selection* – Regionally produced, recycled, reclaimed, and/or sustainably acquired, durability, not destructive to the environment, resource efficient
- *Indoor Environmental Quality* – Prevention of biological contamination; benign material selection; water, electromagnetic, acoustics, and lighting; heating, cooling, and ventilation safety; construction and building commissioning protocols
- *Occupant Education*

The most analytically complex concept in green building is energy efficiency, which has much farther reaching design implications and potential for payback than simply buying energy star appliances. The key concept, known as *whole house design,* is to design the entire building from the beginning to minimize the amount of energy it uses. It means thinking of the house as an air flow machine, taking in air in various places, transmitting it through the house with vents and fans to get maximum use out of it, and then expelling unwanted air in order to maintain a comfortable temperature at all times of the year. It also requires thinking about which rooms in a house are used for which uses at what time of day, and how hot air and cool air flow through the house. This concept affects design and materials for walls, windows, doors, floors, and the roof, all of which comprise the *building envelope,* which gathers and then holds or releases air. The interior layout of the house works together with the building envelope design in order to transmit air, once received, to all parts of the house. Designing a highly energy efficient building is also one of the areas of green building with the most obvious and quantifiable cost savings to the home buyer through reduced utility bills, and therefore is easy to sell.

Passive solar design

Designing a passive solar house is, arguably, one of the least expensive ways to significantly increase energy efficiency, because it means designing the house to maximize heat gained from sunlight in the winter and minimize heat gained from the sun in the summer, thereby reducing the use of *active heating and cooling* systems to a minimum. It requires high quality windows and perhaps additional insulation, but does not include any additional building components

that would not be required anyway. There are some particularly effective alternative building materials for walls, especially prevalent in the southwest, which will be further explored in the Survey of Builder Pricing discussion below. Key design concepts are as follows.

Most of this section on passive solar design concepts, unless noted otherwise, is taken from The Passive Solar Energy Book, Edward Mazria, 1979. Though the book is old, it is the seminal research and writing on passive solar design. Edward Mazria lives in Santa Fe, NM, and gave the keynote speech at the 2005 AIA conference.

- ❒ Sun rotation – First, an understanding of the movement of the sun is critical. In summer it rotates directly overhead, and the roof will be the warmest area of the house. In the winter it rotates much lower to the horizon, on the south side of the house, and thus the south wall of the house will get the most direct heat. In addition, the west side of the house will be much warmer than the east because the sun hits the east side after cooling off all night but hits the west side after warming up all day.
- ❒ Thermal mass – Second, the concept of mass is extremely important. Mass refers to masonry substances such as concrete, brick, adobe, etc. that will retain heat and release it over time. A passive solar house will usually cost about the same as a masonry house, but a frame house would require additional insulation cost.

GENERAL HOUSE DESIGN

- ❒ House shape – A square house is not the optimum form (for solar heat gain in the winter) in any location. The optimum shape is a rectangle with the long sides facing north and south, because the most solar gain is obtained through the south wall. Shape the building so that the north side slopes toward the ground to minimize the shadow cast by the north wall outside, especially in the winter when the sun does not rotate directly overhead, but along the south side of the building.
- ❒ House orientation – Orient the house with the south wall facing 10 degrees east of true south.[7] Because most compasses measure south as 15 degrees west of true south, this means the south facing wall of the house should be 20-25 degrees east of south according to a compass.[8]
- ❒ Wind protection – Put a dense row of trees or bushes along the north wall of the house to block the wind in the winter.
- ❒ Placement of rooms – Place rooms to the southeast, south, and southwest according to the need for sunlight at various times of day (to minimize the need for electric light.) Put rooms that are occupied at all hours of the day on the south side of the house. Put hallways, closets, garages, etc. on the north wall of the house to create a buffer between the cold north wall and interior spaces of the house. Create a main entry area with an interior door and exterior door, to limit the amount of cold air that is let in during the winter.

STAYING WARM IN WINTER

- Cover windows – Use movable insulation such as insulated curtains in the winter at night to retain the heat gained during the day.
- Sun tempered window area ratio – Generally speaking, a house with up to 7% window area/floor area ratio will be sun tempered, meaning simply that when it is sunny the house will be warmer, without any heat storage occurring in the house for later use. A sun tempered house can reduce heat requirements by up to 20-30%, depending on construction, sun hours, etc., simply be adding more windows to the south wall.[9]
- Direct gain window area ratio – The area of windows on the south wall should equal 7-12% of floor space, but be advised that increasing window area also requires an increase in mass (next). Depending on construction, sun hours, etc., this could provide 50-80% of heating requirements.[10] Windows on the north and east sides should not exceed 4%, and windows on the west side should not exceed 2%.
- Thermal mass – To minimize indoor temperature fluctuations, use thermal mass, meaning masonry walls, at least 4" thick (but not more than 6", notes Chiras) for interior walls and floors to absorb and transmit solar heat. The mass should be evenly distributed (like a wall) and not in a clump. Materials with higher conductivity will transfer heat from the surface of the wall to the interior where it is stored and released later. Note that materials with higher conductivity also have higher density. Make masonry floors a dark color, masonry walls any color, and all walls with lightweight construction a light color to reflect the light into masonry surfaces. Do not carpet the floor.

Thermal Storage Material Properties

Material	*Conductivity*	*Density*
Concrete	1.00	140
Brick	0.42	120
Adobe	0.30	106

Source: The Passive Solar Energy Book, Edward Mazria

- Glass to mass ratio – When window area exceeds 7% of the floor area, additional mass is needed to store and redistribute heat to avoid overheating the house. Beyond the 7% threshold, each square foot of window area requires 5.5 square feet of uncarpeted, directly sunlit floor area, or 40 square feet of un-sunlit floor area, or 8.3 square feet of wall mass (the industry is inconclusive about whether or not the wall mass needs to be directly sunlit).
- Wall color – Edward Mazria suggests making the south wall a dark color to absorb the winter sun. Daniel Chiras states that "Rather than choose dark colors for all direct-contact mass, many architects now prefer a reflection and absorption strategy" using light colors on the south side of the house where the sun enters, and dark colors on the colder north side of the house [to absorb heat].[11] Determine the colors of the east and west walls according to whether additional heat in winter or additional cooling in summer is a bigger concern.
- Insulation – Insulate only the exterior face of masonry walls, so that they will absorb as much heat as possible on the interior face of the wall, and will not release it to the exterior.

- ❒ Insulation – Use waterproof insulation on the foundation walls to prevent any heat stored in the floor from escaping. (*Note: Three builders I've spoken with favor using insulation directly under the floor for this reason.)* ICFs or insulated concrete forms which include rebar reinforcement use much less concrete than traditional foundations and have insulation on both the interior and exterior of the wall.[12]
- ❒ Insulation level – Many builders use Energy Star recommended levels as a minimum. [13]
- ❒ Attached greenhouse – One way to generate heat, and create an additional useable space at the same time, is to build a greenhouse attached to the south wall of the house. To heat one square foot of interior floor area, 0.65–1.5 feet of double paned glass on the greenhouse is needed.
- ❒ Cloudy days – To collect and store heat for cloudy days, slightly increase the size of windows and thermal mass.
- ❒ A note about skylights – Keep in mind that the sun is directly overhead in summer and low on the horizon in winter. Therefore skylights, while visually appealing, may make the house warmer in summer and have little solar effect in winter depending on placement.

STAYING COOL IN SUMMER

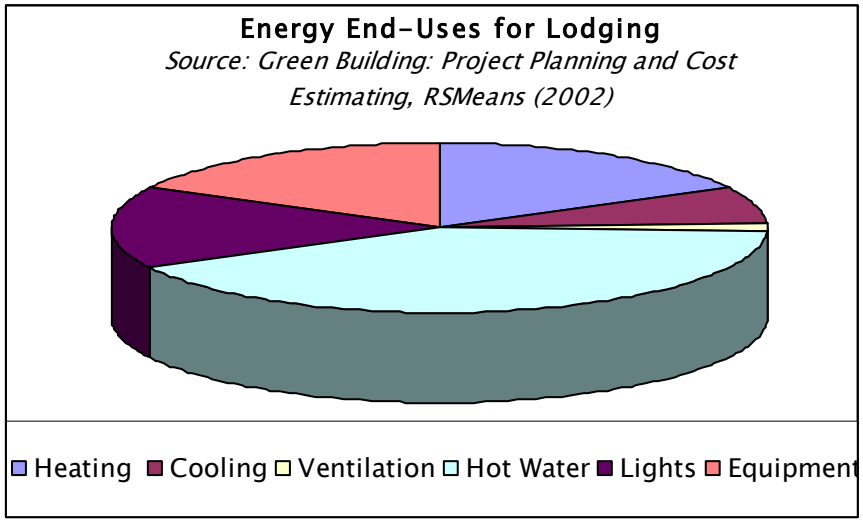
- ❒ Roof color – Make the roof a light color or reflective material to reflect the summer sun.
- ❒ Insulation – Insulation on the exterior face of the outer walls, as discussed above, will minimize the amount of heat transmitted in the summer through the walls of the building.
- ❒ Window placement – Locate large windows on the wall facing the summer breezes, and set similar size windows in the opposite wall for air flow.
- ❒ South window overhang – Shade south windows with an overhang on the outside. The depth of the overhang should be ¼ the window height in southern latitudes, and ½ the window height in northern latitudes. A trellis overhang with dense vines that shed their leaves in winter is an easy and unique option.
- ❒ Window shades – Use shades in the summer to keep out the sun. Plant trees in front of windows to strategically block the sun in summer, especially if they will lose their leaves in the winter and allow sunlight through. Planting trees or bushes on the east and west sides of the house is particularly important.

Active solar systems

Active solar usually refers to one of two systems – either solar heating, or photovoltaics (PV). A *solar heating system* has a collector on the roof that intakes solar power to heat a fluid that travels through a pipe in the floor creating radiant heat. It is a closed loop system, which means there is no off switch, though it is possible to direct heat away from certain rooms. Regulating solar power and heat intake is achieved through positioning the solar collector on the roof vertically – at a 90 degree angle to the roof – so that in the summer when the sun is directly

overhead, it is not absorbed by the solar collector. The difficulty occurs in the spring and fall if it is unseasonably warm, because the sun is not directly overhead as it is in the summer and therefore will generate heat through the active solar collectors. This effect is counteracted, for additional cost, by channeling this unwanted heat into the hot water heating system. An automatic control can be installed that switches the active solar system from radiant floor heating to hot water heating when the temperature outside passes a given limit.[14] It should also be noted that a solar heating system cannot be used to generate electricity for other uses in the house, because the system does not generate electricity at all, but rather generates heat.

These systems are generally believed to be worth the investment due to the relatively high cost of electricity or natural gas heat, particularly given the large percentage of energy costs that are attributable to heat and hot water as shown at right, compared to the relatively low cost of a solar heating system. A prominent solar heat designer and installer in Santa Fe estimates that for a house of less than 2000 square feet, it costs $18-20 per square foot including radiant floor, boiler, water heater, solar collector, zone valves, thermostats, and automatic controls. This equates to approximately $21,600-$24,000 for a 1,200 square foot house. Without the automatic controls and connection to the hot water heater (and a new hot water heater), the system costs much less. The full system will save the entire natural gas heating bill and most of the cost of hot water generation, which usually accounts for a large portion of the electric bill, and saves the cost of purchasing a boiler.



Photovoltaic systems generate electricity to be used for any electric powered device in the house. Because they are intended to be in use year round, they work best if there is an automatic mechanism on the roof to change the angle of the PV collectors based on the location of the sun, though this is extremely expensive and usually not feasible. PV collectors, therefore, are usually mounted flat on the south facing side of a roof, which is the second best option. Installation of a PV system large enough to heat a house is very expensive. A PV installer in Santa Fe gave me a ball park estimate of $40,000.

This, however, is counter to the opinion expressed by many builders, local developers, and a teleconference on the future of the PV and solar heating markets given by the American Bar Association, Section of Environment, Energy, and Resources, Renewable Energy Resources

Committee, which all unanimously state that solar heat has an approximate 7 year payback period and PV has a 20 year payback period, making solar heat worth the investment while PV is not. The existence of *net metering* for solar generated power in New Mexico, however, may make PV a viable option. This will be discussed further below.

Note: Do not assume that because you do not live or work in the southwest, solar powered heat or electricity is not an option for you. Several studies have shown that the overall difference in peak sun hours between the southwest and northeast, for example, does not preclude use of solar power generation in these other areas.

Resource efficiency

Resource efficiency is often explained by thinking of the house as a living breathing organism, considering how it collects, uses, and re-uses water, and how it collects, uses, and re-uses air. Another term often used is "systems thinking", where the uses of resources, or chains of uses, are considered together to determine where efficiencies occur. For example, rainwater can be collected on the roof, filtered, and used for showering, and the runoff from showering can then be filtered and used to water plants that grow food that we eat. Therefore the same water has served 2-3 different purposes. A deck outside can be not only a deck but also a cover under which mushrooms are grown. Trees outside can not only bear fruit but also shade windows in the summer. (These ideas are all contributed by a water harvest system installer in Santa Fe.) In order to plan landscaping, estimate how much water is needed to support the landscaping, estimate the average rainfall in an area, and additional water recycling opportunities (called greywater), a water budget is produced for a property that forms the basis for designing a system to produce that water while reserving water from pipes or wells only for drinking and cleaning dishes.

Embodied Energy of Building Materials	
Material	***MJ/KG***
Straw bale	0.24
Adobe	0.47
Concrete block	0.94
Concrete	1.0-1.6
Concrete (precast)	2
Hardwood timber, kiln dried	2
Softwood timber, kiln dried	2.5
Cellulose insulation	3.3
Cement	7.0-8.0
Plywood	10.4
Fiberglass insulation	30.3
Carpet (nylon)	148

Source: Alcorn, A. (1998). Embodied Energy Coefficients of Building Materials, Centre for Building Performance Research, New Zealand. In The Solar House: Passive Heating and Cooling, Daniel Chiras, 2002.

Resource efficiency also relates to materials. The more simple concepts of using recycled materials and reducing waste are straightforward to conceive, though perhaps not straightforward to implement. A less obvious but important concept is called *embodied energy.* In some scorecards this is included in energy efficiency, and in others it is listed under resource efficiency or sustainability. Embodied energy refers to the amount of energy necessary to harvest and manufacture a product or product components, to transport all the necessary inputs to a product to the factory, and then to transport the finished product to the customer. Building with adobe bricks made from mud, with little or no greenhouse gases

produced during the manufacturing process, does not help the environment if the adobe then has to travel on a truck from New Mexico to Massachusetts for a customer. Similarly, a product that is produced locally but through a manufacturing process that requires a great deal of energy also is not helping conserve resources. Thus, a complete consideration of green building materials will include not just what goes into the materials (e.g. the % of recycled content included in the material) but also the embodied energy necessary to produce it and ship it to the building location. The chart on the previous page gives embodied energy of several building materials, as does the chart at right taken from Mazria (1979). Though the data is old and technology certainly has improved since then, this chart gives an idea of the relative levels of energy required to manufacture various materials, when compared to each other.

