

DESIGNING A SUSTAINABLE AND AFFORDABLE NEIGHBORHOOD IN BOULDER, COLORADO

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It wasn't exactly a simple mission: To create a sustainable, "green" housing development that is also more than 40% permanently affordable. (1) However, the proposed Holiday Neighborhood development – about 330 homes on 27 acres on one of Boulder, Colorado's last undeveloped sites – had a lot going for it.

To begin with, the Master Site Developer, The Boulder Housing Partners (BHP), had a vision for creating affordable neighborhoods that are also very lively, pedestrian-friendly, and energy-efficient. Cindy Brown, Co-director of BHP, said, "From the beginning, our goal has been to create a desirable place to live and work for people earning different incomes and seeking different types of housing choices. We've always wanted streetscapes at Holiday that are varied, like those that evolved in many older Colorado towns." By hiring a team of the region's most forward-looking developers (rather than just one), the City and BHP arranged diversity by design. (2)

In 1998, at a workshop to seek input from the community, neighbors and other participants were asked to finish the sentence, "The Holiday project will be a success if it..." The responses included:

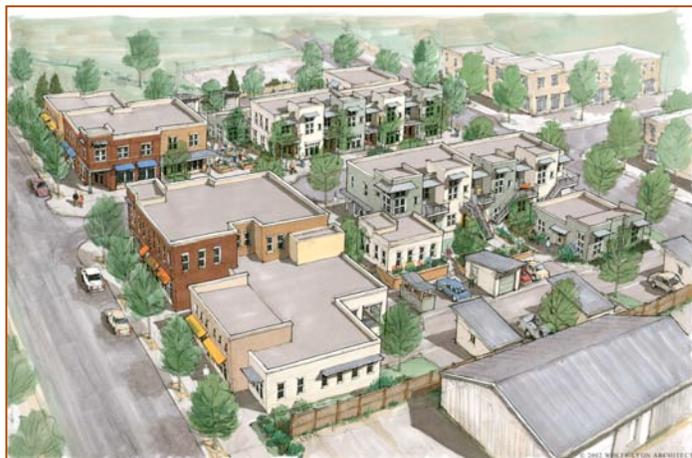
- Is exemplary – better than a "typical" development
- Provides affordable, quality housing
- Provides economic opportunities for residents
- Is multigenerational
- Has a gathering place
- Fits in with surroundings
- Promotes community

Qualities such as these were in alignment with Boulder's mission to create pedestrian-friendly neighborhoods that would reduce travel, partly because people meet more of their needs right in the neighborhood.



A drive-in theater occupied the site from 1969-1989

BHP and the City of Boulder contracted with Barrett Studio Architects of Boulder to be master site planners of the Holiday Project. As a result of their efforts and the input from City planners, prospective developers and others, the project began to take shape. In a project that emphasized sustainability's "three E's" (economy, equity and environment), several basic principles emerged. The project should be built for the long term, carefully considering how the buildings will look and perform in 50 years. It should be built for the children, creating a safe environment for them to grow up in. And it should be built for the planet, using materials and technologies that will encourage and enhance sustainability.



Main Street North at
Holiday
Neighborhood

Holiday Neighborhood Takes Shape

With these principles as a framework, specific features began to appear in the plan, including a two-acre park; a community garden and orchard; small neighborhood businesses; a pedestrian walkway and bike trail connections; state-of-the-art efficiency in building design; space for arts studios and work/live residences; a mixture of home ownership and rentals. As Barrett Studio architect George Watt phrased it, "In order to make this a walkable, pedestrian-oriented community on the edge of a city that is dominated by cars, we needed to introduce a concept that would literally get people back on their feet. We designed gardens, pathways, and interesting spots to work, play, and grow on the site. The greenway that extends from Broadway to U.S. 36 – from a retail area to an orchard -- is the backbone of that strategy." (3) The greenway also goes through the two-acre "park at the heart" and also through a live/work cluster of residences called Studio Mews, where pedestrians will be able to watch artists and craftspeople create.



The Holiday Neighborhood Site Plan

From the beginning, the aim of the public-private partnership at Holiday was to incorporate the best of locally based sustainable design, the arts, health, and affordable living. Although the inclusion of many partners added complexity and sometimes conflict, it also yielded many assets, such as a wealth of ideas (from the six development partners and twelve architectural/design firms); sweat equity (from Affordable Housing Alliance and Habitat for Humanity); and the enrichment of the design process (partly through funding assistance from EPA brought to the project by Sustainable Futures Society).

Another asset was Boulder's environmentally progressive policies; many mandates for sustainable development are already established. For example, to receive a building permit, any new project has to comply with the Green Points ordinance. The Holiday Project went even a step beyond Green Points, establishing Green Guidelines for the new development that challenged project designers to use innovative, efficient designs and technologies that were also sufficiently cost-effective to turn a profit in a project focused on affordability. The list of Green options includes such building and landscape elements as foundations, framing, plumbing, land use, electrical systems, insulation, energy efficiency, resource conservation, building materials, recycling, indoor air quality, windows, HVAC systems and solar/renewable energy. (4)

Said designer David Johnston, whose company, What's Working, fine-tuned both Green Guidelines and Green Points, "In order to get a building permit in Boulder, you have to meet the conventional building code, then you have to get the appropriate number of Green Points on top of that. From a list of 60 or 70 options such as low-VOC paint that improves indoor air quality or cement siding rather than cedar, you pick and choose the options that will get you there. For example, to build affordable homes in the Holiday Neighborhood, a builder needs 65 points. But for every 50 square feet above 2,500 square feet you have to get another Green Point. So a 5,000 square foot house needs to have 130 Points, and if you get larger than that, it gets really difficult. So the Green Points act as a way of keeping housing costs and housing sizes down, so that more people who actually work in the community can afford to own a house here."

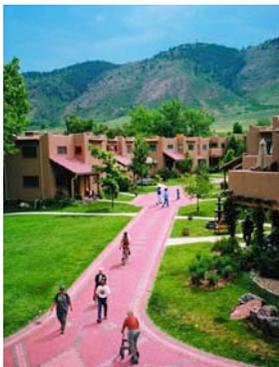
Boulder Green Points Checklist Requirements

Construction/Demolition and Use of recycled materials	29 points
Land use and Water conservation	25
Framing	30
Energy code measures	113
Plumbing	5
Electrical	10
Insulation	34
HVAC	51
Solar	79
Indoor air quality	48
Innovation	10
Total Possible Points	434

Fortunately, the builders selected for the Holiday Project were already well familiar with affordable and sustainable development and specified insulation, appliances and other options that surpassed the Green Guidelines. One of the builders, John Wolff of Wolff/Lyon Architects, explained his firms' mission: "Many of our recent projects have explored patterns of development where there is less reliance on the automobile and where the emphasis is on compact and livable communities with a variety of building types and uses. We welcome projects that must balance real-world financial and programmatic requirements and, most importantly, that create livable and sustainable communities." Wolff/Lyon was the primary designer in three Holiday sites: Main Street North, North Court, and Northern Lights, each of which balance quality-built, new urbanist construction with affordability and "sufficiency" -- a quality that great design delivers, enabling even small houses and yards to feel elegant.

