Enterprise green communities®

Davis Langdon
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ENTERPRISE GREEN COMMUNITIES CRITERIA:

Incremental Costs, Measurable Savings **Update**

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About Enterprise Green Communities

Enterprise Green Communities is the first national green building program focused entirely on affordable housing. Launched by Enterprise in fall 2004, Green Communities is designed to help developers, investors, builders and policymakers make the transition to a greener future for affordable housing. To date, Enterprise has invested $1.8 billion in grants, loans and equity to support the development and preservation of over 27,000 green affordable homes. Visit *www.EnterpriseCommunity.org/green*.

About Enterprise

Enterprise is a leading provider of the development capital and expertise it takes to create decent, affordable homes and rebuild communities. For 30 years, Enterprise has introduced solutions through public–private partnerships with financial institutions, governments, community organizations and other partners that share our vision that one day, every person will have an affordable home in a vibrant community, filled with promise and the opportunity for a good life. Since 1982, Enterprise has raised and invested more than $11 billion in equity, grants and loans to help build or preserve nearly 300,000 affordable rental and for-sale homes to create vital communities and more than 410,000 jobs nationwide. Visit *www.EnterpriseCommunity.org*.

About Davis Langdon

Davis Langdon, an AECOM company, provides a comprehensive and integrated construction consultancy delivered through cost management, risk consulting, and sustainability consulting and research business units. Their multidisciplinary teams possess a wide ranging understanding of construction, making it possible to plan, manage and control all aspects of projects. Their integrated knowledge galvanizes decision making, bringing much needed certainty to the development process. As a global organization with over 3,000 staff in 100 offices around the world Davis Langdon brings global resources to address local circumstances. Their teams bring together creative minds from many disciplines, resulting in a comprehensive integration of knowledge and a unique grasp of the economics of sustainable development.

Acknowledgments

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Enterprise green communities®

INTRODUCTION

When we launched Enterprise Green Communities with our partners in 2004, we made a commitment to track the costs and benefits of meeting the Green Communities Criteria. We remain dedicated to ensuring that the homes designed, constructed and rehabilitated to meet the Criteria deliver cost-effective health, economic, and environmental benefits to the developers, the residents and the surrounding communities.

Three years ago, we reported that the utility costs saved over the lifetime of the measures included in the Criteria exceed the costs of implementing the Criteria. We're pleased to report that our latest study upholds our 2009 findings.

This latest report illustrates how we expanded our study to include 52 projects, up from the 27 we included in 2009. We also intentionally increased the percentage of rehabilitation projects. Applying the same methodology, we hired Davis Langdon to complete the analysis. Just as in 2009, we met challenges in collecting design and construction cost and utility-consumption data. Once again, their findings found that energy criterion and the healthy living environment criterion drive most of the incremental costs. In addition, high variability in actual-versus-predicted energy consumption levels continues.

At the same time, our analysis found that energy price escalation estimations decreased. The cost of healthier building materials dropped. Perhaps most importantly, many criteria have become standard practice across the industry. These are encouraging findings in our pursuit to make green and affordable housing one and the same.

However, Davis Langdon's analysis also notes that predicted energy and water usage is often lower than actual consumption. This may be due in part to the models employed to determine the predicted usage which may not factor in plug loads. This finding underscores the critical importance of engaging the residents and the operations and maintenance staff to understand how the property will be used. Not surprisingly, the project in our sample with the highest costs for integrative design experienced the lowest overall incremental costs. We highlight many advantages of the integrative design process in our report, *The Success of Charrettes* (www.EnterpriseCommunity.org/greenresources). Creating a process that allows the entire development team to fully understand residents' needs at the start of the project informs decisions that determine a project's overall performance and design excellence.

Our experience shows that development teams can minimize costs and maximize savings by applying lessons learned from one project to the next. We encourage development teams to share what works and what doesn't on the Enterprise Green Communities Discussion Forum (www.EnterpriseCommunity.org/forum). Together, our network can drive down construction costs while we continue to seek methods, materials and systems that increase overall utility cost savings.

We owe our deepest thanks to the many developers, advocates, and experts whose experience and insight made this report possible. Transitioning the building sector to more effectively use energy and water, to dramatically reduce carbon emissions, and to provide healthy homes for all is imperative and within our reach. The report's positive findings on the incremental costs and measurable savings of Enterprise Green Communities have been a catalyst for 2020 Green, a national campaign to bring the benefits of green to all affordable housing by 2020 (www.EnterpriseCommunity.org/calltoaction). Many have already signed on to the campaign and we are grateful for their pledge. We urge you to join us in continuing to make green homes and living possible for all communities.

Dana Bourland, *Vice President, Green Initiatives*
Enterprise Community Partners

Downtown at 700, Albuquerque, NM
Developer: Supportive Housing Coalition of New Mexico

EXECUTIVE SUMMARY

As green building becomes increasingly widespread, and as both owners and communities are requiring the adoption of green building elements into both new and rehabilitation projects, the questions of cost and return on investment are still major concerns for developers and owners of projects. This question is particularly acute for developers and owners of affordable housing projects, where development costs are usually highly constrained by the limits on rent, or sale price, or from public financing restrictions.

In this report, we present findings of an analysis of 52 affordable housing developments from across the United States that were built using either the 2005 or the 2008 versions of the Enterprise Green Communities Criteria. In addition, this report provides a more detailed look at estimated versus actual use of water and energy, and relates that to utility cost impacts for both the developers and the residents of the

affordable housing communities included in this study. This report updates the findings from the 2009 report *Incremental Cost, Measurable Savings: Enterprise Green Communities Criteria*.

The average project analyzed in this study achieved a lifetime utility cost savings of $3,709 per dwelling unit, while the incremental cost per dwelling unit for the average project to comply with the Enterprise Green Communities Criteria was $3,546. In summary, the lifetime savings exceed the cost of integrating the Enterprise Green Communities Criteria into affordable housing.

The lifetime savings was based on conservative assessments of the economic life of building elements, using a typical life of 20 years before replacement or renewal. In practice, since many of the design solutions are passive in nature, such as improved insulation and windows, better building solar orientation, and reduced environmental impact of materials, the economic life of these elements will greatly exceed 20 years, appreciably increasing the actual lifetime savings.

There are many additional benefits from integrating the Enterprise Green Communities Criteria that do not have direct measurable financial impacts. These include but are not limited to: improved occupant health and well-being through less exposure to environmental pollutants, improved connectivity to services and walkable neighborhoods, and good daylighting. The benefits extend beyond the occupants to the neighboring community by supporting local community services and providing activation of the neighborhood streets, as well as by improving water quality and reducing the impact of rainwater run-off on neighboring sewer systems and water courses.

Enterprise Green Communities

The Enterprise Green Communities Criteria provides a guideline to affordable housing developers for building greener buildings, which use less energy and water, have a smaller or positive impact on the environment, and offer health benefits and a better quality of life to their residents. The first version was released in 2005; the second version, released in 2008, provided some minor clarification to a number of the 2005 criteria, and also included several additional criteria, expanding the scope of methods by which developers could build or rehabilitate a more sustainable and beneficial affordable housing community.

Data was collected from 52 affordable housing developments (36 following the 2005 criteria, and an additional 16 that followed the 2008 criteria). For each criterion, project sponsors provided the cost to implement (defined as the cost required beyond that necessary to meet existing state or local building codes), the method by which the criterion was implemented, and, in the case of water and energy-efficiency measures, the estimated reduction in resource use expected through implementing these measures. The 52 units together comprise 3,677 dwelling units containing over 3.6 million square feet.

How the Savings Were Achieved

The developments in this study were designed with an emphasis on delivering health, economic, and environmental benefits to the residents, developers, and surrounding communities. Sites were selected that provided easy access to public transit and community amenities, and avoided disturbing existing greenfield space, wetlands, or other sensitive natural environments. Buildings were placed on the site to maximize

natural light. Interiors were designed to provide a healthier environment, including the use of low-VOC flooring, paints, and other materials, and providing ventilation in bathrooms and kitchens to minimize moisture infiltration and mold growth, and to introduce more fresh air into the spaces. Each developer also provided guidelines to the residents and maintenance staff to educate them on the green measures that were incorporated, so they could take ownership in maintaining their homes and properties in a sustainable and healthy manner.

The overall median cost to meet the 2008 Enterprise Green Communities Criteria was $3,546 per unit, which equates to a 2 percent increase in total development cost for a project. To integrate only the energy and water saving efficiency criteria, the median cost was $1,139 per unit. Projected lifetime utility cost savings for implementing just the water and energy criterion is $3,140 per unit, based on a 20-year life cycle.

In general, developers found ways of integrating green measures into their affordable housing designs, and were able to implement them in cost-effective ways. As was seen in the earlier report, developers were able to meet a number of criteria for no additional cost, and even where a cost premium did occur, the overall impact was very small:

- The median cost to meet all *mandatory* site selection, location, and site improvements criteria was $0. This is not surprising, as most of the projects were built in areas where local and state building codes already mandate that projects meet many of the measures included in the mandatory Criteria.
- The median cost to meet the water conservation criteria was only $83 per unit, and the median payback was for less than two years.
- Costs to meet the mandatory energy conservation criteria ($1,056 per unit) accounted for the majority of the premium associated with meeting the Criteria.
- There was a small cost premium related to materials selection, a median of only $165 per unit.
- The cost to meet the Healthy Living Environment section of the Criteria accounted for the second-highest cost premium, with a median cost of $680 per unit. However, 14 of the 52 projects reported no cost premium at all to meet these criteria, suggesting that some projects were able to incorporate these particular green measures within their existing budgets.

Renewable Energy

Twenty-two projects indicated that they had incorporated some form of renewable energy system, and full cost data was available for 11 of these. The majority of systems were photovoltaic systems, although one included wind turbines. The systems ranged in size from 3.5kW to 75kW. Some projects reported receiving financial support in the form of subsidies or grants; some did not.

For most projects, the renewable energy elements were not cost effective, except where subsidized. The median payback period was 33 years.

Utility Costs and Escalation

There was a wide range of costs for both electricity and water. The cost for electricity ranged from a low of $0.03 to a high of $0.24/kWh, while water ranged in price from under $3 to over $16/1,000 CF. Clearly this has a significant impact on the lifecycle value of the savings. It was clear that the projects with the lowest return on investment and the longest payback periods were the ones with the lowest costs for utilities.

In a similar manner, escalation forecasts have a significant effect on the estimates of overall life-cycle savings. For the analysis, energy escalation was based on data from the U.S. Energy Information Administration. The escalation forecasts are relatively low, at around 2.2 percent in the long term, although these are in line with the escalation experienced in the past 10 years. There is no comparable government forecast for water, and the study used a long-term escalation rate of 5 percent, reflecting the high level of infrastructure replacement needed in the coming years. Higher forecast escalation rates give higher future costs, and greater lifetime savings for avoided consumption.

In addition to the long-term escalation rates, utility costs are subject to high levels of volatility and potential for price shock. While energy is usually in the headlines, water rates are perhaps more likely to be very varied and changeable. Many communities have substantial deferred maintenance issues on their infrastructure and will need to make major investments in the coming years. These will result in very sharp rate increases in many locations, often doubling, or more, the cost of water. Not only does energy and water conservation reduce the long-term cost, it also reduces the properties' exposure to sudden price change.

Actual vs. Modeled Energy and Water Usage

In addition to evaluating costs and projected savings, the study also looked at data for actual energy and water use. Actual energy usage data was available for 28 of the projects, and water usage data for 15.

Perhaps one of the most interesting findings of this study was the high variability in actual energy use versus predicted. Actual energy usage ranged from a low of 47 percent of the predicted amount to a high of 277 percent of predicted. A number of factors are likely responsible for this wide variability, including occupant behavior and base model assumptions, but it does speak to the fact that developers in general may need to reassess how initial energy use models are conducted, and to take such factors as occupant behavior and plug loads into consideration when modeling future buildings.

Water consumption was more difficult to analyze, due in part to the small number of projects providing consumption data and, more important, to the fact that indoor use and outdoor use were not monitored separately. Of the 15 projects that provided consumption data, the majority (12) consumed more water than was predicted during the design process. However, first year water usage tends to be higher, due to the need to establish landscaping plantings, so this may have played some role in the findings.

Comparison to the 2009 Study

This study uses a significantly larger data set, with 52 projects as opposed to the 27 from 2009. The geographical distribution is not greatly changed, but there are some significant changes in the population mix.

Building Type

The percentage of high-rise buildings was virtually unchanged. The percentage of low-rise single or clustered townhouses fell significantly, from 33 percent to 19 percent, while the percentage of mid-rise rose correspondingly, from 22 percent to 36 percent.

Building Size and Cost

The median building size increased moderately, from 55,600 square feet to 63,900 square feet. The median number of units, however, was unchanged at 60. The median area per unit increased from 986 square feet to 1,007 square feet. The median total development cost per square foot increased from $187 to $202.

Rental / For Sale

The percentage of For Sale properties fell from 11 percent to 6 percent.

New / Rehabilitation

The percentage of Rehabilitation projects rose from 22 percent to 28 percent.

Urban / Suburban / Rural

The percentage of urban projects fell from 70 percent to 65 percent, suburban projects rose from 19 percent to 25 percent, and rural projects fell from 11 percent to 10 percent.

The findings from this study largely mirror those from the 2009 study in that the lifetime financial benefits from implementing the Enterprise Green Communities Criteria largely cover the cost of implementation, although the margin has reduced, largely due to the lower valuation of future benefits due to lower escalation projections.

The most significant change between the two studies is not related to the survey data or the cost experience of the projects, but instead is due to the changing economic climate and, in particular, to the escalation outlook for energy. In 2009, energy escalation forecasts were higher by around 2 percent. Since then, energy prices escalation expectations have lowered, and the current Energy Information Administration escalation projection has a lower rate than that used in the 2009 study. In addition, the 10 year average for past inflation has fallen by some 2 percent. This has the effect of *decreasing the valuation* of future benefits, since the future costs avoided are not as high. If the 2012 analysis is re-run with the escalation rates from the prior study, the lifetime savings rise to $4,646, a value virtually identical to that of the 2009 study.