Embodied Energy of Materials		
Material	*Btu/lb to Produce*	*Btu/unit to produce*
Steel	19,974	
Aluminum	112,676	
Concrete	413	
Cement	3,755	
Concrete block		15,200
Glass	11,438	
Drywall	2,160	
Insulation (board)		2,040 psf
Paint	4,134	
Lumber		5,019 per linear foot
Roofing		6,945 psf
Vinyl tile	8,000	
Brick	138	682 per block
Source: Mazria, E. (1979). The Passive Solar Energy Book.		

Indoor air quality

Indoor air quality is impacted by construction and by air flow through the house. Basic concepts such as not putting an air intake duct from the garage to the house are straightforward. Others, such as ensuring that dry materials do not get wet during construction and produce mold are more involved and require the builder's attention. Other components include handling of dust in duct work and making sure that fireplaces and boilers are vented to the outside and sealed from the inside. The combination of these strategies creates cleaner air and healthier occupants in the house.

Green building process

Following are some of the key sources of information and experts involved in green building, who will be important players in the process.

Architects and builders – Because of all the considerations mentioned above for green building, it is important to get builders and architects involved, where possible, who are already familiar with the concepts. While it is not necessary to be working with industry leading experts in the field, it is helpful to have either a builder or an architect who has been involved with several projects and can offer ideas about how to do things better. I learned 50% of what is included in this section by talking to builders about their suggestions. This not only helped increase my

knowledge, but gave me a platform for getting to better know builders and their skill levels before deciding which builder to employ. The difficulty with identifying appropriate organizations is that green building is becoming a trend and thus everyone claims to know how to do it. I have seen many developments that claimed to be "green" which, upon further scrutiny, did little more than purchase Energy Star appliances. As you have seen above, this is the least complicated part of green building, and while it certainly is better than nothing, there is a lot more energy to be saved and resources to be conserved through many other practices.

Building energy analysts – These are some of the hardest people to come by, because they are experts at the most complex part of green building. I found 3 organizations that do energy analysis (I'm sure there are more), and in 3-4 weeks of attempts I wasn't able to get any of them on the phone in time for this report. The first is Architectural Energy Corp. in Boulder, Colorado, which usually works on larger commercial projects. The second is Building Science Corp. in western Massachusetts, which has experts not just on energy, but also on indoor air quality. The third is Mark Rosenbaum with Energysmiths in New Hampshire, who did an analysis of the tradeoff between building envelope costs and heating costs. A fourth great source of expertise is solar heating system designers. These organizations are all well versed in estimating how much heat will be required to maintain a comfortable temperature in the house so that the tradeoffs between passive solar building costs, active solar building costs, and the cost for construction and operation of traditional heating systems can then be evaluated.

Pricing versus bidding – Almost unanimously, builders I spoke with refuse to take part in competitive bidding, as counterintuitive as that may seem, to the extent that they will forego potential work. Their reasoning is that to develop a bid, it means examining detailed construction documents and sending them to all relevant subcontractors, and then compiling results which takes weeks to complete, and that they have been "burned" too often by people who request bids from builders simply to check prices of their already favored builder. A method I've used to get around this is to ask them for "pricing" on the house or a "schedule of values" based on schematic drawings, an example of which is included on the following page, for which builders estimate prices based on recent projects completed to give a ball park idea of the cost. The upside is that this allows a comparison of prices between builders, and between building materials and heating systems for passive solar or other designs. The downside is that there is no guarantee that the prices will reflect actual bid numbers, and that assumptions can vary widely about what to include in the price estimate without a list of specifications for interior wall finishing, cabinetry, appliances, etc.

Because pricing is based on simple schematic drawings, builders' costs for interior finishes like cabinets will vary greatly without specifications for these items. I made adjustments for items like utilities and permitting which have separate line items in the feasibility analysis and thus are already included, for yard walls which the builder suggested adding but will not be included in the final house design, for the heating system which shouldn't be necessary (except for

backup wall units) if the house is designed as passive solar, and for floor finishes because the floors will be stained or dyed concrete to make room in the budget for green building costs.

SCHEDULE OF VALUES		
Item	*Builder Price*	*My Adjustment*
Permits	$ 6,500	$ (6,500)
Site Facilities - Portable Toilet & Dumpster	$ 3,000	
Site Preparation - Grading & Leveling	$ 1,200	
Utility Installations - Water, Sewer, Gas, Electric & Tele.	$ 1,500	$ (1,500)
Footings - 160 lf	$ 4,490	
Stemwalls - 160 lf	$ 6,720	
Yardwalls - 153 lf @ 5' tall	$ 15,300	$ (15,300)
Slab - 1120 sf	$ 8,500	
Framing - 1776 sf	$ 31,950	
Roofing - 600 sf flat roof & 1294 sf metal roofing	$ 7,624	
Insulation - 2836 sf/ R19 & 1120 sf/ R38	$ 2,980	
Exterior Doors & Windows	$ 18,703	$ (3,000)
Interior Doors (includes installation)	$ 3,250	$ (2,000)
Door Hardware (includes installation)	$ 1,980	$ (1,500)
Drywall - 5629 sf	$ 8,429	
Exterior Plaster, House - 335 yrds	$ 8,375	
Exterior Plaster, yardwalls - 153 yrds	$ 3,825	$ (3,825)
Bath Tile - walls, floor & vanities (305 sf)	$ 2,745	$ (1,500)
Floor Finishes - 1500 sf	$ 13,500	$ (10,000)
Cabinets, Vanities & Built-ins	$ 9,500	$ (5,000)
Counter Tops	$ 3,000	$ (2,000)
Paint, Stain & Finishes	$ 7,102	$ (2,000)
Plumbing	$ 6,400	
Plumbing Fixtures - 2/ tubs, 2/toilets & 3/sinks	$ 3,000	
Heating & Gas Lines	$ 13,800	$ (9,300)
Air-conditioning	$ 3,540	$ (2,500)
Electrical	$ 10,450	
Electrical Fixtures	$ 3,000	$ (1,500)
Alarm & Audio/Video or speaker wiring	$ 2,000	$ (2,000)
Closet Systems	$ 1,800	$ (1,500)
Finish Carpentry	$ 1,000	$ (500)
Appliances	$ 3,000	
Bath Accessories	$ 1,200	
Final Grading & Clean up	$ 2,500	
	$ 215,363	$ 143,938
Supervision & Misc. Crew Labor	$ 7,538	$ 5,038
	$ 222,901	$ 148,976
Overhead	$ 22,290	$ 14,394
Profit	$ 17,832	$ 11,515
	$ 263,023	$ 174,885
NM GRT	$ 20,055	$ 13,335
Total	$ 283,078	$ 188,220
Cost per square foot	$ 159	$ 106

**Source: Jim Cebak, Cedar Southwest Construction, Santa Fe, NM*

Commissioning agent – If a green building certification is desired, a commissioning agent is responsible for informing the builder and owner of the process and necessary requirements, reviewing the work done, submitting necessary paperwork, and tracking progress. This can be an architect, engineer, or someone who has done it before and is familiar with the process.

Energy analysis with E-10 software – Many builders and solar heat designers use E-10 software for sizing heating systems, created by the U.S. Department of Energy, and available for $150 (or $75 for students) from the Sustainable Buildings Industry Council (www.sbicouncil.org). Through E-10 the user inputs different assumptions about building design and materials, and the software determines how much heat is needed for the building. A prominent solar heat system designer in Santa Fe states that "At some point you'll be making improvements to the building [in E-10] where the energy consumption of the building doesn't change – this is the optimal state" for a building design.[15] The corresponding building solution then needs to be priced by builders to determine feasibility of using a minimum energy consumption building design with smaller heating system, versus a slightly larger (more expensive) heating system with lower cost building design.

Specifications

Because green building is a fairly new field and very few builders are well versed in all green building techniques (though *some* builders are well versed in *some* techniques) I wanted to locate a list of green building specifications to consider including in instructions to builders when I was ready to request an official bid. After spending a year asking everyone I could find in Santa Fe, Cambridge, Boulder, or elsewhere, I located two sources for green building specifications. They are:

1. Green Building Materials: A Guide to Produce Selection and Specification, by Ross Spiegel and Dru Meadows (1999). This was recommended to me by a professor in the Building Technology department at MIT. The authors are both professional specification writers, and Spiegel was on the Board of Directors of the USGBC at the time of publication. This book is a fabulous source of information, though somewhat technical and with much more information on specification writing than the layperson/ homeowner would want.
2. Green Building Products: The GreenSpec Guide to Residential Building Materials, Edited by Alex Wilson and Piepkorn (2005). One of the copublishers is Building Green, the residential green building certification program in Vermont. It is a 300-page reference list by product category and sub-category, of suppliers of eco-friendly products. Each product/supplier listing has a 1-2 sentence description of the pros and cons of each product, which simultaneously teaches the reader about which products are good or bad for which reasons, and where to find them locally.

3. Green Building: Project Planning and Cost Estimating, RSMeans (2002). This intimidating 500 page book includes a very easy to understand 25-page description of green building considerations by CSI division, a 2-page green building checklist by CSI division, and a 6-page green building product list.

Included in Appendix C is a sample list of "considerations" I've developed, which are neither technical nor comprehensive, but are more a layperson's list of concepts to be included or considered in a green built house. (For more technical specification wording, see the 150 pages included in resource #1 above, or for a more comprehensive list see resources #2 or #3 above.) A bid request to a builder can include these concepts, while letting the builder respond with specific suggestions for the best way to deliver the concept. The kind of information needed from builders is:

- What does it cost including installation?
- How much does it produce or save?
- How long does it last until it will need to be replaced?
- How long is it warrantied?
- What are the maintenance costs or processes?
- How is it controlled by the end user?
- Will I notice a difference in usage compared to typical systems?
- What will it cost me to run it?
- How long has the product been in use? How sure are we that it works?
- Who fixes it if it breaks? Is there more than one company in town who can fix it?

Building Science Corporation has recently completed a project called "Buildings That Work", which evaluates design requirements for various climate zones in the country. These are available on their web site at http://www.buildingscience.com. The profile created for the Albuquerque area is included in Appendix D.

COSTS AND BENEFITS OF BUILDING GREEN

There is a cultural and organizational similarity between the current green building emergence and internet e-commerce emergence in the late 1990s (of which this author was a part before switching careers and getting out just in time!)

- Discrete parts of a web site are not as valuable as the site as a whole. Adding masonry walls to a house will not decrease heating costs nearly as much as if high quality windows are also used and design is adjusted to account for direction of the sun.
- The marketing "front end" of a web site is similar to the streetscape of a house – the user experience makes the investment more profitable. Making sure that the house is attractive, heating and cooling systems are easy to use, and that the house design is functional and pleasant will affect the selling price. Making attractive green components visible, such as a

roof planted with grasses, will help the customer visualize the environmental sustainability of the house.

- The back end systems of a web site are similar to the systems of a house – this is what reduces operations cost if done correctly. When companies first started investing in e-commerce systems, they were concerned with the cost, but soon learned the efficiencies of electronic automation. Many builders and developers ask what it costs to build green, but the benefits are compounded by the entire house system working together, and ultimately can reduce operating costs enough to make the extra up front building cost (if any) worth it.
- The E-commerce team was initially a hybrid – bringing together information technology experts, marketing managers, and operations staff. The green building team, similarly, brings the architect, engineer, and builder together as cost, function, profitability, and feasibility are continually evaluated to create a house as a functioning system.

To answer the question "Why build green?" as it relates to building envelope (walls, roof, floor) materials and design, we look first to national surveys and research that were created to help builders and developers answer that question, and then consider what this means for development in Santa Fe. The most cited research is summarized in the following boxes.

Greg Katz, Capital-E (2003). The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force, available at http://www.cap-e.com/ewebeditpro/items/O59F3259.pdf.

Recognizing that the cost issue was becoming more and more of a prohibitive factor in the mainstreaming of green building not only within California but across the country, several members of the Task Force funded an Economic Analysis Project to determine more definitively the costs and benefits of sustainable building…

Figure ES-1. Financial Benefits of Green Buildings Summary of Findings (per ft^2)

Category	20-year NPV
Energy Value	$5.79
Emissions Value	$1.18
Water Value	$0.51
Waste Value (construction only) - 1 year	$0.03
Commissioning O&M Value	$8.47
Productivity and Health Value (Certified and Silver)	$36.89
Productivity and Health Value (Gold and Platinum)	$55.33
Less Green Cost Premium	($4.00)
Total 20-year NPV (Certified and Silver)	**$48.87**
Total 20-year NPV (Gold and Platinum)	**$67.31**

Several dozen building representatives and architects were contacted… Cost data was gathered on 33 individual LEED registered projects (25 office buildings and 8 school buildings) with actual or projected dates of completion between 1995 and 2004. The average premium for these green buildings is slightly less than 2%...

The financial benefits of green buildings include lower energy, waste disposal, and water costs, lower environmental and emissions costs, lower operations and maintenance costs, and savings from increased productivity and health. These benefits range from being fairly predictable (energy, waste, and water savings) to relatively uncertain (productivity/health benefits). Energy and water savings can be predicted with reasonable precision, measured, and monitored over time. In contrast, productivity and health gains are much less precisely understood and far harder to predict with accuracy.

These findings are based on office and school buildings. The value derived from "Productivity and Health Value" in the above chart refers to increased productivity of employees, of students, and reduced absenteeism of both, which have been cited in several studies specifically on these topics. These values will clearly not apply to single family houses in most cases. *However, even if we only consider energy value and water value above compared to the green cost premium, there is still a net positive value.*

Lisa Fay Matthiessen and Peter Morris, Davis Langdon (2004). Costing Green: A Comprehensive Cost Database and Budgeting Methodology. Available at http://www.davislangdon-usa.com/publications.html.

[The study compared costs for 138 LEED-seeking and non-LEED academic buildings, libraries, and laboratory buildings.] …the cost per square foot for the LEED-seeking buildings was scattered throughout the range of costs for all buildings studied, with no apparent pattern to the distribution. This was tested statistically using the t-test method… This test indicated that there was no statistically significant difference between the LEED population and the non-LEED population… there is such a wide variation in cost per square foot between buildings on a regular basis, even without taking sustainable design into account, that this certainly contributed to the lack of statistically significant differences between the LEED-seeking and non-LEED buildings…

Within the 61 LEED-seeking buildings we studied, we found that over half the projects had original budgets that were set without regard to sustainable design, and yet received no supplemental funds to support sustainable goals… the range of monies provided, for those few that required it, was typically in the range of 0-3% of initial budget. The projects that were most successful at remaining within their original budgets were those which had clear goals established from the start…

… Additionally, our analysis suggested that the cost per square foot for buildings seeking LEED certification falls into the existing range of costs for buildings of similar program type.

In percentage terms, Capital-E (authors of the first study above) evaluated the additional cost for green building using data from the U.S. Green Building Council, with the results shown in the chart at right. LEED certified buildings carry only a 0.66% increase in costs. These results are due to companies choosing first, to build a LEED certified building and second, figuring out how to pay for it within their allotted budget. Therefore, costs are not increased because companies choose to make tradeoffs in the building program in order to incorporate LEED certification into their pre-existing budget. As LEED certification level increases, so do building costs, but this often creates corresponding savings in operating expenses that offset the additional cost.