Jim Leach of Wonderland Hill Development Company is another of the innovative builders brought into the Holiday project. His firm is the foremost builder in the U.S. of cohousing communities (they've built about twenty so far), which Leach succinctly defines as "small-scale neighborhoods that provide a balance between personal privacy and a sense of community where people know and care about each other." (5)

Leach's commitment to sustainable design is apparent in his comment, "Like a flame draws a moth, cohousing attracts a certain type of house builder. Somewhere in the back of our minds we think we are going to save the world, our country or at least our hometown from environmental and social degradation through the quality of the housing we create. This challenge keeps a lot of us going in an industry that is filled with political adversity and economic risk." Other major developers, Coburn and Peak Properties, are especially interested in housing for low-income residents, and in small, mixed-use projects such as Coburn's Studio Mews, where artists will live above their studio-shops.



Cohousing emphasizes common open spaces and participatory design

Another pre-existing asset for the Holiday development was the bike- and bus-friendly infrastructure of Boulder -- a city that is also well endowed with parks and open space and incredible solar access (the sun shines 320 days a year). Transit options make the Holiday neighborhood less car-reliant, just as excellent passive solar design makes it less reliant on fossil fuels.

The Holiday project also faced a challenge for which city leaders were determined to find a solution: many of the workers that Boulder relies on, such as teachers, nurses, firemen, and merchants, could not afford to live in the city. Boulder was a victim of its own success; people were willing to pay for its high quality of life, and housing values floated ever upward. This resulted in congested streets, as low to middle income workers commuted from more affordable areas to and from work. It also limited the social and economic diversity of Boulder. In 1993 the City initiated the Integrated Planning Project to look at the trade-offs of growth, affordable housing, transportation, the economy and the environment. The project's motto became "What's best for what's left." The Holiday project was born in the shadow of this self-examination, and was seen as an opportunity to make Boulder more sustainable by providing affordable homes in the community. The Holiday neighborhood would also offer a large number of rental homes, arranged for by BHP.



Studio Mews, a work/live opportunity at the Holiday Neighborhood

The EPA Sustainable Development Challenge Grant

When the Sustainable Futures Society (SFS) received a sizable EPA Sustainable Development Challenge Grant in 2001 to help "green" the Holiday Neighborhood project, the non-profit organization was open to all possibilities. SFS promotes sustainability through research, education, publications and videos, and community capacity building. The goal of the SFS/EPA grant is to demonstrate and provide a model for reductions in air and water pollution from the sustainable design of a large new development. (6)

Clearly, America's built environment has huge environmental impacts. According to green building expert David Johnston, "Forty percent of all the stuff we make and use in the U.S. goes into buildings, with all the associated pollution and impacts. Thirty-five percent of all the raw energy we use -- the oil, natural gas and coal -- is directly attributable to buildings, and sixty-six percent of all the electricity that's generated is used in buildings, primarily for heating, cooling, lighting and appliances. We are also using approximately seventy trillion board feet of softwood

(a board foot is a one-inch board, twelve by twelve inches) in our buildings every year to build houses.”

Johnston summed up, “When we start to reduce those numbers incrementally, building by building and city by city, we can have a dramatic, mitigating effect on how our country uses energy and resources. If we want to reduce air and water pollution as well as preserve material resources and habitat, we should look closely at the design of our buildings.”

Since the terms of the grant specified that funding could not be used for construction or hardware expenses, SFS proposed that design become the grant’s primary focus. Some of the grant’s final products are design scenarios that can serve as models for other builders, planners, and designers. The design concepts will also be documented in a video program that was filmed throughout the evolution of the design process.

One of the first tasks SFS accomplished was to convene a design workshop at which the cutting-edge organization, Rocky Mountain Institute, was the primary presenter. On the table at that January 2001 meeting were discussions about renewable energy, on-site wastewater treatment and energy generation, rooftop gardens, strategies for limiting the use of automobiles such as car-sharing cooperatives, and strategies for creating on-site enterprises where future residents might work in sustainable businesses such as production of water-conservative landscaping or marketing of innovative energy systems.

At the meeting, many next-generation technologies such as fuel cells, Living Machines for on-site sewage treatment and photovoltaic cells embedded in building materials were part of the discussion, further informing a design process that already incorporated many “new urbanist” strategies for enriching quality of life in the neighborhood.

SFS project directors were excited that Boulder Housing Partners and the City of Boulder envisioned a diverse neighborhood where walking would be pleasant and access to public transit would be excellent. The project would further reduce transportation by incorporating a few stores, recreational opportunities, artist studios, parks, a community garden, and a mosaic of architectural types.



George Watt of Barrett Studio Architects, points to several elements that integrated sustainable design into the project right from the start:

“Ours is a project with a focus on sustainability throughout – sustainability realized through passive solar siting, resource conservation, the diversity of residential building types, residential affordability, the vitality and longevity within the neighborhood created by a mixture of uses including personal service shops, artist studios, parks, gardens, offices, a community center – all woven into the neighborhood. So when SFS afforded us the opportunity to research sustainable stormwater systems, we jumped at the chance...” (7)

Watt worked with the City on several critical zoning issues, attending many planning, zoning, and City Council meetings.

1. Density. The site was originally zoned for 10 units /acre, however the site designers realized that if more than 40% of the development was to be affordable, houses and lots would have to be smaller. The City approved a change in zoning to build up to 20 units per acre.
2. Mixed use. The City was at first reluctant to allow retail spaces in the neighborhood, but the issue of traffic congestion caused a change in strategy: 30-40 retail spaces, including artists galleries, restaurant, bakery, coffee shop and other amenities, were included in the plan.
3. Smaller setback and “bulk” requirements, resulting in many small lots with diverse purposes.

“Under the old setback requirements, we often end up with gardens too big to maintain and lawns too small to use,” said Watt. “With smaller setback requirements, we can define the street edge better, with small houses closer to the street.”

Another infrastructure feature that became more sustainable was parking requirements. At Wild Sage, the design team and community applied for and received a variance in the parking requirement. The City allowed the project to supply only 1.1 spaces per housing unit compared to the typical 2 spaces. Said developer Jim Leach, “With less space taken up by parking spaces, there can be more common space for everyone’s use, and with less pavement and more green space, the neighborhood will be much cooler.”

Three Design Scenarios Chosen as Focal Points for the Holiday Project

Throughout Year One of the project, SFS continued to meet with its various partners regarding potential design elements that could be included at the Holiday Neighborhood to increase project sustainability and demonstrate tangible air and water quality benefits. Strategic alliances were formed with Wonderland Hill Development Company, Rocky Mountain Institute, National Renewable Energy Laboratory, the City of Boulder, and as many designers at the Holiday site as possible. After SFS and its partners investigated the economic and legal feasibility of potential technologies and approaches for the Holiday Neighborhood, three focus areas were considered to have the highest potential for making a contribution to the sustainability of the design. (Each of these design scenarios is discussed in depth below).

1. Energy Efficient Building Systems;
2. State-of-the-Art Lighting Guidelines;
3. Innovative Stormwater Management strategies.

1. From the beginning, architect Jim Logan stated his intention to strive for a Zero Emissions project at Wild Sage Cohousing Community, meaning that no pollution related to fossil fuels would be generated for heating and cooling, lighting, appliances, and other household (and community) uses. He wanted to include as much active solar energy (for heating water and space, and possibly generating electricity) as possible, in addition to the passive solar that would

heat and daylight the homes. Resource efficiency was the cornerstone of the strategy, and fortunately, the future residents of Wild Sage, with whom the architects and developer co-designed the project, were advocates of a “green” neighborhood.



