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Pictured on the cover: Top - Drachma Housing in West Oakland: dual glazed vinyl windows in historic rehab. Photo by Dan Adams.
Middle - Rich Sorro Commons in San Francisco: stained concrete flooring in lobby. Photo by Gonzalo Castro.
Bottom - Nueva Vista Family Housing in Santa Cruz: rooftop photovoltaic panels. Photo by Fred Pollack.

ACKNOWLEDGEMENTS

The content of this Handbook has been compiled and formatted by Rob Rich and Anne Romero of the San Francisco Mayor's Office of Housing, and Dan Adams, Rose McNulty, and Irene Yang of Asian Neighborhood Design. However, the information presented in the pages that follow represents the input of literally hundreds of San Francisco Bay Area affordable housing practitioners: non-profit developers, architects, city officials, property management staff, and builders whose knowledge and experience in affordable housing development has not only been invaluable to the creation of this Handbook, but more importantly, essential to the creation and management of thousands of quality affordable housing units in the Bay Area. It is to this community of affordable housing specialists that we owe our first debt of gratitude.

The process of compiling the initial version of the Handbook began in 1996 when the San Francisco Mayor's Office of Housing (MOH) and Asian Neighborhood Design (AND) sponsored a series of seminars. A central goal of those initial seminars was to provide an opportunity for developers, designers and property managers to sit down together and share their experiences regarding what worked and what didn't work in multifamily affordable housing. Quotes, insights, anecdotes and admonitions from this first group of workshop participants still ring true and we have continued to draw and reflect upon their sage recommendations throughout this updated version of the Handbook.

In order to update the Handbook, AND and MOH collaborated once again in 2001 holding a series of workshops which investigated the potential for incorporating emerging "green" technologies and sustainable building techniques within high density affordable housing in San Francisco. Presenters at the four part series were: Kevin Drew (SF Environment), Gary Ashbrook (Sanitary Fill Company), Jim Steinmetz (Reusable Lumber), Bobbi Sue Hood (Hood Miller Assoc.), Antonia Bava (Antonia Bava Landscape Architects), Larry Strain (Siegel and Strain Architects), Bill Burke (Pacific Energy Center), Mark Palmer (SF Environment), Raymond Brooks (Raymond Brooks Engineers), Jim Fagler (AND), Rick Diamond (Lawrence Berkeley National Laboratory), Marc Delany (Ghoti & Co.), Glenn Kellerer (Chinatown CDC), Scott Smith (Roberts-Obayashi), Lynn Simon (Simon & Assoc.), Chuck Palley and Paul Kohler (Cahill Contractors), Doug Shoemaker (NPH), Pat Dyas (State of California), and Joel Lipski (MOH). Their interest in and knowledge of green building and affordable housing has served as inspiration for this document and we have attempted to translate much of the content of their presentations to these pages.

The drafting of this work could not have been accomplished without the important collaboration and considered input of several individuals including: Gonzalo Castro, Joel Lipski, and Mae Chan Frey. We were also very fortunate to work with Amy Dryden, our tireless intern who provided valuable research and writing on a variety of green building materials and construction methods. In addition, several organizations helped immeasurably by freely sharing their expertise and encouragement, including: SF Environment, Pacific Energy Center (PEC), Alameda County Waste Management Authority (ACWMA), Non-Profit Housing Association (NPH), Rebuild America, Strategic Energy Innovations, and the Green Affordable Housing Coalition. Also, the Enterprise Foundation, through the Frederick P. Rose Architectural Fellowship, provided financial support for Dan Adams' work at Asian Neighborhood Design during much of the drafting of the Handbook.

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KEY CONCEPTS AND CHALLENGES

INTRODUCTION

The purpose of the *Materials Handbook: Guidelines for Sustainable Affordable Housing* ("Handbook") is to share knowledge about building materials and design strategies that have been used to create healthy, high quality, multifamily affordable housing for low income people in San Francisco. A guiding principle of the Handbook is that projects benefit when developers actively participate in important design decisions. While the need for this participation may seem obvious, developers operate in a world of multiple demands. When faced with competing deadlines, it can be tempting to let the architect "take care of the design." Without undermining the designer's critical role, the developer can actively participate in the design process in order to help ensure that buildings are healthy, high quality, and affordable for the long term.

The Handbook strongly encourages project managers to foster an active and ongoing dialogue among stakeholders throughout the design and value engineering process. No one better understands what works (and what doesn't) in the design and operation of affordable housing than the people who live there and those who provide the maintenance, asset management and support services for these buildings. Developers need to draw upon the collective experience of these stakeholders to replicate elements that are working well, and to avoid some of the problems that have arisen on other projects. While the Handbook may help to highlight some critical issues that should be carefully considered, it is not a substitute for dialogue between the development, property management and support services teams.

Sustainable Buildings

Building housing that is healthy, high quality and affordable for the long term is consistent with many of the ideals of green[1] or sustainable[2] development. For example, improving energy efficiency helps to maintain affordability by reducing utility bills/operating costs and protecting the building from some of the volatility of fluctuating energy markets. Improving energy efficiency is also a core element of green design because a reduction in energy usage typically results in a reduction in green house gas emissions. However, due to the strict funding limitations under which affordable housing operates, the concept of "sustainable" used in this Handbook primarily focuses on measures that directly improve the health of the tenants and the affordability of buildings over time, rather than on measures that provide important, yet somewhat diffuse, environmental benefits.[3]

The Handbook does not establish rigid design requirements. These are only guidelines intended to help spark a dialog that leads to more informed design decisions. It only addresses selected issues, and even then it does not define specific solutions to design questions. Rather, the Handbook is best used as a "living document" to be augmented and annotated by the user. In addition, for those seeking to create or update their own "standard specifications,"[4] it may help identify some issues that deserve input from other affordable housing stakeholders.

Long Term Affordability

A central premise of the Handbook is that affordable housing should be designed to remain "affordable" over the long term, and ideally, for the useful life of the building. While such long term affordability depends in part on keeping initial construction costs as low as possible, long term operating and replacement cost savings are equally important.

In light of the scarcity of subsidies and in the context of extraordinarily high development costs in the Bay Area compared to other areas in the state and country, keeping a lid on initial construction costs is one way to maximize the effectiveness of those subsidies. If an "economical" construction budget results in a development that needs additional capital subsidies from time to time because a lack of durability or efficiency places unsupportable burdens on replacement reserves, and operating costs are too high relative to income to support capital improvement financing, then it is falsely "economical." The scarcity of capital subsidies is only exacerbated by developing housing that needs periodic infusions of additional subsidies to maintain and preserve its affordability, subsidies that might otherwise be used for new housing.

Since the goal of long term affordability is to provide healthy, high quality, affordable housing that can be operated over time on relatively low operating income, every element of a development's planning and implementation should be undertaken with an eye toward minimizing the need for operating income. The very purpose of capital subsidies for initial construction and development is to reduce or eliminate long term debt and the burden it places on operating income. Similarly, sustainable development activities that over the long term reduce the need for operating income should be encouraged. "Life Cycle Costs Analysis" (described below) may be used to justify higher construction costs when it can be demonstrated that increasing the initial investment will generate long-term savings through lower operating and replacement costs, and thereby promote affordability.

Life Cycle Cost Analysis

Life cycle cost analysis is a tool to help evaluate the long term financial consequences of design decisions, including decisions involving durability and energy efficiency. “Life cycle costs"[5] typically include an analysis of three elements: initial cost, operating costs, and useful life (replacement costs). Perhaps the simplest measure of life cycle costs is the "payback period,” or the time it takes to recoup a marginal additional investment through savings captured over time.

payback calculation...

Simple payback can be calculated using the following formula:

P = I/S

P = Payback (typically represented in years)
I = Initial cost differential (the additional cost of the proposed feature)
S = Savings per year, including energy and maintenance costs

Case Study: A comparison of residential washing machines

A nonprofit developer[6] compared the life cycle costs of "regular" washing machines (those that comply with minimum efficiency standards) with "Energy Star" models[7] in order to determine how long it would take for the utility savings generated by the Energy Star models to "payback" ("P") the higher initial cost. The initial cost to purchase each Energy Star washer ("I") was approximately $324 more than base models.