Level of Green Standard	*Average Green Cost Premium*
Level 1 – Certified (8)	0.66%
Level 2 – Silver (18)	2.11%
Level 3 – Gold (6)	1.82%
Level 4 – Platinum (1)	6.50%
Average of 33 Buildings	**1.84%**

Source: Understanding LEED Project Costs and Returns, U.S. Green Building Council

An important caveat is: "The cost impact of bid climate is more pronounced when bidders have plenty of alternative work. When work is scarce, bidders are more willing to discount the risk in order to remain in business." (RSMeans, 2002, and Davis Langdon, 2004)

Cost of building green in Santa Fe – survey of builder pricing

In order to create a building strategy or program, and begin making tradeoffs about how to build green within the budget given for the feasibility analysis shown above, I met with 6 Santa Fe builders for 1-3 hours each and received additional data back from 3 of them, as well as conducting telephone conversations with 3 Boston area builders/value engineering firms. All Santa Fe builders have been in business for at least 10 years, and most have been building houses for at least 20 years. The questions asked of each of them and their answers are:

Is plumbing priced per linear foot or per fixture?
Some builders said per foot, some said per fixture, some said both, and one finally admitted that it's a game and no one really knows how plumbing subcontractors determine prices.

How is electrical priced?
Electrical is priced initially per square foot of floor area and then adjusted for extra connections for task lighting, etc. Because code dictates that electrical must run along and through every wall, there is less fluctuation in the price of electrical, except due to prices for fixtures or additional task lighting (over and above basic wall/ ceiling lighting.)

What is the price difference for walls built with frame, adobe, rastra, eCrete, and pumice-crete, including load-bearing requirements, equal (insulating) r-value, and any associated extra cost for plumbing and electrical?

Item	Developer 6		Developer 5		Developer 4		Developer 7	
	Material only		Material only		Wall structure		Wall structure	
Pumice					$ 73	130%	$ 39	122%
Adobe	$ 41	520%					$ 38	119%
eCrete			$ 15-17	168%			$ 37	116%
Rastra	$ 25	320%						
Frame	$ 8	100%	$ 8-11	100%	$ 56	100%	$ 32	100%

Item	Developer 6		Developer 4		Developer 7	
	Whole house		Whole house		Whole house	
Pumice			$ 198	109%	$ 166	104%
Adobe	$ 187	150%			$ 166	104%
eCrete					$ 164	103%
Rastra	$ 176	141%				
Frame	$ 125	100%	$ 181	100%	$ 159	100%

- Developer 6 – Gives the price for material only, comparable to Developer 5. The increase in price % for eCrete versus frame shown here is artificially high because prices do not include electrical, framing, plaster/paint and insulation, which have a minimal % change in price. This shows only the component (wall material) that changes the most.
- Developer 4 – Includes framing, insulation, electrical, interior paint/sheetrock or plaster.
- Developer 5 – Includes wall material and labor only. The increase in % for eCrete versus frame shown here is artificially high because prices do not include electrical, framing, plaster/paint and insulation, which have a minimal % change in price. This shows only the component (wall material) that changes the most.
- Developer 7 – Includes framing, insulation, interior plaster/paint, electrical, and adjustments to foundation.

What are least cost design strategies for plumbing, electrical, roof, walls, and floor?

- Plumbing – Several said that locating the kitchens and baths near each other reduces plumbing costs, while one said there was no cost difference, and one said there was a maximum $800 cost difference for a moderate sized house.
- Electrical – Almost unanimously, builders said that because wiring is included through and along all walls per code, there is not much room for reducing cost.
- Roof – Several builders believe that a pitched roof is better because it tends to leak less, and several believe that flat roof technology has advanced enough that leaking is no longer a problem. Structurally, a flat roof is cheapest, then a pitched roof with triangle shaped

trusses and a flat ceiling underneath, and a scissor truss (shaped roughly like a boomerang) is the third cheapest while allowing for some additional ceiling height. Exposed beam is the most expensive because extra structure has to be built to create a space for insulation. Brai roofing material was recommended by several builders for flat roofs, but as a petroleum by-product, it is not the best alternative from a green building perspective.

	Developer 2	Developer 6	Developer 4	Developer 5	Developer 7	Developer 8
Flat Roof	Spray foam (very toxic) $6/sf	Brai	NA	Tar (not good) $1.50	Brai $3-3.25	Brai or membrane
Pitched Roof		Galvalum incl. install $2.80	NA	Propanel $4/sf	Propanel, corrugated $3.50-4.50	Corrugated (non-galvanized) $8/sf

- Walls – Unanimously, builders said that building a structure with 4 walls and 4 corners – a square or rectangle – is cheapest. Adding contours and additional corners increases costs enough that "by inverting the corner insets of [the house design shown at the beginning of this section], you could significantly increase the square footage of the house, without increasing exterior wall area or significantly increasing structural cost, thus providing a larger house at a lower cost/sq. foot." (Senior Vice President of a Boston construction and engineering consulting firm)
- Floors – 5 builders believe that stained or dyed concrete is cheapest, while one believes that the cost to protect it during construction makes it more financially feasible to put inexpensive ceramic tile on the floor after construction is completed. Interestingly, builders completely disagreed on whether stained concrete (allowing for interesting color variations) or integral dye (mixed in concrete at the factory thus producing a uniform color) is cheaper. Prices range from $2-5/sf for stained, and $1.50-8/sf for integral dye.

	Developer 6	Developer 4	Developer 5	Developer 7	Developer 8
Integral Dyed	$ 2.00	NA	Less expensive	$ 1.90	light $1.50-2.00 dark $7.50-8.00
Stained	$ 2.00	NA	More expensive	$ 3.00	$4.00-5.00

- Windows – One builder reported that it's cheaper to do one bigger window than 2 smaller windows. (However, one price quote received from a window supplier showed 2 side-by-side windows costing slightly more than twice the single window price.) The following chart shows the price increase from insulated windows to Low-E 140 windows, assuming that most people would not buy single glazed windows in a cold climate. The increase for double hung windows is 13%.

SINGLE-LIGHT	Price		U-Value		R-Value		SHGC	
	Clad	Not Clad	Clad	Not Clad	Clad	Not Clad	Clad	Not Clad
Double Hung 2 1/2 X 4								
Single Glaze	$ 220	$ 150	0.88	0.97	1.14	1.03	0.64	0.66
Insulated	$ 229	$ 174	0.48	0.49	2.08	2.04	0.58	0.57
Insulated Low-E 172	$ 256	$ 201	0.35	0.34	2.86	2.94	0.31	0.33
Insulated Low-E 140	$ 259	$ 204	0.35	0.35	2.86	2.86	0.20	0.21
Outswing Door - 3 1/2 x 9								
Single Glaze	$1,207	$ 974	0.89	0.84	1.12	1.19	0.52	0.52
Insulated	$1,228	$ 995	0.50	0.46	2.00	2.17	0.45	0.45
Insulated Low-E 172	$1,291	$ 1,058	0.39	0.35	2.56	2.86	0.27	0.26
Insulated Low-E 140	$1,301	$ 1,068	0.40	0.35	2.50	2.86	0.18	0.17
(Not opening) 3 1/2 X 6								
Single Glaze	$ 303	$ 265	1.00	0.98	1.00	1.02	0.67	0.68
Insulated	$ 322	$ 269	0.50	0.47	2.00	2.13	0.58	0.59
Insulated Low-E 172	$ 377	$ 324	0.35	0.32	2.86	3.13	0.33	0.34
Insulated Low-E 140	$ 385	$ 332	0.36	0.33	2.78	3.03	0.30	0.21
Transom (casement) 3 1/2 X 2								
Single Glaze	$ 405	$ 359	0.78	0.70	1.28	1.43	0.42	0.43
Insulated	$ 422	$ 358	0.51	0.43	1.96	2.33	0.37	0.37
Insulated Low-E 172	$ 430	$ 753	0.44	0.35	2.27	2.86	0.23	0.22
Insulated Low-E 140	$ 432	$ 379	0.44	0.36	2.27	2.78	0.16	0.16

Source: Many thanks to Sierra Pacific Windows in Santa Fe for providing this information.

What is an additional solar collector (for solar heat or PV) worth compared to the extra cost for better windows?

Builders universally responded that money should first be spent on good quality windows to contain heat and cool air. Windows and doors are the biggest source of heat loss in the winter, and require insulated shades in addition to high quality windows to keep warm in winter.

Saving landscaping cost through recycled materials

Lastly, a local permaculture/sustainability expert noted that boxes used for shipping materials to the site can be used for sheet mulch, and any trees that cannot be protected and must be removed can be chipped and used for mulch or for structural components on the house.

A note on tax credits for solar power, Federal and NM

The Energy Policy Act, or EPACT, was passed in 2005 and provides federal tax credits equal to 30% of the cost for solar heat and photovoltaic systems up to $2,000. New Mexico provides a further credit for 30% of the cost of a system, up to $9,000, for a total of $11,000 available to pay 30% of the cost of a system. In addition, the utility company in Santa Fe (PNM) pays a net metering credit of $0.0803 per kWh produced but not used through a PV system, and $0.13 per kWh for Renewable Energy Certificates. PNM estimates that a customer with a 1 kilowatt PV system could receive credit for $3,650 in 12 years, or an average of $304 per year, according to a February 22, 2006 letter to residents.

For more information on tax credits in NM, see:
Renewable Energy & Energy Efficiency Incentives, both Federal and New Mexico, Version: January 4, 2006. Compiled by the Coalition for Clean Affordable Energy (www.NMCCAE.org).

For more information on the federal tax credit, see:
The Guide to Federal Tax Incentives for Solar Energy, Solar Energy Industries Association, January 27, 2006. Available at http://www.seia.org.

For information on other states' tax credits, see the Database of State Incentives for Renewable Energy at http://www.dsireusa.org.

REVISED FEASIBILITY FOR A GREEN BUILT HOUSE IN SANTA FE

The remaining question is, is it worth it? It's the question everybody asks – what does green cost? Following is a back-of-the-envelope analysis of the cost difference for construction of the house design given at the beginning of this section, using traditional construction methods versus green building methods. It is a work in progress and will take several months to complete and verify, but it begins to answer the key question on everyone's mind.

The preliminary results show that after considering extra costs and associated savings from construction cost only, the cost premium to build a passive solar adobe house is $4,799 more than the cost to build a traditional house. *In addition, a 2x6 wood joist costs $3.90 from a local supplier while a 2x6 recycled steel joist costs $2.00, and thus sustainable options may be available to further reduce the remaining $18,000 framing budget. Lastly, utility cost savings from reduced heating and cooling bills and reduced electrical consumption from appliances are not included here and further offset the additional cost of green building.*

The analysis on the following page shows only those components that are affected, holding all else equal. Not included in this premium are costs for FSC certified wood but since framing is not required, the use of wood is minimal for headers and roof trusses only.

Converting Cost to Green Built, Passive Solar			
	Add	*Subtract*	*Comment*
Gas hookup		$ (4,192)	
Extra stemwall and footing*	$ 480		
Extra slab			
Extra headers, bond beams, r. bucks*	$ 3,393		
Extra wall material and labor*	$12,040		
Framing*		$(14,094)	Adobe does not require wall framing, so subtract the cost of the framing package.
Plaster*			Plastering the inside of adobe walls is more traditional at an additional $3,915. This cost can be saved by oiling or whitewashing instead, out of the existing painting budget (which would have to be done anyway to seal them.)
Insulation*	$ 1,192		From R-19 to R-22 costs an additional 10-15%, and blown-in cellulose is 25% more than fiberglass batt. Add 40%
Doors and windows	$ 3,180		Additional cost for windows per Sierra Pacific Windows is 13% and 20%, so use 17% est. increase for Low-E 140 windows.
Energy Star appliances	$ 1,000		Typically cost extra, this is an estimate
Heating**	$ 4,500	$(13,800)	No radiant heat, estimate 3 wall mounted electric heaters. Rinnai's vent-free models boast efficiencies of 99.9%. $1,000-$2,000 each installed (as of 2002). ***
Extra electrical*	$ 3,100		
Septic	$ 3,000		Difference between regular septic cost and Piranha or Multiflow
Greywater/rainwater	$ 5,000		Though $7,000 is budgeted, rainwater collection is required by the city so estimate $5,000 additional cost.
COST DIFFERENCE	$36,885	$(32,086)	It costs an estimated $6,743 extra to build a passive solar house with adobe.

Next Steps in Analysis		
Savings from reduced utility bills	(Next step)	E-10 software will help estimate the reduced energy consumption resulting from a passive solar design.
Cost for FSC certified wood	(Next step)	
Cost for environmental insulation	(Next step)	

* These estimates generously provided by Jim Cebak at Cedar Southwest Construction, Santa Fe, NM.
** The primary benefit of a passive solar design is reduced need for heating and cooling.
*** This information is from D. Chiras (2002). The Solar House: Passive Heating and Cooling.

An analysis of PV payback period was also conducted, for a system producing 250 KwH/month, using an estimated 300 KwH/month needed to power a passive solar house. The resulting system has a payback period of less than 15 years. Without the 30% Federal and State tax credits, the payback period is 21 years. Without tax credits, REC credits, or net metering, the payback is 35 years. State and federal incentives play a critical role in determining feasibility of PV systems.

An alternative to PV is a solar heating/hot water system, the smallest of which costs $6,500-$8,000 installed,[16] and may be appropriate for a passive solar house, but systems without a battery backup will only be useful on sunny days when it is so cold that passive solar is not sufficient, and systems with battery backup will be useful during long cloudy periods, which are uncommon in the southwest. PV, though more expensive, is a worthwhile option to provide year-round benefits. Continuation of net metering and REC credits will be critical, however.

Estimating the Payback of a Photovoltaic System			
PV producing 275 KwH/month	$20,000		A Santa Fe PV installer gave a ball park estimate of $20,000 for a system that produces 250 KwH/month.
Tax Credit @ 30%		$ (6,000)	State and federal tax credits pay 30% of cost up to $11,000.
Net Cost	$14,000		
REC credits (annually) @ $0.13/KhW		$ 390	NM utility company pays for each KwH produced, whether or not it is used.
Net metering (annually) @ $0.08/KwH		$ (38)	NM utility company pays $0.08 for each KwH that is produced but not used.
Utility bills saved (annually)		$ 600	There is an added benefit of generating free electricity for personal use.
Total annual cost recovery		$ 952	Sum of REC credits, net metering, and utility bill savings.
Total years for payback	14.71		Net cost / total annual cost recovery = years for payback.

Putting these costs back into the schedule of values from page 73, we see on the following page that the cost per square foot is $121 including PV, or $111 without PV but with the additional green premium.

Returning to the feasibility analysis findings on page 57, which stated that 3 houses or more are feasible at $125/sf, we can now conclude from preliminary analysis that a passive solar, adobe house powered with a PV system, containing greywater and rainwater conservation measures as well as a Piranha or similar septic system, is feasible at $120/sf, if the variance allows 3 houses or more to be built on the West Alameda property, for a selling price of $300,000. This is affordable to people making 100-120% of median income, and sited in an area of the city that is due to be developed and in accordance with the regional plan, thus meeting multiple policy priorities of the City of Santa Fe while still being profitable.