TABLE 1.1
Comparison of Costs and Benefits, 2009 and 2012

	Cost of Implementing Enterprise Green Communities Criteria (excluding renewable energy)	Lifetime Savings From Implementing the Enterprise Green Communities Criteria (excluding renewable energy)
2009 Incremental Costs, Measurable Savings	$3,499	$4,664
2012 Incremental Costs, Measurable Savings Update	$3,546	$3,709

Rheingold Heights One Apartments, Brooklyn, NY
Developer: Ridgewood Bushwick Senior Citizens Council, Inc.

FINANCIAL IMPACT OF GREEN AFFORDABLE HOUSING

The median cost of implementing the Enterprise Green Communities 2008 Criteria was $3,546 per unit. This represents a 1.85 percent increase to the total development cost for the project. The median cost to integrate only the energy and water criteria was $1,139 and returned $3,709 in predicted lifetime utility cost savings.

It is worth noting that the costs reported do not represent the minimum possible cost for compliance in most cases. Many projects incorporated elements that exceeded the minimum requirements. Examples include rainwater harvesting, green roofs, and graywater systems. Even in the more conventional systems such as water-conserving plumbing fixtures, there is variation in the quality of the fixture. The reported costs therefore represent a sampling of the range of ways in which actual projects have chosen to meet the requirements, rather than an analysis of the minimum possible cost of compliance.

New and Rehabilitation

There is an appreciable difference in both cost and savings between new and rehabilitation projects. The new projects have both a lower cost and a lower lifetime savings.

The lower cost is not unexpected since, generally, integrating green features into new construction is appreciably easier than for rehabilitation. In some instances, this is because, at the design stage, there is no appreciable added cost for specifying the green product: for example, new water-saving fixtures do not cost much more than conventional fixtures, and so within new construction the premium is limited to the difference in fixture price, whereas for rehabilitation, the incremental cost could include the cost of removal and the full fixture cost. In other cases, the higher cost for green rehabilitation is the result of the enabling work required to install the green material. An example of this is improved wall insulation. In new construction, the premium cost is simply the added cost of the extra insulation, whereas for rehabilitation, the premium could include the work required to open up and refinish the walls.

The higher lifetime savings is likely the result of the baseline performance. New construction is measured against a minimally compliant reference building, whereas rehabilitation is measured against known performance of the existing building. Typically the reference building for new construction has higher performance than an existing building. This means that a rehabilitation project starts from a lower energy performance (higher energy consumption) baseline, and so has greater scope for energy reduction.

Financial Analysis Approaches

In order to evaluate the direct financial benefits arising from the utility cost reductions effected by the Enterprise Green Communities Criteria (the Criteria), Davis Langdon applied three commonly used approaches:

- Simple Payback — the estimated number of years of utility cost savings required to pay back the initial incremental costs of the green improvements, without reference to the time value of money.
- Net Present Value (NPV) of utility cost reductions over an economic life.
- Internal Rate of Return (IRR) — the percentage return on investment in energy- and water-saving improvements, represented by the estimated future utility cost savings over the economic life.

For these analyses, the economic life was modeled at both 20 years and 40 years to establish the sensitivity of the life cycle cost to duration of the economic life. Twenty years is commonly used for energy and water analysis, since it represents the typical life of many equipment elements. For affordable housing, however, a large number of the energy reduction strategies are passive as opposed to active (improved insulation, better glazing, etc.), so many of both the energy and the water saving measures have long economic lives. It is therefore reasonable to use a longer economic life for the evaluation.

Extending the modeled economic life from 20 to 40 years effectively doubles the NPV of both water and energy savings. Extending beyond 40 years, however, has little impact; the economic life would have to be extended to 100 years to effect another doubling of NPV. This does, however, show the value of integrating passive improvements wherever possible, and ensuring that systems are durable and have as long an economic life as possible.

TABLE 2.1
Median Reported Cost of Meeting Green Communities Criteria (52 projects)

	New (Photovoltaic energy not measured)	**Rehabilitation** (Photovoltaic energy not measured)
Green premium per ownership/rental unit	$3,529	$4,654
Green premium per square foot	$3.89	$3.93
Percent added to total development cost	1.82%	3.31%

TABLE 2.2
Median Predicted Lifetime Savings from Energy and Water Conservation Measures

	New	**Rehabilitation**
Utility savings per home/rental unit	$3,052	$6,136
Utility savings per square foot	$3.56	$5.13
Internal rate of return	18.1%	17.1%
Percent added to total development cost	5.32%	5.59%

Simple Payback

The simple payback method of estimating financial benefits is useful for quick assessment of cash flows, and can be used as a rough guide to financial performance. It provides an easily understood estimate of financial benefits, but, unlike the NPV and IRR approaches, it does not account for the useful life span of the improvements or the cost of capital used to finance the improvements. In addition, this method uses only the first year's estimated utility savings, without accounting for inflation of energy and water costs.

Simple payback calculations are useful as rough indicators. Measures with short payback periods are typically good investments. For commercial developments, payback periods of five years or less are typically acceptable without further analysis, and payback periods of up to 10 years may be worthwhile, depending on the cost of capital. In the current low-interest environment, longer payback periods can still show valuable investments.

Energy Efficiency

For energy, the median simple payback associated with all energy reduction measures was 8.9 years; excluding renewable energy and special systems, such as ground source, thermal mass, etc., the median payback period drops to 3.4 years.

The payback period for renewable energy systems alone was over 33 years. The very long payback periods should decrease as installed costs continue to fall. Nevertheless, the data does indicate that renewable energy systems are not generally economically feasible for affordable housing projects without special funding, capital vehicles, or other market support.

The payback for new construction, excluding renewable energy and special systems, was 2.5 years, and 6.3 years for rehabilitation. The range of payback periods was from a low of 0.75 years to a high of 52 years, even excluding renewable and special systems. Almost two-thirds, however, had payback periods of less than five years.

Water Efficiency

For water, using the data from the 47 analyzable projects, the median simple payback was less than one year, with savings predicted at a median of $0.04/SF and costs at a median of $0.03/SF, or $47 and $84 per unit respectively.

For new construction, the median payback was zero, with just over half of the projects reporting no cost premium. For rehabilitation, the median payback was 1.6 years. Over three-quarters of the projects had payback periods of five years or less, although the range of payback periods was from zero to 46 years. Of the seven projects with payback periods in excess of 10 years, six had water costs less than half the median water cost of $7.50 per 1,000 gallons, and many had opted to incorporate grey water or rainwater harvesting, neither of which is specifically required under the Criteria.

Net Present Value (NPV)

For this report, life cycle costs were modeled using a 6 percent nominal discount rate. This is appreciably higher than the current extremely low cost of money, but reasonably representative of long-term nominal discount rate trends for commercial projects.

Escalation rates of 2.1 percent for operation and maintenance, 2.2 percent for energy, and 5 percent for water were used. Operation and maintenance escalation is based on Office of Management and Budget projections, and energy on the U.S. Energy Information Administration projections (*www.eia.gov/forecasts/aeo/er/*). Forecast escalation rates for water are not published by government agencies, but studies by Pacific

Northwest National Laboratory (*www.govenergy.com/Files/1Presentations/Water/Session8_EGiever_FINAL.pdf*) indicate that water inflation has been higher than core inflation for several years, and that the trend is likely to continue as the cost of deferred infrastructure projects is incorporated into the rates. Many locations are experiencing water rate escalation in excess of 20 percent per annum. For this study, 5 percent was used as a reasonable national average based on long-term trends.

Sensitivity testing was undertaken at higher and lower discount rates to assess the sensitivity of the NPV to differing baseline rates.

Residual value was set at zero, as was cost of removal or demolition.

Energy

Using data from the 43 analyzable projects, the median NPV at 20 years, excluding renewable energy, was $1.82/SF, or $2,178 per unit. Extending the period to 40 years, the NPV rises to $4.22/SF, or $4,480 per unit. It should be noted, however, that one project (a rehabilitation project) had a negative NPV of –$2,000 per unit at 40 years. This project, located in Michigan, focused on extensive envelope improvements. At the high end of the range, the greatest NPV was over $55,000 at 20 years and $100,000 at 40 years. This project included photovoltaics (the installation of which was supported by a subsidy) to provide electricity to the underground garage. This is, however, an outlier, and the next highest NPV was around $30,000 at 40 years.

Adding in renewable energy did not significantly change the median values, but did increase the negative values, in one case to nearly –$10,000 for 20-year life. On its own, the renewable energy systems universally had negative NPV, for both 20 and 40 years, excluding grants and subsidies. The median NPV per kWh of annual production was –$2.30 at 20 years and –$1.23 at 40 years.

Water

Using data from the 47 analyzable projects, the median NPV at 20 years was $0.57/SF, or $768 per unit. Extending the period to 40 years, the NPV rises to $1.10/SF, or $1,528 per unit. Six projects had negative NPVs, the largest being –$438 per unit at 20 years and –$198 at 40 years. All of the units with negative payback had very low cost of water. If their rates were adjusted to the median cost of water, all but one of the projects would show a positive NPV. At the high end of the range, the greatest NPV was over $10,000 at 20 years and $20,000 at 40 years. This unit had the highest unit cost of water, at over double the median cost.

Sensitivity

The discount rate used in the base analysis is based on a 6 percent nominal (market) interest rate, and inflation rates of 2.1 percent for operation and maintenance, 2.2 percent for energy, and 5 percent for water. These yield real discount rates (nominal rate minus inflation rate) of 3.9 percent for operations and maintenance, 3.8 percent for energy, and 1 percent for water. These real rates are higher than current market conditions, where real rates, in many cases, are near zero, if not negative, for some funding sources. The rates used do represent a reasonable estimate of long-term rate trends. Rates can vary over time as interest and inflation change, and it is important to understand the effect of assumed long-term rates on the analysis, to ensure that the reported NPVs are not dependent on specific assumptions, and to provide confidence in the projected savings.

Adjusting the real rate downward by 2 percent, which represents a decrease in the nominal cost of money (continued low interest rates), an increase in long-term escalation, or a combination of the two, increases the NPV moderately. For energy, excluding renewable energy, the 20-year NPV rises by $700 per unit, and the 40-year NPV by $2,000. For water, the increases are $200 and $800, respectively.

Increasing the effective real discount rate by 2 percent, which represents increased cost of borrowing or prolonged low inflation, decreases the NPV moderately. For energy, excluding renewable energy, the 20-year NPV falls by $600 per unit, and the 40-year NPV by $1,000. For water, the decreases are $150 and $500, respectively.

Generally, since interest rates typically trend with inflation, rising or falling together, these sensitivity boundaries are relatively unlikely scenarios. Of the two, the reduced discount rate is the more likely in the short term, with the cost of borrowing constrained by low economic activity, but inflation push from other more rapidly growing economies.

The sensitivity testing indicates that the cost–benefit analysis is moderately sensitive to both nominal (market) interest rates and inflation, and that, in the short term, the NPVs established by the baseline analysis are, if anything, slightly understated.

Internal Rate of Return (IRR)

The estimated IRR of the energy and water measures is calculated with a method similar to the one used for NPV, except that the resulting rate is expressed as a percentage. The percentage represents the real discount rate that would yield a neutral NPV. This is the method typically used by investors to determine the benefits of making a particular investment or alternative investments. In this report, the IRRs are indicators of the relative benefits of making decisions to adopt—i.e., invest in—individual Criteria, based on the average IRRs of the projects surveyed.

Energy

Using data from the 43 analyzable projects, the median IRR for energy conservation measures at 20 years, excluding renewable energy, is 16.4 percent. This rises to 17.2 percent at 40 years.

Water

Using data from the 47 analyzable projects, the median IRR at both 20 and 40 years is 30 percent. Only nine projects have IRRs of less than 10 percent.

Cost Premiums and Lifetime Savings by Occupancy Type

Three categories of occupancy were analyzed separately: supportive housing, rental housing for general populations and for-sale homes. In general, the rental properties invested less than the supportive housing projects, and received lower savings. The median cost of all criteria for rental housing was $3.35 per square foot, or $3,740 per unit. For the supportive housing projects, the median cost for all criteria was $6.31, or $6,140 per unit. In general, this is because the supportive housing projects incorporated more sustainable elements, both in energy and for other criteria groups, such as site and healthy materials. While supportive housing made up slightly over 50 percent of the total population, nine of the 15 properties that included renewable energy were supportive housing, and 19 of the 32 properties reported incorporating Criteria 5.5, Additional Energy Reduction. In addition, these housing types spent more on sustainable features for site development and for materials beneficial to the environment. Overall, from discussions with owners, one possible reason for this trend is that, because more of the operational costs for supportive housing are borne by the owner as opposed to the tenant, owners of supportive housing are more ready to invest in long-term savings. The population contained only three for-sale properties, which is not sufficient for statistical inference.

The NPV over 40 years for rental housing was $3,987 per unit and $4,677 for supportive housing.

TABLE 2.3

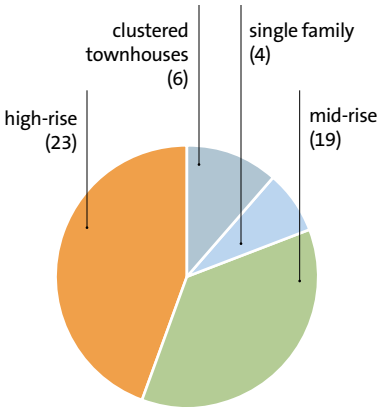
Characteristics of 52 Projects Included in Report

Project Information

	Projects
Year Completed	
2012	1
2011	2
2010	7
2009	13
2008	13
2007	10
2006	6
Geographic Location*	
California	9
Colorado	2
District of Columbia	1
Georgia	1
Illinois	2
Maryland	1
Massachusetts	2
Michigan	3
Minnesota	6
New Jersey	1
New Mexico	2
New York	6
Ohio	4
Oregon	2
Pennsylvania	2
Texas	2
Virginia	2
Washington	3
Wisconsin	1

*Projects are located in 14 states plus the District of Columbia.