The Energy Star model was estimated to use about ½ the electricity of the base model (with electrical savings calculated at $55/yr). In addition, the Energy Star model used much less water than a conventional clothes washer, conserving about ½ the gas used by the base model to heat the water for washing clothes (with gas savings calculated at $20/yr). Consequently, the combined utility savings for each Energy Star washer was estimated at $75 per year ("S").

P = $324/$75
P = 4.3 years

Therefore it was estimated that it would take about 4.3 years of utility savings to "payback" the initial price difference between the base and Energy Star model.[8] Since the useful life of the appliance (estimated at 12 years)[9] far exceeded the payback period (4.3 years), the payback period analysis helped to justify a higher initial budget for washing machines.[10]

Whole Building Analysis

Although the "initial cost" of a proposed design element is certainly important, it can be somewhat elusive. An accurate analysis of initial costs requires a "whole building analysis," which is the consideration of the effects that design decisions have on interrelated building systems.[11] For example, at first blush, the initial cost of electric baseboard heat appears quite low because electric resistance heaters themselves are relatively inexpensive. However, a building using electric heat may need to have a larger supply of electricity then would otherwise be required, including larger sub-panels and potentially even a transformer. In addition, electric baseboard heat consumes so much energy that the California Building Code ("Code")[12] only permits it when the design realizes sufficient energy efficiencies elsewhere to make up for the energy consumption of electric resistance heat.[13] Therefore, a building using electric baseboard heaters may need to provide windows, insulation or water heaters that are more efficient than the Code otherwise requires. The marginal costs of increased electrical capacity and required energy efficiency measures are appropriately considered part of the initial cost of electric baseboard heat under the whole building analysis.

Organization of the Handbook

The three sections of the Handbook are meant to flow from (1) a general introduction of concepts to (2) the application of those concepts to different areas of a building to (3) a more detailed description of selected building materials and components. The first section, **Key Concepts and Challenges**, introduces principles that guide the analyses in subsequent sections. The four Key Concepts are: durability and ease of maintenance, energy efficiency, indoor air quality, and recycling. The first section closes with a discussion of common challenges that project managers frequently encounter: funding for sustainable buildings, comparing costs, changing standard construction practices, and the rehabilitation of existing buildings.

The second section, **Design**, looks at different building areas by location and use. By sharing lessons learned, this section can help the reader to incorporate proven features while avoiding some of the problems that affordable housing projects in San Francisco have experienced. For example, intensively used common areas, such as lobbies or corridors, need durable finishes that are easily cleanable. In addition, some materials that are mentioned in this section, such as real linoleum (a durable, easily cleanable, natural floor covering), are cross-referenced for a more detailed analysis in section three.

The third and final section, **Materials**, provides a more detailed evaluation of selected building materials and components. Once again, the evaluation is guided by the key concepts introduced in the first section. Utilizing a flexible format, selected materials and components are described, the advantages and disadvantages are discussed, recommendations or environmental considerations are raised, and links are provided to other resources for additional information.

1 For a good definition of "Green Building," see BuildingGreen.com (publishers of Environmental Building News), "What is Green Building" at *http://www.buildinggreen.com/about/whatsgb.html.*

2 For a good definition of "Sustainable Development," see Energy Efficiency and Renewable Energy Network (EREN), "Overview of Sustainability" at *http://www.sustainable.doe.gov/overview/ovintro.shtml.*

3 Most multifamily affordable housing in San Francisco meets sustainability goals for the building site, such as density, brownfield redevelopment, and access to public transportation. For more information on these, and other sustainable development considerations, see "LEED Green Building Rating System," US Green Building Council, *www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf.*

4 A "standard specification" is a document prepared by a developer based on their past experience that defines materials, fixtures and equipment that should be used on future projects. It can be an excellent tool to reduce design fees and operating costs. Developers that know what they want and communicate that in advance to their designers save valuable design time, and insure consistency across buildings. It is important to regularly update standard specifications because building standards change and developers gain new design insights over time.

5 The definition of "Life Cycle Costs" used in the Handbook is based on the Federal Energy Management Program (FEMP) that evaluates the cost effectiveness of equipment purchases for Federal facilities. For further information, see http://www.eere.energy.gov/femp/. It should be distinguished from the similarly titled "Life Cycle Assessment" that considers broader "cradle to grave" environmental impacts including "embodied energy" and environmental effects of manufacturing. For further information regarding Life Cycle Assessment, see the Building for Environmental and Economic Sustainability (BEES) web page and software, *http://www.bfrl.nist.gov/oae/software/bees/buzz.html.*

6 The life cycle cost analysis was performed in June 2002 for Mercy Housing California, by Brown,Vence & Associates under contract with the SF Department of the Environment, for the Carter Terrace family housing development.

7 For more information regarding the Energy Star program, see *www.energystar.gov.*

8 The energy efficiency requirements for appliances, and the standards for "Energy Star" rated appliances, change regularly. Therefore, this example may not be applicable for subsequent appliance standards or Energy Star ratings. However, Energy Star rated models will always provide greater energy efficiency than baseline models, with operating savings accruing to the building.

9 According to Energy Star's "Savings Calculator," washing machines are assumed to have a useful life of 12 years. *www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CW_savings_calc.xls.*

10 If the estimated payback period exceeds the useful life of the item, then the investment cannot be justified solely on a life cycle cost basis.

11 For a good overview of Whole Building Analysis (also known as "Whole Building Design", or "Integrated Design"), as well as links to tools for more sophisticated Life Cycle Cost Analyses, see *www.eere.energy.gov/buildings/design/wholebuilding/index.cfm.*

12 Also commonly referred to as "Title 24."

13 Unlike most of California that has heavy air conditioning loads, electric heat in San Francisco causes an electrical usage "peak" during cold winter weather that strains local generation and distribution capacities.

KEY CONCEPTS IN AFFORDABLE HOUSING

This Handbook stresses four key concepts: Durability (and ease of maintenance), Energy Efficiency, Indoor Air Quality, and Recycling. The first two concepts help to insure that housing remains high quality and affordable over the long term. The third key concept, Indoor Air Quality ("IAQ"), is intended to insure that housing is healthy, particularly for people with respiratory problems, such as asthma. The last key concept, Recycling, is very broad, combining everything from "recycling" entire buildings (rehabilitation, or "rehab"), to using building materials that contain recycled materials.

This section will address the following issues:

A. Durability and Ease of Maintenance

B. Energy Efficiency

C. Indoor Air Quality ("IAQ")

D. Recycling

Durability and Ease of Maintenance

Durability may be the single most important concept for insuring that housing remains healthy, high-quality and affordable for the long term. Intensely used housing, like Single Room Occupancy (SRO) hotels or multifamily rental housing, requires durable materials to stand up to heavy use. Finishes and fixtures commonly found in market rate housing often cannot withstand the demands of high use, high density, affordable housing. In addition, the neighborhoods in which affordable housing is located, or the populations it is designed to serve, sometimes present challenges not typically found in market rate housing.

Finishes chosen for low initial cost without sufficient consideration of long-term maintenance needs may require frequent replacement and repair and thus greatly increase operating costs. If durability is sacrificed, the burden of avoidable repairs can cause a building to begin a downward spiral where deferred maintenance leads to increased tenant vacancies that further compound cash flow problems. Without an infusion of additional funds, this spiral can have catastrophic consequences. Therefore, durability is not a luxury, but a crucial part of the initial investment that helps to maintain affordability by reducing pressure on a building's operating and replacement reserves.