SCHEDULE OF VALUES		
Item	*Builder Price*	*My Adjustment*
Permits	$ 6,500	$ (6,500)
Site Facilities - Portable Toilet & Dumpster	$ 3,000	
Site Preparation - Grading & Leveling	$ 1,200	
Utility Installations - Water, Sewer, Gas, Electric & Tele.	$ 1,500	$ (1,500)
Footings - 160 lf	$ 4,490	
Stemwalls - 160 lf	$ 6,720	
Yardwalls - 153 lf @ 5' tall	$ 15,300	$ (15,300)
Slab - 1120 sf	$ 8,500	
Framing - 1776 sf	$ 31,950	
Roofing - 600 sf flat roof & 1294 sf metal roofing	$ 7,624	
Insulation - 2836 sf/ R19 & 1120 sf/ R38	$ 2,980	
Exterior Doors & Windows	$ 18,703	$ (3,000)
Interior Doors (includes installation)	$ 3,250	$ (2,000)
Door Hardware (includes installation)	$ 1,980	$ (1,500)
Drywall - 5629 sf	$ 8,429	
Exterior Plaster, House - 335 yrds	$ 8,375	
Exterior Plaster, yardwalls - 153 yrds	$ 3,825	$ (3,825)
Bath Tile - walls, floor & vanities (305 sf)	$ 2,745	$ (1,500)
Floor Finishes - 1500 sf	$ 13,500	$ (10,000)
Cabinets, Vanities & Built-ins	$ 9,500	$ (5,000)
Counter Tops	$ 3,000	$ (2,000)
Paint, Stain & Finishes	$ 7,102	$ (2,000)
Plumbing	$ 6,400	
Plumbing Fixtures - 2/ tubs, 2/toilets & 3/sinks	$ 3,000	
Heating & Gas Lines	$ 13,800	$ (9,300)
Air-conditioning	$ 3,540	$ (2,500)
Electrical	$ 10,450	
Electrical Fixtures	$ 3,000	$ (1,500)
Alarm & Audio/Video or speaker wiring	$ 2,000	$ (2,000)
Closet Systems	$ 1,800	$ (1,500)
Finish Carpentry	$ 1,000	$ (500)
Appliances	$ 3,000	
Bath Accessories	$ 1,200	
Green Building Premium		$ 4,799
PV System		$ 14,000
Final Grading & Clean up	$ 2,500	
	$ 215,363	$ 162,737
Supervision & Misc. Crew Labor	$ 7,538	$ 5,696
	$ 222,901	$ 168,432
Overhead	$ 22,290	$ 16,274
Profit	$ 17,832	$ 13,019
	$ 263,023	$ 197,725
NM GRT	$ 20,055	$ 15,077
Total	$ 283,078	$ 212,801
Cost per square foot	$ 159	$ 120

Recall that house prices are capped at $300,000 to be affordable to the minimum 3,075 rental conversion or high cost homeowner households who have at most 60-98 units available for sale in their price range each year. Thus, while a house on one acre would usually sell for a higher price than a house on ½ acre, here if the lot size increases, price does not, making the 6-house option significantly more profitable. With 3 houses on the land, total profit is $59,190. With 6 houses on the land, total profit is $262,944.

Maximum Selling Price Does not Vary by # of Houses Built				
	1	2	3	6
Cost for 1,200 sf @ $121/sf	$300,000	$300,000	$300,000	$300,000

Construction Budget Varied by # of Houses Built				
	1	2	3	6
Cost for 1,200 sf @ $121/sf	$382,729	$304,363	$280,270	$256,176

Profit Varied by # of Houses Built				
	1	2	3	6
Cost for 1,200 sf @ $121/sf	$ (82,729)	$ (8,726)	$ 59,190	$ 262,944

A NOTE ON FINANCING

Many banks and financing institutions are unfamiliar with green building techniques and do not want to assume the risk of financing an asset they do not understand. However, there are increasingly more lenders becoming familiar with green building. A prominent Santa Fe developer reports that local banks recognize that the increased risk of new technologies is offset by the lower risk resulting from customers' monthly utility costs becoming a) lower, b) more predictable, and c) less subject to increases due to gas and electric rate increases, which decreases the probability of default on the loan.

Along these lines, "Mainstream consumer lending institutions like Countrywide Home Loans, Chase Manhattan Mortgage, and Bank of America are taking energy cost savings into account when determining the size loan for which the applicant is eligible." (RSMeans) An hour on the phone and Internet revealed sources locally and nationally that not only provide loans for green building, but provide them at decreased interest rates, for example: Energy efficient mortgages are available from HUD and FHA, Energy Star and Fannie Mae both have green development loan programs, and Los Alamos National Bank has an Ecosmart loan for land development and construction with points reduced to 0.5%, no fees, a rate equal to prime for 24 months, and a loan amt to 75% of forecasted appraisal.

ENDNOTES

[1]McGraw Hill Construction (2006). Green Building Smart Market Report, p. 7.
[2] A Green Dream in Texas, Thomas Friedman, The New York Times, January 18, 2006.
[3] Making the Business Case for High Performance Green Buildings, U.S. Green Building Council. In Green Building, Selected References (2005), InfoPacket No. 396, Urban Land Institute.
[4] http://www.usgbc.org
[5] http://www.builtgreen.org
[6] http://www.energystarhomes.com
[7] Chiras, D. (2002).The Solar House: Passive Heating and Cooling. Chelsea Green Publishing Company: White River Junction, VT.
[8] Interview, Bristol Stickney, Cedar Mountain Solar, Santa Fe, NM.
[9] Chiras, D.
[10] IBID.
[11] IBID.
[12] Chiras, D.
[13] IBID.
[14] Interview, Bristol Stickney, Cedar Mountain Solar, Santa Fe, NM.
[15] IBID.
[16] IBID.

4. CONCLUSION: HOW TO DEFINE SUCCESS?

Measuring profit is a quantifiable means of assessing success, although determining whether "enough" profit was earned based on the risk of the project is always an unanswered question. Evaluating softer, less tangible, non-profit oriented results can be even more elusive and is often much less quantifiable. Foundations, nonprofits, and government agencies across the country have become experts at measuring success through a statistical practice called "program evaluation", in order to evaluate grant-making practices, report to donors, or inform regulatory bodies about how funds are used.

The W.K. Kellogg Foundation's Evaluation Handbook (January, 1998) presents a great overview of program evaluation practices. Basic concepts are:

Context evaluation – In general, a context evaluation asks: What about our community … hinders or helps us achieve project goals? Early on, context evaluation might focus on: assessing the needs, assets, and resources of a target community in order to plan relevant and effective interventions within the context of the community; and identifying the political atmosphere and human services context of the target area to increase the likelihood that chosen interventions will be supported by current community leaders and local organizations.

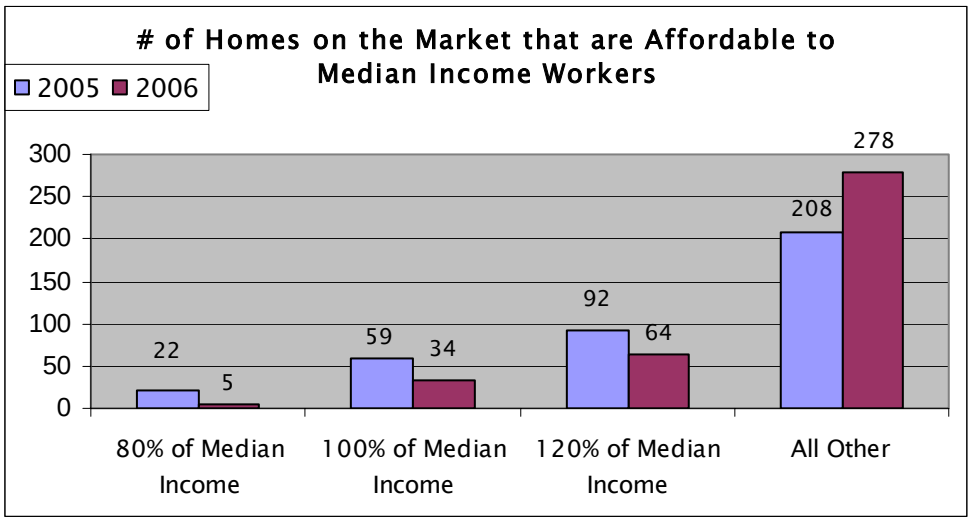
Implementation evaluation – Implementation activities enhance the likelihood of success by providing indications of what happened and why. Successful implementation of new project activities typically involves a process of adapting the ideal plan to local conditions, organizational dynamics, and programmatic uncertainties. Even well-planned projects need to be fine-tuned in the first months of operation, and often information needs to be continually analyzed to make improvements along the way.

Outcome evaluation – Outcome evaluation assesses the short and long term results of a project and seeks to measure the changes brought about by the project. Outcome evaluation questions ask: What are the critical outcomes you are trying to achieve? What impact is the project having on its clients, its staff, and its community? What unexpected impact has the project had?

Measuring impacts through use of a program logic model – One effective method of charting progress toward interim and long term outcomes is through development of a program logic model which links outcomes (short and long term) with program activities/processes and theoretical assumptions/principles of the program, providing a roadmap of the program, highlighting how it is expected to work, what activities need to come before others, and how desired outcomes are achieved. Alternatively, an activities model may be appropriate for complex initiatives which involve many layers of activities and inter-institutional partnerships.

Outcomes measures have been widely employed by the United Way for years, and are the most difficult to measure. For example, if the "double bottom line" of the West Alameda property is both profit and reducing the number of households in the 100-120% of median income range who are not homeowners, it would require identifying all those households and tracking whether or not the number decreases over time due to the West Alameda project and other subsequent projects like it. It will likely take years to implement and will be difficult to ascertain if the targeted population is growing or shrinking.

An activities model provides intermediate steps, such as how many houses are developed each year and sold to this population. A context evaluation helps to continually re-evaluate development priorities to ensure they are in keeping with city priorities, and whether the 100-120 % of AMI group is still the appropriate target population. An implementation evaluation will assess how well the development team is working together and how well it is working with real estate brokers, city planners and politicians, neighborhood groups, contractors, and other necessary relationships. In this way, as profit is evaluated, so too can the developer assess the social impact of development, success at where development is located, whether the market population's need is being met, and which components of green building are most advantageous, creating a double bottom line in support of development, not growth, remembering:



Growth is an increase in size, while development is an increase in quality and diversity. Development increases the value of both public and private investments, while growth tends to require increases in these investments that may or may not increase value.

– Kinsley, M. et al. (1995). Paying for Growth, Prospering from Development, Rocky Mountain Institute Policy Paper.

APPENDIX A
SOURCE: A PROMINENT SANTA FE REAL ESTATE AGENT

HIGH	LOW	AVERAGE	MEDIAN	LISTING COUNT
$12,500,000	$189,750	$942,361	$639,000	431

Asking Price	Approx Total Square Feet	Price per Sq Ft	BR	BA
$189,750	1170	162.18	3	2
$189,750	1170	162.18	3	2
$208,000	1040	200.00	3	2
$215,000	900	238.89	0	0
$215,000	1012	212.45	2	1
$220,000	1180	186.44	3	1
$225,000	1608	139.93	2	2
$234,900	1017	230.97	3	1
$235,000	0	0.00	3	1
$235,000	2112	111.27	2	1
$239,000	1290	185.27	2	2
$239,900	1176	204.00	3	2
$239,900	1176	204.00	3	2
$239,900	1176	204.00	3	2
$245,000	1351	181.35	3	2
$246,000	1400	175.71	3	2
$248,000	1793	138.32	3	2
$249,000	1115	223.32	3	2
$249,900	1260	198.33	2	2
$249,900	1600	156.19	3	2
$249,900	729	342.80	2	2
$250,000	0	0.00	2	1
$255,000	1500	170.00	3	2
$258,000	1467	175.87	3	3
$259,000	1900	136.32	3	2
$260,000	1594	163.11	3	2
$260,000	1296	200.62	3	2
$263,000	1175	223.83	3	2
$264,900	1200	220.75	2	2
$264,900	1440	183.96	3	2
$265,000	0	0.00	3	1
$269,000	1400	192.14	3	2

$269,000	1174	229.13	2	2
$269,000	1300	206.92	3	2
$275,000	0	0.00	3	2
$279,000	2400	116.25	4	2
$279,500	2020	138.37	4	2
$285,000	0	0.00	3	2
$289,000	0	0.00	1	1
$289,000	1360	212.50	4	2
$289,000	1650	175.15	4	2
$289,000	1645	175.68	3	2
$289,000	1600	180.63	3	2
$289,000	1471	196.46	3	2
$292,500	1824	160.36	4	2
$298,000	1200	248.33	3	2
$298,500	1577	189.28	4	2
$299,000	0	0.00	3	2
$299,000	2150	139.07	4	2
$304,900	1586	192.24	3	2
$306,000	1320	231.82	2	1
$309,900	1384	223.92	2	2
$310,000	1400	221.43	2	1
$315,000	1650	190.91	3	2
$315,000	1550	203.23	3	2
$317,500	1050	302.38	2	1
$319,000	1863	171.23	4	2
$319,000	1900	167.89	3	3
$319,000	652	489.26	1	1
$319,500	1358	235.27	3	2
$319,500	1599	199.81	3	3
$319,900	1334	239.81	3	2
$322,800	2087	154.67	3	3
$324,000	1750	185.14	3	2
$329,000	1550	212.26	3	2
$329,000	1805	182.27	3	2
$330,000	0	0.00	3	2
$332,000	1500	221.33	3	2
$334,500	2000	167.25	3	2
$334,900	1416	236.51	3	2
$335,000	1074	311.92	3	2
$335,000	1032	324.61	3	1

$339,000	1650	205.45	3	2
$339,000	2375	142.74	4	4
$340,000	1985	171.28	4	3
$345,000	1780	193.82	3	2
$345,000	1795	192.20	5	2
$349,000	0	0.00	3	2
$349,000	1833	190.40	4	3
$349,000	2361	147.82	4	3
$349,000	0	0.00	1	1
$350,000	1364	256.60	3	2
$350,000	505	693.07	1	1
$350,000	1691	206.98	3	2
$359,000	0	0.00	3	2
$369,500	849	435.22	1	1
$370,000	1630	226.99	3	2
$374,500	1675	223.58	4	2
$374,900	0	0.00	4	3
$375,000	1641	228.52	3	2
$379,000	1458	259.95	4	2
$379,000	1348	281.16	3	2
$379,500	1850	205.14	3	2
$379,900	1635	232.35	3	2
$382,000	2250	169.78	3	2
$384,500	1898	202.58	3	3
$385,000	1600	240.63	3	3
$389,000	0	0.00	3	2
$393,000	1364	288.12	3	2
$395,000	1231	320.88	2	2
$395,000	2046	193.06	3	2
$396,000	1850	214.05	3	3
$399,000	1449	275.36	2	1
$399,000	2744	145.41	5	3
$399,000	1709	233.47	3	2
$406,000	1598	254.07	3	2
$409,000	1300	314.62	3	2
$409,000	1500	272.67	3	2
$410,000	1271	322.58	3	2
$410,000	1705	240.47	3	2
$415,000	1887	219.93	3	2
$419,000	2112	198.39	4	2