Property Type



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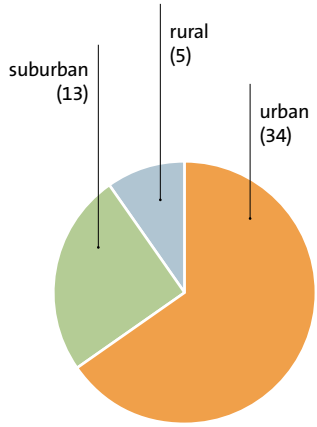
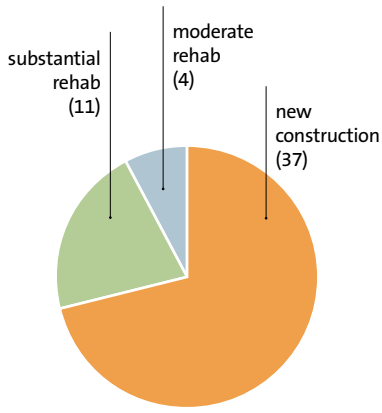


Construction Type



Armstrong Place Senior Housing, San Francisco, CA
Developer: Bridge Housing Corporation

METHODOLOGY

The data was collected through survey forms and progress reports submitted by project developers. All data was self-reported. The survey returns included both quantitative data related to costs, benefits, and other building characteristics, and narrative data describing the buildings and strategies used to meet the criteria.

The survey population comprises developments that have received Enterprise Green Communities grants, and agreed to report the costs and benefits of complying with the Green Communities Criteria. All grants were conditioned upon compliance with the Criteria; submission of documentation outlining compliance measures; and agreement to report incremental design and construction costs, and utility usage and cost savings. Many grantees reported extensive project data on the cost–benefit survey form and signed a release permitting Enterprise to obtain actual utility usage and cost data directly from utility companies for a project's first year of full operations.

Once construction documents were completed, Enterprise used a two-step process to verify that projects incorporated all of the required Criteria. First, the developer was required to submit a certification of compliance signed by the project's green design specialist, architect and project sponsor. These certification forms described the methods (and in some cases materials) that would be used to achieve compliance with particular Green Communities Criteria. Second, Enterprise staff reviewed these certifications to confirm compliance.

Statistical Analysis

The data was analyzed using standard statistical methods.

Population Size and Range

The population size, at 52, is sufficiently large to provide meaningful statistical data, although not large enough to permit highly detailed analysis of subsets of the data, particularly given the large number of variables and the large variations in data ranges. The range of project size is from 16,400 square feet to 186,000 square feet, and the unit count ranges from 14 to 185. The area per unit ranges from 458 square feet to 1,919 square feet, and the total development cost per unit ranges from $45,000 to $382,000.

The data is voluntarily self-reported. As such, this does not represent a random sample of the full population of affordable green housing. Nevertheless, since the data was required as a condition of the grant, and since there was no incentive to report specific outcome or performance, it is likely that there is no inherent selection bias in the data: that is to say that the data is unlikely to be biased to either optimistic or pessimistic data values.

Median Values

The median value was used to characterize the data in preference to the average, since the median represents, in effect, the average project, since half of the population falls below the median and half above. Typically within the data sets in this study there is a moderate skew, with the bulk of the incremental cost data clustering around the median, and one or two high cost outliers. In most cases, the higher costs for the outliers result from incorporation of strategies that are not specifically required by the Criteria. For example, one project included a green roof, and applied the cost increment to Criterion 6.5a: Heat Island Effect Reduction. While the green roof meets the requirements, it is not required to satisfy this criterion. These outliers represent valid data points, and are noted where applicable in the report.

It is important to note that, in most cases, the outliers of this data set represent projects that seek to go above and beyond, to deepen the level of efficiency and sustainability of their affordable housing properties.

Outliers

Many of the incremental cost data sets include one or two outliers, where the values are significantly different from the bulk of the population. While it is important not to allow these to distort the characterization of the data set as a whole, it is also important to understand the reasons for the deviation and to understand the likelihood or conditions for recurrence. For this reason, in most cases within the detail portion of this report, the outliers are specifically explored.

Incremental Costs

The incremental cost was defined as the additional costs incurred in adopting a particular criterion as compared to the cost of what the developer otherwise would have installed.

Predicted Utility Cost Savings

The savings are largely based on energy models undertaken during the design phase of the project; some are developed from assessments based on prescriptive path improvements. Not all projects in the population provided estimated savings for energy or water.

Energy

A total of 43 projects provided estimated energy savings.

Water

A total of 47 projects provided estimated water savings.

Actual Utility Usage

Energy

Actual energy usage data was available for 28 of the projects. Of these 28, 23 also had predicted energy use, allowing for comparison of predicted to actual energy consumption. There was significant variation between predicted and actual energy consumption within these 23 projects:

- Thirteen consumed more energy than predicted.
- Ten consumed less energy than predicted.
- Six had an energy consumption amount within 10 percent of their predicted levels.
- Fourteen reported energy consumption levels more than 25 percent higher or lower than their predicted levels.

In summary, energy consumption ranged from a low of 47 percent of predicted, to a high of 277 percent of predicted, with a median deviation of 5 percent (or consumption at 95 percent to 105 percent of predicted levels).

Actual energy usage deviates from predicted for many reasons, largely related to the assumptions included in the energy model or prescriptive data. Often, the assumptions are required by the modeling protocols to ensure that project teams do not manipulate the model during the design phase. This is most common where the modeling rules are established by code. A subset of these projects was evaluated to identify, where possible, reasons for the deviations. From the projects evaluated, the following factors were identified:

- *Occupant Behavior:* Occupant behavior was identified as a strong factor, both in the patterns of energy usage (hours of operation) and in the adherence to the energy-saving measures and practices. For example, at one property, it was noted that some residents appeared to be using supplemental heating and air-conditioning units within their apartments.
- *Base Model Assumptions:* Related to occupant behavior, some of the model assumptions may not be realistic. For example, models assume heating to 68 degrees in winter, which may not match reality for many residents. The analysis found greater discrepancies in general during the heating season than in the cooling season.
- *Plug Load Assumptions:* Often energy models disregard plug load savings, and this can be significant where Energy Star appliances are used. This can be the result of simplification, or of code modeling requirements. A sampling of the energy reports for this study indicates that the reduced appliance load was not factored into the energy models, resulting in an underestimate of the potential savings.

- *Building Quality:* While no data indicated that the buildings were not constructed according to requirements, based on general industry research into energy modeling performance, there is a strong likelihood that the envelope and systems are not performing up to design; in particular, that thermal bridging and air infiltration are greater than modeled.

Water

Actual water usage was available for 15 of the projects. Comparison with predicted use is, however, not a meaningful way of validating the models, since the modeled water use reflects only indoor water consumption, while the actual includes both indoor and irrigation water usage. The comparison does, however, highlight the need for better water usage models and data. Separately metering indoor and outdoor water will provide meaningful comparisons with modeled water use, and developing usage models that incorporate outdoor use will provide better cost reduction guidance for developers.

Of the 15 projects, three had water consumption lower than predicted, while 12 had consumption higher than predicted; two had deviations lower than 10 percent, while 12 had deviations greater than 25 percent.

The median deviation was 60 percent: that is, the typical building in the data set used 60 percent more water than predicted. The lowest reported usage was 19 percent of predicted, while the highest was 413 percent of predicted. The reasons for the deviation are similar to those for the deviations in energy usage, with occupant behavior being the most likely culprit. More in-depth education on the importance of efficient water use may be warranted. Alternatively, providing residents a regular snapshot of total water used may also help, by showing them how much they have used compared to their neighbors.

Use of Predicted vs. Actual Consumption in Analysis

Predicted energy and water consumption was used in the cost–benefit analysis portion of this study. Predicted consumption has the advantage of having uniform assumptions for both baseline and predicted consumption. As a result, even though the predicted consumption may differ from the actual consumption, the predicted savings should be reliable.

For example, if the actual usage is higher because occupants are using greater than modeled plug load, through more appliances or higher draw appliances, both the baseline model and the predicted model would have the same increase in usage. The result of this would be that the predicted savings would remain the same.

SECTION 4

Sara Conner Court, Hayward, CA
Developer: Eden Housing

TECHNICAL REPORT

This section provides a detailed overview of the incremental costs associated with each of the Enterprise Green Communities Criteria (the Criteria). Our data set includes affordable housing projects that met either the 2005 or the 2008 versions of the Criteria.

Fifty-two projects were analyzed and compared to assess the incremental costs associated with meeting the Green Criteria; 36 projects were developed using the 2005 version of the Criteria, while 16 projects were developed using the 2008 version of the Criteria.

As part of this analysis, 2005 and 2008 incremental cost data was combined where the requirements of the Criteria remained functionally consistent, to allow for a comparison across all 52 projects. Within this report, whenever appropriate, we indicate where there are substantive differences in the intent of the Criteria measures

between the 2005 and 2008 versions of the Criteria. Where criteria numbering changed between the 2005 and 2008 versions of the Green Communities guidelines, the numbering follows the 2008 version.

In addition to incremental cost data, project teams submitted brief narratives indicating how they intended to meet the requirements of each criterion, as well as progress reports on actual implementation measures. Where possible, Davis Langdon reviewed this information to supplement the statistical analysis.

As the costs to meet some of the Criteria can be very dependent on factors such as climate or local/state code requirements, the projects were grouped into six regions, seen in Table 4.1.

For comparison purposes, all costs were adjusted to a common base location of Washington DC, using the Marshall and Swift location index (*www.marshallswift.com*).

Overall, the incremental cost data collected from the 52 projects reflects what would be expected based on previous findings from version one of the *Enterprise Green Communities Incremental Cost, Measurable Savings* report.

Cost Impacts of Green Affordable Housing

The median cost per dwelling unit to comply with the Criteria was $3,546, $2,741 of which was for meeting just the mandatory criteria. The median cost to integrate just the energy and water criteria was $1,139; however, the predicted lifetime utility cost savings (per unit) for the projects included in this study is $3,709.

TABLE 4.1
Collected Data by Region

Region	Number of Projects
Pacific Northwest (Oregon and Washington)	5
California	9
Colorado and New Mexico	4
Illinois, Michigan, Minnesota, and Ohio	16
Mid Atlantic (Washington DC, Maryland, New Jersey, New York, Virginia, and Pennsylvania)	15
South (Georgia and Texas)	3

TABLE 4.2

Median Cost of Meeting Green Communities Criteria

	52 projects (Photovoltaic energy not measured)
Green premium per ownership/rental unit	$3,709
Green premium per square foot	$3.65
Percent added to total development cost	2.0%

TABL4.3

Median Lifetime Savings from Energy and Water Conservation Measures

	52 projects (Photovoltaic energy not measured)
Utility savings per home/rental unit	$3,140
Utility savings per square foot	$3.87
Internal rate of return	16.8%
Simple payback period (years)	5.59

1. Integrated Design Process

Sustainable building strategies should be considered from the moment an affordable housing developer initiates the project. An integrated design process incorporates sustainability up front, uses a holistic and total-systems approach to the development process, and promotes good health and livability through the building's life cycle. The goal is to establish a written commitment that informs the project's objectives through the building's life cycle.

Incremental Cost Overview

The median cost reported for this section was $0.02 per square foot, or $24 per unit, with about 40 percent of the projects reporting no cost impact at all, and roughly the same percentage reporting costs of $0.20 per square foot or less. Reported costs were scattered between $0.01 and $0.90 per square foot, or between $5 and $800 per unit, with a substantial majority (75 percent) reporting less than $100 per unit.

Costs for this section are generally not correlated to size of project, since the preparation of a Green Development Plan is essentially a fixed effort. The total reported costs ranged from $0 to $50,000, with a median of $1,000, and only five projects reporting total costs over $25,000. The projects with high costs per unit, therefore, tended to be the smaller projects (total development cost under $10,000,000).

< Criterion 1.1 > Green Development Plan *[Mandatory]*
Submit a Green Development Plan to Enterprise Green Communities that outlines the integrated design approach used for the development, demonstrating the involvement of the entire development team.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would drive a cost difference between the two versions.

Cost Impacts

Since there is only one criterion under *Section 1: Integrated Design Process*, the incremental cost analysis is as stated above.

Reported design phase costs ranged from $750 to $41,495; it should be noted that the $41,495 included ongoing monitoring throughout the construction period. Two projects reported construction phase costs of $10,000 and $39,000.

No projects reported cost impacts related to land and development, and four projects listed commissioning costs for this category. The commissioning costs ranged from $1,000 to almost $25,000. It is possible, however, that the $25,000 reported cost included commissioning during the construction phase.

Within compliance documentation provided to Enterprise, two projects explicitly noted that a green design charrette was held, and four projects listed the names of specific people who would be responsible for developing the plan. Several projects noted specific municipal green codes or requirements that would be followed, such as the City of Seattle "Build it Green" Checklist, Portland Development Community "Green Building Criteria for Affordable Housing," and "Multifamily Green Building Guidelines" from the Alameda County Waste Management Authority. Only two projects indicated that they were going to attempt LEED®—one LEED NC registered and one LEED ND Pilot.

Region, Project Type, and Urban Density

Half the urban/inner-city projects reported costs, almost all of the suburban projects reported costs, and none of the rural projects reported any costs.

Findings and Considerations

It is likely that the reason why most projects did not report additional cost was that the project teams were able to incorporate the establishment of a Green Development Plan into the standard design effort for the project. This would be not altogether unexpected. In many cases, project teams are already comfortable with Criteria, having previous experience with other green programs, and are thus able to incorporate the effort to include Criteria as part of their typical practice. Previous experience suggests that when all parties are already familiar with the concepts of green design, selecting the desired criteria, and then establishing the methods by which these criteria will be met, are processes that can be done within the context of a regular project design meeting. In these situations, it becomes difficult, if not impossible, to separate out the cost of establishing a Green Development Plan, since the plan itself is simply a part of the overall design concept. Another reason, just as likely, could be to fact that, in many cases, design costs are not broken down by task; soft costs related to design are more often simply lumped into design phase (Schematic or Design Development, for example). Hence, the team was not able to separate specific design impacts for developing this plan; the effort was simply lumped in with all the other efforts of a particular design phase.

It is worth noting that the projects that reported the highest costs for development of the Green Development Plan also reported some of the lowest overall incremental costs.

Only two projects noted construction costs ($39,000 and $10,000, respectively) linked with developing the Green Development Plan. While the definition of Criterion 1.1 does not require management of the plan throughout the design and construction process, it is possible that these costs were listed to cover the person(s) responsible for undertaking the plan management.

Most projects used a standard language in their submissions to note that the plan was developed during the Schematic Design phase of the process. Occasionally a project would note a responsible party or reference LEED registration or a local green building program, but these references were not further clarified as to how they affected the Criteria of the project.