Durability is an important concept in green design because durable building components last longer and therefore generate less waste that needs to be disposed of in our landfills. Durability also provides significant, though less obvious, benefits by insulating tenants from unnecessary replacement and repairs performed in an occupied building. For example, carpet removal can generate a tremendous amount of dust. Even in newer buildings this dust can contain mold, dust mites, and other asthma triggers. In older buildings the dust may also contain hazardous levels of lead.[1] In addition, new carpeting may "offgas"

volatile organic chemicals ("VOCs") that can create health problems for people with chemical sensitivities.[2] Therefore, a decision to use a more durable floor covering can improve a building's operating budget, save precious landfill space, and protect indoor air quality.

Although durability is an important consideration, things eventually wear out and break. Some property managers prefer components that are either "'bombproof' or easily replaceable." This means things should either be extremely durable, or easy to fix and replace. In order to be easily replaceable, replacement parts should be locally available, and maintenance or repair should not require highly specialized skills. Otherwise, a component may be rendered unusable due to a lack of readily available replacement parts or skilled labor.

Energy Efficiency

Energy efficiency can provide significant financial benefits to the residents, managers and owners of affordable housing. Not only has California's recent energy crisis and rising energy costs necessitated a change in energy use on the part of the general population, but housing developers and property management firms have had to review and adjust proformas and operating budgets to take into account rising energy costs. Methods for saving energy have the potential to offer considerable financial savings that help to preserve affordability. Life-cycle cost analysis (introduced above) of energy efficiency measures can be used to evaluate whether financial savings generated over time justify higher up front costs. In addition, lower energy costs can directly translate into lower operating costs, and the savings may be used to help leverage additional financing for the project.

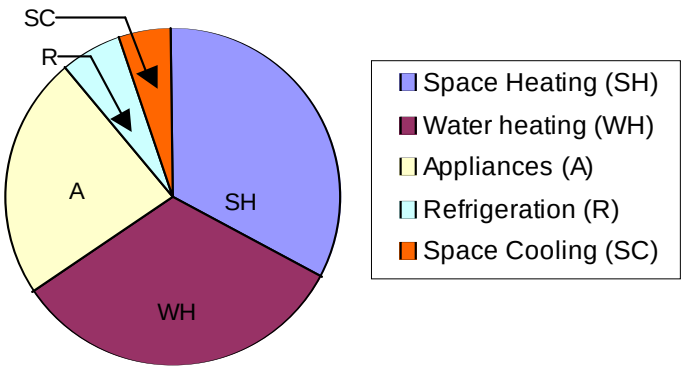
Decisions made early in the design will impact energy use throughout the life of a building. The basic design of the building envelope has a substantial impact on the building's energy use. For example, access to natural light and air on at least two sides of units provides opportunities for "daylighting"[3] and cross ventilation.[4] This in turn will reduce the need for artificial light and mechanical ventilation, thereby lowering energy consumption and utility bills. Another example of how early design decisions can impact energy use is the space allocated to heating systems. If adequate space is not provided in the initial ("schematic") design for an energy efficient boiler or furnace, then it can be very difficult later in the project to incorporate these essential features.[5]

Although developers may not have the time or expertise to analyze different energy efficiency scenarios, there are growing sources of energy information, software and consultants. For example, many affordable housing projects already use consultants to provide sophisticated energy use analyses to "model" buildings when a design does not meet the prescriptive energy standards of the Code. These same consultants can also be used to increase energy efficiency beyond the Code-required minimum in ways that can be justified through life cycle costs.

New energy efficient buildings have vastly lowered utility costs when compared to older, existing buildings. Some local Housing Authorities have recognized this distinction by establishing alternative utility allowances that more accurately reflect the actual energy usage of efficient buildings. In addition, on a project-by-project basis, the California Tax Credit Allocation Committee ("TCAC") regulations allow the use of an alternate utility allowance if the local utility company certifies projected utility costs for the building. To secure this certification, the sponsor's engineers must first calculate projected unit energy costs and determine if they are substantially lower than the standard utility allowance. The local utility company must review and certify the calculations presented by the sponsor's engineers. In addition, according to current TCAC regulations, the local utility must re-certify the alternative utility schedule annually. Although it may be difficult to establish an alternative utility allowance, the benefits can be significant. With a lower and more accurate utility allowance, the project may be able to leverage more financing, thereby improving project feasibility.

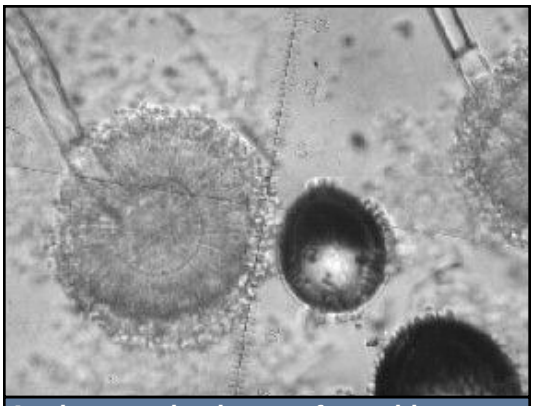
Four factors drive demand for energy use in a typical San Francisco residence: space heating, refrigeration, plug loads (such as lighting and small appliances), and water heating. Many of these issues can be addressed, and energy use minimized, through the installation of energy efficient equipment, windows, appliances and light fixtures. Look for the Energy Star label to maximize energy efficiency.

Energy Use in Multifamily Buildings



Dept. of Energy Building Technologies ProgramMultifamily Best Practices
Office of Energy Efficiency & Renewable Energy
(*www.eere.energy.gov*).

A microscopic picture of a dust mite



A microscopic picture of a mold spore

Indoor Air Quality

Indoor Air Quality ("IAQ") refers to air pollution inside a building. IAQ is important because the air inside a building is frequently far more polluted than the air outside.[6] Since people spend a great deal of time indoors, the negative health impacts of poor IAQ can be significant. Although no simple formulas exist for calculating the financial benefit of improving residential IAQ,[7] cleaner indoor air promotes healthier housing.

The types of indoor air pollution that can be controlled through thoughtful design and careful construction can be separated into three basic categories: **Dust, Mold** and **Gases**. All three have been identified as asthma triggers. Asthma is a growing problem, particularly among low-income inner city children.[8] In order to control asthma, it is important to minimize the amount of pollutants within a building. Fortunately, there are a number of rather simple and effective strategies that can be used to minimize indoor air pollutants, and thereby improve the health of all residents, especially those living with asthma or other respiratory diseases.

Dust ("respirable particulates") is perhaps the most common indoor air pollutant. It can be responsible for eye, nose and throat irritation, increased susceptibility to respiratory infections, bronchitis, and asthma. A simple, inexpensive first step to help control dust is to provide removable floor mats at the main entry to the building to reduce the amount of outdoor contaminants that are tracked inside.[9]

In general, hard, easily cleanable floor surfaces, such as linoleum, should be used wherever possible.[10] Simply put, carpeting can become a "dust magnet" that is very difficult to clean adequately. In addition, if carpeting gets wet, it may quickly become a breeding ground for mold and mildew.[11] Even vacuuming carpeting is considered to be an asthma trigger.[12]

Perhaps surprisingly, cockroaches have been identified as a significant asthma trigger for many people.[13] Fortunately, proper design and construction can help to exclude cockroaches, thereby improving IAQ and reducing the need for toxic pesticides within tenants' homes. Cracks 1/16" and larger, particularly around cabinets and baseboards, should be caulked. Penetrations for plumbing pipes and electrical conduit should be covered and sealed.[14] As an added benefit, these measures can also be helpful in excluding mice, rats,[15] and to a limited degree, even bedbugs.[16]

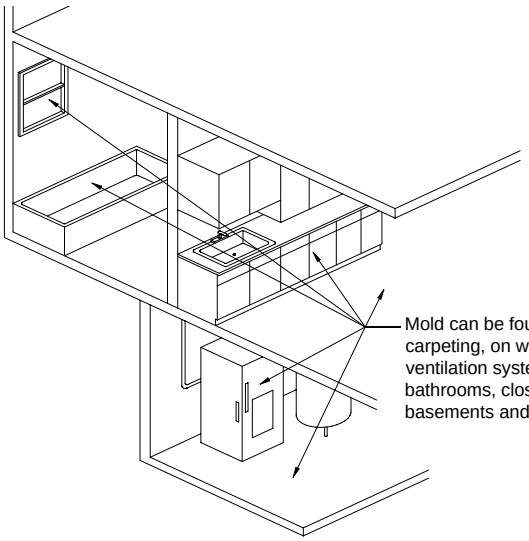
Another significant, preventable, asthma trigger is the dust that is created in an occupied building during rehabilitation. It is extremely important to prevent the uncontrolled migration of dust outside of a work area, because even "benign" dust can cause respiratory problems and trigger asthma. Therefore, dust containment (or "engineering controls"), safe work practices that reduce the amount of dust generated (such as "wet methods"), and regular clean-up (preferably with vacuums using HEPA filters) are important to help to maintain healthy IAQ during occupied rehabs.[17]

Ways to reduce dust...