$419,900	2864	146.61	5	5
$424,000	1883	225.17	3	2
$425,000	2273	186.98	4	3
$425,000	2017	210.71	4	3
$425,000	2042	208.13	3	2
$425,000	900	472.22	1	1
$425,000	1500	283.33	3	1
$429,000	1875	228.80	3	2
$429,000	1600	268.13	3	2
$429,000	2800	153.21	4	4
$435,000	2300	189.13	3	3
$435,000	2256	192.82	4	2
$439,000	1900	231.05	4	3
$439,900	0	0.00	4	3
$439,900	2380	184.83	4	3
$442,500	2100	210.71	4	3
$442,900	1850	239.41	3	3
$445,000	1671	266.31	2	1
$447,900	2200	203.59	3	2
$449,000	1800	249.44	3	3
$449,000	0	0.00	4	2
$449,000	1010	444.55	2	1
$449,500	2388	188.23	3	3
$450,000	1367	329.19	3	1
$450,000	1488	302.42	1	2
$450,000	1500	300.00	3	2
$459,000	1425	322.11	2	2
$459,000	1594	287.95	3	1
$459,000	2510	182.87	4	3
$465,000	2122	219.13	3	2
$465,000	2400	193.75	3	3
$469,000	2019	232.29	2	2
$475,000	1320	359.85	2	2
$485,000	2634	184.13	3	3
$485,000	1550	312.90	3	3
$486,900	1986	245.17	3	3
$488,900	1922	254.37	3	2
$489,000	1540	317.53	3	2
$489,000	2407	203.16	3	2
$489,000	2595	188.44	3	3

$495,000	2396	206.59	4	3
$495,000	2854	173.44	4	4
$495,000	1687	293.42	3	2
$495,000	2024	244.57	3	3
$499,000	1758	283.85	3	2
$499,000	1550	321.94	3	3
$499,000	2639	189.09	3	2
$499,000	2736	182.38	4	2
$499,000	2000	249.50	4	2
$499,000	1955	255.24	3	2
$499,500	2514	198.69	5	3
$499,500	2060	242.48	4	3
$500,000	800	625.00	1	1
$509,900	2100	242.81	4	2
$510,000	1700	300.00	2	2
$515,000	3436	149.88	4	3
$519,000	1255	413.55	3	2
$519,000	2800	185.36	3	3
$520,000	2900	179.31	3	4
$524,500	2340	224.15	3	3
$525,000	2055	255.47	3	2
$525,000	3200	164.06	3	2
$525,000	2017	260.29	4	3
$525,000	1472	356.66	1	1
$525,000	2400	218.75	3	3
$529,000	2077	254.69	3	2
$529,000	2216	238.72	3	3
$530,000	1000	530.00	2	1
$535,000	2600	205.77	3	3
$535,000	2096	255.25	3	2
$539,000	2100	256.67	3	2
$545,000	2462	221.36	4	3
$549,000	2117	259.33	3	4
$549,000	1490	368.46	2	3
$549,000	1906	288.04	3	3
$549,000	3400	161.47	3	3
$549,500	0	0.00	3	2
$550,000	3306	166.36	4	3
$557,000	0	0.00	2	2
$557,000	1336	416.92	2	2

$559,000	2744	203.72	4	3
$565,000	1750	322.86	3	2
$565,000	1360	415.44	2	1
$569,000	1875	303.47	3	3
$579,000	2248	257.56	4	2
$579,900	2800	207.11	4	3
$580,000	735	789.12	1	1
$580,000	2899	200.07	4	3
$585,000	3046	192.06	3	3
$585,000	2000	292.50	3	3
$589,900	3226	182.86	4	3
$595,000	2023	294.12	3	3
$599,000	1500	399.33	3	2
$599,000	1832	326.97	3	2
$599,000	2600	230.38	3	2
$599,000	3086	194.10	5	4
$599,000	2100	285.24	3	2
$599,000	1931	310.20	3	2
$599,500	1959	306.02	3	2
$614,000	1412	434.84	3	1
$615,000	2724	225.77	3	3
$624,000	1350	462.22	3	2
$635,000	2534	250.59	3	2
$639,000	3200	199.69	4	2
$639,000	2214	288.62	3	3
$639,000	2892	220.95	5	2
$649,000	3500	185.43	3	2
$649,000	3800	170.79	3	2
$649,000	2800	231.79	3	3
$649,900	2421	268.44	3	3
$650,000	1680	386.90	2	1
$664,900	2080	319.66	3	2
$669,000	2250	297.33	3	2
$669,500	2615	256.02	4	3
$675,000	2844	237.34	3	3
$675,000	1241	543.92	2	1
$678,000	2080	325.96	3	2
$679,500	2130	319.01	3	2
$684,900	3198	214.17	3	3
$687,500	2900	237.07	3	3

$695,000	1980	351.01	3	2
$695,000	0	0.00	2	2
$699,000	2850	245.26	4	3
$699,000	0	0.00	3	2
$699,000	2631	265.68	4	3
$699,000	2615	267.30	5	3
$700,000	1500	466.67	2	2
$705,000	1814	388.64	3	2
$719,000	2000	359.50	3	1
$719,000	3892	184.74	3	3
$719,000	2145	335.20	4	3
$721,500	3009	239.78	2	4
$725,000	2700	268.52	3	3
$725,000	2804	258.56	3	3
$729,000	2350	310.21	3	3
$745,000	3896	191.22	5	3
$749,000	3000	249.67	3	4
$749,000	2350	318.72	3	2
$759,000	1706	444.90	3	2
$759,000	1500	506.00	2	2
$765,000	2202	347.41	3	2
$775,000	2743	282.54	3	3
$780,000	2437	320.07	3	2
$785,000	4863	161.42	5	3
$793,000	2715	292.08	3	3
$795,000	1250	636.00	2	2
$795,000	2492	319.02	3	3
$798,000	2030	393.10	4	2
$799,000	2740	291.61	3	3
$799,900	0	0.00	5	6 +
$825,000	2648	311.56	4	4
$825,000	2400	343.75	4	3
$829,000	2764	299.93	4	3
$829,000	3171	261.43	3	3
$829,500	2053	404.04	3	2
$835,000	2100	397.62	3	3
$849,000	2525	336.24	3	3
$849,900	3264	260.39	4	5
$850,000	1990	427.14	2	2
$850,000	1550	548.39	2	2

$850,000	1500	566.67	2	2
$850,000	2300	369.57	5	2
$852,000	2576	330.75	3	3
$860,000	4040	212.87	4	3
$869,000	2133	407.41	3	2
$875,000	4421	197.92	3	4
$875,000	2650	330.19	2	2
$876,000	4000	219.00	3	3
$885,000	2228	397.22	3	4
$889,900	3474	256.16	4	3
$895,000	3881	230.61	4	4
$895,000	0	0.00	4	2
$895,000	2700	331.48	3	3
$895,000	1832	488.54	2	2
$895,000	3400	263.24	4	3
$895,000	2897	308.94	2	3
$895,000	4196	213.30	3	4
$895,000	2814	318.05	3	3
$895,000	2432	368.01	4	3
$899,000	1804	498.34	3	2
$899,000	3311	271.52	4	4
$899,000	2150	418.14	3	3
$899,000	3118	288.33	3	4
$899,100	2968	302.93	5	3
$939,000	3960	237.12	3	3
$945,000	2800	337.50	3	3
$945,000	2300	410.87	4	3
$949,000	0	0.00	4	3
$950,000	2781	341.60	4	3
$950,000	0	0.00	2	3
$950,000	1633	581.75	4	4
$950,000	3500	271.43	3	3
$975,000	1934	504.14	2	1
$975,000	1896	514.24	3	2
$995,000	3518	282.83	3	3
$995,000	0	0.00	2	2
$995,000	3600	276.39	4	3
$995,000	4125	241.21	4	3
$995,000	2175	457.47	2	3
$999,000	1905	524.41	3	3

$1,050,000	2500	420.00	3	2
$1,090,000	3637	299.70	4	3
$1,090,000	4000	272.50	4	4
$1,100,000	5690	193.32	4	3
$1,100,000	0	0.00	3	3
$1,125,000	2700	416.67	3	2
$1,125,000	4240	265.33	4	3
$1,150,000	3923	293.14	4	6 +
$1,150,000	2750	418.18	3	3
$1,150,000	2750	418.18	2	2
$1,175,000	2334	503.43	3	3
$1,175,000	2500	470.00	2	2
$1,195,000	2805	426.02	5	3
$1,195,000	3427	348.70	2	2
$1,200,000	2349	510.86	3	3
$1,200,000	4050	296.30	4	4
$1,235,000	3181	388.24	3	4
$1,239,000	3006	412.18	3	3
$1,250,000	2800	446.43	3	3
$1,250,000	0	0.00	3	3
$1,250,000	1645	759.88	1	2
$1,295,000	2942	440.18	4	3
$1,295,000	3020	428.81	3	3
$1,295,000	3958	327.19	4	5
$1,295,000	3000	431.67	3	3
$1,295,000	3684	351.52	3	4
$1,299,000	2006	647.56	2	3
$1,299,995	3525	368.79	3	3
$1,350,000	3300	409.09	3	4
$1,375,000	5100	269.61	3	4
$1,375,000	3488	394.21	3	4
$1,395,000	3300	422.73	4	4
$1,395,000	3875	360.00	3	4
$1,395,000	3242	430.29	5	4
$1,395,000	3100	450.00	3	3
$1,395,000	3256	428.44	3	4
$1,450,000	3060	473.86	3	3
$1,450,000	3259	444.92	3	3
$1,475,000	2650	556.60	3	3
$1,485,000	0	0.00	3	4

$1,495,000	2075	720.48	2	3
$1,495,000	3600	415.28	3	4
$1,495,000	3419	437.26	3	3
$1,500,000	2225	674.16	3	2
$1,500,000	3334	449.91	3	4
$1,500,000	2919	513.87	5	5
$1,500,000	2100	714.29	5	3
$1,535,000	2600	590.38	4	3
$1,550,000	0	0.00	3	3
$1,575,000	1743	903.61	2	2
$1,575,000	4200	375.00	4	3
$1,590,000	3388	469.30	2	3
$1,595,000	3325	479.70	3	4
$1,595,000	4768	334.52	4	4
$1,650,000	0	0.00	4	4
$1,650,000	4073	405.11	3	3
$1,650,000	3037	543.30	3	3
$1,675,000	0	0.00	4	4
$1,675,000	3200	523.44	3	4
$1,675,000	2608	642.25	3	3
$1,695,000	6460	262.38	4	6 +
$1,700,000	4400	386.36	3	4
$1,719,000	4800	358.13	3	4
$1,750,000	2200	795.45	3	3
$1,750,000	5690	307.56	5	6 +
$1,750,000	4100	426.83	3	5
$1,774,000	4980	356.22	4	4
$1,775,000	3747	473.71	6 +	5
$1,795,000	4650	386.02	3	4
$1,798,000	4258	422.26	4	5
$1,800,000	3548	507.33	4	3
$1,820,000	2800	650.00	4	4
$1,850,000	4900	377.55	4	6 +
$1,865,000	4300	433.72	3	3
$1,870,000	3825	488.89	4	4
$1,875,000	5502	340.79	3	4
$1,875,000	4119	455.21	3	4
$1,895,000	5785	327.57	3	4
$1,925,000	2356	817.06	5	4
$1,945,000	4700	413.83	4	4

$1,950,000	5576	349.71	4	5
$1,950,000	4565	427.16	4	5
$1,950,000	5307	367.44	4	5
$1,950,000	4986	391.10	2	3
$1,995,000	2826	705.94	2	2
$2,195,000	4800	457.29	4	6 +
$2,200,000	3280	670.73	5	5
$2,200,000	5400	407.41	4	4
$2,200,000	4150	530.12	3	4
$2,250,000	5416	415.44	4	5
$2,250,000	6722	334.72	4	5
$2,250,000	3600	625.00	3	4
$2,300,000	4555	504.94	4	3
$2,350,000	6144	382.49	6 +	6 +
$2,447,000	4000	611.75	3	4
$2,650,000	5500	481.82	4	6 +
$2,840,000	6207	457.55	5	6 +
$2,895,000	6575	440.30	4	6 +
$2,900,000	4553	636.94	4	3
$2,950,000	5714	516.28	5	6 +
$2,975,000	4536	655.86	4	4
$2,995,000	5611	533.77	4	5
$2,995,000	6090	491.79	4	5
$2,997,000	5332	562.08	6 +	6 +
$3,000,000	6183	485.20	5	6 +
$3,200,000	5100	627.45	3	3
$3,200,000	7383	433.43	3	4
$3,290,000	4420	744.34	4	6 +
$3,300,000	4555	724.48	4	3
$3,350,000	5000	670.00	6 +	6 +
$3,595,000	6570	547.18	3	4
$3,750,000	8500	441.18	4	5
$3,850,000	8000	481.25	5	6 +
$3,850,000	10000	385.00	5	6 +
$3,950,000	7966	495.86	3	6 +
$3,975,000	6045	657.57	3	5
$4,000,000	0	0.00	4	4
$4,250,000	6745	630.10	3	3
$12,500,000	15875	787.40	6 +	6 +

LEED for HOMES

Project Checklist

(Version 1.73 - October 19,2005)

Builder Name:	Maximum Points [2]
Address (Street/City/State):	Dry Normal Wet

Detailed information on the measures in the checklist below are provided in the companion document "LEED for Homes Rating System"