A Rendering of Wild Sage Cohousing, Year Two of the Design Process

2. Second, in a project constrained by the need for affordability, the operating costs for future residents became a critical factor. How can a building be considered affordable if it has high utility bills? Clanton Engineering was selected to develop a set of Sustainable Electric Lighting Guidelines, which, according to owner Nancy Clanton, can reduce monthly utility bills by a factor of five. (8)

3. Stormwater management was selected as a third design focus for several reasons. As RMI's Richard Pinkham explained, “Urban and suburban runoff from impervious surfaces like streets and rooftops is one of the most severe water quality impacts in the U.S. Pesticides, fertilizers, heavy metals, animal feces, automotive by-products and many other pollutants are washed into waterways where they degrade the water for various uses such as drinking water, recreation, and natural habitat.” By 2006, the next phase of EPA stormwater requirements (Phase II) will require even small towns to develop stormwater management practices that reduce pollution from runoff, so the Holiday project was seen as a potential model. Graywater (what flows from sinks, bathtubs and washing machines) was also seen to be a resource well worth utilizing in Holiday Neighborhood landscapes. However, Colorado State law regulates graywater as if it were sewage, making the recycling of this resource difficult to achieve – especially since the project was already underway. (9)

After researching various technologies related to water quality (such as neighborhood-scale sewage treatment and graywater systems), SFS grant directors concluded that stormwater management innovations had the greatest chance of being successful at the Holiday project. Grant funding was supplemented by funds from the City of Boulder to support research by Wenk Associates, nationally known for innovative landscaping that provides water quality benefits. This firm developed specific “Best Management Practices” (BMPs) to remove pollutants from Holiday Neighborhood's stormwater runoff, and produced a handbook explaining their design and implementation. The engineering firm Carter Burgess, site designer Barrett Studio, and University of Colorado researchers Jim Heaney and Don Alexander also contributed to the research. (10)

1. Designing for Zero Emissions at Wild Sage Cohousing

In Year One of the project, architect Jim Logan expressed a lofty goal: to try to achieve Zero Emissions for the 34 homes and common building of Wild Sage. Logan has been designing solar homes for several decades, and wanted to see how far he could take energy efficiency and renewable energy toward that goal. If a house is as efficient as it can be, he reasoned, much less renewable energy will be required to meet residents' needs. So if you want to include active solar, first be blue ribbon efficient. With funding from the SFS/EPA grant, and working with colleagues Bryan Bowen, an architect, Jim Leach, the project developer, energy engineering firm Nexant, the National Renewable Energy Lab, and members of the Wild Sage cohousing community, Logan first conducted extensive computer analyses to identify the most energy efficient and commercially feasible technologies and designs. As part of that research, he calculated costs and payback periods for each design element, and arranged them into "bundles" of strategies that can be evaluated for both cost and energy efficiency. (11)

Design Options Sorted into Synergistic Bundles

Bundle 1 - Basic insulation and glazing upgrade
Wet spray cellulose in walls
14" loose blown cellulose in ceiling
2" extruded polystyrene in basement walls only
Low-E glass - soft coat
Bundle 2 - Conservation package
Wet spray cellulose in walls
14" loose blown cellulose in ceiling
2" extruded polystyrene in basement walls only
Low-E glass - soft coat
92% efficient boiler
Bundle 3 - Conservation package - Icynene
Icynene insulation in walls and ceiling
2" extruded polystyrene in basement walls only
Low-E glass - soft coat
92% efficient boiler
Bundle 4 - Conservation package with solar component
Wet spray cellulose in walls
14" loose blown cellulose in ceiling
2" extruded polystyrene in basement walls only
Double pane vinyl on south, soft coat Low-E on N,E,W
92% efficient boiler
Bundle 5 – Passive solar tempered, super-insulated
Wet spray cellulose in walls
14" loose blown cellulose in ceiling
2" extruded polystyrene in basement walls only
Double pane vinyl on south, soft coat Low-E on N,E,W
92% efficient boiler
Exposed 1" concrete topping slab
Additional layer of 1/2" drywall

One of the most important findings of the numbers-crunching research at Wild Sage is that soft coat Low-E glass, widely available in less expensive low emissivity glazings, can prevent solar energy from being a major contributor to space heating. “Even south facing glass begins to be a net energy loser if it prevents solar energy from entering the building,” said Logan. At Wild Sage, he specified windows with a high solar heat gain coefficient (SHGC) in south-facing exposures, and windows with a low SHGC in east and west exposures, to minimize overheating in the summer. (13)

He explained these findings in a February, 2002 presentation to other Holiday architects and developers. He also stressed the need to minimize air infiltration with the Airtight Drywall Approach, Simple Caulk and Seal, and Polyethylene Wrap. Because it is cost-effective and very energy conservative, he used wet-blown cellulose insulation (made from recycled newspaper), with low-VOC expanding foam around such trouble spots as electrical boxes.

Solar Energy as a Design Strategy at Wild Sage

An investigation of on-site electrical generation -- for example, with a microturbine, fuel cells or photovoltaic panels -- occurred in Year One of the Wild Sage design effort. SFS, Logan Architects and NREL engineers Doug Balcomb and Craig Christensen investigated possible demonstration funding or grant funding and discovered that fuel cells and PV panels were already being demonstrated in the Denver area and that no money seemed to be available. A neighborhood microturbine system (about the size of a large refrigerator) seemed to be financially viable if Xcel Energy would offer incentives for reductions in peak load or a single utility bill for the entire neighborhood. (The single bill concept was thought to be workable in a cohousing neighborhood, where cooperation is part of the neighborhood mission).

Microturbines at the scale necessary for the project (34 units and the common house) have been in use for more than 20 years and are reliable and efficient. The net emissions of CO₂ and other pollutants from natural gas are less than from coal, which fuels much of the country's electrical generation, and about three-fourths of Colorado's energy. Logan and his NREL colleagues were also attracted to the idea of the waste heat generated by a natural gas-powered microturbine because the waste heat from this technology was a good fit with the central boiler system they had in mind for each of the multi-household buildings. Microturbine manufacturers Capstone Company in Chatsworth, California and Global Energy Company in Madison, Wisconsin were contacted by researchers, and the technical literature carefully evaluated. The primary deterrent was the first-cost of a microturbine, however leasing arrangements in which the vendor also provided ongoing maintenance were attractive and made the design team carefully consider this option.



Microturbines work like natural gas-powered jet engines but produce electricity instead of thrust.

However, after careful computer analysis, the team concluded that active solar energy to supply hot water and space heating made more sense financially as a sustainable source of energy. To meet the Zero Emissions target, Logan and colleagues proposed purchasing “green” power generated by wind, photovoltaics, or hydroelectric power.

Logan’s design concept for active solar includes several basic elements that will in the near future result in solar-powered water and space heating at Wild Sage. First, in a design session with future residents of the cohousing community, the group agreed that solar energy is important to them, and after a thorough explanation by Logan and Bryan Bowen, they reached consensus that the neighborhood would not use forced air heating or central air conditioning (evaporative cooling, whole house fans and ceiling fans were judged to be more than sufficient), leaving the door open for active solar systems based on the heating and distribution of water. Next, Logan made a case for a centralized boiler in each of the neighborhood’s multi-household buildings rather than having redundant (and oversized) units in each house. The group also agreed on this concept, after much discussion. Each building will have a single hydronic baseboard mechanical heating system run by a 96% efficient boiler that is zoned by unit. Beneath the mechanical room, a space is provided for an oversized drain-back tank to store hot water from the solar heating system, or any other source of hot water (e.g., fuel cells, which produce waste heat but remain very expensive).