2. Site, Location, and Neighborhood Fabric

Location within existing communities—or contiguous to existing development—helps conserve land and the spread of storm water runoff to new watersheds. It also reduces travel distances. Proper site selection avoids development of inappropriate sites and damage to or loss of fragile, scarce environmental resources. The greatest savings come from developing in areas that already have infrastructure and civic amenities. Site selection is also an opportunity to clean up and redevelop brownfields, and restore the land and infill segmented communities. Compact development encourages more resource-efficient development of land, reduces development costs and conserves energy. It also can contribute to creating more walkable, livable communities, while helping to restore, invigorate and sustain livable development patterns.

Incremental Cost Overview

The data shows a median cost of $0 for all the Criteria combined under Section Two. This is not surprising, as many of the Criteria are compatible with elements that support a successful affordable multifamily project, such as locations that are adjacent to transportation and community amenities.

Most (more than two-thirds) of the projects analyzed for this report are located in urban/inner-city locations, with ready access to sidewalk connections and close utilities. These types of sites are not often impacted by the habitat protection requirements found in this Section, due to the intense urban development that surrounds them already.

Development of brownfields can be supported if mitigation measures are absorbed by redevelopment agencies or grants, and we would not expect to see these types of projects developed in locations where contamination mitigation is disproportionately higher than in other available locations nearby.

Higher densities and compact development go hand in hand with affordable housing design, indicated by densities far beyond the Criteria baselines in most cases.

The one criterion element within this category that is worthy of greater implementation in affordable housing development is good orientation for passive solar heating and cooling. Within the group of projects that were analyzed for this report, 13 projects noted compliance with this optional criterion.

< Criterion 2.1a > Smart Site Location: Proximity to Existing Development — New Construction *[Mandatory]*

Provide site map demonstrating that the development is located on a site with access to existing roads, water, sewers and other infrastructure within or contiguous (having at least 25 percent of the perimeter bordering) to existing development.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions.

Cost Impacts

Only one project reported costs for this criterion, less than $2,000 in total.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The requirements of this criterion can be met only through appropriate site selection. For non-conforming sites, projects cannot purchase compliance through development expenditure, short of constructing the required neighborhood development. As such, this criterion should typically have no cost impact beyond land acquisition.

The cost findings support the expectation that there should be no additional costs associated with selecting the project location.

< Criterion 2.1b > Smart Site Location: Protecting Environmental Resources — New Construction *[Mandatory]*

Do not locate new development, including buildings, built structures, roads, or other parking areas, on environmentally sensitive sites in order to minimize the impact of development and protect the environment.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions.

Cost Impacts

Only one project reported an incremental cost, at $0.23 per square foot, or $220 per unit. Since the majority of projects reported no cost, the median cost for the criterion was $0. The one that reported costs listed the cost as a design cost, suggesting that the expense was related to designing to avoid sensitive sites, rather than the cost of mitigation.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

It is likely that suburban and rural sites would, in general, be more affected by this criterion. While environmentally sensitive sites do exist in urban settings, they are more commonly found in previously undisturbed sites, which are typically in suburban or rural settings. Suburban and rural settings also tend to have lower development densities, requiring more site area per unit, and so having more site impact per unit. Typically, the approach to this criterion would be to avoid sensitive sites at the selection stage, rather than incur cost to mitigate development impact. As a result, cost impact for this criterion is likely to be zero in most cases.

Findings and Considerations

The cost findings support the assumption that developers avoided sites that impacted habitat or would require fees to mitigate habitat impact or develop in flood plains.

< Criterion 2.1c > Smart Site Location: Proximity to Services — New Construction *[Mandatory]*

Provide a location map with exact distances indicating that the project is located within one-quarter mile of at least two, or one-half mile of at least four, of the following facilities: adequate public transportation, supermarket, public school, library, licensed child care center, usable park space, bank, medical or dental office, post office, convenience store, laundry/dry cleaner, pharmacy, place of worship, or community or civic center that is accessible to residents.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

No projects reported incremental costs for this criterion.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The requirements of this criterion can be met only through appropriate site selection. For non-conforming sites, projects cannot purchase compliance through development expenditure, short of constructing the required services. As such, this criterion should typically have no cost impact beyond land acquisition except, perhaps, for the cost of opening connectivity from the site to neighborhood services.

As noted with the findings of Criterion 2.1a, the lack of cost reported for these criteria, even for land acquisition, supports the concept that developers are choosing sites that provide the adjacent amenities needed to make a project of this type viable. It is reasonable to assume from what is typical of the affordable housing market that

these projects are associated with good access to community connections, and developers do not see the section of sites with good connectivity as a premium.

< Criterion 2.2 > Compact Development — New Construction *[Mandatory]*

The project architect must complete the density calculation and certify its correctness. The minimum net density for new construction must be six units per acre for detached or semi-detached houses, 10 for townhomes, and 15 for apartments.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

No projects reported incremental costs for this criterion.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The lack of cost impacts for this criterion supports what we would expect to see, since higher densities are typically associated with this project type. Developers are usually focused on achieving a high density per acre as a major design goal related to budget and do not consider this a green project premium.

< Criterion 2.3 > Walkable Neighborhoods — Sidewalks and Pathways *[Mandatory]*

Connect the project to the pedestrian grid. Provide a site map indicating that sidewalks or other all-weather pathways exist or were created within a multifamily property or single-family subdivision to link the residential development to public spaces, open spaces, and adjacent development.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions.

Cost Impacts

Most projects reported no cost for this mandatory criterion; however, five projects did report costs associated with sidewalks and pathways, ranging from $0.10 to $1.05 per square foot, or $100 to $1,100 per unit. The median cost was $0.

All projects were in settings where adjacent sidewalks were already present; even those in rural communities typically were in small town settings. For most projects, the incremental cost was for additional sidewalks and paths for interior walking paths, or paths to link buildings across streets or to adjacent community resources.

Region, Project Type, and Urban Density

Three of the projects reporting costs were in urban or inner-city areas, while the other two projects are located in a suburban setting. None of the projects located in rural settings reported costs.

It is unlikely that there would be a significant cost difference between project types for this criterion. Even though low-density projects typically will have higher site costs and proportionately more site circulation, this criterion does not materially increase the extent of site circulation over that which might reasonably be provided absent the criterion.

Findings and Considerations

This is a criterion where we would typically only expect to see costs associated with rural projects. Most municipalities in suburban and urban areas require sidewalk connections regardless of green strategies.

< Criterion 2.4a > Smart Site Location: Passive Solar Heating / Cooling *[Optional 2.4 points]*

Orient building to make the greatest use of passive solar heating and cooling.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions, with the exception of more stringent shade requirements for glazing. Also, it is important to note that the 2005 version assigned five optional points to this measure.

Cost Impacts

Thirteen projects indicated that they intended to pursue this criterion. Of these, five projects reported costs, ranging from $0.07 to $1.70 per square foot: three were for $0.25 per square foot or less, while the other two were for significantly higher amounts. Costs per unit ranged from a group of three at around $100 to $200/unit, to the higher two at $1,000 and $2,000/unit. The two projects with higher costs indicated that these were specifically for added canopies and solar shading. All other projects reported no cost impact. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

It is possible that urban projects, particularly urban infill projects, would find compliance with this criterion difficult, since such project sites are typically more constrained with respect to layout, both from limited site area and from the orientation of existing streets and adjacent buildings. For rural and suburban sites, compliance should usually be less challenging, although site constraints such as slopes, required setbacks, etc., can also make good orientation challenging.

Findings and Considerations

There are two distinct elements to this criterion. Projects receive two points for optimizing solar orientation, and a further two for a series of strategies to optimize the use of passive solar heating and cooling, including glazing orientation and shading, and provision of roof area suitable for solar applications.

Of the 13 projects that indicated that they intended to meet this criterion, 10 were targeting both orientation and optimization, and three were only targeting orientation.

The elements of this criterion are quite separate regarding site use and cost. Elongated east–west orientation is primarily driven by site and other site-related elements, such as access, views, density goals, etc. Typically, there are few costs associated with good solar orientation, although there may be costs related to site grading to accommodate adverse slopes or for additional work around other site constraints. As the importance of good orientation becomes more accepted, designers are increasingly integrating good orientation into site layouts.

The other elements of this criterion are not site driven. Reduced glazing on the east–west walls can be driven primarily by design and may not have any recognizable associated costs. Shade for south-facing glazing and roof set-aside areas for solar applications, however, can have specific cost impacts. Of the 13 projects that indicated that they aimed to meet this criterion, 10 listed a goal of five points. However, nine of these did not report any additional costs, suggesting that balanced overall design supported these concepts, leading to their inclusion at no cost impact.

< Criterion 2.4b > Smart Site Location — Grayfield, Brownfield, or Adaptive Reuse Site *[Optional 2.4 points]*

Locate the project on a grayfield, brownfield, or adaptive reuse site.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Four projects reported cost impact for this criterion: one at $1.09 per square foot, or $1,100 per unit, and the others clustered within $3 to $3.50 per square foot, or between $3,000 and $4,000 per unit. The median cost was $0. Thirty projects set a goal of 10 points, or otherwise indicated that they would be developing on a grayfield, brownfield, or adaptive reuse site.

Region, Project Type, and Urban Density

Thirty projects indicated that they intended to try to meet this criterion. Nearly all were inner-city, infill, or urban sites.

Typically, this criterion is more likely to be available to urban projects, since grayfield, brownfield, and adaptive reuse sites are less common in suburban or rural settings.

Since the cost is related to site and footprint, the cost per square foot or per unit will be lower for higher-density and high-rise projects. High-rise projects have a particular cost advantage, since they both demand less site overall and require less site penetration due to their smaller footprints, relative to total development area.

Findings and Considerations

Ninety-five percent of all the projects claiming the points for this criterion reported no additional land development fees, design, or construction-related costs. This seems unusual. In most cases, we would expect to see some costs associated with developing on grayfield or brownfield sites. However, as a majority of the projects that indicated that they were achieving this criterion did not report any cost, it is possible that the cost of mitigating any associated site issues was dealt with prior to the land purchase, or that adaptive reuse costs were assumed in the baseline project estimate. It is also possible that some sort of grant funding or municipality support mitigated any associated costs.

< Criterion 2.5 > Compact Development

[Optional 5 points]

Increase average minimum density for new construction to meet or exceed seven units per acre for detached or semi-detached, 12 units per acre for town homes, and 20 units per acre for apartments.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Of the 41 projects that indicated that they intended to comply with this criterion, only one project reported an incremental cost, at $0.12 per square foot, or $96 per unit. The median cost for this criterion was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The affordable multifamily housing market typically designs for the highest density achievable. While a higher density translates to cost savings for these projects, it is a driving design goal regardless of green criteria. We would not expect developers to separate costs related to high densities, as the highest achievable density is typically the project baseline.

The median density (based on those projects that provided this information) was 43 units per acre. However, not all projects specified the type of unit (single-family, townhome, apartment, etc.). While not all projects provided density data, the

data provided did suggest that the average density achieved is much greater than the thresholds required by this criterion.

< Criterion 2.6 > Walkable Neighborhoods

[Optional 5 points]

Provide a site map demonstrating at least three separate connections to sidewalks or all-weather pathways in surrounding neighborhoods.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Of the 43 projects that indicated that they would achieve this optional criterion, only 10 reported costs, ranging from $0.05 to $0.57 per square foot, or $5 to $650/unit. Of these 10, eight reported costs of less than $0.20 per square foot, or $150/unit. Two reported significant costs of $360 and $650 per unit. These two projects both had significant work elements that would not directly be required by the criterion: one project incorporated a bridge across a creek, the other additional site circulation. In both instances, the work enhanced the walkability significantly. The median cost for the criterion was $0.

Region, Project Type, and Urban Density

Of the 10 projects that reported costs, five are located in suburban neighborhoods, one in a rural setting, and four in urban settings. For those projects that did not report any additional cost, four are in suburban areas, two are in rural areas, and the rest are located in urban or inner-city locations.

Findings and Considerations

For this criterion, we would expect to see very low costs, as most projects will have paved access to neighboring sidewalks as part of their basic design, even in rural settings. Where incremental costs were noted, they tended to relate to enhanced connectivity, either for a greater number of access points or for added features, such as the bridge across the creek.

This may be another criterion where code and local zoning would dictate multiple egress or access points. With a density of over 100 units per acre, three or more egress points would be typical to meet life safety requirements.

< Criterion 2.7 > Transportation Choices

[Optional 6 or 12 points]

Provide a context map demonstrating that the site is within one-quarter mile radius of adequate bus service, or one-half mile radius of adequate fixed rail or ferry station.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Of the 47 projects that provided cost data, only four reported an incremental cost. Costs reported ranged from $0.09 to $0.30 per square foot, or $70 to $560 per unit, and the median cost was $0. Eighty percent of all of the projects indicated that they would comply with this optional criterion. A majority of projects described all of the access points provided.

Region, Project Type, and Urban Density

While this is a criterion normally associated with urban development, it is worth noting that all the rural projects and 80 percent of the suburban projects claimed this criterion; these are areas where we would typically expect that transportation access would be more difficult to achieve. That as many rural and suburban developers were able to achieve compliance with this criterion is an indication that developers are making accessibility and connectivity a priority and seeking sites that can provide adequate transportation options.

Findings and Considerations

One project described the cost for a bike rack structure that, while it may not be directly related, would support convenient access to light rail or bus lines. In general, we would not expect to see any costs associated with this criterion unless items such as bike storage, carpool drop-off area, or kiosks for alternative transportation were accepted as legitimate costs for this criterion; if so, these costs should be minor, and of no significant project impact.

Any expected major cost impact would most likely be from selecting a site that had good access to transportation as opposed to some other site, but there were no land or development premiums noted for any of the projects, indicating that most developers assumed good transportation access as a baseline criterion in site selection.

3. Site Improvements

The Criteria include minimum standards for environmental remediation and erosion control, while also encouraging developers to use advanced techniques for surface-water management.

Incremental Cost Overview

For the most part, projects demonstrated that they were able to meet the mandatory requirements within this Section (Criteria 3.1 to 3.3) with little to no additional cost, and for the majority of projects that did report any incremental costs, most managed to satisfy the requirements for less than $1.50 per square foot. There were several outliers, however, all of which reported significantly higher cost impacts. Most notable among these were for environmental remediation, where one project had outlying costs of $8.43 per square foot ($5,500 per unit respectively). It is important to note, however, that this project, included the demolition of light industrial buildings and remediation of hazardous soil on the site, clearing the way for this affordable housing property. Despite this outlier, the median cost for all criteria in this section was $0.15 per square foot, and $0 for the three mandatory criteria.