Yes	?	No								
Location and Linkages (LL)								OR	10	
HOLD				1	LEED-ND Neighborhood			LL2-5	10	
			☒	2	**Site Selection**	Avoid Environmentally Sensitive Sites and Farmland		LL1	2	
				3.1	**Infrastructure**	Site within 1/2 Mile of Existing Water, Sewer, and Roads		LL1	1	
				3.2		Select an Infill Site		LL1	1	
				4.1	**Community Resources**	Within 1/4 mile of Basic Community Resources / Public Transportation		LL1	1	
				4.2	*OR*	Within 1/4 Mile of Extensive Community Resources / Public Transportation		LL1	2	
				4.3	*AND/OR*	Within 1/2 Mile of Green Spaces		LL1	1	
			☒	5.1	**Compact Development**	Average Housing Density >/= 7 Units / Acr		LL1	1	
			☒	5.2	*OR*	Average Housing Density >/= 10 Units / Acre		LL1	2	
			☒	5.3	*OR*	Average Housing Density >/= 20 Units / Acr		LL1	3	
			Sub-Total							
Yes	?	No	**Sustainable Sites (SS)**						14	
Y				1.1	**Site Stewardship**	Minimize Disturbed Area of Site (If Site > 1/3 Acre)			Mandatory	
Y				1.2		Erosion Controls (During Construction)			Mandatory	
Y			☒	2.1	**Landscaping**	Basic Landscaping Design			Mandatory	
				2.2		Apply 3 to 4 Inches of Mulch Around Plants			1	
				2.3		Limit Turf	5		3	1
			☒	2.4		Minimize Landscape Water Demand	3		2	1
				3	**Shading of Hardscapes**	Locate and Plant Trees to Shade Hardscapes			1	
Y				4.1	**Surface Water Management**	Install Permeable Material for at Least 65% of Lot (If Lot >/= 1/4 acre)			Mandatory	
				4.2		Use Permeable Paving Materials	1		3	5
				4.3		Design and Install Permanent Erosion Controls	1		2	3
				5	**Non-Toxic Pest Control**	Select Insect and Pest Control Alternatives from Lis			2	
			Sub-Total							
Yes	?	No	**Water Efficiency (WE)**						12	
			☒	1.1	**Water Reuse**	Rainwater Harvesting System			1	
			☒	1.2		Grey Water Re-Use System			1	
Y				2.1	**Irrigation System**	Main Shutoff Valve, Sub-Meter, and Third-Party Inspection			Mandatory	
			☒	2.2		Select High Efficiency Measures from List	5		3	1
				2.3		Rain Sensing Controls			1	
				3.1	**Indoor Water Use**	High Efficiency Fixtures (Toilets, Showers, and Faucets)			3	
				3.2	OR	Very High Efficiency Fixtures (Toilets, Showers, and Faucets)			6	
			Sub-Total							
Yes	?	No	**Indoor Environmental Quality (IEQ)**					OR	14	
				1	**ENERGY STAR with IAP**	Meets ENERGY STAR w/ Indoor Air Package (IAP)		IE2-10	10	
Y				2.1	**Combustion Venting**	Space Heating and DHW Equip w/ Closed/Power-Exhaust; & CO Monitor		IE1	Mandatory	
Y				2.2		Fireplaces w/ Outside Air Supply and Closed Combustion		IE1	Mandatory	
			☒	3	**Humidity Control**	Analyze Moisture Loads AND Install Central System (where Needed)		IE1	1	
Y			☒	4.1	**Outdoor Air Ventilation**	Meets ASHRAE Std 62.2		IE1	Mandatory	
				4.2		Dedicated Outdoor Air System (w/ Heat Recovery)		IE1	2	
				4.3		Third-Party Testing of Outdoor Air Flow Rate into Home			1	
Y			☒	5.1	**Local Exhaust**	Meets ASHRAE Std 62.2		IE1	Mandatory	
				5.2		Timer / Automatic Controls for Bathroom Exhaust Fans		IE1	1	
				5.3		Third-Party Testing of Exhaust Air Flow Rate Out of Home			1	
Y			☒	6.1	**Supply Air Distribution**	Meets ACCA Manual D		IE1	Mandatory	
				6.2		Third-Party Testing of Supply Air Flow into Each Room in Home			2	
Y				7.1	**Supply Air Filtering**	>/= 8 MERV Filters, w/ Adequate System Air Flow		IE1	Mandatory	
				7.2		>/= 10 MERV Filters, w/ Adequate System Air Flow			1	
				7.3	*OR*	>/= 12 MERV Filters, w/ Adequate System Air Flow			2	
Y				8.1	**Contaminant Control**	Seal-Off Ducts During Construction		IE1	Mandatory	
				8.2		Permanent Walk-Off Mats *OR* Central Vacuum			1	
				8.3		Third-Party Testing of Particulates and VOCs before Occupancy			1	
Y			☒	9.1	**Radon Protection**	Install Radon Mitigation System if Home is Located in EPA Region 1		IE1	Mandatory	
			☒	9.2		Install Ground Contaminant Mitigation System (Outside of EPA Region 1)		IE1	1	
Y				10.1	**Vehicle Emissions Protection**	No Air Handling Equipment OR Return Ducts in Garage		IE1	Mandatory	
Y				10.2		Tightly Seal Shared Surfaces between Garage and Home		IE1	Mandatory	
				10.3		Exhaust Fan in Garage OR No Garage in Contact with Hom		IE1	1	

Yes	?	No					
			Materials and Resources (MR)				**24**
			1	**Home Size**	Home that is Smaller than National Average		10
			2.1	**Material Efficient Framing**	No Extra Uses of Lumber for Aesthetic Purposes		Mandatory
			2.2		Advanced Framing Techniques		2
			3	**Local Sources**	Materials Extracted / Manufactured / Produced within 500 Miles		3
Y			4.1	**Durability Plan**	Detailed Durability Plan; (Pre-Construction)		Mandatory
			4.2		Third-Party Verification of Implementation of Durability Plan		1 3 5
Y			5.1	**Environmentally Preferable**	Tropical Hardwoods, if used, must be FSC		Mandatory
			5.2	**Products**	Select Environmentally Preferable Products from List		4
Y			6.1	**Waste Management**	Max of 2.5 Lbs Per Square Foot of Construction Waste Sent to Landfill		Mandatory
			6.2		0.5 Pts for Each Additional 0.5 Lbs Per Square Foot Reduction		2
			Sub-Total				
Yes	?	No	**Energy and Atmosphere (EA)**			OR	**29**
Y			1.1	**ENERGY STAR Home**	Meets ENERGY STAR for Homes with Third-Party Testing		Mandatory
			1.2		Exceeds ENERGY STAR for Homes, 2 Pts Per HERS Point > HERS 86	**EA2-7**	16
Y			2.1	**Insulation**	Third-Party Inspection of Insulation Installation, At Least HERS Grade II	**EA1**	Mandatory
			2.2		Third-Party Inspection of Insulation Installation, At Least HERS Grade I	**EA1**	1
			2.3		*OR* Above Code Insulation; At Least 5% > Local Code Per REScheck	**EA1**	1
Y			3.1	**Air Infiltration**	Third-Party Envelope Air Leakage Tested </= 0.35 ACH	**EA1**	Mandatory
			3.2		Third-Party Envelope Air Leakage Tested </= 0.25 ACH	**EA1**	1
			3.3		*OR* Third-Party Envelope Air Leakage Tested </= 0.15 ACH	**EA1**	2
Y			4.1	**Windows**	Windows Meet ENERGY STAR for Windows (See Table)	**EA1**	Mandatory
			4.2		Windows Exceed ENERGY STAR for Windows by >/= 10% (See Table)	**EA1**	1
			4.3		*OR* Windows Exceed ENERGY STAR for Windows by >/= 20% (See Table)	**EA1**	2
Y			5.1	**Duct Tightness**	Third-Party Duct Leakage Tested </= 5.0 CFM25 / 100 SF to Outside	**EA1**	Mandatory
			5		Third-Party Duct Leakage Tested </= 3.0 CFM25 / 100 SF to Outside	**EA1**	1
			5.3		*OR* Third-Party Duct Leakage Tested </= 1.0 CFM25 / 100 SF to Outside	**EA1**	2
Y			6.1	**Space Heating and Cooling**	Meets ENERGY STAR for HVAC w/ Manual J & refrigerant charge test	**EA1**	Mandatory
			6.2		Exceeds ENERGY STAR for HVAC by >/= 10%, w/ Manual J	**EA1**	1
			6.3		*OR* Exceeds ENERGY STAR for HVAC by >/= 20%, w/ Manual J	**EA1**	3
			7.1	**Water Heating**	Improved Hot Water Distribution System		3
			7.2		Improved Water Heating Equipment	**EA1**	3
			8.1	**Lighting**	Energy Efficient Fixtures and Controls		1
			8.2		*OR* ENERGY STAR Advanced Lighting Package		3
			9.1	**Appliances**	Select Appliances from List		2
			9.2		Very Efficient Clothes Washer (MEF > 1.8,*AND* WF< 5.5)		1
			10	**Renewable Energy**	Renewable Electric Generation System (1 Point / 10% Annual Load Reduction)		6
			11	**Refrigerant Management**	Minimize Ozone Depletion and Global Warming Contributior		1
			Sub-Total				
Yes	?	No	**Homeowner Awareness (HA)**				**1**
Y			1.1	**Homeowner Education**	Basic Owner's Manual and Walkthrough of LEED Home		Mandatory
			1.2		Comprehensive Owner's Manual and Multiple Walkthroughs / Trainings		1
			Sub-Total				
Yes	?	No	**Innovation and Design Process (ID)**				**4**
			1.1	**Innovative Design**	Provide Description and Justification for Specific Measure		1
			1.2		Provide Description and Justification for Specific Measure		1
			1.3		Provide Description and Justification for Specific Measure		1
			1.4		Provide Description and Justification for Specific Measure		1
			Sub-Total				
			Project Totals [1] (pre-certification estimates)				**108**

Notes: 1. **Certified** 30-49 points **Silver** 50-69 points **Gold** 70-89 points **Platinum** 90-108 points
2. "Points" are shown for 3 precipitation zones: Dry (< 20 inches / year); Normal (20-40 inches / year); and Wet (> 40 inches / year)

I hereby attest that I have verified all of the indicated credits above as installed in the home identified above.

Rater's Name _____ Company _____

Signature _____ Date _____

I hereby attest that I have reviewed the verification information, and certify that this home meets the requirements of LEED for Homes

Provider's Name _____ Company _____

Signature _____ Date _____

Page 2

LEED
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

LEED-NC Version 2.1 Registered Project Checklist

Yes	?	No			
			Sustainable Sites		**14** Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
			Credit 1	**Site Selection**	1
			Credit 2	**Development Density**	1
			Credit 3	**Brownfield Redevelopment**	1
			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
			Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
			Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
			Credit 6.2	**Stormwater Management**, Treatment	1
			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
			Credit 8	**Light Pollution Reduction**	1
Yes	?	No	**Water Efficiency**		**5** Points
			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
			Credit 2	**Innovative Wastewater Technologies**	1
			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
			Credit 3.2	**Water Use Reduction**, 30% Reduction	1
Yes	?	No	**Energy & Atmosphere**		**17** Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
			Credit 1	**Optimize Energy Performance**	1 to 10
			Credit 2.1	**Renewable Energy**, 5%	1
			Credit 2.2	**Renewable Energy**, 10%	1
			Credit 2.3	**Renewable Energy**, 20%	1
			Credit 3	**Additional Commissioning**	1
			Credit 4	**Ozone Depletion**	1
			Credit 5	**Measurement & Verification**	1
			Credit 6	**Green Power**	1
Yes	?	No	**Materials & Resources**		**13** Points

Y			Prereq 1	**Storage & Collection of Recyclables**	Required
			Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
			Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
			Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
			Credit 2.1	**Construction Waste Management**, Divert 50%	1
			Credit 2.2	**Construction Waste Management**, Divert 75%	1
			Credit 3.1	**Resource Reuse**, Specify 5%	1
			Credit 3.2	**Resource Reuse**, Specify 10%	1
x			Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
x			Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
x			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
x			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
x			Credit 6	**Rapidly Renewable Materials**	1
x			Credit 7	**Certified Wood**	1
Yes	?	No	**Indoor Environmental Quality**		**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
			Credit 2	**Ventilation Effectiveness**	1
			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
x			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
x			Credit 4.2	**Low-Emitting Materials**, Paints	1
			Credit 4.3	**Low-Emitting Materials**, Carpet	1
x			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1	**Controllability of Systems**, Perimeter	1
			Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
			Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No	**Innovation & Design Process**		**5** Points
x			Credit 1.1	**Innovation in Design**: Provide Specific Title	1
			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
			Credit 1.3	**Innovation in Design**: Provide Specific Title	1
			Credit 1.4	**Innovation in Design**: Provide Specific Title	1
			Credit 2	**LEED™ Accredited Professional**	1
Yes	?	No	**Project Totals (pre-certification estimates)**		**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Features of an Energy Star Qualified Home

ENERGY STAR qualified homes achieve energy savings through established, reliable building technologies. Builders work with Home Energy Raters to select from a number of features when planning and building homes.

1. **Effective Insulation**

Properly installed, climate-appropriate insulation in floors, walls, and attics ensures even temperatures throughout the house, less energy consumption, and increased comfort.

2. **High-Performance Windows**

Energy-efficient windows employ advanced technologies, such as protective coatings and improved frame assemblies, to help keep heat in during winter and out during summer. These windows also block damaging ultraviolet sunlight that can discolor carpets and furnishings.

3. **Tight Construction and Ducts**

Sealing holes and cracks in the home's "envelope" and in duct systems helps reduce drafts, moisture, dust, pollen, and noise. A tightly sealed home improves comfort and indoor air quality while reducing utility bills.

4. **Efficient Heating and Cooling Equipment**

In addition to using less energy to operate, energy-efficient heating and cooling systems can be quieter, reduce indoor humidity, and improve the overall comfort of the home. Typically, energy-efficient equipment is also more durable and requires less maintenance than standard models.

- Qualified Heating Equipment)
- Qualified Cooling Equipment
- Mechanical Ventilation

5. **Lighting and Appliances**

ENERGY STAR qualified homes may also be equipped with ENERGY STAR qualified products — lighting fixtures, compact fluorescent bulbs, ventilation fans, and appliances, such as refrigerators, dish washers, and washing machines. These ENERGY STAR qualified products provide additional energy savings to the owner.

- Qualified Appliances
- Qualified Lighting
- Advanced Lighting Package
- High Efficiency Water Heaters

6. **Third-Party Verification**

With the help of independent Home Energy Raters, ENERGY STAR builder partners choose the most appropriate energy-saving features for their homes. Additionally, raters conduct onsite testing and inspections to verify that the homes qualify as ENERGY STAR.

APPENDIX C – SAMPLE LIST OF GREEN BUILDING COMPONENTS AND SUPPLIERS

Following is a list of "specifications" or considerations I've developed which are neither technical nor comprehensive, but are more a layperson's list of concepts to be included or considered in a green built house. A bid request to a builder can include these concepts, while letting the builder respond with specific suggestions for the best way to deliver the concept. Where pages are noted, the concept comes from The GreenSpec Guide to Residential Building Materials, Edited by Alex Wilson and Piepkorn (2005). For a more comprehensive list, refer to the resources listed in Appendix E.