An analysis performed by NREL engineer Craig Christensen indicated that because the community had acquired 20 used solar panels, payback for each building’s solar panel installation would be ten years: using a typical hot water demand of 431 gal/day, the panels would supply 85% of the hot water demand at a price of \$.44 per therm. However, because affordability is a central aspect of the project, the budget was simply too tight to install the panels before occupancy.

Said architect Bryan Bowen, “The savings from the first solar panels installed will be reinvested in an account that will pay for installation on the next building. All the buildings are pre-plumbed for solar, so eventually we’ll be completely solar-powered, except for electricity.”

Before designing the Wild Sage solar hydronic system, Jim Logan conferred with other solar architects, some of whom had been designing solar buildings for 30 years. “The overwhelming conclusion was that to work effectively, systems have to be as simple as possible, with as few complicated components, heat exchangers and motors as possible. Most of the architects I talked with recommended the drain-back system, in which water in the panels drains back into the storage tank when the sun goes down.”



Wild Sage members salvaging solar panels.

Flat roofs on some of the buildings for inconspicuous mounting of the panels was a point of contention for aesthetic reasons, but ultimately the group decided to continue on their path toward solar energy and opted for the flat roofs. Architect Bryan Bowen -- who began to feel so much at home working with Wild Sage that he and his wife joined the community and bought a house -- made a case for 1" thick concrete floors that could make the solar energy system even more effective. Said Bowen, "Distribution pipes are embedded in the concrete floors to provide radiant heating at lower water temperatures than typical solar-thermal systems of the 70s. The concrete floors store solar heat that comes in through the windows, releasing it slowly at night."

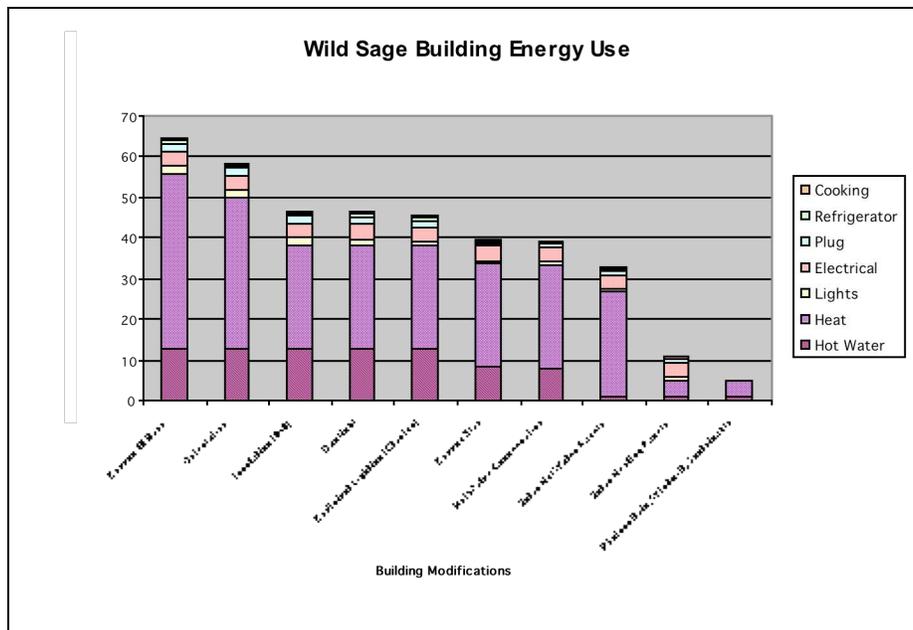
In fact, one of the community members had lived in Tucson without air conditioning because of the heat-absorbing properties of a concrete slab her house had. Her story got Wild Sage members interested in the idea, despite its higher first-cost as compared to conventional flooring.

Energy Efficiency First

The most fundamental aspect of the Wild Sage Zero Emissions goal is efficiency. Some of the energy savings at Wild Sage are due to cluster development, in which homes effectively share heat (and cooling). Computer models of an interior home indicated that an inexpensive electric baseboard heater would be sufficient to supplement passive solar heating and thick, well-applied insulation. "But electricity is mostly generated with coal," said Logan, "and takes us off the path to Zero Emissions."

Being efficient in the use of water is also important. If less hot water is needed, it can more easily be supplied by the solar panels. "Engineers often over-estimate the amount of hot water needed by an individual or household. By using efficient fixtures such as showerheads and faucet aerators, and just being conservative in the length of a shower, we can easily cut hot water usage in half," said Logan.

The bar chart below, generated by Jim Logan and Bryan Bowen, presents an overview of the Wild Sage quest for Zero Emissions design. Each additional measure reduces the emission of energy-related air pollution, taking the project one step closer to Zero Emissions. Write Logan and Bowen, "By designing with life-cycle energy efficiency in mind, buildings can have a positive impact on environmental quality and reduce energy costs throughout their lifetimes."



Here's a brief, condensed explanation of each incremental improvement:

10 Steps to Zero Emissions

1. Energy 10 Base: A computer program, Energy 10, generalizes the energy use of building components based on 1997 UBC requirements and typical energy use of appliances based on Energy Star values. This program enables a comparative look at the efficiency and cost of insulation, glazing, and electrical plug loads.

2. Orientation: The first step in lowering energy use is to properly place the building in the site. By evaluating sun, shade, and wind, a building can be oriented to take advantage of these natural site forces to reduce energy use. South-facing windows increase energy absorbed from the sun, while shading decreases cooling loads in the summer.

3. Insulation: The next step is to buy extra insulation and reduce infiltration. Bundle 4, referenced above, is a package based on basic conservation strategies modeled in Energy 10 including wise building orientation, appropriate glazing, increased insulation, reduced infiltration, and high efficiency mechanical equipment.

4. Daylight: By using natural light, electrical loads can be substantially reduced during daytime hours. This study found that use of daylighting techniques reduced lighting loads by 20%.

5. Efficient Lighting: Replacing existing bulbs with compact fluorescent lamps decreased lighting loads by 50%. More sophisticated systems can include dimmable ballasts, occupancy sensors, photocells, and timers.

6. Energy Star: New Energy Star guidelines were enacted in January 2004 by the U.S. Department of Energy, and can reduce plug loads by 54% over conventional appliances.

7. Hot Water Conservation: Steps as simple as lowering the temperature on the washing machine and hot water heater can have an impact on energy use. Water efficient showerheads, faucets, and appliances are readily available with little increase in cost.

8. Solar Hot Water Panels: Solar collectors take advantage of the energy provided by the sun to heat water which is used for domestic fixtures and appliances. By collecting solar energy we can substitute a sustainable resource for the traditional coal-fired electrical sources. Using solar collectors for hot water reduces total gas loads by 20%.

9. Solar Heating Panels: Using solar panels for heating further reduces gas loads by an additional 80%

10. Renewable Energy Sources: By purchasing electricity that was produced with renewable energy such as wind, solar, biomass, hydro, and other clean energy sources, Wild Sage or any other development can attain the goal of Zero Emissions.

The Wild Sage design team was very conscious of other energy-related choices as well. For example, the flat roofs in the project have light-colored surfaces to reduce the need for cooling. "If designers and engineers used white reflective surfaces for all roofs and pavements," said Bowen, "we could reduce the urban heat-island effect by up to 8 degrees." The project's carports will have a sod roof, which will absorb rainfall and further enhance the coolness of the neighborhood through evaporative cooling.