- ✓ Specify hard, cleanable floor surfaces, such as linoleum, wherever possible.
- ✓ Vaccum regularly (preferably using HEPA filters) to help maintain healthy IAQ during occupied rehabs.
- ✓ Provide removable floor mats at the main entry to the building to reduce the amount of outdoor contaminants that are tracked inside.

Mold and other biological agents such as dust mites can also trigger asthma and allergic reactions.[18] In order to control mold and dust mites, it is necessary to control water and indoor humidity.[19] The building envelope (roof and exterior walls), plumbing systems and HVAC systems must be properly designed, constructed and maintained to prevent leaks and control humidity. As an added benefit, proper design, construction and maintenance help prevent "dryrot" in wooden framing, thereby avoiding expensive, and avoidable, structural repairs in the future.

Adequate ventilation, particularly to exhaust moisture/steam from cooking and bathing, is essential for controlling mold. In general, ducted exhaust fans should be provided in the kitchen and bathroom to remove excess moisture from the air.[20] Quiet fans are more likely to be used than noisy fans.[21] In addition, adequately sized operable windows are an excellent, time-tested, energy efficient means that can assist with the elimination of excess moisture and indoor air pollutants.



Even the condensation that forms on the interior surface of single-paned windows or on aluminum window frames can provide sufficient moisture for mold and mildew to grow. Dual glazed windows typically prevent this problem in San Francisco's moderate climates.[22] In addition, dual glazed windows improve energy efficiency and decrease thermal differentials within a room, thereby making the space feel "more comfortable."

If mold or mildew is encountered, it is important to determine the source of the moisture that is causing the problem. If the moisture is not eliminated, then the mold or mildew will simply return, regardless of the amount of cleaning. The cleaning of moldy or mildewed items should be performed in a safe fashion to prevent contaminating workers, tenants, or other areas of the building.[23]

Ways to reduce exposure to molds...

✓ Prevent water leaks and moisture intrusion through proper detailing and maintenance of the building envelope.

✓ Provide adequate ventilation through the provision of operable windows and ducted exhaust fans in the bathroom and kitchen.

✓ Specify dual glazed windows to limit condensation (and increase overall energy efficiency and comfort!).

Gases (including volatile organic chemicals, or "VOCs") are the third major source of indoor air pollution that can be reduced through careful design and construction. Gases can cause a myriad of health problems, including asthma, headaches, and even lung damage.[24] Some gases are invisible and odorless, and therefore difficult to detect.

Cooking and oven cleaning have been identified as activities that can cause unhealthy indoor air, generating high levels of nitrogen dioxide and formaldehyde.[25] Fortunately, a good, ducted kitchen exhaust fan can remove these pollutants from a unit, and thereby improve IAQ. In addition, all gas appliances and heaters need to be properly installed and maintained to prevent the build-up of unhealthy levels of carbon monoxide within a unit.[26]

Many building materials, including paint, composite wood products (such as particleboard and plywood), adhesives, and carpeting, may contain VOCs that can "off-gas" at normal temperatures.[27] For example, the adhesives used in composite wood products often contain urea-formaldehyde resins. Formaldehyde is a VOC that has been identified as a toxic air contaminant and carcinogen.[28] Individuals vary widely in their sensitivity to VOCs such as formaldehyde.[29]

Project managers seeking to reduce off-gassing can select low VOC, or VOC-free paints, adhesives, carpeting, and composite wood products such as medium density fiberboard ("MDF") with no added formaldehyde. In addition, all plywood, particle board, or MDF with added formaldehyde should be sealed, painted or covered with a laminate to minimize off-gassing. Also, the sequencing of construction can be scheduled so that soft finishes (such as carpeting) that can absorb, and then re-emit VOCs, are installed after high emissions work (such as painting) is completed.[30] Finally, it is important to involve property management and tenants in all efforts to control VOCs because cleaning supplies and personal hygiene products have been identified as a significant source of air pollution.[31]

Ways to reduce exposure to gases...

- ✓ Install a good, ducted kitchen exhaust fan.
- ✓ Properly install and maintain gas appliances and heaters.
- ✓ Select low VOC or VOC-free paints, adhesives and carpeting during construction.
- ✓ Seal, paint or cover all plywood, particle board or medium-density fiberboard.
- ✓ Control VOCs that come from cleaning supplies and personal hygiene products used by tenants and property management.

Recycling

Anyone who sets aside cans, bottles, and newspapers for curb-side pick-up is familiar with the concept of recycling. San Francisco recently met the state mandated waste management goal of diverting at least 50% of all waste from landfills.[32] However, San Francisco has "upped the ante" by establishing a goal of diverting 75% of all waste from landfills by 2010.[33] Therefore, affordable housing needs to provide adequate space within units and within buildings for recycling. In order to meet the 75% recycling goal, buildings should typically provide two to three times the space for recycling that is provided for trash.[34] Recycling, however, can also be pursued at a much larger scale - the scale of land development - with the benefit of keeping thousands of tons of waste out of landfills.

Rehabilitation ("Rehab"). The most important and beneficial form of recycling is to reuse entire structures. Rehabilitation projects are inherently green in this respect because they can save tremendous amounts of resources when compared to new construction.[35]

Recycled Content: What does it mean?

The term "recycled content" typically refers to both "post consumer material" and "secondary" material. Post consumer material comes from products which were purchased by consumers, used, and then discarded (recycled). For example, a newspaper which has been read, recycled, and then used as base material for new paper products, is an example of post consumer recycled material.

Secondary material, also called "preconsumer" or "postindustrial", consists of material waste produced during the manufacturing process itself, which is then recaptured and used as base material for new products. Scraps of carpet trimmed from finished rolls in the manufacturing plant which are then used as base material for production of new carpet fibers is an example of secondary recycled content.

Source: Recycled Content Product Database, sponsored by the California Integrated Waste Management Board. *www.ciwmb.ca.gov/rcp.*

Deconstruction (or "salvage") recognizes that old buildings may contain valuable materials that can be reused. For example, the lumber used in older buildings is often of much higher quality than most new lumber available today.[36] Deconstruction works best when an experienced deconstruction contractor begins working with the project team long before the time when demolition is scheduled to begin. Since deconstruction is typically more labor intensive than traditional demolition, it can be more costly. However, these costs can be controlled if a market is identified in advance for the materials that will be removed from an existing building. For example, old growth structural lumber can be removed/deconstructed from an existing building prior to demolition. The old growth lumber can then be re-milled and reused as finished flooring in the new affordable housing that will be constructed on the site. In addition, deconstruction can provide an excellent vehicle for promoting hiring programs designed to provide employment opportunities for low-income neighborhood residents.[37]

Construction and demolition debris. According to the California Integrated Waste Management Board, 12% of California's waste is generated from construction and demolition ("C&D").[38] Project managers can encourage C&D recycling by including Waste Management Plans with recycling requirements in their specifications.[39] In addition, builders experienced with C&D recycling can use their expertise to differentiate themselves from other builders, and thereby increase their market share.[40]

Materials with recycled content. The value and ease of recycling grows as the demand for products with recycled content grows. Projects that specify materials that include a percentage of post consumer waste product help to limit the extraction of new natural resources and encourage the growth of markets for recycled products. For example, some carpet is now made from 100% recycled plastic bottles.[41]

1 For further information regarding lead, see HUD's "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" available at www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm.