It is not unexpected that the median cost to meet the mandatory criteria was $0. In many locations around the country, local and state codes already require that projects meet some, if not all, of these three criteria, so many of the projects in this study would have already had to take some of these requirements into account.

For the optional criteria, the incremental cost data reflects what would be expected. There was little if any cost impact for labeling storm drains (for those projects that chose to meet this criteria), while there was some cost impact due to meeting the surface water management goal. As with the mandatory requirements, however, costs reported for surface water management did include some fairly high outliers.

< Criterion 3.1 > Environmental Remediation

[Mandatory]

Conduct a Phase I Environmental Site Assessment and additional assessments required to determine whether any hazardous materials are on site.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Seventeen projects reported an incremental cost for this criterion, with costs ranging from $0.06 to $8.43 per square foot. Median cost for this criterion was $0. Of the reported incremental cost information, the high value should be considered as an outlier. The remaining 16 projects reported costs of less than $2.50 per square foot.

The compliance documentation of most projects that indicated no cost impacts noted a Phase I Environmental Site Assessment. A few of the projects with cost impacts noted the reason, one being monitoring wells for $18,000 and the other noting asbestos removal for $12,000.

Region, Project Type, and Urban Density

The projects reporting development costs were split evenly between urban and suburban, while most of the projects reporting construction costs were urban/inner-city projects. Only two of the 14 projects defined as rehabilitation reported construction cost impacts. None of the projects that reported land or development fees also reported any associated design or construction fees.

Findings and Considerations

A median cost of zero for this mandatory requirement may reflect that project teams were able to absorb the effort of developing a Phase I Environmental Site Assessment within the project team management costs. It is also possible that projects were required to develop some sort of environmental site assessment document regardless of the Criteria, such as the CEQA assessment required for some California projects, so that no additional costs were incurred for this mandatory criterion.

The Phase I assessment can usually be conducted by a construction or design manager and does not necessarily require a third-party consultant, thus incurring little cost. Outside consultants are usually hired when there is a Phase II Abatement Plan required, or when contaminants are known and abatement programs must be developed. With most of the projects reporting no costs, it is reasonable to assume that, for the most part, developers avoided any significant cost impacts due to this assessment.

< Criterion 3.2 > Erosion and Sedimentation Control *[Mandatory]*

Implement EPA's Best Management Practices for erosion and sedimentation control during construction, referring to the EPA document, *Storm Water Management for Construction Activities* (EPA 832-R-92-005).

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Only seven projects reported an incremental cost for this criterion, ranging from $0.01 to $2.88 per square foot, or $20 to $2,200 per unit. Of these, all but one reported costs of $0.32 or less per square foot, or $150 per unit. For the outlier project, the high incremental cost reported reflects storm water infrastructure costs. The median cost for this criterion was $0. A majority of project plans noted that projects already had to comply with local or state storm water requirements.

Region, Project Type, and Urban Density

Half of the projects that reported an incremental cost were in suburban settings.

There should be no significant cost difference between project types to comply with this criterion, although it is possible that lower density developments will have proportionately more site area, and therefore more site storm water to manage.

Findings and Considerations

Storm water protection requirements are mandatory for projects developing over one acre in most states. Even projects of less than one acre must usually comply with local storm water management practices. We would therefore expect to see little or no additional costs reported for compliance with this criterion, and this was supported by the cost data provided.

< Criterion 3.3 > Landscaping *[Mandatory]*

Commit to providing a tree or plant list, to be certified by the Architect or Landscape Architect at the Construction Documents stage, that the selection of new trees and plants is at least 50 percent native species, 100 percent appropriate to the site's soil and microclimate, and does not include invasive species.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions.

Cost Impacts

Sixteen projects reported information for this criterion. Of those, six projects reported an incremental cost, ranging from $0.01 to $2.91 per square foot, or from under $10 to $3,300 per unit. Four of those six projects reported both design and construction costs, ranging from $0.01 to $0.37 per square foot, or under $400 per unit. The median cost for this criterion was $0. Most projects simply noted compliance, or the fact that there were no plantings on site. Of the two projects that reported costs above $2 per square foot, only two commented on planting in their compliance documentation, and no specific difficulties were noted.

Region, Project Type, and Urban Density

Four of the six projects reporting cost impacts were in suburban settings.

Findings and Considerations

We do not normally see cost impacts beyond those of the landscape design team to incorporate native, adaptive, and non-invasive planting into projects. Adaptive plant types are readily available in the market, and many municipalities now have a list of invasive planting that is not allowed, per code. With most of the projects responding with no cost impact, we can assume that this mandatory criterion is being easily incorporated into most projects.

< Criterion 3.4 > Surface Water Management *[Optional 5 points]*

Capture, retain, infiltrate, and/or harvest the first one-half inch of rainfall in a 24-hour period.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Thirty-six projects reported information for this criterion. Of these, 19 reported an incremental cost. More than half (13) of these projects met this criterion for less than $0.80 per square foot, or $700 per unit, while the remainder of costs ranged from $1.27 to $6.21 per square foot, or $1,000 to $4,500 per unit. The median cost was $0.

Most projects simply listed compliance with this optional requirement, although a few noted that some sort of storm water capture was a code requirement. For those projects with cost impacts of more than $1.50 per square foot, only one specified an exact reason (installation of a cistern).

Region, Project Type, and Urban Density

Costs were evenly distributed between all regions and project types.

Findings and Considerations

For this criterion, some type of design effort was required to calculate and ensure that storm water capture on site was adequate. With more than half the projects reporting compliance at no additional cost, baseline project budgets must have included this effort. Whether it was from natural or designed swales, landscaped areas that could contribute, or the more aggressive efforts of drywells or tanks, most projects did not see this as a cost premium.

< Criterion 3.5 > Storm Drain Labels *[Optional 2 points]*

Assure that the project plans and specifications call for labeling of all storm drains or storm inlets to clearly indicate where the drain or inlet leads.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Twenty-six projects indicated compliance with this criterion; of these, 15 reported cost impacts, all below $0.05 per square foot, or $30 per unit. The overall median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Storm water drain labeling is becoming a code requirement in many locations where storm water drains to beaches or public parklands. Projects easily included this requirement with little to no cost impact. As such, this measure has been removed from the 2011 Enterprise Green Communities Criteria, as it has become more common practice.

4. Water Conservation

Americans use about 80 gallons of water every day, and 70 percent of that water, on average, is used indoors. Showers and faucets account for approximately 33 percent of indoor water use, while toilets account for approximately 27 percent, according to the American Water Works Association Research Foundation publication *Residential End Uses of Water*. Reducing water use translates into utility savings, both by reducing the energy required for heating water and by reducing water and sewer bills, since sewer fees are typically tied to water usage. EPA estimates that water-conserving fixtures meeting the national Energy Policy Act of 1992 guidelines reduce the amount of water used in showers and sinks by 75 percent and 50 percent, respectively, when compared with pre-1992 fixtures.

Incremental Cost Overview

The median cost for this section was $0.09 per square foot, or $83 per unit, indicating that most of the projects were able to meet the requirements for water conservation and efficiency for little or no additional cost. This is not surprising, as fixtures and appliances that meet the requirements are becoming more standard across the industry, with little or no price differential. In addition, in many instances, local codes and ordinances already require water conservation to the level established in the mandatory criteria, so meeting the Criteria goals requires little or no additional effort.

More than half of the projects reported an incremental cost for the inclusion of appliances and fixtures that meet the mandatory requirements of this section. Of these, the majority reported cost impacts of $0.25 per square foot or less, and the median cost for all projects was $0.02 per square foot, or $20 per unit. In addition, most projects found low- or no-cost solutions to meet the mandatory criteria for efficient irrigation, such as installing more efficient irrigation systems and finding ways to collect rainwater to minimize the use of potable water for irrigation purposes. Only 12 projects reported any cost impact, and, of those, the majority (eight) reported a total cost impact of $0.26 per square foot or less, while the median cost impact for all 52 projects was $0.

Only a handful of the projects (seven) attempted to meet the additional (optional) water conservation goals added in the 2008 version of the Criteria, suggesting that fixtures and appliances that meet those goals may not have yet proved to be cost-accessible at the time data was collected for this report. Of these, only two reported cost impacts, at $0.33 and $0.36 per square foot.

Despite the fact that a majority of projects were able to meet all mandatory criteria for little or no cost impact, in each case there was a small

number of outliers. Two projects reported cost impacts of $0.62 and $0.80 per square foot to meet the mandatory requirements for installing efficient fixtures and appliances. Both of these projects were rehabilitations, so it is possible that the cost impact came about because, without the desire to meet the Enterprise Green Communities Criteria goals, they would not have replaced the fixtures at all.

There were also a handful of outliers for efficient irrigation, reporting costs of $5.33, $1.11 and $1.09 per square foot. These higher costs were reported by projects that implemented systems beyond the minimum requirements of the criteria (for example, two of the three outliers reported installing grey water piping systems, to be used for irrigation).

Cost Savings

Water conservation is one of two sections that have a direct cost saving related to the conservation measures. Forty-seven of the projects reported anticipated water consumption reduction and the associated cost savings. Overall, the water conservation measures showed significant lifetime value, with median payback for the measures being less than two years. The median NPV at 20 years was $0.56 per square foot, or $750 per unit. The value of the savings was highly dependent on the cost of water, which varies significantly across the population of projects, with costs ranging from as low as $0.88 per 1,000 gallons to as high as $16.54 per 1,000 gallons, with a median of $7.14 per 1,000 gallons. As would be expected, the payback period was significantly greater, and the NPV significantly lower, where water costs were lower.

< Criterion 4.1a and 4.1b > Water-Conserving Appliances and Fixtures *[Mandatory]*

Install water-conserving fixtures such as toilets, showerheads, kitchen and bathroom faucets.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language for 2008 decreased water use limits on toilets from 1.6 gpf to 1.3 gpf. Because the market has followed decreased water consumption for toilets, we do not see any cost implications between the two criteria versions.

Cost Impacts

Twenty-nine of the 52 projects reported incremental cost. Construction costs reported ranged from $0.01 to $0.80 per square foot, or $20 to $650 per unit. The majority (21) of the projects reported costs of less than $0.25 per square foot, or under $250 per unit. Only two reported costs higher than $0.60 per square foot. Both of these were rehabilitations.

Only three projects reported any impact to design cost, ranging from $0.01 to $0.08 per square foot. All other projects reported a $0 cost impact from this criterion.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Water-saving fixtures are readily available in the current market, and the data suggests that the developers were able to find ways to incorporate these features into their projects for little or no additional cost. Also, as noted in the section introduction, these features have a very short payback period.

Developers could encourage further water savings with individual water meters and educational material on water reduction strategies. Without individual metering, there is less incentive for residents to change their own behavior to consume less water. Individualized usage reports provide clear feedback to each household, not only in terms of total water used, but also in terms of the financial benefit of reducing water consumption.

Education is a key component in encouraging residents to modify their behavior, as it provides the residents with a better understanding of how much water even the simplest action can use (for example, turning off the faucet while brushing your teeth can save up to 20 gallons of water per household per day).

< Criterion 4.1c > Conserving Appliances and Fixtures *[Optional 5 points]*

Install resource-efficient water-conserving fixtures that go beyond the flow rates within mandatory Criteria 4.1a and b.

Significant Changes Between 2005 and 2008 Criteria

This optional criterion, to further reduce water consumption from the mandatory levels noted in Criteria 4.1a and 4.1b, was not included in the 2005 Criteria.

Cost Impacts

Of the 17 projects included in the 2008 data, five projects indicated that they intended to achieve this criterion, and, of those five, only two reported any cost impact, at $0.33 and $0.60 per square foot.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Three of the five projects that listed intent to comply with this criterion did not report any additional cost to achieve the additional water savings.

While water-efficient fixtures are becoming more available on the market, we would expect to see some cost impact for efficient fixtures that also meet the more stringent maintenance performance that developers require.

< Criterion 4.2 > Efficient Irrigation *[Mandatory]*

If irrigation is necessary, use recycled grey water, roof water, collected site runoff, water from a municipal recycled water system, or a highly efficient irrigation system.

Significant Changes Between 2005 and 2008 Criteria

The criterion for 2005 required 95 percent of all water used for landscaping to come from non-potable water sources *or* efficient irrigation. For 2008, this was amended to address 100 percent of the irrigation systems, and included several prescriptive requirements that were mandatory if an irrigation system was used.

Cost Impacts

Of the 52 projects, 38 indicated that they would be installing some sort of irrigation system; of these, only 14 reported any costs related to this criterion, with costs ranging from $0.01 to $4.60 per square foot for construction. The remaining 38 projects reported no cost impact at all, indicating that they were able to meet this criterion without spending any additional funds. For those 14 that reported construction costs, the majority (eight) of the projects reported costs of $0.20 or less per square foot. Five of the six projects with costs over $0.20 had costs between $0.50 and $1.25 per square foot. The most expensive project had a cost of $4.60 per square foot; however, this project included a rainwater storage tank in the basement. All of the six projects—Cornerstone Apartments, Ewing Independent Living, Madrone Plaza, Schiff Residences ($4.60), Spring Terrace, Downtown @700—reporting over $0.20 per square foot incorporated some form of rainwater capture or grey water use.

Of the 12 projects that reported an incremental cost for construction, six also reported design cost impacts, which ranged from $0.02 to $0.13 per square foot. Only one project reported any impact to commissioning costs, with a cost of $0.03 per square foot.

Most projects simply reported some of the elements that would be included in their irrigation systems, such as drip delivery or use of timers. Only one project provided a more detailed description of how they would meet the requirements for this criterion, by noting that the project would have a mix of xeriscaping and high-efficiency irrigation.

Many projects noted some mix of xeriscaping, drought-tolerant, native, and adaptive planting under this criterion as opposed to describing them for Criterion 3.3.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

While this is a mandatory criterion, it is difficult to compare landscape water use between projects, as the total site development can vary to such a large degree. Additionally, not every municipality supports long-term water storage, and this remains an expensive option with many maintenance issues.

Continued support for low-water-use planting, smart site design, and water-saving irrigation technology, when needed, will move projects toward lower water-use and maintenance costs.