The team specified siding for the homes that combines wood and cement to be more durable and use less old-growth timber. As many recycled and low-toxicity materials as possible were used in the project to maintain good indoor air quality. For example, concrete floors, low VOC paints, natural stains and finishes, and carpeting made from recycled pop bottles will reduce pollutant loads in homes as well as reduce the amount of energy that went into the manufacture of the materials (the "embodied energy.")

The Wild Sage design process also focused on transportation, a major source of both air and water pollution. The designers and future residents worked with the City of Boulder to get a parking variance to reduce required parking spaces and increase living space. Rather than requiring the conventional 2 cars per household, the City required 1.1, based on several variables.

- Because there are fewer driveways and other “curb cuts” in the project, there is more on the street parking available.
- Each Holiday resident will get a complimentary bus pass
- As a community, Wild Sage residents demonstrated great interest in a carsharing operation that will decrease the need for a second car in a typical household. They also own a higher proportion of bicycles per household and can easily access the bike paths that lead to downtown Boulder and other strategic locations.

2. Spotlight on Efficiency

SFS chose Boulder lighting expert Clanton & Associates to research and present *Residential Lighting Guidelines for Energy Efficiency* for several reasons:

- Utility bills would be lower for the 43% of Holiday Neighborhood residents who live in affordable housing
- Lighting comprises 7% of total household energy, on average
- The proposed design vignette approach, in which lighting options for different rooms are presented, is easy to understand
- Lighting guidelines that de-mystify the use of highly efficient fluorescent equipment, has universal applicability.

Nancy Clanton’s approach to sustainable lighting is to integrate natural daylighting with quality electric lighting, which together increase the visual comfort and quality of a space. At the same time, this approach saves money as well as energy and natural resources.

Her hierarchy of priorities for residential lighting is:

- **Maximize daylight with good orientation.** Orienting the house such that the majority of windows are facing south or north, selecting high performance glazing or glass, controlling glare and heat gain, and trying to daylight the majority of rooms in the building all increase the available daylight.
- **Reduce dependency on table lamps by installing permanent lighting at the time of construction that illuminates surfaces.** This ensures that the efficiency benefits will continue throughout the life of the house.
- **Use fluorescent lamps that are designed for residential applications.** Fluorescent lamps now “mimic” incandescent lamps in color, quiet operation and dimming capabilities. The advantage of fluorescents is their low energy consumption and very long life. Dim lights when possible and use occupancy sensors to turn off lights.
- **Dim lights when possible and use occupancy sensors to turn off lights.** Dimming not only creates “moods” but also saves a lot of energy. Occupancy sensors, especially in transitional areas, keep the lights off when no one is in the area.

Clanton & Associates’ handbook (see appendix) presents concepts that many people don’t even think about. For example, by lighting walls and ceilings first, we expand a space visually and can also accent artwork and wall hangings. The typical “downlighting” from overhead recessed cans often results in glare and overly bright spaces. Clanton suggests providing task lighting instead, such as under-cabinet fluorescents in the kitchen that put the light right where it’s needed. “The

color appearance of food is very important in the kitchen and dining room,” she writes, “and glare can be distracting or prevent a person from reading a recipe.”

Clanton is used to comments about how compact fluorescent lighting is “unnatural” or makes people look “unhealthy,” however she responds that, “Fluorescent lamps now ‘mimic’ incandescent lamps in color, quiet operation and dimming capabilities, and far surpass them in their low energy consumption and long life.” To achieve the warm color similar to incandescent lamps, select a color temperature of “3000 K,” she advises.

She observes that the greatest opportunities for efficiency improvements are in the areas of highest use, such as the living room and kitchen. At the same time, areas that are used infrequently can be energy drains when lights are left on, because they may go unnoticed. Occupancy sensors are perfect for children’s playrooms and porch lights -- which are frequently left on – or for laundry rooms, because your hands are usually full when leaving the room.

Ceiling surface brightness and task lighting



Accent on Artwork



The emphasis on quality lighting that precisely meets the need enables fewer watts to deliver better service. In the table below, the Clanton & Associates report quantifies the energy and monetary savings that are achievable with greater attention to human physiology, particular uses of a space, and new equipment that is now available.

ECONOMIC AND ENERGY ANALYSIS OF EFFICIENT LIGHTING, Clanton & Associates

SPACE (1)	Base Case Approximate Energy Cost (\$/YR) (2)	Guideline Approximate Energy Cost (\$/YR) (2)	Percentage Energy Savings	Approximate Energy Cost Savings (\$/YR)	Annual CO2 Savings (lbs/year) (3)	Base Case Approximate Energy Cost Savings with Controls(\$/YR)	Guideline Approximate Energy Cost Savings with Controls(\$/YR)
Living Rooms	77.09	36.09	53%	\$41.00	769		
Dining Rooms	42.05	11.45	73%	\$30.60	574		
Kitchens	58.52	29.08	50%	\$29.43	552		
Family / Rec Rooms	29.20	8.18	72%	\$21.02	394		
Bathrooms	24.53	6.54	73%	\$17.99	337	\$11.04	\$2.94
Bedrooms	17.52	4.91	72%	\$12.61	237	\$7.88	\$2.21
Exterior Entrance	5.84	1.31	78%	\$4.53	85	\$5.26	\$1.18
Laundry / Utility Rooms	2.92	0.93	68%	\$1.99	37	\$1.02	\$0.33
Garages	2.92	0.93	68%	\$1.99	37	\$1.02	\$0.33
Stairs	0.88	0.23	73%	\$0.64	12		
Hallways	0.73	0.20	72%	\$0.53	10		
Entry Areas	0.44	0.12	73%	\$0.32	6		
NOTES:							
1. Spaces are listed in order of maximum energy saving potential.							
2. Cost estimates based on \$0.08 per kWh.							
3. Annual CO2 savings based on 1.5 pounds of CO2 per kilowatt hour.							

As the above table illustrates, energy savings of between 50% and 73% are possible if higher efficiency fixtures, natural daylight, and task-oriented design are used.

3. Water Management at the Holiday Neighborhood

At the Holiday Project, the EPA Sustainable Development Challenge Grant enabled a holistic look at how water is managed in the buildings and landscapes of a state-of-the-art development. Richard Pinkham, adjunct staff member at Rocky Mountain Institute, performed a thorough analysis of water resource opportunities in the Holiday project.

Although some of the water-related technologies and designs evaluated for the Holiday project were not ultimately implemented, discussion, references and contact information about them are included in this report, so they can be considered for use in other projects.

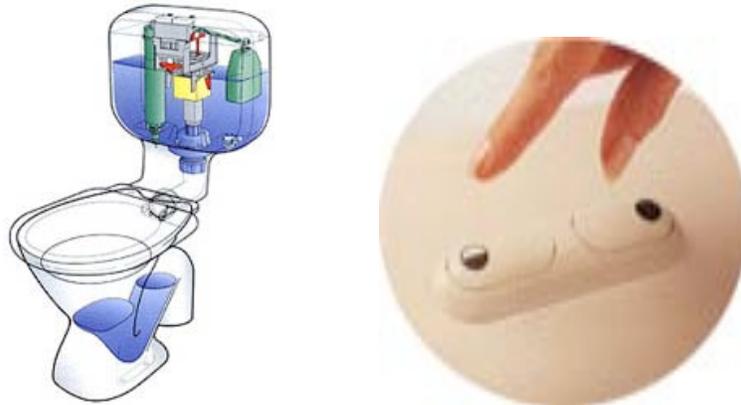
Water Efficiency

“Water strategy can best be thought of as a relationship among water supply, water use, wastewater management and stormwater management,” Pinkham explains. To capture the full value of water, he promotes the integration of these four elements. “Water use is a good place to start, since the less water that is required in a house or landscape, the less water will have to be supplied and later managed as wastewater,” he says.