2 The Carpet and Rug Institute ("CRI") has established a "Green Label" testing program to identify carpet products that are truly low VOC. See, *www.carpet-rug.com/drill_down_2.cfm?page=8&sub=6*.

3 Daylighting uses natural sunlight to light a building's interior. See, US Dept. of Energy, Energy Efficiency and Renewable Energy ("EERE"), "Passive Solar Heating, Cooling and Daylighting." *www.eere.energy.gov/RE/solar_passive.html.*

4 "Natural ventilation through operable windows can be an effective and energy-efficient way to supplement HVAC systems to provide outside air ventilation, cooling, and thermal comfort when conditions permit (e.g., temperature, humidity, outdoor air pollution levels, precipitation)." See, "IAQ Design for Schools: HVAC Systems - Potential for Natural Ventilation and Operable Windows," EPA, *www.epa.gov/iaq/schooldesign/hvac.html.*

5 When feasible, projects funded in whole or in part by the San Francisco Mayor's Office of Housing ("MOH") must provide adequate space for an energy efficient furnace and boiler in the schematic design phase.

6 "Indoor Air Pollution: A Serious Health Problem," California Air Resources Board, May 2, 2001, *www.arb.ca.gov/research/indoor/rediap.htm.*

7 By contrast, businesses have documented productivity gains of up to 16% after undertaking green measures. Romm, Joseph and Browning, William, "Greening the Building and the Bottom Line: Increasing Productivity Through Energy Efficient Design," (Rev. 1998), Rocky Mountain Institute, *www.rmi.org/images/other/GDS-GBBL.pdf.*

8 Eleven percent of the children in the U.S. have asthma, more than double the number in 1980. EPA, "IAQ Tools for Schools Vol. 3," www.epa.gov/iaq/schools. Asthma is the number one cause of hospitalization among children under the age of 15. American Lung Assoc., "Asthma in Children Fact Sheet," www.lungusa.org/asthma. Children from poor neighborhoods are far more likely to be hospitalized for asthma than are children from better-off neighborhoods. "Asthma hits children hardest in poor neighborhoods," Reuters Health, 7/27/99, *www.calnurse.org/can/new1/Post672899.html*. Nearly 500,000 Americans are hospitalized annually and more than 5,000 die annually of asthma. "Asthma," *www.MayoClinic.com.*

9 Floor mats should be designed and maintained to avoid creating a trip hazard. It may be appropriate to design the floor covering so that there is a "recess" within which a standard sized mat fits.

10 Although this discussion is geared toward an analysis of health issues, since hard surfaces are typically more durable than carpeting, they can also provide excellent value over time.

11 "If a carpet becomes wet and is not dried thoroughly within 24 hours, it can support mold and mildew." The first step is to determine the source of the water. "Only carpet damaged by sanitary water can be treated non-professionally." HUD Rehab Guide Vol. 5 (2/2000), "Partitions, Ceilings, Floors & Stairs", pg. 37.
www.huduser.org/publications/destech/rehabbds.html.

12 The American Lung Association ("ALA") recommends against vacuuming when people with asthma are present. In addition, the ALA suggests that "if vacuuming must be done, a dust mask may help." See, "Controlling Asthma Triggers," 2/2000.
www.lungusa.org/air/air00_triggers.html.

13 Cockroach droppings or body parts are a recognized asthma trigger for many people. Indoor Air - Asthma, "Asthma Triggers - Cockroaches", EPA, *www.epa.gov/iaq/asthma/triggers/pests.html.*

14 Pest Notes Publication 7467, "Cockroaches," University of California Division of Agriculture and Natural Resources, Nov. 1999, *www.ipm.ucdavis.edu.*

15 "Doctors Now Blame Mice For Asthma in Urban Areas," San Francisco Chronicle, 12/12/2000. Pest Notes Publication 7483, "House Mouse," University of California Division of Agriculture and Natural Resources, Nov. 2000. Pest Notes Publication 74106, "Rats," University of California Division of Agriculture and Natural Resources, Jan. 2003. www.ipm.ucdavis.edu.

16 Pest Notes Publication 7454, "Bedbugs," University of California Division of Agriculture and Natural Resources, Rev. Sept. 2002. *www.ipm.ucdavis.edu*.

17 An excellent description of engineering controls, safe work practices and clean-up can be found in HUD's "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" available at www.hud.gov/offices/lead/guidelines/hudguidelines/index.cfm. When the guidelines are followed even when lead is not present, then the occupants should be protected from the hazards of dust inside a building during an occupied rehab.

18 "Indoor Air Pollution: A Serious Health Problem," California Air Resources Board, May 2, 2001,
www.arb.ca.gov/research/indoor/rediap.htm.

19 "A Brief Guide to Mold, Moisture, and Your Home," EPA, *www.epa.gov/iaq/molds*.

20 "Sources of Indoor Air Pollution - Biological Pollutants", EPA, www.epa.gov/iaq/biologic, "Install and use exhaust fans that are vented to the outdoors in the kitchen and bathrooms and vent clothes dryers outdoors … [to] eliminate much of the moisture that builds up from everyday activities."

21 Effectiveness of bath exhaust fans may be improved even further by the use of timers directly wired to a light switch so that the fan operates for a predetermined period of time each time the light is switched on.

22 If aluminum frames are used, the high thermal conductivity of aluminum can cause condensation to form on the frames. This problem can be eliminated by using aluminum frames with a thermal break.

23 When cleaning mold, use a dust mask and good ventilation. Clean with detergent followed by a 10% bleach formula (1 ½ cup bleach per gallon of water). For further information see, "Guidelines for Mold Control," San Francisco Public Health/Environmental Health (415.252-3800). In addition, "Mold in My Home: What Do I Do?" California Dept. of Health Services, www.cal-iaq.org/mold0107.htm, and "A Brief Guide to Mold, Moisture, and Your Home," EPA, *www.epa.gov/iaq/molds/moldguide.html*.

24 "ARB Fact Sheet: Air Pollution Sources, Effects and Control," California Air Resources Board, October 29, 2001,
www.arb.ca.gov/research/health/fs/fs2/fs2.htm.

25 "Advisory: Cooking Activities Cause Unhealthy Indoor Air", California Environmental Protection Agency News Release, November 21, 2002, *www.arb.ca.gov/newsrel/nr112102.htm.*

26 "Protect Yourself and Your Family from Carbon Monoxide Poisoning", EPA (10/96), *www.epa.gov/iaq/pubs/coftsht.html.*

27 "Off-gassing" occurs because some building materials "can contain contaminants that are gradually emitted (off-gassed) throughout the life of the material." See, "IAQ Design Tools for Schools: Controlling Pollutants and Sources", EPA
www.epa.gov/iaq/schooldesign/controlling.html.

28 "Fact Sheet: Composite Wood Products," California Air Resources Board, *www.arb.ca.gov/toxics/toxics.htm.*

29 "Some people are not bothered by moderate levels, while others are affected by low levels." Formaldehyde in the Home, California Air Resources Board, September, 1991,
www.arb.ca.gov/research/indoor/formald.htm.

30 "IAQ is affected not only by the materials that are used but also by the order in which they are installed…. Contaminants off-gassed by … materials can be absorbed by 'fuzzy' or 'fleecy' materials … [that] can become repositories (often referred to as 'sinks') for substances that can be released much later…" See, "IAQ Design Tools for Schools: Controlling Pollutants and Sources," EPA *www.epa.gov/iaq/schooldesign/controlling.html.*

31 "Ordinary household products such as cleansers, cosmetics and paints are now the Los Angeles region's second leading source of air pollution," Chemicals in Home a Big Smog Source, LA Times, March 9, 2003, *www.latimes.com.*

32 "San Francisco Recycles More than it Throws Away," SF Environment, *www.sfgov.org/sfenvironment/articles_pr/2002/pr/121202.htm.*

33 "SF seeks to recycle 75% by 2010," SF Environment, *www.sfgov.org/sfenvironment/articles_pr/2002/article/100102.htm.*

34 In general, the total amount of space devoted to household waste facilities should not have to increase in order to provide adequate space for collecting recycling and compostables. Rather, the space dedicated to household waste needs to be flexible to accommodate waste diversion strategies which today include separate bins for trash, recycling and compost. Of course, the smaller the unit, the less likely it is that there will be adequate space within the unit itself for separating waste.