5. Energy Efficiency

The energy-efficiency section of the Enterprise Green Communities Criteria is intended to increase resident comfort while also reducing utility bills and lowering carbon emissions. On a global scale, these criteria help to mitigate the accumulative burdens of energy production and delivery, extraction of non-renewable natural resources, air quality degradation, global warming, and increasing concentrations of pollutants.

Incremental Cost Overview

Of the projects that had both cost and savings data for energy, the simple payback period ranged from less than one year to over 50 years. Generally, however, the buildings fell into two main cohorts: those with payback periods of five years or less, and those with payback periods of greater than 10 years. Twenty-six projects had payback periods of five years or less, 13 of greater than 10. The ones with paybacks greater than 10 years typically had incorporated specific high-performance strategies: one had a geothermal system, two had significant solar thermal systems, and three had photovoltaic (PV) systems. The ones with the shorter payback periods had typically incorporated standard energy-improvement strategies, such as improved insulation and windows, and Energy Star lighting and appliances.

The median cost for all projects, excluding renewable energy measures, was $1.16 per square foot, or $1,860 per unit. There was a modest but significant difference in cost profile between new and rehabilitation projects. The rehabilitation projects had moderately higher costs for standard energy-efficiency measures than did the new projects. The median cost for new projects was $0.85 per square foot, or $1,000 per unit; for remodels, the median incremental costs were $2.40 per square foot, or $3,100 per unit. This is not unexpected, since it is generally easier to incorporate improved insulation, glazing, and lighting from the start than during rehabilitation. The difference between new and rehabilitation becomes more significant when compared to Total Development Cost, which is typically lower for rehabilitation. The median Total Development Cost for new construction was $192 per square foot, whereas the rehabilitation was $136 per square foot. The median energy cost increment therefore was roughly 1.6 percent for rehabilitation, and less than 0.5 percent for new construction.

The projected savings were higher for rehabilitation projects, with a median of $343 per unit as opposed to $189 per unit for new construction. This is possibly because new units have a higher code minimum baseline than existing projects, and the potential for savings is greater.

The maximum reported costs were nearly $6.30 per square foot for new construction and $8.24 per square foot for rehabilitation for basic energy measures. If Criterion 5.5: Additional Reductions in Energy Use is added in, the maximum costs rise to $13.90 and $15.70 per square foot, respectively.

< Criterion 5.1a > Efficient Energy Use — New Construction *[Mandatory]*

Provide verification demonstrating energy efficiency by meeting one of the following:

- Energy Star standards (HERS Index of 85 in climate zones 1–5, or HERS Index of 80 in climate zones 6–8) for all residential structures under four stories.
- Residential structures four stories or more must exceed ASHRAE 90.1-2004 by 15 percent.
- Projects in California must exceed Title 24 by 15 percent.
- Low-rise projects in Oregon, Washington State, Idaho, and Montana must meet the performance requirements of Northwest Energy Star.

The design-specific criterion language requires projects in different regions to meet targets related to the energy standards for that particular region. For this reason, we have separated the analysis of cost and regional impact into the energy zones defined by the criterion language. General energy-efficiency analysis is captured in the overview section above.

Significant Changes Between 2005 and 2008 Criteria

In 2008, the language was updated to include climate zones.

< Criterion 5.1b > Efficient Energy Use — Moderate and Substantial Rehabilitations *[Mandatory]*

Conduct an energy analysis of the existing building condition and identify cost-effective energy improvements by preparing an energy-improvement report. Implement energy improvements adequate to improve the building's energy performance by 15 percent from pre-rehabilitation figures.

Significant Changes Between 2005 and 2008 Criteria

There was a significant change for rehabilitation projects between the 2005 and the 2008 criterion language. In 2005, projects needed to generate an energy improvement report and implement any improvements with a payback period of 10 years or less. In 2008, the language was changed to mandate a 15 percent energy improvement over a preconstruction energy baseline.

Costs and Benefits by Region

Of the 47 projects with data, 30 reported an incremental cost. The incremental cost ranged from less than $0.10 per square foot to $8.24 per square foot, or under $20 per unit to $6,570 per unit. The median cost across all projects (regardless of climate zone) was $0 per square foot.

California Title 24: All California projects were required to be 15 percent more energy-efficient than the California Energy Code (known as Title 24) minimum standards. There were nine projects built under the 2005 criterion (there were no projects completed in California under the 2008 criterion). Of these, cost data was available for eight of the projects. The median cost for all measures, excluding renewable energy, was $0.21 per square foot, or $334 per unit, and the median payback period was 2.35 years. One of the projects was rehabilitated. That project had the highest incremental cost at $4.50 per square foot, or $2,068 per unit, and the highest payback at over 16 years. For the new construction projects, the

median cost was $0.21 per square foot, or $206 per unit, and the median payback period was 2.18 years. Only two of the new construction projects had costs greater than $1 per square foot, or paybacks over five years.

The cost benefit surveys for these projects typically noted that the projects used better insulation and window glazing than code, and typically utilized an electric heat pump system.

While costs for energy-efficient lighting, Energy Star appliances, and additional energy reductions beyond the mandated 15 percent and PV installations are discussed under their own criterion numbers, it is important to look at these costs as a whole, as the combination of all these efforts equate to the energy reductions seen in the projects. The median cost impact for all the energy saving efforts on California projects was $0.21 per square foot. The mandatory measures of 15 percent energy reductions, efficient lighting, and Energy Star appliances had a median cost of $0.13 per square foot.

Five of these nine projects included some level of PV energy generation, at a median cost of just over $2.84 per square foot, and median simple payback period of 27 years. These projects most likely achieved the 15 percent energy consumption reduction from Title 24 requirements, in part, due to photovoltaic generation. This would support the relatively low cost impacts noted under this criterion for achievement of the mandatory energy reductions.

Northwest Energy Star: Low-rise projects in Washington, Oregon, Idaho, and Montana were required to meet the Northwest Energy Star Standards. Five projects reported in this category, four of which were scattered or clustered single family or townhome units. Energy performance predictions were available for only three of the projects, all of which were new construction.

The median cost for all measures, excluding renewable energy, was $1.24 per square foot, or $1,330 per unit, and the median payback period for the three projects with energy consumption predictions was 8.87 years. Three projects had payback periods in excess of five years. The median cost for just the mandatory measures was $0.65 per square foot.

Two of these projects included some level of renewable energy generation, at a median cost of just over $1.37 per square foot. Energy performance data was available for only one of the renewable systems, which had a payback period of in excess of 50 years.

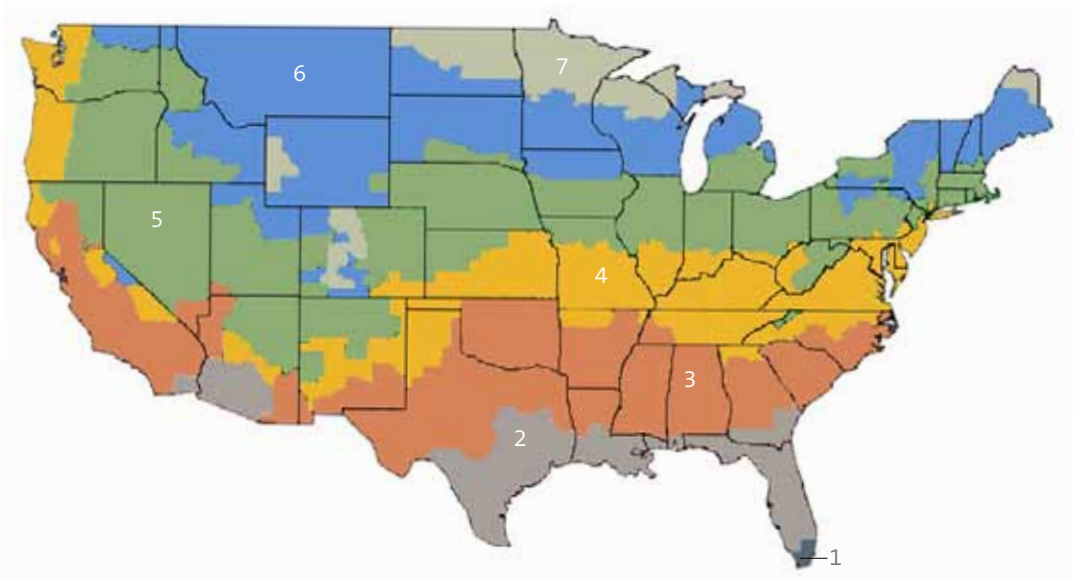
HERS Climate Zones 1–5 (below four stories): Eighteen projects in this category reported costs; of these, 15 had predicted energy consumption data. The median cost for all measures, excluding renewable energy, was $1.06 per square foot, or $990 per unit, and the median payback period was 3.78 years. Five of the projects were rehabilitation, and the other 13 were new construction. For new projects, the median cost was $0.81 per square foot; for rehabilitation projects the median cost was $1.62 per square foot. The median cost for just the mandatory measures was $0.83 per square foot.

Five of these projects included some level of PV energy generation, at a median cost of just over $5.80 per square foot, and median simple payback period of 34 years.

HERS Climate Zones 6–8 (below four stories): Three projects in this category reported costs and all three had predicted energy consumption data. The median cost for all measures, excluding renewable energy, was $2.65 per square foot, or $5,095 per unit, and the median payback period was 11.57 years. All three projects were rehabilitation. The median cost for just the mandatory measures was $0.83 per square foot.

None of these projects included renewable energy generation.

MAP 4.1
Climate Zones Throughout the Continental United States



ASHRAE Energy Standard (above four stories): Seventeen projects in this category reported costs; of these, 14 had predicted energy consumption data. The median cost for all measures, excluding renewable energy, was $1.23 per square foot, or $1,300 per unit, and the median payback period was 4.86 years. Four of the projects were rehabilitation, and the other 13 were new construction. For new projects, the median cost was $0.42 per square foot; for rehabilitation projects, the median cost was $1.48 per square foot. The median cost for just the mandatory measures was $0.55 per square foot.

Three of these projects included some level of renewable energy generation, at a median cost of just over $2.51 per square foot. Energy performance data was available for only one of the renewable systems, which had a payback period of 18 years.

Costs and Benefits by New or Rehabilitation

Thirty-six of the projects with cost data were new construction, and 12 were rehabilitation. Predicted energy usage was available for 28 of the new projects and all 12 of the rehabilitation projects.

The median cost for the new projects was $0.74 per square foot, or $829 per unit. For rehabilitation, the median cost was $2.91 per square foot, or $3,124 per unit. The simple payback period was 4.68 years for new construction, and 8.86 years for rehabilitation.

Rehabilitation projects reported a variety of methods for meeting this criterion, including installation of a ground source HVAC system, increased insulation throughout the building that likely triggered replacement of interior drywall and/or exterior siding, and replacement of existing PTAC units.

< Criterion 5.2 > Energy Star Appliances *[Mandatory]*

Install Energy Star clothes washers, dishwashers, and refrigerators.

Significant Changes Between 2005 and 2008 Criteria

There were no changes in the language between the two versions.

Cost Impacts

Thirty projects reported an incremental cost, ranging from $0.03 to $0.52 per square foot. The median cost for this criterion was $0.05 per square foot.

Most projects simply reported that Energy Star appliances were included in the project. A sampling review of the energy model reports from the projects found that energy reductions arising from the use of Energy Star appliances were not taken into account for plug load reductions. This is not unusual, as many energy model approaches disregard reductions in plug load. As such, the energy models are understating potential energy reductions

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The majority of projects were able to meet this criterion with very little cost (approximately 50 cents per square foot or less). This is as we would expect, as Energy Star appliances have become mainstream in the marketplace, with many options to choose from. While some options still carry a slight cost premium, the energy savings can be significant to the consumer, with very short payback periods, sometimes of less than one year.

< Criterion 5.3a > Efficient Lighting—Interior *[Mandatory]*

Install the Energy Star Advanced Lighting Package in all interior units, and use Energy Star or high-efficiency commercial-grade fixtures in all common areas and outdoors. If reusing existing fixtures in rehabilitation, installing compact fluorescent light bulbs (CFLs) is permitted.

Significant Changes Between 2005 and 2008 Criteria

There were no differences between the 2005 and 2008 criterion language.

Cost Impacts

Projects meeting the 2005 Criteria: Of those projects the cost data for Criteria 5.3a and 5.3b was combined, so analysis of this data includes costs for both interior and exterior lighting. Within this data set, 20 projects reported an incremental cost for interior and exterior lighting (combined), and ranged from $0.03 to $2.82 per square foot, or $100 to $1,300 per unit, with a median of $0.07 per square foot. However, of these 20 projects, all but two met the criterion with an incremental cost of $0.46 or less. The project with the highest cost was a rehabilitation project that included costs for replacement of existing fixtures.

Projects meeting the 2008 Criteria: Of those projects providing cost information, 12 reported an incremental cost and five did not. Costs reported ranged from $0.05 to $3.16 per square foot, or $40 to $1,700 per unit, with a median cost of $0.10 per square foot. Of those projects that reported an incremental cost, the majority (14) were able to meet the criterion for less than $0.50 per square foot.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

While most projects did report some cost impact, the impact seemed minimal overall. There was no single location or project type that was more impacted, and in fact the substantial rehabilitation projects had a slightly lower cost per square foot than the new construction projects.

For new construction, energy-efficient lighting packages can carry an incremental cost for those developers who do not normally consider Energy Star lighting, but for those developers who usually include some energy-efficient lighting, the change to make all fixtures meet Energy Star criteria may not be very difficult. However, we would assume that rehabilitation projects that did not otherwise intend to replace some or all of the lighting fixtures would have a greater cost impact to meet this mandatory criterion.

< Criterion 5.3b > Efficient Lighting — Exterior *[Mandatory]*

Install daylight sensors or timers on all outdoor lighting, including front and rear porch lights in single-family homes.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions.

Cost Impact

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 5.3a and 5.3b. Analysis of this data is included in the 5.3a section, above.

Projects meeting the 2008 Criteria: Only four projects reported any cost impact, ranging from $0.02 to $0.42 per square foot. The median cost was $0. For the project reporting a cost of $0.42 per square foot, the majority of the cost ($0.30) was for design services.

Region, Project Type, and Urban Density

Three of those projects reporting costs were substantial rehabilitations; however, the other two substantial rehabilitations did not report an incremental cost.

Findings and Considerations

The data suggests that projects were able to meet this criterion with little or no cost. This is unsurprising, as many municipalities are requiring daylight sensors and dimming equipment for multifamily and commercial projects. We can therefore assume that costs for this criterion will continue to diminish. Rehabilitation projects not otherwise intending to replace fixtures, however, would have a greater cost impact to meet this mandatory criterion.