An average American home uses 75 gallons of water a day per person. By using commonly available fixtures and appliances, that per capita use can easily be reduced to 50 gallons. For example, conventional showerheads use 3-5 gallons a minute, and the National standard is now 2.5 gallons for new construction. However, there are many styles and models available that

deliver highly satisfactory showers for 1.5 to 2 gallons minute. “It’s important for architects and builders to realize that the new generation of showerheads provides both efficiency and comfort,” says Pinkham.

The dual-flush toilet is another device that was evaluated for use at the Holiday project, and is an option for homebuyers in the Wild Sage Cohousing part of the development. While many American homes now have 3.5 gallon toilets and 1.6 gallons is the U.S. standard for new construction, the dual-flush toilets require less than a gallon to flush urine, and 1.6 for a full flush, resulting in savings of 25% over the national standard. A slight cost premium is soon paid back from savings in water bills.



Water-wise landscaping and irrigation are other key aspects of water efficiency. As mentioned above, the entire Holiday project was guided by the rigorous Green Points system that the City of Boulder requires for all new construction or remodeling projects greater than 500 square feet. In the comparatively small, affordable homes built at Holiday, 50 points are required for new homes up to 1,500 square feet, and 65 points for homes between 1,500 square feet and 2,500 square feet.

Drought-tolerant landscaping, or “xeriscape,” receives up to four Green Points; drip irrigation receives one, and for every 10,000 gallons of water savings from efficient devices or landscaping, another Point is awarded. In addition, the use of engineered swales to filter stormwater runoff receives three points if implemented. (See Appendix for reference to more information on the Green Point program).

Wastewater Management

At the beginning of the Holiday project, the Sustainable Futures Society coordinated research on cutting-edge wastewater treatment technologies such as solar aquatics, also known as Living Machines. This technology, developed by John Todd of Ocean Arks International, presents a sustainable alternative to conventional sewage treatment. In a Living Machine, wastewater is treated with a succession of biological habitats ranging from bacteria and algae to cattails, snails and fish. Typically housed in a greenhouse, these miniature ecosystems avoid the use of chemicals, process energy, and piping, producing water in the final stage that is clean enough for general, non-potable use.

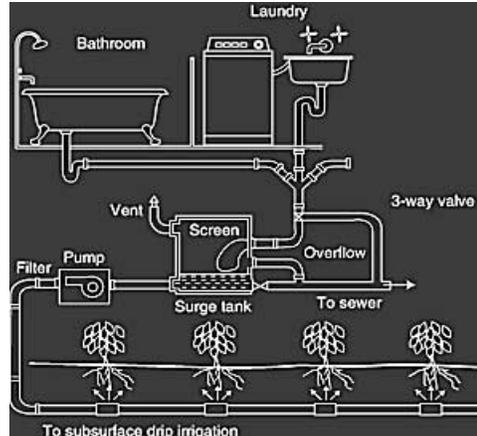
There are more than 20 Living Machines in operation, including a large facility in Australia that treats 200,000 gallons a day of industrial wastewater. The Living Machine at the PAWS, Inc. facility in Muncie, Indiana (home of the cartoon and toy empire “Garfield”) has been certified by the State of Indiana to be as effective as conventional treatment, and the State will issue permits to other Living Machines based on the performance of the PAWS plant, in operation since 1990.

Other Living Machines are in operation at Penn State University, Oberlin, College, the Darrow School in New York State, The Body Shop in Toronto, The City of San Francisco, Henderson Foods in Nevada, and other locations. Project researchers investigated the potentials of building a solar-powered greenhouse to house a Living Machine, however the cost and operating requirements as well as the permitting challenges were difficult to overcome.



The Living Machine at the Darrow School in New Lebanon, New York

Project researchers then investigated the potential reuse of graywater from sinks, showers and washing machines. Potential synergies existed between the active solar domestic hot water design at the Wild Sage Cohousing project and waste heat contained in graywater.



Typical Graywater system, courtesy of *Home Energy Online*

A heat exchanger like the GFX product developed under a grant from the U.S. Department of Energy could augment the heat captured by solar panels, recouping a small portion of the heat energy that literally goes down the drains of U.S. buildings – energy equivalent to 2 billion gallons of oil annually wasted in the U.S. according to DOE estimates.

In the State of Colorado, regulations currently require that graywater be treated with the same standards applied to sewage. While this made graywater use problematic in the Holiday project, research revealed that many other states permit use of graywater. See web sources listed in the appendix for more information.

Stormwater Management

In a conventional development, a large percentage of the landscape is covered with impervious streets, parking lots, and rooftops. Stormwater is channeled off-site as quickly as possible into pipes, channels and streams. This method is perceived as the best way to prevent flooding as well as developer liability. However it has negative consequences, as landscape architect Bill Wenk explains. “When you channel stormwater off-site, you lose several important opportunities – to naturally irrigate the landscape, and to remove pollutants before they enter a stream or river. We typically put water into storm sewers to transport it off the land and then pay good money to import other water for irrigation.”

Alternative stormwater management strategies, often called Low-impact Development (LID), remove pollutants like lawn chemicals, oil and gas residues, and sediment before they are carried off-site. A study performed at the University of Maryland concluded that “grassed swales” that enable water to soak in rather than run off remove 50% of the nutrients in stormwater, and up to 90% of pollutants like lead, zinc, and copper.



Stormwater management in South Livermore and Palo Alto, California: bioswale for residential neighborhood (left) and pervious surface in parking lot (right).

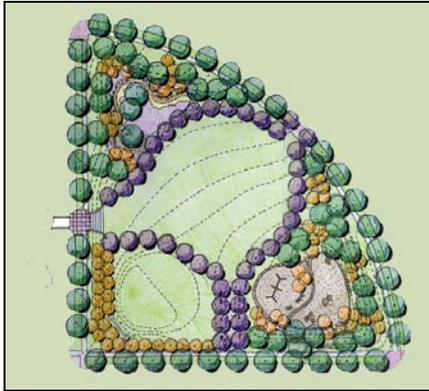
And in a study titled “Comparison of Conventional and Low-Impact Development Drainage Designs,” funded by the EPA Sustainable Development Challenge Grant (see appendix), Don Alexander concluded that while conventional stormwater management techniques removed pollutants as effectively in heavy flood events, they are not as effective in smaller storms, which account for 80% of the total runoff. Low-impact development techniques aimed at infiltration rather than immediate “export” reduce average annual runoff by up to 26%, Alexander concluded, and can be constructed at or below the cost of the conventional drainage design. “The removal of several structural components of the pipe network offsets the slightly higher unit costs of LID design, so construction costs are roughly the same,” writes Alexander.

Bill Wenk, who designed the Low-impact systems for the Holiday project, concurs. “By incorporating alternative designs early in a given project, you may eliminate the need for pipes and retention areas, freeing up valuable land for development.”

Wenk Associates’ Best Management Practices for the Holiday Project include the Park Area Sand Filter Beds that enable the 2.5-acre park to remove stormwater pollutants by infiltration and microbial decomposition. Says Wenk, “The public park presents an opportunity to accomplish water quality goals on a larger scale than elsewhere on the site. By using a sand filter bed in place of a dry or wet detention pond, the area can be used for park functions as well as storm detention and water treatment.”