35 The LEED Green Building Rating System recognizes the inherent sustainability of rehab by providing a "Materials and Resources" credit for "Building Reuse" because it conserves resources, retains cultural resources, reduces waste and reduces environmental impacts of new buildings as they relate to materials manufacturing and transport. *www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf.*

36 Structural lumber typically needs to be certified. Therefore, most lumber reclaimed through deconstruction is ultimately used as finish materials, in order to avoid the need to undergo costly structural certification.

37 "A Guide to Deconstruction: An Overview of Deconstruction with a Focus on Community Development Opportunities", HUD Office of Policy Development and Research, NAHB Research Center (February, 2000).

38 "Sampling of solid waste disposed in California for the year 1999 indicated that 12 percent of the material disposed was classified as C&D materials," See, "Construction and Demolition Debris Recycling," *www.ciwmb.ca.gov/ConDemo/* .

39 Due to extremely limited space on most urban construction sites, project managers should work with their contractors to fashion project specific Waste Management Plans that establish achievable goals. In San Francisco, C&D recovery rates are now commonly in the 65% range, even when the contractor is not engaging in any construction site recycling or sorting.

40 See, "Case Study: New Construction Recycling - Citation Homes Recycles 86% of New Construction Waste," *www.stopwaste.org/citation.html.*

41 Green Resource Center, "'Greener' Carpet", (Rev. 11/11/02), *www.greenresourcecenter.org/MaterialsSheets/GreenerCarpet.html.*

CHALLENGES IN AFFORDABLE HOUSING

No project is perfect. Challenges are inevitable. Perhaps no challenge is greater than the fact that funding for affordable housing is extremely limited. Furthermore, the initial construction cost for projects that are designed to be durable and energy efficient, with good indoor air quality, and that promote recycling may not compare favorably to other projects that do not incorporate those features. In addition, affordable housing developers seeking to include new or different construction materials may be faced with resistance from the builder, especially if the sponsor is directing the builder to perform the work in a way that varies from standard construction practices. Finally, several issues concerning the rehabilitation of existing buildings ("rehabs"), with a special emphasis on occupied rehabs, are considered.

This section will address the following issues:

A. Funding for Sustainable Buildings

B. Comparing Initial Costs to Other Buildings

C. Changing Standard Construction Practices

D. Rehabilitation of Existing Buildings

Funding for Sustainable Buildings

Although limited, there is an assortment of programs that can help fund some green features of a development, including the Federal Low Income Housing Tax Credit Program, the California Energy Commission's Emerging Renewable Program for Affordable Housing, local utility rebates and incentive programs, and some foundations. These programs can complement each other. For example, PG&E's multifamily ENERGY STAR Homes Program will fund 3rd party energy consultants that can provide the technical expertise needed to achieve the common goals of exceeding Title 24 requirements under all three programs.

Tax Credit Program

The California Tax Credit Allocation Committee (TCAC), which administers the Federal Low Income Housing Tax Credit Program, promotes sustainable building through both application scoring and through an increase in the threshold basis limits[1] to help pay for the additional initial cost of certain items.

Application Scoring. In 2003, the TCAC application scoring allows up to 8 points for a variety of sustainable building methods. The applicant and project architect must certify in the application and at the project's placed-in-service date that the items have been included. The first five points are for a project application that utilizes materials that will increase energy efficiency by at least 15% above Title 24 energy standards, or a rehabilitation project that will increase its existing energy efficiency by at least 25%.

TCAC Application Scoring...

Projects that incorporate items from the following list may receive an additional 1 point for each, to a maximum of 3 points:

✓ Use of energy efficient appliances with the Energy Star rating for all appliances and for all heating and cooling systems

✓ Use of natural gas for cooking and space heating

✓ Use of occupancy sensors for all bathrooms, garages and storage spaces

✓ Use of florescent light fixtures for at least 75% of light fixtures

✓ Use of simple, low water landscape or irrigation design that reduces water use by a minimum of 10% over conventional irrigation designs

✓ Use of formaldehyde free or fully sealed particleboard or fiberboard for all cabinets, countertops and shelving

Increase in threshold basis limits. In 2003, the tax credit program provides a 4% increase in the threshold basis limits for projects that include three of specified energy efficiency/resource conservation/indoor air quality items. This basis boost can increase capital contributions to the project to help pay for these items.

A further increase in basis limits up to 5% is allowed in projects where distributive energy technologies such as microturbines and/or renewable energy sources such as solar will be implemented. To obtain this increase, the applicant must submit evidence of the savings to be created through the use of the technology, and is permitted in the Executive Director's sole discretion.[2]

To illustrate the potential equity value of the TCAC increase in basis limits for sustainable development items, the following is a calculation of tax credits for a hypothetical project that has incorporated energy efficiency items and a renewable energy source, such as solar (photovoltaic) power. The combined energy efficiency and renewable energy basis boost value for this project with a $10 million basis limit is $786,512.

Calculation of Tax Credits and Value of Equity...

Sample Project with improved Energy Efficiency and Renewable Energy

Project Assumptions:

1). 9% Federal Credits (not tax-exempt bonds)
2). Eligible costs exceed basis limits ("basis limited project")
3). Basis limit is a "plugged" figure of $10M
4). Savings generated by renewable energy source exceed $500,000 over 55 years
5). Title 24 exceeded by 15%
6). Energy efficiency/resource conservation/indoor air quality items: *see Page 40 of Regs.*
- (1) Exceed Title 24 standards by at least 20%
- (2) Use Energy Star rated appliances — *Selected*
- (3) Use gas ovens, stoves, and clothes dryers
- (4) Use tankless water heaters — **Must select 3**
- (5) Use linoleum or ceramic tile for kitch/baths
- (6) Use natural fiber, recycled content flooring — *Selected*
- (7) Use Energy Star rated roofs
- (8) Provide hard wiring for computers in units — *Selected*

Basis Calculation		
221(d)(3) Basis Limit		$10,000,000
TCAC Basis Limit (before adjustments)		**$10,000,000**
Plus Prevailing Wage Adjustment	12%	$1,200,000
Plus Special Needs Adjustment	2%	$ -
Plus Energy Efficiency/Resource Conservation	4%	$400,000
Plus Renewable Energy Boost*	5%	$500,000
Totals		**$12,100,000**
High Cost Adjustment	**130%**	**yes**
Qualified Credit Basis		**$15,730,000**
Federal Credit Rate for a 9% project	**8.10%**	
Max Credit Amount		**$1,274,130**
Ten Year Total		**$12,741,300**
General Partner Share	*0.01%*	$1,274
Limited Partner Share	*99.99%*	$12,740,026
Tax Credit Factor	*$0.83*	
Total Tax Credit Equity		**$10,574,221**

Equity Value of Energy Boosts	**Boost Value**	**Equity Value**
Energy Efficiency	$400,000	**$349,561**
Renewable Energy	$500,000	**$436,951**
TOTAL PROJECTED EQUITY VALUE FOR ENERGY BOOSTS		**$786,512**

*Calculation of the boost is based upon the **lesser of** 5% **or** estimated savings to the project over 55 years.