< Criterion 5.4 > Electricity Meter *[Mandatory]*

Install individual or sub-metered electric meters.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Only four projects reported an incremental cost, with costs reported ranging from $0.40 to $1.95 per square foot, or $400 to $2,000 per unit. Three of the projects had costs between $0.40 and $0.75 per square foot. The highest cost impact reported ($1.95 per square foot) was for a substantial rehabilitation project. All other projects reported no cost impact to meet this mandatory criterion. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation in incremental cost was noted between project cohorts.

For most apartments, other than supportive or very-low-income housing, the resident pays for the base load electrical and heating/cooling costs. Separate metering is typical in such circumstances.

Findings and Considerations

Thirty-three projects indicated whether the resident or owner pays for base load electrical costs. Of these, residents paid for base load electricity in 27 of the projects, while the owner paid in the other six. Of the six where the owner paid, five were supportive housing.

Under these circumstances, we would expect to see incremental cost for separate tenant metering only in rehabilitation projects where metering is added, or for supportive housing where it would otherwise not be installed.

< Criterion 5.5 > Additional Reductions in Energy Use *[Optional]*

Analyze and adopt additional energy efficiency improvements above and beyond the requirements set forth within Criterion 5.1.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Thirty-three projects reported data for this optional criterion. Of these, 16 reported incremental costs, with a range of $0.03 to $15.35 per square foot, or from under $30 to over $13,000 per unit.

Of the projects reporting incremental cost, the median cost was $0.52 per square foot; only four had costs over $1 per square foot, and, of those, two were only marginally over $1 ($1.12 and $1.04). Two projects reported significantly higher costs at $12.67 and $15.35 per square foot. One of these incorporated several significant measures to reduce total energy consumption, including solar hot water collectors designed to provide about 80 percent of the domestic hot water use and about 20–30 percent of the space heating needs. The other project included a ground-source heating system and a solar hot water system.

Most projects did not provide much information on the measures incorporated under this criterion. Among the strategies identified, however, were: enhanced envelope performance, including additional insulation, cool roofs, and very high performance glazing and frames; ground source heating and cooling; trombe walls; and solar thermal hot water.

Region, Project Type, and Urban Density

Of the projects that reported cost impact, four were located in California, five were located in HERS climate zone 6–8, three were low-rise projects located in the Northwest Energy Star states, and the remaining were located in HERS climate zones 1–5. Six of these projects were rehabilitations.

Findings and Considerations

For most projects, the incremental costs for additional energy savings were very small. Since the energy performance data was not broken down by strategy, it is not possible to undertake a cost-benefit analysis on the added energy savings portion alone. Analysis of the energy performance is therefore taken across all energy measures.

The two projects with the highest incremental costs also had two of the highest simple payback periods.

< Criterion 5.6a > Renewable Energy *[Optional]*

Install PV panels, wind turbines, or another renewable source to provide at least 10 percent of the project's estimated electricity demand.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Fourteen projects reported installing some form of renewable energy system. Of these, 13 were for PV panels and one was a micro-turbine. In addition, one project with PV panels also included wind turbines. Costs for the systems ranged from a high of $9.25 to a low of $0.33 per square foot. The median was $0.

Eleven projects had sufficient cost data to permit more detailed analysis of the systems costs and benefits. The installed systems ranged in size from 3.50 kVA to 75 kVA, and the installed cost per kVA of capacity ranged from $540 to $10,450, with a median of $4,873. Some of the projects

indicated that they had received grant support for the PV panels, but the grant data was not broken down in sufficient detail to separate grant and non-grant cost data, except to note that the two lowest-cost systems ($540 and $2,270 per kVA) had received grants that offset a significant portion of their cost. Broadly, the higher costs per kVA were associated with the smaller systems, except that the highest cost of $10,450 per kVA was one of the larger systems. We were not able to identify a reason for this, other than that the system was installed on clustered townhouses, which could have led to greater cost. For the large-scale systems, over 30 kVA, the costs fell within the range of $4,500 to $7,100 per kVA.

Cost–Benefit Analysis

For the 11 PV systems that had detailed cost information, the anticipated energy production ranged from 4,000 kWh per year to almost 94,000 kWh per year. The cost of grid electricity ranged from $0.05 to $0.19 per kWh, leading to anticipated annual energy cost savings of $230 to $11,400. The installed cost per annual kWh ranged from $0.37 to $8.40, with a median of $4.12.

Except for the grant-funded projects, payback periods were typically over 25 years, with two projects having simple payback over 50 years. The shortest payback was five years, which was one of the grant-funded projects. Similarly, the NPV was negative at 20 and 40 years for all but the grant-funded projects.

Benefit data was not provided for the micro-turbine or the wind turbines.

Region, Project Type, and Urban Density

Eight of the projects were in California, Texas, or Colorado, all areas with high levels of solar potential. Across the population of projects, anticipated annual production per installed kVA ranged from around 1,200 kWh per kVA to almost 1,500 kWh per kVA (*www.nrel.gov/rredc/pvwatts/site_specific.html*).

The cost and performance of PV systems will be very location dependent. kWh per installed kVA ranged from a high of over 1,600 kWh per kVA in the desert southwest to a low of under 1,000 in areas such as Seattle and Alaska. The cost of electricity also varies widely by location, as do possible grants or other financial support.

Location is also significant for wind generation. It should be noted, however, that building-integrated wind generation appears not to be able to generate as much energy as the wind speed maps would indicate. While research on this is continuing, it appears to be related to turbulence and flow disturbance by the buildings.

Project development density has a small impact. The low- and mid-rise developments have larger roof areas suitable for larger installations. Scattered townhouse developments have less contiguous roof area, leading to more challenging installation. Optimum developments would be low or mid-rise apartment projects.

Findings and Considerations

The PV system installations varied greatly in size and cost, indicating that there is still little consistency in application. All projects had very long payback periods and negative NPVs.

< Criterion 5.6b > **Photovoltaic Ready (PV)** *[Optional]*

Site, design, engineer, and wire the development to accommodate installation of PV in the future.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Only five projects reported inclusion of PV-ready infrastructure. Of those five, two reported cost impacts of $0.06 and $0.36 per square foot. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

While this criterion was not considered for most projects in the study, there is general market evidence that preparing projects, at least electrically, for future rooftop PV has very little cost impact. That stated, not all project locations are appropriate given climate and some urban settings. This criterion might be considered mandatory, given its low cost impact, as PV installations continue to drop with lower payback periods, but only in those locations where PV arrays are practical.

6. Materials Beneficial to the Environment

Reusing and recycling building materials conserves natural resources and reduces emissions associated with manufacturing and transporting raw materials.

Incremental Cost Overview

The median cost for this section across all projects was $0.13, or $165 per unit, with slightly less than half the projects reporting no added cost. Expressed as a percentage of Total Development Cost, the premium is less than 0.01 percent. Nine projects reported costs over $1 per square foot, with the highest premium reported at $6.75, or $5,500 per unit. Typically, the higher premiums were associated with specific strategies that exceeded the base requirements. For example, the maximum premium cost was associated with a green roof. The projects with the next highest premiums included features such as pervious paving (heat island effect), metal roofing, recycled cellulose or cotton insulation, etc.

There was no appreciable difference between the rehabilitation projects and the new construction, except to the degree that the higher-cost projects were all new construction, indicating, perhaps, that there are fewer opportunities to incorporate enhanced features under this section in rehabilitation projects. It is worth noting, however, that rehabilitation projects inherently support the goals of at least half of the Criteria under this section, in that they avoid both the creation of construction waste and the consumption of new or virgin material.

< Criterion 6.1 > Construction Waste Management *[Optional]*

Reduce the amount of construction waste sent to the landfill.

Significant Changes Between 2005 and 2008 Criteria

While construction waste management was encouraged in the 2005 version of the Criteria, there was no minimum threshold established. For the 2008 version of the Criteria, compliance required a minimum of 25 percent diversion. Meeting this requirement requires the tracking of waste for the entire project in order to establish a percentage, which is a significant change in the approach to this criterion but may not have increased costs for those contractors with waste management programs already in place.

Cost Impacts

Thirty projects indicated that they would be attempting to achieve this optional criterion. However, cost data was only collected for those projects that followed the 2008 version of the Criteria. Of those, 13 reported cost data, with eight of the projects reporting no cost impact at all, and the remaining six reporting costs ranging from $0.01 to $0.91 per square foot. The median cost for this criterion was $0. Three noted meeting the LEED NC requirement, which is 50 percent waste diversion.

Region, Project Type, and Urban Density

Of the 14 projects that reported cost data, all but one are located in suburban or urban locations.

Findings and Considerations

Many urban municipalities have processes already in place for recycling construction waste. Recycling and reusing scrap metal, waste concrete, and asphalt has been commonplace within the construction industry for many years, long before the push to green buildings became popular. These materials alone might easily account for the required 25 percent of total construction waste for a project. It is not, therefore, surprising that one project actually reported a savings, as these diverted materials are often sold to manufacturers who reclaim the material. The fees generated by diverting project waste can help offset the costs to separate and haul waste to multiple receiving sites.

Mandatory sorting and recycling of significant percentages of construction waste is becoming more common in larger urban and inner-city settings as municipalities look for ways to protect shrinking landfill options. For example, projects within the City of Los Angeles are required to bring all their construction waste that is not site-sorted to offsite sorting facilities, where 75 percent of all the materials are diverted from Class III landfills. Costs for waste hauling fees have dropped as a result of the savings seen by avoiding landfill fees and selling materials back to industries. Many other urban cities have similar programs and construction waste options.

< Criterion 6.2 > Recycled Content Material

[Optional 2 points for first 5 percent plus 3 points for each additional 5 percent up to 14 points]

The percentage of recycled content material is based on cost or value and does not include mechanical and electrical equipment.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Thirty-seven projects reported cost data for this criterion. Of these, 14 reported that there was no additional cost associated with meeting this criterion, while the remaining 20 reported an incremental cost, with amounts ranging from $0.02 to $5.30 per square foot. While a majority of these projects saw an incremental cost of $1.08 or less per square foot, there were two projects that reported costs that were from two to five times higher. The median cost for all reported data is $0.

Region, Project Type, and Urban Density

Of the 38 projects reporting cost data, all but four are located in urban, inner-city, or suburban locations. The remaining four are in rural locations.

Findings and Considerations

Of the projects that provided narrative information, the highest expected recycled content was 37 percent for a substantial rehabilitation. The average recycled content for all those projects seeking compliance was just over 10 percent.

Steel and concrete framed structures typically have little challenge integrating recycled content material into the construction. Structural steel and reinforcing steel have relatively high recycled content. Wood framed structures have some opportunities for integrating recycled content, such as reusing project form wood for roof sheeting, specifying Oriented Strand Board (OSB) panels with post-industrial recycled content, or using off-site components such as I-beams or roof trusses with some recycled elements. However, these options are not yet readily available for all wood frame projects, and purchasing large framing packages with these specifications can be expensive.

Other options for integrating recycled content that are available to all project types include many floor options, insulation, roofing materials, architectural metals, some drywall products, and countertop materials.

Most projects, even those that are primarily wood frame construction, should be able to achieve 10 percent recycled content with careful material selection. We would not expect that there would be any cost implications to selecting materials with some recycled content from the lists noted above, as many cost-effective options are available in the market.

< Criterion 6.3 > Certified, Salvaged, and Engineered Wood *[Optional 5 points]*

Commit to using at least 25 percent (by cost) wood products and materials that are certified in accordance with the Forest Stewardship Council, salvaged wood, or engineered framing materials.

Significant Changes Between 2005 and 2008 Criteria

The 2008 language for this criterion lowered the threshold from 50 percent achievement to 25 percent achievement, which should result in a cost difference between the two versions.

Cost Impacts

Thirty projects indicated that they had met this criterion—23 following the 2005 Criteria and seven following the 2008 Criteria. Of these, only 10 reported any cost impact: five from projects following the 2005 Criteria, and five from projects following the 2008 Criteria. Cost impacts ranged from $0.02 to $1.27 per square foot, with a median cost of $0. Within just the projects following the 2005 Criteria, the range of reported costs was more compact, running from $0.08 to $0.57 per square foot. These data ranges are contrary to what would be expected based on the reduced threshold in the 2008 Criteria, but the ranges are not unreasonable given the population sizes.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

All projects that indicated that they were attempting to meet this criterion reported an incremental cost. Because FSC-certified wood still remains difficult to attain in large quantities and for specific sizes, and because it remains an expensive option for projects that are primarily wood frame structure, we are not surprised that very few projects were able to meet this criterion. In the general green building market, projects that are primarily steel or concrete construction usually are able to meet this criterion with minimal cost impact, due to the fact that there are limited wood products contained within the project.

For wood framed buildings, we would expect to see an incremental cost of less than $0.50 per square foot for the 25 percent threshold.

< Criterion 6.4a > Permeable Walkways *[Optional 5 points]*

Use water-permeable materials in 50 percent or more of walkways.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 6.4a and 6.4b. Of these, 11 projects reported information, and only four reported any cost impact, ranging from $0.01 to $1.75 per square foot. Three of the four costs reported were for $0.14 or less. The fourth, for $1.75, was more than 12 times higher than the next highest cost. It should be noted that this project is a relatively small (14-unit), low-rise, scattered site development; as such, it is not unreasonable that this criterion should have

proportionately higher cost per square foot or per unit. The median cost for these two criteria combined is $0.

Projects meeting the 2008 Criteria: Four projects that used the 2008 Green Communities Criteria reported cost data, and, of these, three reported an actual cost impact, ranging from $0 to $0.18 per square foot, with a median cost of $0.05 per square foot.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts, except for the high cost for the low-density development noted above. Also, of the 15 projects that incorporated permeable paving, three were in the Great Lakes region. The data set is not large enough to be conclusive, but it is possible that projects in the colder climate zones are less inclined to incorporate permeable paving. It is worth noting that one of the projects in the Great Lakes region was in Chicago, which is a city that has strongly supported the installation of permeable paving.

It is likely that low-density developments will experience significantly higher cost per square foot and per unit for this criterion, since the site development is more substantial for these projects.