During a storm, accumulated runoff ponds in the water-capture area and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. An edge of concrete steps provides a gathering space and helps distribute storm runoff evenly throughout the basin; ornamental grasses and perennials able to thrive in the varying water conditions create an interesting space within the park.

A similar design will be constructed on the Affordable Housing Alliance (Northern Lights) site at the Holiday Project, and still another LID practice will be used at the Wild Sage Cohousing site: shallow vegetated trenches or swales to utilize stormwater from rooftops.



Filter Features in the Holiday Park



Vegetated Swale at Northern Lights

Overcoming Challenges

Wenk, who worked closely with the City of Boulder to get stormwater alternatives into the project, says, “The Boulder project is exciting because the City is rethinking their basic policies about how to manage stormwater.” Part of the challenge is that under Colorado water rights law, stormwater can’t be stored on-site, because downstream users have rights to it. However, the stormwater can be infiltrated for treatment and irrigation purposes and returned to the hydrologic system – the groundwater or surface water.

Wenk Associates also collaborated with Barrett Studio, which served as the overall site designer at the Holiday Neighborhood.

Says George Watt of Barrett Studio Architects: “The goals of our research into stormwater alternatives were straightforward, including to capture water on site and recharge the water table; to have a positive impact on the quality of the water as it leaves the Holiday site; to understand and accommodate the regulatory influences on alternative systems; and to address the City’s regulatory and maintenance concerns.”

The process of achieving these goals, however, was not straightforward, and involved the efforts of the project civil engineers, Carter Burgess; Wenk Associates; and staff in various City departments -- Boulder Housing Partners, development review staff, Public Works, and Parks and Recreation.

After a year-long process, negotiations resulted in the permitting of several Best Management Practices. George Watt offered valuable insights about how to effectively implement stormwater alternatives. (see appendix)

1. Begin the process early. Many of our land use decisions at Holiday Neighborhood were made by the time SFS approached us. We would have had more flexibility within our site plan if we had been able to coordinate design efforts earlier. For example, the designs that were included resulted in a slight net reduction of land dedicated to stormwater systems, providing a small increase in land square footage for other uses such as gardens and parks. If we had started earlier, we could have “saved” additional land for other purposes.
2. Meet with regulatory officials early and often. Get them excited about the project. Engage them in the design process, because if they feel they are contributing to the project, it becomes theirs, and is more likely to get approval.
3. Meet with all concerned agencies to build consensus. The most successful meetings occurred when we had representatives from all agencies to discuss how the issues related from one agency to another. Many decisions were made simply because we had the right people in the room at the right time.
4. The most concerned parties were the maintenance divisions, the people who will inherit the design. They need to care for it and repair it as time goes by. Their ideas were influential and informed the design. These are the people to work with closely.

The New Stormwater Regulations

The implementation of low-impact development Best Management Practices will become more common in the near future because of local state and federal laws which mandate them. In California, for example, state law prescribes acceptable stormwater runoff volumes for new development projects. The Environmental Protection Agency’s Phase II regulations require permits for storm water discharges from Small municipal separate storm sewer systems (MS4s) and from construction sites disturbing between 1 and 5 acres of land. Small MS4s are those not permitted under Phase I regulations and serve a population less than 100,000. For more information about the new regulations, see references cited in the Appendix.

The Benefits of a Sustainable Lifestyle at Holiday Neighborhood

Many resource-saving measures were included in the Holiday Project by design, and function automatically to save energy, water, or materials. For example, when construction was completed, the Wild Sage neighborhood received an EPA energy rating of Five Star Plus -- the highest rating given -- on all of its 34 homes. Clearly, the design team created a winning combination of building elements and features.

Many other resource-saving aspects of the neighborhood rely on human behavior, such as reduction in the number of car trips, consumption and disposal of products, and overall participation in recycling. If Wild Sage is equal to or better than the average cohousing neighborhood in the U.S., residents will drive 30% less, pay 50% less in utility bills and use 40% less water.

For example, because of great linkage with Boulder’s bike trail system and parks, there will be a higher proportion than average of bicycle trips originating from Wild Sage. Chris and Jules Hauck, new residents of Wild Sage, talk about how their new lifestyle has a narrower radius. “Everything we need is within a very small universe,” says Chris. “We take the kids to school by bike, we can walk to shops, and we can take the bus to the bank. By having a smaller radius of activities than before we use fewer resources, and we also have more opportunities for exercise and direct contact with nature and with people.” The couple compares its current lifestyle with their previous home in Texas. “We had to travel an hour by car to get to just about everything, and we ate up a large part of our average day just surviving. Here, we’ve given up our second car, and we have

much more time to be with our kids.” The Haucks have also given away their TV set in favor of such activities as playing guitar and learning to dance the Tango.

Chris is especially excited about the Studio Mews section of the Holiday neighborhood, right down the block from their new home. “I’ve envisioned walking through the Mews and seeing the artists at work on the first floor, and getting to know not only the art, but the artists themselves,” he explained. “The kids will get to see the full cycle of a favorite piece of art, from its creation through its final location in our house.”

Residents of the Holiday neighborhood may be less likely to accumulate consumer goods because the houses are smaller in the Holiday project than the average American home (about 2,000 square feet). Says George Watt, “We realized early on that the way to make houses more affordable was to make them smaller.” Yet, as architect John Wolff explains, smaller houses don’t have to be less enjoyable to live in. “Affordable doesn’t necessarily mean ‘cheap,’ says architect John Wolff. “Building at 30 units per acre is probably the most sustainable thing a developer can do to conserve land, water and energy. If you build at the typical suburban density of 3 units per acre, you’ll need ten times as much land, ten times as much infrastructure for water, sewer, utilities, roads... So if you can build compact, livable, affordable communities and still get the same qualities as at the lower densities, then you get the best of both worlds.”

Gene Rodriquez and Eva Mesmer would agree. They moved to Wild Sage from a 3,500 square foot mountain home with 8 acres, and are looking forward to having a smaller ecological footprint in their new 2,000 square-foot home. In their first month at Wild Sage, a cold spell settled into Boulder for a week or so, but their house was warm, cozy, and inexpensive to heat. Their first energy bill was less than half of what they were used to paying.

Changes that people make to save resources are reinforced by a neighborhood culture that rewards such behavior. For example, at Wild Sage, a community workshop is located under the common house, which will eliminate the need for every household to have a full set of tools. “Why have 34 table saws when one will work fine?” asks Bryan Bowen. A similar argument can be made for the guest room at Wild Sage – this resource eliminates the need to heat and maintain 34 guest rooms.

Says Jules Hauck, “As we began moving in, we began to know who has the extension ladder, the gas-fired grill, or the two-person tent. There’s no doubt that we’ll buy fewer consumer items because of all the sharing, and besides, where would we put all the stuff in a relatively small house?”

The Holiday community garden is a resource-saver, too, supplying favorite foods like ripe tomatoes that don’t have to be shipped 1500 miles to residents’ tables. The average American uses as much energy every year to support his or her lifestyle as it would take to drive two and a half times around the planet, yet maybe in the Holiday neighborhood, that energy consumption will be reduced by a third or more because there are shops, jobs, friends, common areas, recycling containers, energy-efficient houses, a garden and orchard, bus stops and car sharing opportunities right in the neighborhood.