California Energy Commission's Emerging Renewable Program for Affordable Housing

In 2002, the California Energy Commission established a rebate for photovoltaic (PV) systems installed on affordable housing projects, which can reduce the price significantly. PV converts sunlight directly into electricity using semi-conductors, often incorporated into panels mounted on the roof. Affordable housing projects may qualify for an extra 25% rebate above the standard rebate, not to exceed 75% of the system cost based on meeting additional eligibility criteria. This rebate can supplement the tax credit program basis boost to help pay for the installation of solar electric systems. The project must be individually metered, and funding levels decrease every 6 months.[3]

Local utility rebates and incentive programs

As of 2003, energy efficiency rebates and incentive programs for multifamily housing are available statewide. PG&E's ENERGY STAR Homes Program offers up to $150 per multifamily unit for projects that incorporate energy efficient features. To qualify, buildings must be accepted into the program before beginning construction and exceed Title 24 requirements by at least 15%. This program is for new construction, and the project must be in the PG&E service territory. PG&E will provide program support, including additional incentives for multifamily energy consultants and inspections.[4]

While the requirements of funding programs may change from year to year and take time to research and assemble, they can make a critical difference. Incorporation of sustainable building methods into the tax credit program scoring will ultimately raise the bar for certain green building features to become standard in affordable housing.

Foundation Support

The Kresge Foundation, as part of its Green Building Initiative, is providing special planning grants of $50,000 to $100,000 to nonprofits to help cover costs associated with investigating sustainable building design, as well as bonus grants of $150,000 - $250,000 to grantees whose buildings become Leadership in Energy and Environmental Design ("LEED") certified. They will hold green building workshops designed for nonprofit organizations in 2004, and have developed two brochures for non-profits: "Why Build Green?" and "How do I Build Green?" which can be downloaded from www.kresge.org/initiatives/index.htm.

Groups that can provide technical assistance and up-to-date information on sustainable development funding sources...

✓ Green Affordable Housing Coalition. (*www.greenaffordablehousing.org*)

✓ Global Green's Greening Affordable Housing Initiative. (*www.globalgreen.org*)

✓ The Department of Energy's Rebuild America Program. (*www.rebuild.org*)

✓ Twin Pines Cooperative Foundation, "Photovoltaics for Affordable and Cooperative Housing," April 2003. See *www.dcn.davis.ca.us/go/actpcoop* or email verve@dcn.org.

✓ Energy Action. (www.energyactionresources.org)

Comparing Initial Costs to Other Buildings

Affordable housing developers frequently struggle to reduce initial costs to protect a project's comparability to other affordable housing projects. A variety of project-specific issues can drive up construction costs, including unusual site conditions (such as steep slopes or poor soil), neighborhood opposition (generating expensive design features or lowered density), and special needs of the tenant population. These issues may make a project appear unusually expensive when compared to other affordable housing developments. Therefore, it is important to highlight any elements that distinguish one project from others. For example, a design that promotes energy efficiency may have somewhat higher initial costs than a similar project that simply meets Code minimum energy requirements. However, if the higher initial costs can be supported by life cycle cost analyses that demonstrate savings over time, then the higher initial costs actually advance long term affordability. By highlighting the long term savings that differentiate a project from otherwise comparable projects, developers can help to justify higher initial costs that promote healthy, high quality, affordable housing.

Changing Standard Construction Practices

Though much of what comprises green building is really just good design and construction,[5] some green building products and techniques are relatively new. There is always an element of risk when a new procedure is used because, like many things, much of construction is based on habit. Contractors frequently build as they always have. However, when good products are installed incorrectly, they do not perform to their potential and the value of their inclusion in the project is lost. Therefore, in order for green building materials, assemblies and equipment to be correctly installed, the developer should pay careful attention each step of the way.

- ☐ The specification should clearly highlight green measures.
- ☐ Installers should have experience with the materials or techniques.
- ☐ The owner, architect and contractor should collectively review the materials and equipment, installation procedures and potential schedule impacts of green measures prior to the start of construction, and again regularly during the course of construction.

Rehabilitation of Existing Buildings ("Rehab")

Rehab is inherently green because the recycling and reuse of entire buildings eliminates the need to dispose entire buildings. Rehab is inherently affordable because the cost of preserving an existing structure is frequently lower than the cost of new construction. In addition, rehabilitation of older buildings can help to preserve the historical character of a neighborhood. Rehab projects, however, can present a unique set of problems, including unforeseen conditions, code issues involving existing conditions, and working in occupied buildings.

Unforeseen conditions are issues that arise during construction that were unknown when the construction started. Unfortunately, what you don't know *can* hurt you. Delays and cost overruns cased by unforeseen conditions are the bane of rehab projects. Commonly encountered unforeseen conditions include: dry rotted and deficient structural framing, overloaded electrical systems, and deteriorated plumbing or steam pipes. When these issues arise after construction has started, the owner may need to make critical decisions in a very short time, frequently at non-competitive prices.[6] Fortunately, developers can help to minimize unforeseen conditions by insuring that design assumptions are made explicit, and by verifying the accuracy of the assumptions prior to bidding the work.

The three most important resources for verifying design assumptions are: **maintenance staff expertise, exploratory demolition, field measurements** and **systems testing**.

- The ideal situation is when an owner is seeking to rehab a building that they have been managing for a year or more. In this situation, the project manager can work closely with **maintenance staff** and benefit from their experience. A careful review of maintenance work orders combined with in-depth discussions with maintenance staff can reveal many of a building's deficiencies. Special attention should be paid to patterns of problems. The information should be summarized and shared with the project team in order to develop a plan for exploratory demolition and systems testing.

- **Exploratory demolition** simply means the removal of portions of a building's fixtures and finishes in selected areas prior to the rehab in order to be able to visually inspect typical conditions otherwise hidden behind walls, ceilings and floors. Exploratory demolition can be particularly useful to discover dry rot and plumbing problems in bathrooms and kitchens. After the finish surfaces have been removed, the project team should carefully inspect and document the results of the survey. Temporary coverings should be placed over the uncovered areas for safety and to maintain barriers that exclude pests, such as cockroaches. Caution must be used to avoid damaging plumbing pipes or electrical wires. In addition, dust control measures should be implemented to protect the health of workers and tenants.

- **Field Measurements.** "As built" drawings are supposed to show the actual dimensions of previous construction work. When available they can be a valuable tool to expedite rehab design. However, as-built drawings may contain significant errors. Therefore, critical dimensions should be verified by careful field measurements.

- **Systems testing** is generally proposed by an engineer in order to help determine the condition of an existing building system, such as pressure testing of plumbing or steam pipes. Project engineers should be queried very early in the design process to determine whether they have any recommendations for systems testing that could verify their assumptions regarding the condition of existing building systems.

Code issues involving existing conditions typically involve completed work that no longer meets the current Code. With some notable exceptions, work previously performed under a permit in conformance with Code in force at the time will be "grandfathered," and therefore does not need to be upgraded every time the Code changes.[7] However, rehab work often triggers significant mandatory Code upgrades, far beyond what the sponsor may wish to undertake. The rationale is that the appropriate time to bring a building up to current Code is when renovation work is being performed that may extend the useful life of the building. For example, proposed renovations to a unit bathroom to upgrade the toilet, sink and bathtub may trigger Code required upgrades to associated plumbing, structural, electrical, and even fire/life safety systems.[8] Sponsors may elect to schedule pre-permit application plan review meetings with the Building and Fire Departments to better understand how a particular rehab project will be required to address issues of accessibility, fire safety, seismic safety, building systems, etc. within the context of the planned scope and existing conditions.

Occupied rehabs are typically even more challenging, time consuming and expensive than rehabilitating a vacant building. For example, if tenants will need to move out of their units, even for a short period of time, an approved relocation plan is typically required. Relocation of tenants is a significant undertaking requiring an understanding of the applicable law and regulations, good communication and organizational skills, and a commitment of staff from pre-construction planning to final moves after construction completion.[9] At a bare minimum, the developer must insure that the building is safe and habitable during construction, tenants' privacy and security is protected, and tenants do not have to "come out of pocket" for any expenses related to the rehab.