- ❒ *Whole House Fan* – Energy Star has more efficient motor and blade or www.g2art.com
- ❒ *Shelves for Kitchen* – Unfitted kitchen with modular components – adjustable system of shelves made of recycled aluminum – www.atlaseast.com – AS4 modular shelving system
- ❒ *Septic/ rain water/ grey water* – Water filtration/recycling unit such as Pirhana or Multiflow
  - ➢ Rainwater catchment (p.227)
- ❒ *Floors* – stained concrete or
  - ➢ Bamboo flooring – P. 136
  - ➢ Reclaimed wood flooring – p. 153-154 – Utah, Austin
  - ➢ http://www.flooringalternatives.com – Berkeley
- ❒ *Roof* – pitched – reflective material or green roof
  - ➢ Roof beams – reclaimed lumber – Austin TX – p. 62
  - ➢ Flat roof – EPS single membrane – very environmentally sound – laid on then cut to size
- ❒ *Front deck* – (Certified wood or composites p 26-27)
  - ➢ Frontier Wood – Santa Fe – 100% recycled
- ❒ *Windows* – High R-value, Low-E
  - ➢ Wood windows w/ aluminum cladding on outside
  - ➢ Sierra Pacific is FSC certified wood
- ❒ *Carpet for upstairs* – In removable squares, recycled content such as Interface or Bentley Prince Street
- ❒ *Duct mastic* – Instead of duct tape for higher efficiency (if any ducts exist).
- ❒ *Driveway/sidewalk/patio* – Permeable pavers to alleviate runoff
  - ➢ ECO Pavers, salvaged brick, stoney crete (p.13)

- *Foundations* – ICFs are better than cement, using expanded polystyrene foam is better than extruded poly foam w/ HCFCs
- *Framing* – Increasing spacing of joists and studs where possible to reduce the amount of framing material required.[i]
- *Insulation* – Expanded polystyrene foam is the only rigid foam insulation (for the exterior of the house) produced without ozone-depleting chemicals. [ii]
- *Skylights* – Should be operable for venting hot air in the summer, with translucent material (Aerogel) for insulation in the winter.
- *Countertops* – Recycled content such as 3Form
- *Backup heating system for passive solar*
  - Ground source heat pump with refrigerant that does not harm the ozone layer (p. 211)
  - Hydronic panel radiators (p.216)
- *Domestic hot water heat exchanger* – Redirects heat from an air conditioner, refrigerator, or fuel-fired boiler to heat hot water (p. 221)
- *Water heater* – Heat pump or on-demand (p.222, 224)
- *Lighting* – Compact Fluorescent light bulbs and recessed lighting (p. 242)
- *Lighting fixtures* – Made of recycled content (p. 243)
- *PV Modules* – First Solar, Kyocera Solar (p. 267). In Arizona (the primary criticism is that many of these are made over seas, and thus the embodied energy is very large. These companies in Arizona say they are manufactured on-site, though information about pricing is not given.)
  - The Solar Store – Arizona
  - V Solar Products, Inc, Arizona, features a full line of solar panels, inverters and solar electric components as well as energy efficient and green building products
- *Walls*
  - *eCrete* – Life-Style Homes in Santa Fe is a distributor for an AZ based company, or ECO-Block in Dallas, TX
- *Material Good* – Natural Building Materials – www.materialgood.com
- *Recycling* – Use cardboard or drywall cutoffs by grinding for use as a soil amendment. [iii]

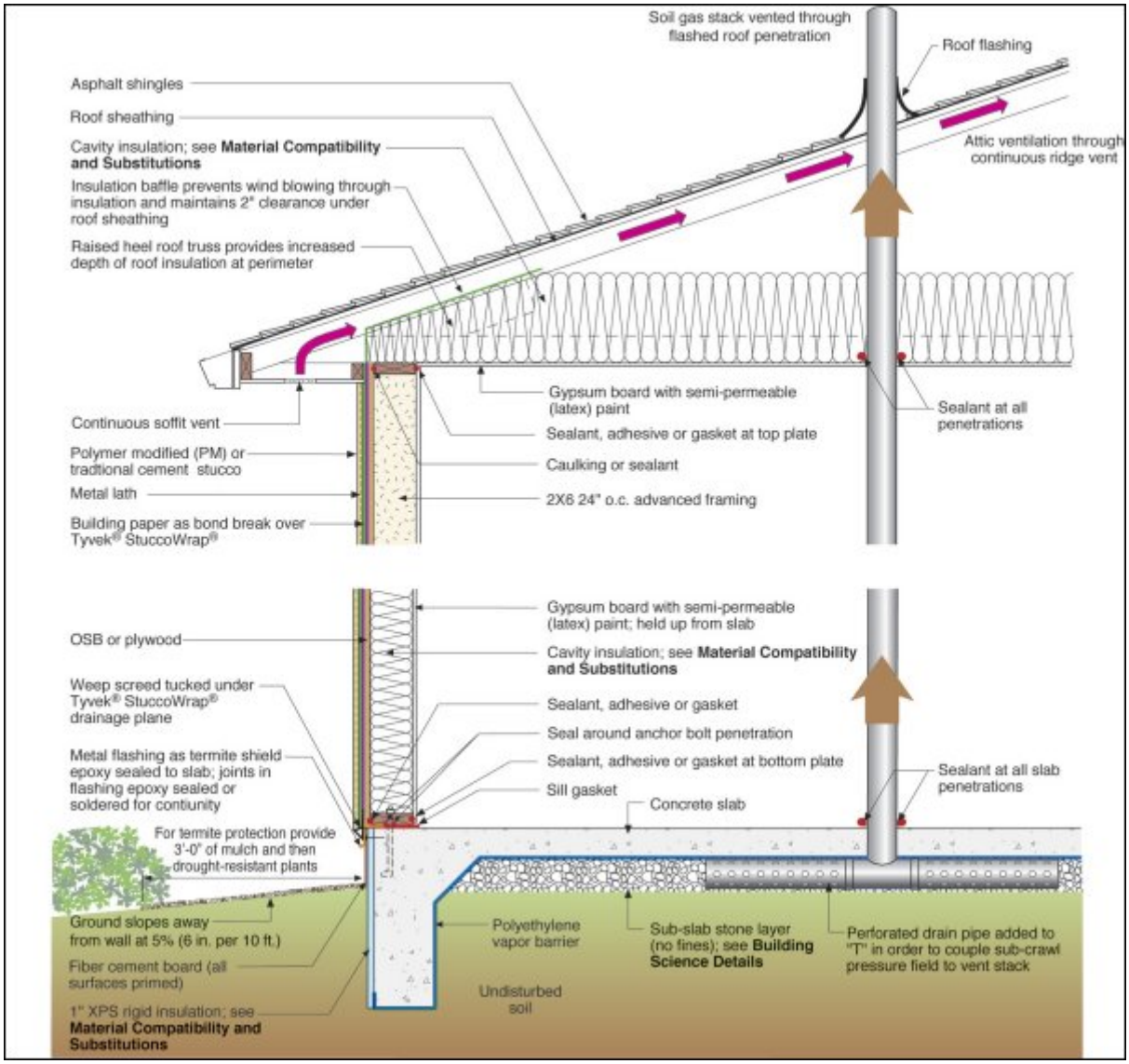
[i] Sustainable Buildings Industry Council and Building America, U.S. Department of Energy (2004). Green Building Guidelines: Meeting the Demand for Low-Energy, Resource-Efficient Homes.
[ii] Chiras, D.
[iii] Sustainable Buildings Industry Council.

Designs That Work

Hot-Dry / Mixed-Dry Climate: Albuquerque Profile

PDF Version

Cross Section



Construction Recommendations

- **Foundation:** Slab-on-grade
- **Above Grade Walls:** Wood frame

- **Cladding:** Stucco
- **Attic:** Unconditioned
- **Roof:** Asphalt shingles

Building Science Notes

- **Ducts in conditioned space** - This building profile is designed to accommodate HVAC equipment and ducts in the living space, specifically in dropped soffits where design and layout permit. HVAC ducts should not be run in exterior walls or the slab.

- **Air sealing details at transitions** – Air sealing can be particularly difficult, but no less important, at assembly transitions such between attached garages and living spaces.
    - **Attached garages** – The building enclosure surfaces shared between conditioned space and an unconditioned garage must have a continuous air barrier. See *Figure 1* and Air Sealing Details for details in terms of using sealants and rigid insulation to create a continuous air barrier between the attached garage and living space.

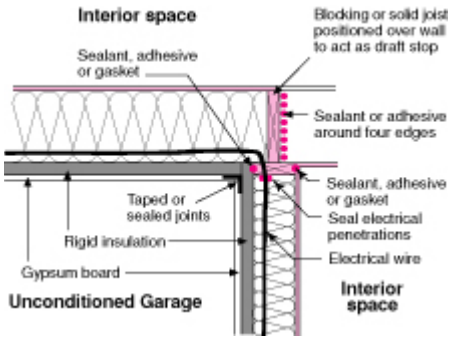


Figure 1

- **Drying mechanisms** – In any climate, vapor control is based on the relationships among the following: the permeability of wall components, the type of cladding (reservoir or non-reservoir), the presence/lack/nature of an air space, and the magnitude/duration of the vapor drive (based on the relationship between the exterior and interior moisture content and temperature differences). The type of sheathing and housewrap used in any wall assembly must be based on an understanding of these inter-relationships. See "Insulations, Sheathings, and Vapor Diffusion Retarders" for more information. This wall assembly permits drying to both the interior and the exterior (depending on the selection of exterior sheathing - see the Building Materials Property Table).
- **Drainage plane, air barrier, and vapor control** – The drainage plane in this wall assembly is the Dupont StuccoWrap® weatherlapped onto the OSB structural sheathing (the building paper just exterior to the drainage plane is the bond break for the stucco cladding). An annual precipitation of 8 inches (30-year average for Albuquerque) means that a face sealed stucco cladding can work, but this system is designed with a drainage plane as a "belt and suspenders" approach for long-term durability. The air barrier is the interior gypsum board installed using the Airtight Drywall approach (see Air Sealing Details). The wall and roof assemblies in this building are "flow-through" assemblies, with moderate to high relative vapor permeability in all components of the wall and roof. This bi-directional drying is the preferred approach in mixed-dry climates.
- **Rough opening flashing** – Window and door flashing details are wall assembly or cladding specific and depend on whether the windows are installed before or after the drainage plane. Refer to the *EEBA Water Management Guide* for more information in the EEBA Bookstore.
- **Advanced framing** – This wall assembly employs all of the advanced framing methods except alternative shear resistance; that is, structural sheathing is used. See Advanced Framing Details.
- **Framing on slabs** – Installing a capillary break between the sill plate and a concrete slab on all walls—exterior, interior, partition—is good practice. A closed cell foam sill sealer or gasket works well. Alternatively, a strip of sheet polyethylene can be used. This isolates the framing from any source of moisture that may be either in or on the concrete slab (and using sill sealer on all walls maintains the same wall height).
- **Soil gas ventilation** – The sub-slab to roof vent system handles conditions that are difficult if not impossible to assess prior to completion of the structure—resultant confined concentrations of air-

borne radon, soil treatments (termiticides, pesticides) methane, etc. The cost of this "ounce" of prevention is well balanced against the cost of the "pound" of cure.

- **Sub-slab stone bed** - The four-inch deep, 3/4-inch stone bed functions as a granular capillary break, a drainage pad, and a sub-slab air pressure field extender for the soil gas ventilation system. Without it, a soil gas ventilation system is not practically possible and the only capillary break between the slab and ground is the polyethylene vapor barrier.
- **Thermal barrier** – In general, we recommend cavity-warming exterior rigid insulation in climates where the average monthly temperature for the coldest month of the year goes below 45°F. But in this assembly, the excellent drying potential of the "flow-through" wall assembly is achieved in part by the absence of any rigid insulation with relatively low vapor permeability. In dry climates with significant, but not extreme, periods of winter temperatures below 45°F, either approach to thermal performance/vapor control works well. The heat loss through the slab perimeter is significant enough to warrant slab-edge insulation. See Termite Control under Field Experience Notes for the detail.
- **Vented attic** – Soffit and ridge vents provide more effective attic ventilation than gable-end vents. Gable exhaust fans do not provide effective attic ventilation. They are generally temperature-controlled, when relative humidity is often the condition that requires higher ventilation rates. They can also depressurize the house causing loss of conditioned air. Generally, the area of the gable and soffit vents, combined with the leakage of the attic ceiling, is such that the fan pulls air not just from the exterior vent but from the conditioned space below.

Climate Specific Details

- **Mechanical systems**
  - **Heating** – Our recommendation for the use of combination space/domestic water heating systems ("Combo" units) comes heavily qualified to high performance production home builders. See the BSC technical resource "Combo Space/Water Heating Systems – 'Duo Diligence'." See *Figure 2*.

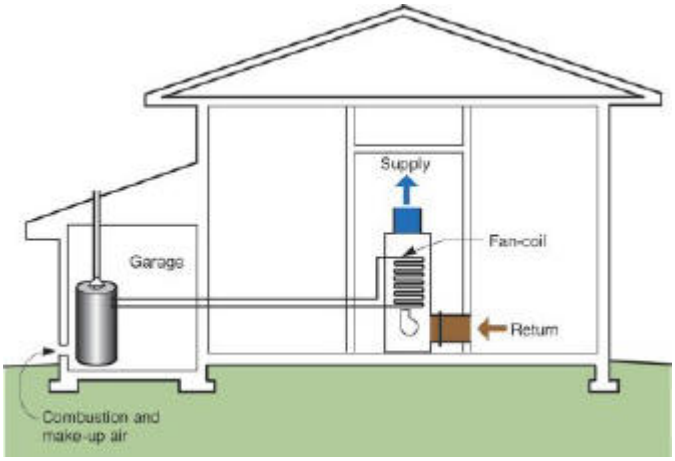


Figure 2

  - **Cooling** - Evaporative cooling is prevalent in Mixed-Dry Climates. We recommend refrigerant cooling in high performance homes in this climate region for three reasons:

1. Refrigerant cooling permits year-round controlled ventilation; evaporative cooling does not.
2. Evaporative cooling can be prone to moisture and indoor air quality problems without frequent and diligent system maintenance; refrigerant cooling is not.
3. While there can be a slight energy penalty with refrigerant cooling in comparison to evaporative, this penalty must be balanced against the year-round comfort provided by refrigerant cooling (evaporative cooling has difficulty supplying comfort in high humidity situations) and the substantial water savings associated with refrigerant cooling (a growing issue in mixed-dry climates).

Follow appropriate sizing procedures. Click here for more detailed information.

- **Ducting** - Single return requires transfer grilles to provide path and avoid pressurizing bedrooms as shown in accompanying figures. Appropriate sizing for ducts, including these pressure relief methods, can be found in the technical resources listed above. See *Figures 3a-d*.