The Holiday Neighborhood is a world-class model of a sustainable, affordable neighborhood. By design, its houses and yards are smaller than average; retail and work/live opportunities are part of the neighborhood; high levels of energy efficiency, water efficiency and passive solar heating and daylighting are standard; and “livability” is enhanced by features such as a large park, a community garden and orchard, and a central, unifying walkway that invites people to get out of their cars and their houses. This neighborhood will be one to watch.

Endnotes

1. Permanently affordable means that sale prices of the homes will always remain essentially the same.

2. For general information about the City of Boulder and the Boulder Housing Partners roles in the project, visit the website holidayneighborhood.com. For information about the affordability aspect, contact Cindy Brown at 720-564-4642; brownc@ci.boulder.co.us.

(3) For information about the Holiday Site Plan, contact Barrett Studio Architects, 1944 20th St., Boulder, CO. 80302, Telephone 303 449-1141; BSA@BarrettStudio.com.

(3) For more about the Boulder Green Points Program, visit the website at http://www.ci.boulder.co.us/buildingservices/codes/greenpoints/1001_web.pdf.

(4) To contact green building expert David Johnston, visit the What's Working website at http://www.ecologos.com/contact_us.html or contact David Johnston at 57 Acorn Lane, Boulder, Colorado 80304; (303) 444-7044 Voice; Email: david@whatsworking.com.

(5) To contact Cohousing developer Wonderland Hill, visit the website at www.whdc.com Shirley Thielen phone: (303) 449-3232, Email shirley@whdc.com

(6) For more about the EPA Sustainable Development Challenge Grant for the Holiday Neighborhood, visit the Sustainable Futures Society website at Sustainablecolorado.org.

(7) Contact George Watt at Barrett Studio Architects for more information about the Holiday site plan and stormwater Best Management Practices at Holiday. Telephone 303 449-1141.

(8) For information about sustainable lighting design or to get a copy of Residential Lighting Guidelines for Energy Efficiency, contact Clanton & Associates, at 4699 Nautilus Court South #102, Boulder, Colorado 80301; 303.530.7229. info@clantonassociates.com.

(9) To contact Richard Pinkham about water conservation and efficiency, call Rocky Mountain Institute, 970 927-3807; swc@rmi.org; 1739 Snowmass Creek Road, Snowmass Colorado 81654-9199.

(10) For information about low impact development for stormwater management or to get a copy of the "Water Quality Report: Boulder Holiday Neighborhood," contact Wenk Associates, Inc., 1035 Cherokee St., Denver, Colorado 80204 (303) 628-0003. For more about the report, "Comparison of Conventional and Low Impact Development Drainage Designs," visit the SFS website at sustainableColorado.org.

(11) To view a copy of "The Energy Report" by Jim Logan Architects, visit the SFS website at sustainablecolorado.org. For questions about the Wild Sage project, contact Bryan Bowen at Jim Logan Architects, 1455 Yarmouth Avenue, Ste 114, Boulder, CO 80304; (303) 449-3274.

APPENDIX

Access to People and Resources Mentioned in this Report

THE DEVELOPERS

NORTHERN LIGHTS
Affordable Housing alliance
Mark Jellison 720-260-2800 m.jellison@att.net
www.wlarch.com/projects/northern.html

STUDIO MEWS -ARTIST STUDIOS, NORTHSTAR PLACE –
Coburn Development
Julie Meko 303-449-7000 julie@juliemeko.com

<http://www.coburndevelopment.com/>

GARDEN CROSSING—TOWNHOUSES AND CARRIAGE HOUSE UNITS
Peak Properties & Development
Marybeth Friesz 303-444-3020 marybethf@peak-properties.com
www.peak-properties.com

NORTH COURT—TOWNHOUSES AND ARTIST STUDIOS
MAIN STREET NORTH—LOFTS, TOWNHOUSES, COMMERCIAL
Wolff/Lyon Architects
Melissa Emery 303-447-2786 melissa@wlarch.com
www.wlarch.com

WILDSAGE COHOUSING COMMUNITY
JIM LEACH
WONDERLAND HILL DEVELOPMENT COMPANY
745 POPLAR AVE.
BOULDER, CO. 80304
(303) 449-3232

TO LEARN MORE ABOUT POTENTIAL ELIGIBILITY FOR
AFFORDABLE HOUSING, PLEASE CONTACT
City of Boulder Housing and Human
Services
303-441-3157 www.ci.boulder.co.us/hshhs/

HOMES FOR RENT – TO REQUEST AN APPLICATION, CONTACT:
DIVERSIFIED PROPERTIES
Lisa Luckett 303-598-0942 www.boulderhousing.org

Water Management

Water Quality Report: Boulder Holiday Neighborhood
Wenk Associates (303) 628-0003
Barrett Studios (303) 449-1141

Water Efficiency

www.waterwiser.org
www.epa.gov/owm/water-efficiency
www.sustainable.doe.gov/efficiency/weinfo.shtml
www.rmi.org/sitepages/pid15.php

Water 2010: Four Scenarios for 21st Century Water Systems
by [Richard Pinkham](#), [Scott Chaplin](#)
Rocky Mountain Institute; (March 1996)

Dual Flush Toilet

<http://www.caromasa.com/testimonial/Dual-Flush%20Fixture%20Studies.pdf>

Boulder Green Points Program

http://www.ci.boulder.co.us/buildingservices/codes/greenpoints/1001_web.pdf

Xeriscape

www.denverwater.org/xeriscapeinfo/xeriscapeframe.html

<http://www.xeriscape.org/bibliography.html>

Living Machines

www.oceanarks.org/ecodesign/industrialecology

<http://www.goodwater.com/html/livtech.htm>

www.livingmachines.com

From Eco-Cities to Living Machines: Principles of Ecological Design
by [Nancy Jack Todd](#) (Contributor), [John Todd](#), [Jeffrey Parkin](#) (Illustrator)

Graywater Reuse

<http://www.graywater.net/>

<http://ag.arizona.edu/AZWATER/arroyo/071rain.html>

www.wvu.edu/~agexten/hortcult/homegard/graywate.htm

http://www.birdcrossstitch.com/Family_Focus/Rainwater_Collection.html

<http://gfxtechnology.com/contents.html#selection>

Stormwater Management

http://www.oznet.ksu.edu/urbanwater/stormwater_management.html#TOR

<http://www.lowimpactdevelopment.org/>

<http://www.lowimpactdevelopment.org/links.htm>

<http://www.cleanwaterprogram.com/startatthesourceflyer%20.pdf>

http://www.stormwaterreporter.com/newsletter_archives/newsletters_2003-04_phase2.html

Air Quality, Energy Efficiency, Sustainability

Software tools for analyzing buildings in the design phase:

Energy 10 software is available from:

Sustainable Buildings Industries Council

1331 H St. NW, Suite 1000

Washington, D.C. 20005-4706

(202) 628-7400, ext. 210

email: sbic@sbiccouncil.org

www.sbiccouncil.org

DOE2 is available from:

James L. Hirsch and Associates

12185 Presilla Road

Camarillo, CA 93102-9243

(805) 553-9000

www.doe2.com

“AIR QUALITY BENEFITS OF SUSTAINABLE DESIGN: Holiday Neighborhood, a Case Study,” a report produced by Robert Duprey for Sustainable Futures Society, is available at www.sustainablecolorado.org.

For information about renewable energy and energy efficiency, visit the website, <http://www.eere.energy.gov> that has links to many other websites.

For information about the EPA Energy Star program, visit the website www.energystar.gov.

For more information about the Sustainable Futures Society and its current projects, visit the web site at www.sustainablecolorado.com