Some issues that take on larger significance during occupied rehabs include: dust, lead-based paint, noise, safety, security, accessibility, and notice/utilities. In addition, the contractor will need adequate space for a job site office, deliveries, staging and storing materials, as well as access for moving personnel, materials and equipment through the building.[10] Perhaps most importantly, property management will have the challenge of operating a building under construction. When something goes wrong, the parties need to work together to quickly fix the problem, sometimes even before responsibility for the problem has been determined.[11]

- **Dust**. As noted in the IAQ section, even "benign" dust can trigger asthma or other pulmonary problems for people exposed to dust.[12] Ironically, work designed to improve IAQ, such as removing carpeting so that it can be replaced with hard surfaced flooring, can temporarily create dust hazards if the work is not performed carefully. Therefore, care must be used to insure that dust does not migrate in an uncontrolled fashion out of the work area. Measures include the installation and maintenance of plastic sheathing to contain dust, wet work methods to reduce the generation of dust, and frequent clean-up to collect and dispose of dust.

Considerations during occupied rehabs include maintaining...

- ✓ fire/life safety systems (alarms, sprinklers, smoke detectors, and exiting)
- ✓ accessibility
- ✓ security
- ✓ habitability (including dust, noise and vector control)
- ✓ utilities (electricity, water, heat, telephone, trash/recycling, cable, etc.)
- ✓ adequate space for a job site office, deliveries, staging and storing materials, as well as access for moving personnel, materials and equipment through the building

- **Lead based paint** is nearly ubiquitous in older buildings in San Francisco. In general, the mere presence of lead based paint in a building does not mean that there is a "lead hazard" that requires abatement by a specialty contractor. However, any work (even normal maintenance or "unit turnover" work by the owner's own staff) that will impact or disturb surfaces that may be coated with lead based paint requires planning, training and careful work practices to protect the health of tenants and workers.[13]
  - If the paint is in good condition, and it will not be damaged by construction, it can typically be safely maintained in place in accordance with an Operations and Maintenance Plan.
  - Each contractor impacting surfaces coated with lead based paint (such as demolition and painting subcontractors) needs training and State certification in order to perform the work safely.[14]
  - Developers working on rehab projects need lead expertise and certification on the project team (either in-house staff or an outside consultant) for inspection/risk assessment, final clearance, and on-going operations and maintenance.

- **Noise**. Unfortunately, some tasks, such as breaking up concrete, are inherently noisy. In occupied rehabs, it is important that the project manager understands the tasks and schedule well enough to communicate to tenants when the noisiest tasks will be taking place. In addition, the owner may want to impose some limits on the contractor's noise making activities. For example, in order to minimize disruption to tenants, the owner may wish to prohibit the noisiest construction activities from commencing prior to 8am or continuing after 6pm. However, overly restrictive limitations will tend to delay the work and drive up costs, so it is important to strive for a balance that gets the work done as quickly and efficiently as possible with a minimum of inconvenience to tenants.

- **Safety**. While safety is always a primary concern, the concern is heightened during an occupied rehab. For example, the simple act of removing sheetrock from a wall exposes structural wood framing to the risk of fire.[15] Similarly, a barricade erected for the protection of tenants to separate them from construction activities may have the unintended consequence of blocking an emergency exit in case of a fire. With proper planning and coordination with the Fire Department, these and other issues can be addressed to maximize safety during an occupied rehab. The Fire Department may require that fire sprinklers and alarms be active throughout the building during the entire course of construction, even if the original construction schedule called for this work to be performed at the end of the project.

- **Security**. The need for construction workers to access the building must be balanced with the need to prevent unauthorized people from entering the building. Project managers may elect to require all workers to sign-in when they enter or leave the building and to wear hardhats with stickers identifying them by name and the company they work for. In addition, prior to the start of construction, the sponsor must clearly establish and communicate any access restrictions. For example, workers should not be permitted to prop doors open, even for a short period of time, if by doing so it could allow an unauthorized person to gain access to the building. If a secured door, such as a door to the exterior, needs to be unlocked, there should be a worker stationed at the door at all times that it is unlocked.

- **Accessibility**. Maintaining accessibility for people with mobility impairments or with other disabilities can be extremely challenging during an occupied rehab. Special consideration is needed to insure that an accessible path of travel is maintained at the building entry, in common areas (including common bathrooms), and within units during construction. In the event that elevator service will be interrupted, the developer may need to temporarily relocate people who rely on the elevator, or to provide equivalent facilitation, such as delivering groceries or hand delivering mail during the time the elevator is inoperable.

- **Notice/Utilities**. Tenants are obviously entitled to advance notice before any construction worker enters their unit. In practice, contractors may not always understand that in order for the owner to provide 24 hour notice to tenants, the contractor must provide sufficient time for the owner to prepare and distribute such notices. Tenants should be similarly notified before utility service is interrupted, the elevator is shut down, or common areas are worked on. In general, it is a good idea to have regular communication with all tenants before and during an occupied rehab so that everyone understands what will be done, why, and how long it will take.

1 Threshold Basis Limit is the maximum specified amount, determined by TCAC on a per unit basis (221(d)(3) limits), that a project can earn tax credits if eligible costs exceed this specified amount. A "basis boost" is an increase in this maximum amount for certain items, such as incorporating energy efficiency items and renewable energy.

2 See Section 10327(c)(5)(E) of the tax credit regulations. www.treasurer.ca.gov/ctcac.

3 For more information, see www.consumerenergycenter.org.

4 For more information, see www.pge.com/003_save_energy/003b_bus/comfort_builders.shtml.

5 "Green building is just applied common sense." Alameda County Waste Management Authority, "Green Building Guidelines: Home Remodeling," (10/2001), pg. 6, *www.stopwaste.org/gbguide.html*

6 Change order work is not competitively priced because it is performed by a contractor already on the job. "Under these circumstances, it is understood that some premium (approximately 15%) is paid for work that is not competitively priced." Maxwell, Paul A., "Measurement of A/E Errors and Omissions," Albert Kahn Associates, Inc., *www.albertkahn.com/news_art_full.cfm?artid=5*

7 Notable exceptions to this rule include issues of fire and life-safety, including seismic bracing, fire escapes and fire sprinklers.

8 In this example, no work is required by Code until the owner proposes to make certain upgrades. At that time, the Building Department may require that the work, and associated building systems, be performed in accordance with the current Code.

9 The scheduling and coordination of tenants' moves between units in an occupied rehab is a common source of delay. On a typical occupied rehab, it may take two weeks or more to relocate tenants to vacate a portion of the building for the contractor to work on. In the event that a tenant contests relocation, the delay can span months.

10 In general, separation between workers and tenants is preferred in order to expedite the work and minimize the risk of conflict. Ideally, workers and tenants enter and exit the building through separate doors, and move through the building using separate corridors, stairs and elevators. Of course, for safety reasons work areas need to be secured to prevent unauthorized people, including tenants, from gaining access.

11 Care should be taken to avoid having the contractor become de facto maintenance staff during an occupied rehab. All communications between the owner and contractor should be through designated personnel, preferably the owner's project manager. In case of emergency, when the normal lines of communication between contractor and owner cannot be followed, the project manager should be notified of any communications as soon as possible.

12 Construction dust should not be assumed to "benign." In addition to lead, asbestos is frequently found on interior and exterior wall surfaces of older buildings.

13 For an excellent, easy to use resource for understanding lead safe work practices, see, "Lead Paint Safety: A Field Guide for Painting, Home Maintenance and Renovation Work," HUD, *www.hud.gov/offices/lead/training/LBPguide.pdf.* For more detailed, comprehensive, and technical information regarding lead, including HUD's requirements for ongoing Operations and Maintenance procedures, see "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" (also known as the "HUD Guidelines"), *www.hud.gov/offices/lead/guidelines/index.cfm.*

14 For information on State certification for lead workers, see California Department of Health Services (DHS), Childhood Lead Poisoning Prevention Branch, *www.dhs.ca.gov/childlead/*

15 Fires can accidentally ignite during construction from a variety of sources, including welding, painting, soldering plumbing pipes, cutting metal, or electrical work. The best protection against fires during construction is a general contractor that demands and enforces safe means and methods of construction for all trades on a job.