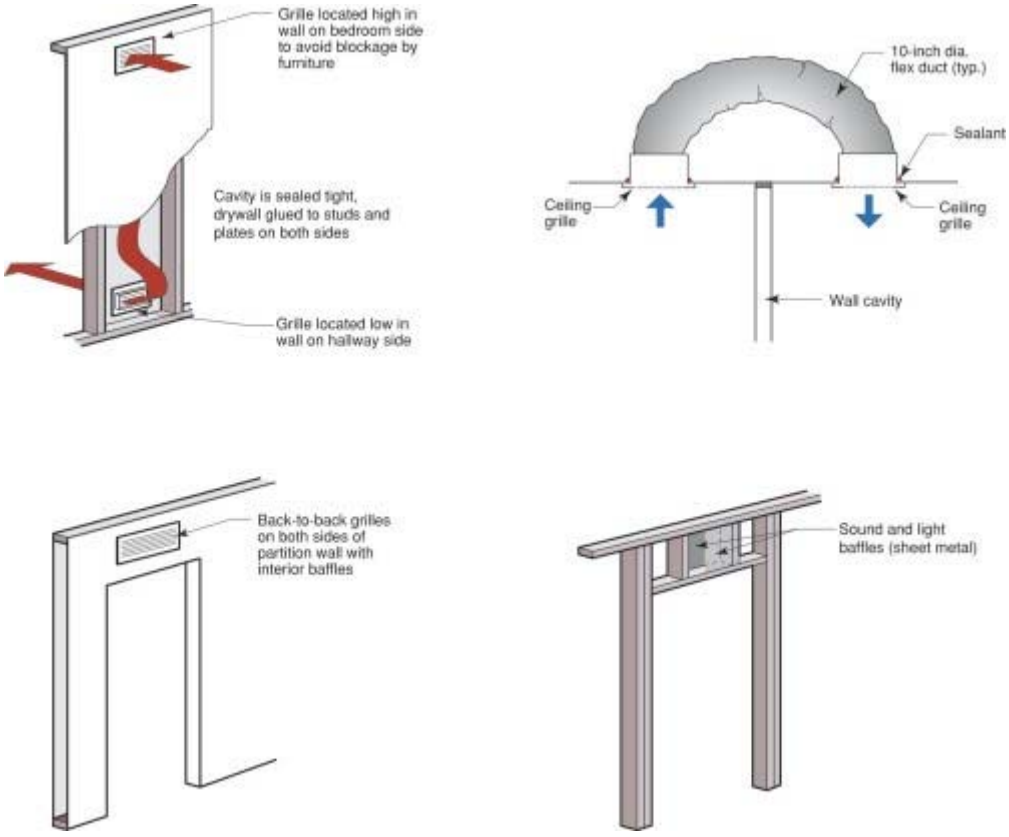
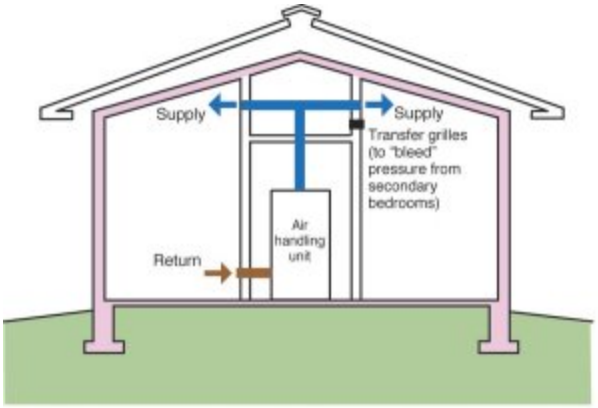


Figure 3a-d

- **Controlled mechanical ventilation** - Intermittent central-fan-integrated supply, designed to ASHRAE 62.2P rate, with fan cycling controls set to operate the central air handler as much as 33% of the time, but not less than 25% of the time, occurring within at least every three hours to provide ventilation air distribution and whole-house averaging of air quality and comfort conditions (installed cost: $125 to $150). Optionally include a normally-closed motorized damper in the outside duct with the AirCycler FRV control (installed cost: $50 to $60). See *Figures 4, 5 and 6*.



Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.

Figure 4

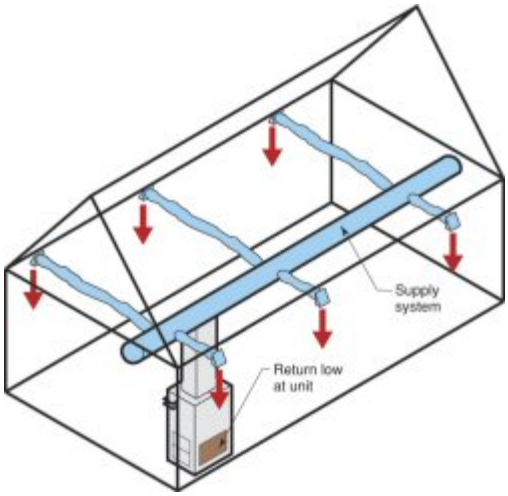


Figure 5

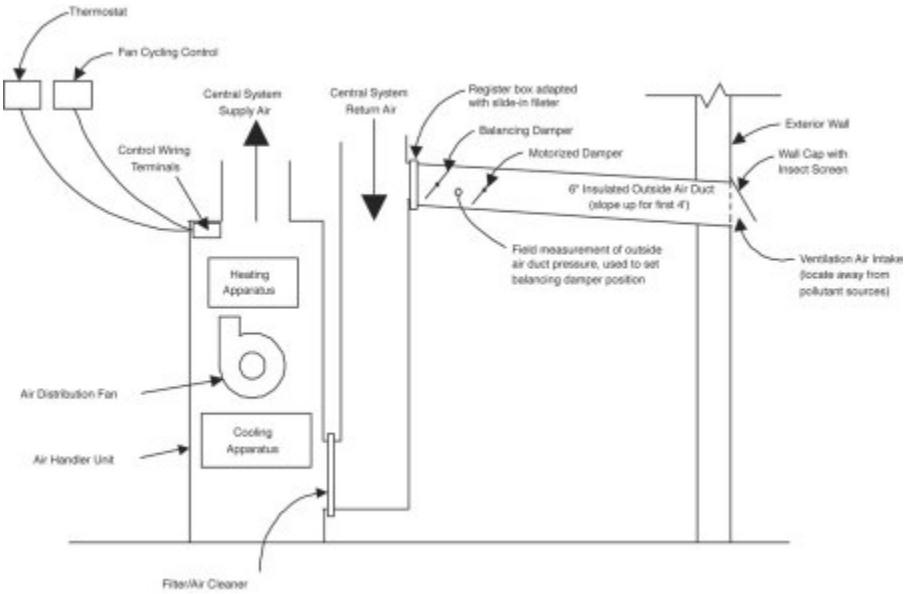


Figure 6 - Interior Closet Configuration

- **Termite management –** Termites are best managed with a three-pronged approach that deals with the three things termites need—cover from sunlight, moisture, and food (wood or paper):
    - **Reduced cover** – Keep plantings 3 feet away from the building perimeter, thin the ground cover (wood mulch or pea stone) to no more than two inches depth for the first 18 inches around the building, and maintain any termite inspection zone on the exterior of the foundation above grade.
    - **Control moisture** – Maintain slope away from building as shown, carry roof load of water at least three feet away from building, and make sure that irrigation is directed away from the building.
    - **Chemical treatment** – Use an environmentally-appropriate soil treatment (such as Termidor®) and a building materials treatment (such as Bora-Care®) for termite-prone near-grade wood materials.

- **Inter-relationship of first three points** – Since a builder and a homeowner's ability to employ or stick to each of the three strategies above will vary, make sure that an inability to fully employ one strategy is compensated for by complete rigor with the others. For example, if for some reason, chemical treatment of soil or building materials is not an option, then complete rigor in moisture control and ground cover is required.

- **Landscaping for wildfire control –** Keeping woody materials of any type, living or otherwise, away from the building is good practice in dry climates where wildfire presents a significant risk.

Field Experience Notes

- **Termite control –** Local codes and interpretations by building inspectors can make details involving slab insulation difficult. We have found that building officials accept the flashing/fiber cement board shown in the building profile and *Figure 7*.
- **Termite flashing continuity –** In order for the metal flashing to be effective, all joints must be epoxy-sealed (or welded) and the horizontal edge must be epoxy-sealed to the concrete.

Figure 7

- **HVAC commissioning** – The most efficient equipment means little if the system is not set up and started up properly. Follow high performance start-up procedures. In dry climates, it is generally a good idea to set up the air distribution fan to run a little longer at the end of each cycle to bump up the sensible efficiency.
- **Location of HVAC outdoor unit** – It's tempting to put the condenser right on the roof where evaporative cooling units are typically located, particularly when lot lines are really tight. We do not recommend rooftop location of the condenser for the following reasons: it makes even routine maintenance more difficult; it puts the unit at what is most likely the hottest spot on the entire property; and it introduces more roof penetrations.

- **Energy trusses –** There are a number of different truss configurations that yield greater depth at the heel, but they vary quite a bit in cost. The truss shown in Figure 8 (sometimes called a "slider" truss) has proven to be among the most cost-competitive. And of course, the pitch of the roof affects just how much insulation you can get at this location, regardless of the type of truss.

Figure 8

- **Advanced framing -** For a technical resource that may help with resistance to advanced framing methods from local code officials, see the Building Safety Journal article written by Peter Yost of BSC.
- **Slabs –** In dry climates, it is quite common for builders to use a sand layer in between the polyethylene sheet and the cast concrete to prevent differential drying and cracking problems.

This moisture-holding layer should never be placed between the poly and concrete. Differential drying and subsequent cracking should be handled with a low water content concrete and wetted burlap covering. See this technical resource for more information.

- **Keeping ducts in conditioned space –** Many builders in Mixed-Dry climates build in areas where the prevailing architecture can make locating all ducts and HVAC equipment in conditioned space more than a bit challenging, particularly when moving from smaller, more affordable homes to more architecturally complex upgrade homes. Moving from slab-on-grade to a conditioned crawlspace is one way to maintain the local architectural vernacular and high performance. *Figure 9* shows how one Mixed-Dry climate Building America production builder used the conditioned crawlspace to make the change cost-efficiently, in terms of builder construction costs, homeowner operating costs, and maintained energy and comfort. Here are some points to remember when making the change from slab-on-grade to a conditioned crawlspace.

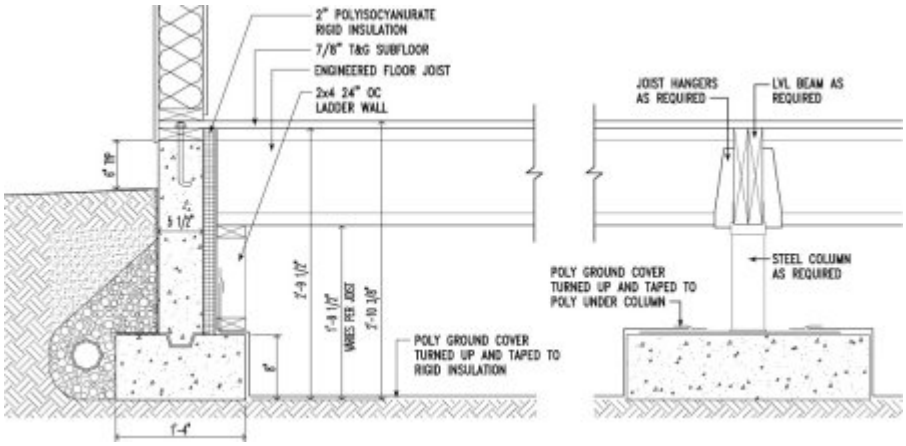


Figure 9

- **Conditioned crawlspace –** Conditioning of the crawlspace means that this space must be constructed much like a living space; it must be supplied by the HVAC system and have a transfer grille to return air back to the HVAC system located in the living space. The supply air should be directed horizontally across the crawlspace with good enough "throw" to provide some mixing, not directed down at the floor. Sizing of the supply air should be about 5% of the conditioned crawlspace floor area (for example: $0.05 cfm/ft^2 * 1600 ft^2 = 80$ cfm for a 1600 ft2 conditioned crawlspace). A single 6" diameter supply duct typically suffices. Transfer air should go back to the central area of the living space above the crawlspace. Two grilles (10 inches by 4 inches) on opposite sides of the crawlspace will usually be sufficient. The transfer area should be calculated in the same manner as for closed bedrooms connecting to hallways, using the 3 Pa pressure difference limit. Some form of mechanical moisture control for the crawlspace is necessary. We recommend one of the following approaches:

    1. Controlled ventilation strategy using the intermittent central fan-integrated supply; it provides both mixing and moisture removal for the crawlspace as well as the house.
    2. A stand-alone dehumidifier installed in the crawlspace.
    3. A continuously-operating crawlspace exhaust fan with make-up air extracted from the house.

In this assembly the rigid insulation is applied to the interior face of the exterior foundation walls. Moisture control is important to proper performance, in particular the vapor barrier ground cover on the floor of the crawlspace. The vapor barrier must be continuous and sealed to the

perimeter wall and any supporting piers.

This assembly may require discussion with the local building code official. See the Building Safety Journal article written by Nathan Yost of BSC.

- **Crawlspace access –** The preferred location for crawlspace access is through the subfloor; any access through the perimeter wall must be airsealed and insulated.
- **Air sealing –** Most codes can be interpreted to require only protection of foam from "ignition" in crawlspaces ("where entry is made only for service of utilities "). The same applies to foam at the rim joist (this is an interstitial space protected from ignition by gypsum wall board on one side and floor sheathing on the other). Protection from ignition can be accomplished with 11/2-inch-thick (38 mm) mineral fiber insulation, 1/4-inch-thick (6.4 mm) wood structural panels, 3/8-inch (9.5 mm) particleboard, 1/4-inch (6.4 mm) hardboard, 3/8-inch (9.5 mm) gypsum board, or corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).
- **Layout and floor framing –** The introduction of floor framing means that floor plans and dimensions that worked well for a slab may not be efficient in terms of wood use in the floor framing package. Be prepared to investigate the relationship between design and efficient wood use. See the following technical resource for more information: "Using Wood Efficiently: From Optimizing Design to Minimizing the Dumpster."

Material Compatibility and Substitutions

- **Interior latex paint -** The substitution of low permeability interior finishes (vinyl wall paper, oil-based paints) for latex paint is strongly discouraged as drying to the interior is important in mixed climates.
- **Building papers with stucco –** There must always be two components here: the bond break material and the drainage plane. Although StuccoWrap® is advertised as both a drainage plane material and the layer receiving the stucco, these two materials should never be combined or reversed in this assembly.
- **Exterior sheathing materials –** In this assembly, the reservoir cladding means that a moisture sensitive material such as fiberboard should not be used. On the other hand, the lack of cavity-warming exterior insulation means that an impermeable sheathing such as thin-profile structural sheathing (e.g. Thermo-ply®, Energy Brace) should not be used. Plywood is an acceptable substitution for OSB in this wall assembly. For more information, see the Building Materials Property Table or "Insulations, Sheathings, and Vapor Diffusion Retarders."
- **Cavity insulation materials –** Acceptable cavity insulation includes any that have a relatively high vapor permeability—cellulose, fiberglass, foam (as long as air sealing is accomplished by a separate component or system when cellulose or fiberglass is used). User discretion can be based on properties other than building science.
- **Flooring -** Because curing concrete releases significant moisture for several months after being cast, we recommend that a low w/c concrete ratio (< 0.45) be used to protect the integrity of finished flooring. We recommend that vinyl flooring not be installed over a concrete slab
- **Gypsum wallboard –** Areas of potentially high moisture, such as bathrooms, basements, and kitchens, are excellent candidates for non-paper faced wallboard systems (e.g. James Hardie's Hardibacker®, GP's DensArmor®, USG's Fiberock®). In addition, paper-faced gypsum board should never be used as interior sheathing or backer for tub or shower surrounds where ceramic tile or marble (any material with joints or grout lines) is used as the finish.
- **XPS vs. EPS exterior foundation foam insulation –** There are three rigid insulations appropriate for exterior use on foundations where the insulation will extend below grade and be in contact with soil conditions:
  - **XPS** – This material's density, impact resistance, and resistance to liquid penetration make it the preferred material.

- **EPS** – In areas where resistance to insects—termites and carpenter ants—is a desired or required characteristic of the insulation, EPS may be indicated, because it is the only foam insulation that comes with a borate-treatment. However, water penetration and subsequent leaching of the borate treatment require a capillary break between the soil and the insulation, This is best accomplished with a gravel layer or an Enkadrain® mat just exterior to the EPS insulation.
- **Rigid fiberglass** - A great material for exterior insulation because of its drainability and resistance to insect degradation. However, availability of this material has been and remains the main constraint of its use.