Findings and Considerations

We would expect that projects integrating permeable paving would experience slightly higher costs, since permeable surfaces that are stable enough for ADA purposes are typically more expensive than standard sidewalk surfaces. It is possible that, since only 50 percent of walkways must be permeable to comply with this credit, non-ADA paths were converted, using a material such as decomposed granite, which is less expensive than concrete, allowing for no premium cost.

That only 15 projects sought to comply with this criterion also indicates that permeable walkway surfaces have not yet become widely accepted.

< Criterion 6.4b > Permeable Parking Areas

[Optional 5 points]

Use water-permeable materials in 50 percent or more of paved parking areas.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 6.4a and 6.4b. Analysis of this data is included in the 6.4a section, above.

Projects meeting the 2008 Criteria: Only one project reported any data for this optional criterion, with an incremental cost impact of $0.06 per square foot.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts. It is worth noting that the one project integrating permeable paving for parking is also in Chicago.

Findings and Considerations

While permeable paving has been used for single family homes with lightweight vehicles, it is typically not used for larger parking areas. Permeable paving often requires two to three times the depth of base preparation of standard paving or concrete. Additionally, negative maintenance issues are still prevalent with many permeable paving systems, including flooding and clogging.

< Criterion 6.5a > Reducing Heat-Island Effect — Roofing *[Optional 5 points]*

Use Energy Star–compliant and high-emissive roofing or install a "green" (vegetated) roof for at least 50 percent of the roof area.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Eighteen projects reported information for this criterion, with the 14 reporting an incremental cost. Costs reported ranged from $0.02 to $6.75 per square foot. Of these, the majority (11) reported costs of less than $0.50 per square foot. Three of the remaining four reported costs from $1.34 to $1.84 per square foot. The project with the highest cost incorporated a green roof, which has a higher cost than the other methods described in the Criteria. The median cost for this criterion was $0.

Region, Project Type, and Urban Density

Of the 18 projects that reported that they met this criterion, 12 were in urban or inner-city locations, while the remainder were located in suburban locations. No rural projects attempted this criterion.

This criterion is likely to have a higher cost impact on low-density development, since the ratio of roof to building area or unit count is greater. The reported data populations are not large enough to demonstrate this characteristic.

Findings and Considerations

The cost findings reflect the fact that many compliant roofing products are now available at competitive prices in the roofing market. Complete green roof systems supporting embedding planting (as opposed to rooftop planters) continue to be very expensive, not only affecting the roof system but typically driving up structural and other building system costs. Unless there is no other access to green spaces available to the residents, cost impacts for green roofs must continue to be weighed against other environmental benefits that can be derived from their associated budgets.

< Criterion 6.5b > Reducing Heat-Island Effect — Paving *[Optional 5 points]*

Use light-colored, high-albedo materials and/or an open-grid pavement, with a minimum solar reflective index (SRI) of greater than or equal to 60 for over at least 30 percent of the site's hardscaped area.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Fifteen projects reported information for this criterion. Of these, only four reported any cost impact, with values ranging from $0.04 to $0.73 per square foot. The median cost impact reported for this criterion was $0.

Region, Project Type, and Urban Density

Of the 15 projects, eight were from either urban or inner-city locations, four were from suburban locations, and three were from rural locations.

This criterion will have a higher cost impact on suburban and rural projects, since these projects are more likely to have surface parking, and proportionately higher site hardscape areas.

Findings and Considerations

Projects with on-grade parking may not be able to overcome the cost impact of switching from asphalt to a qualifying material such as colored concrete. For many projects, "white" concrete, which is one of the few qualifying materials, becomes a maintenance concern within a short period of use, especially in high-traffic and family-use areas, and therefore is not often accepted by developers. Additionally, 100 percent open paving is usually very difficult to achieve in urban settings, as code-mandated collection of storm water often dictates more specific controls than a 100 percent open grid paving system can allow. Some locations may work for open grid paving, but usually the entire site paving cannot be designed as open grid and still collect the predicted amount of storm event water.

The minimum threshold for this criterion is very high, requiring an SRI of 0.6 or better or complete open grid pavement. The LEED standard for heat-reducing paving is an SRI of 0.29 and/or 50 percent of paving as open grid. Non-colored concrete typically has an SRI of 0.29, and would qualify under the LEED Standard.

< Criterion 6.5c > Reducing Heat-Island Effect — Plantings *[Optional 5 points]*

Locate trees or other plantings to provide shading for at least 50 percent of sidewalks, patios, and driveways within 50 feet of the home. Shading should be calculated for noon on June 21, when the sun is directly overhead, based on five years' growth.

Significant Changes Between 2005 and 2008 Criteria

This criterion did not exist in the 2005 Criteria.

Cost Impacts

Five projects reported information for this criterion, although only one of them reported any cost impact ($0.28 per square foot).

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The absence of documented cost for this criterion is not surprising. In most cases, compliance with this criterion can be achieved within the planned landscaping at no premium cost.

7. Healthy Living Environment

Designing buildings and selecting materials to promote a safe, healthy living environment is a significant green building issue that directly affects residents. Safety includes using materials that do not cause negative health impacts for residents, especially for more sensitive groups, such as children, seniors, and individuals with existing respiratory problems and compromised immune systems. Creating a healthy living environment requires minimizing residents' and workers' exposure to toxic materials and using safe, biodegradable materials as alternatives to hazardous materials. Proper home ventilation and minimal moisture buildups are crucial to maintaining healthy indoor air quality and reducing the potential for mold growth in living areas and basements.

Below are findings on the incremental costs of implementing 15 mandatory Criteria and two optional criteria (in the 2008 version) that promote healthy living environments.

Incremental Cost Overview

This group contains a wide range of criteria. The cost allocations appear to have a high degree of subjectivity: Some owners reported relatively high costs for low-VOC paints and for formaldehyde-free casework, for example, while others reported no cost; others indicated costs for these in their compliance documentation, but not in their cost allocation. Together, these make detailed statistical analysis difficult for this section. Overall, however, the aggregated cost data provides some indication for the whole section, since individual inconsistencies have less overall weight.

The median cost for this section is around $0.60 per square foot, or $680 per unit, which represents 0.31 percent of Total Development Cost. There is no appreciable difference between rehabilitation and new construction. The maximum premiums are $4 per square foot for rehabilitation and $5 for new construction, or $5,200 and $6,450 per unit, respectively. Nine projects reported premiums over $2 per square foot, and a further eight reported premiums between $1 and $2. Fourteen projects reported no cost for compliance with this section. Generally, the higher costs are related to one of two specific issues: ventilation (Criteria 7.5 through 7.7 and 7.13), and Green Label and healthy flooring materials (Criteria 7.4 and 7.16). Ventilation can have a premium cost if mechanical ventilation is required, and the reported premiums at around $2 per square foot appear reasonable. The premium costs for flooring relate more to material choices, such as wood or other enhanced materials. The premium costs in the range of $2 to $4 per square foot are reasonable for these materials, but are not a necessary cost for compliance with these criteria.

Overall, it is reasonable to expect a relatively wide range of costs for complying with this group, depending very much on individual project conditions and choices. It is likely, going forward, that projects should expect to experience premium costs ranging from a low of less than $0.50 per square foot to a high of $2 for minimum compliance, with a median in the range of $1 per square foot. Zero premiums are possible, but unlikely in most cases. Premiums in excess of $2 per square foot will generally reflect choices not directly compelled by the Criteria but by a focus on creating a safe and healthy home for residents.

< Criterion 7.1 > Low/No-VOC Paints and Primers *[Mandatory]*

Specify that all interior paints and primers must comply with current Green Seal standards for low VOC limits.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

This is a required criterion, so data was provided by all projects. Only 20 projects reported an incremental cost for meeting this criterion, with costs ranging from $0.01 to $1.48 per square foot, or from $20 to $1,270 per unit. Of these 20 projects, all but one were able to meet the criterion for less than $0.40 per square foot. The remaining project reported a cost of $1.49. Due to the large variance between this project and all remaining projects, and the reasonably expected cost for compliance with this criterion, it is possible that there may have been some confusion in how data was provided. This project should be considered an outlier. The median cost impact for all projects reporting was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Many states now limit VOCs in paint and primers; for example, California now uses the Green Seal standards in the state code requirements. We would expect to see fewer projects experiencing cost impacts as low-VOC requirements are incorporated into each state's updated building code.

We would, however, not be surprised to see small cost impacts for specialty paints and primers such as wood floor sealers or certain metal primers, where the low/no-VOC option still comes at a small premium.

< Criterion 7.2 > Low/No-VOC Adhesives and Sealants *[Mandatory]*

Specify that all adhesives must comply with Rule 1168 of the South Coast Air Quality Management District. All caulks and sealants must comply with regulation 8, rule 51, of the Bay Area Air Quality Management District.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Only 16 of the projects reported any incremental cost for meeting this mandatory criterion, with costs ranging from $0.02 to $0.43 per square foot, or $20 to $360 per unit. All other projects reported no cost impact at all. The median cost for this criterion was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

As with low-VOC paints, more state and local building codes are integrating requirements for low-VOC adhesives and sealants. Thus we would expect to see fewer projects reporting any cost impact going forward, and what impact might be experienced should be very small.

< Criterion 7.3 > Urea-Formaldehyde–Free Composite Wood *[Mandatory]*

Use particleboard and MDF that is certified compliant with the ANSI A208.1 and A208.2. If using composite wood that does not comply with ANSI, all exposed edges and sides must be sealed with low-VOC sealants.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was slightly updated between the two versions but there are no changes that would drive any cost changes.

Cost Impacts

While this is a mandatory criterion, four projects indicated that it was not applicable to their particular circumstances, because they had not used any composite wood products. Three of these were rehabilitation projects. Of the remaining 48 projects that provided cost information, only 17 reported any incremental cost impact, with costs reported ranging from $0.02 to $1.06 per square foot, or from under $10 per unit to almost $1,000. The highest reported cost, however, should be considered an outlier, as it is nearly three times as much as the next highest cost. It is worth noting, however, that this project was one of the earliest in the data set, and was developed at a time when urea-formaldehyde–free composite wood was not readily available in many markets The median cost impact for all projects reporting was $0.

Region, Project Type, and Urban Density

Ten of the projects reporting cost were located in the Midwest, perhaps indicating that building codes in these locations do not yet require urea-formaldehyde–free woodwork in housing. California and New York State now ban urea-formaldehyde wood products.

Findings and Considerations

As with low-VOC paints and adhesives, elimination of urea-formaldehyde in composite wood is being incorporated into state code requirements, just at a slower pace. There are many urea-formaldehyde–free composite wood options available, with cabinet and OSB manufacturers now switching their entire product lines to urea-formaldehyde–free materials rather than just offering a more expensive urea-formaldehyde–free option. As this trend continues, we would expect to see fewer projects reporting any cost impact for meeting this requirement.

< Criterion 7.4 > Green Label Certified Flooring *[Mandatory]*

Do not install carpets in below-grade living spaces, entryways, laundry rooms, bathrooms, kitchens, or utility rooms. If using carpet, use products that meet the Carpet and Rug Institute's Green Label certified.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Eighteen projects reported an incremental cost for this criterion, while the remainder indicated that they were able to meet the criterion for no additional cost. Cost impacts ranged from $0.03 to $0.71 per square foot, or under $10 to $650 per unit, with a median cost of $0 for the entire project pool.

About the same percentage of projects reported cost impacts (roughly one-third) from both versions of the guidelines.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The carpet industry has shown some of the earliest and strongest leadership in the green building movement, and almost every carpet manufacturer offers Green Label carpet options for all price ranges. We should expect to see future cost impacts

completely eliminated as Green Label carpet standards become baseline products for multifamily affordable housing developers.

While it is industry standard to avoid carpet in laundry rooms, kitchens, and bath areas, this criterion also mandated that no carpet be installed in entry areas, which could result in a small cost increase if both carpet and alternative flooring must be installed in a space where a living area also acts as an entryway, simply due to the fact that this area would be relatively small and possibly involve a separate installation effort. This requirement could be a savings if some low-cost material completely replaces carpet.

< Criterion 7.5a > Exhaust Fans — Bathrooms

[Mandatory]

Install Energy Star–labeled bathroom fans that exhaust to the outdoors and are connected to a light switch, and are equipped with a humidistat sensor or timer, or operate continuously.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 7.5a and 7.5b, so analysis of this data includes costs for both bathroom and kitchen exhaust fans. Of these, 34 projects provided information. Seventeen reported an incremental cost, ranging from $0.01 to $0.93 per square foot, or $10 to $740 per unit, while the remaining 19 reported no cost impact at all. Of the 17 reporting incremental costs, 13 had costs under $0.35 per square foot. The median cost for all projects was $0.

Projects meeting the 2008 Criteria: Fifteen projects provided information; of these, only four reported an incremental cost, with values ranging from $0.02 to $1.62 per square foot. The highest cost impact reported should be considered an outlier, as the remaining three costs reported were all $0.06 per square foot. Median cost for all projects was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Even among the projects that indicated that there was an incremental cost, the median cost impact was $0.14 per square foot. These low-impact numbers indicate that there was a small cost increase to install a bath fan with timer, or to the cost associated with wiring the bath fan and light fixture together if they were not already planned as a single unit.

< Criterion 7.5b and 7.5c > Exhaust Fans — Kitchen

[Mandatory for New Construction and Substantial Rehab, Optional for Moderate Rehabilitation — 5 points]

Install power-vented fans or range hoods that exhaust to the exterior.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was changed in 2008 to mandate kitchen exhaust for moderate rehabilitation.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 7.5a and 7.5b. Analysis of this data is included in the 7.5a section, above.

Projects meeting the 2008 Criteria: Twelve projects provided information, with six reporting an incremental cost. Costs reported range from $0.02 to $0.50 per square foot, or from $15 to $310 per unit, although all but one project were able to meet this criterion for $0.12 per square foot or less. The median cost impact was $0.

Region, Project Type, and Urban Density

Four of the six projects reporting costs were described as rehabilitations. We would expect to see greater cost impact for this project type if there was no kitchen exhaust prior to the rehabilitation.

Findings and Considerations

As so few projects reported impacts, we can assume that exterior exhausting kitchen hoods are baseline equipment for most new construction project types.

< Criterion 7.6a and 7.6b > **Ventilation** *[Mandatory for New Construction and Substantial Rehab, Optional for Moderate Rehabilitation — 10 points]*

Install a ventilation system for the dwelling unit providing adequate fresh air per ASHRAE 62.1-2007 for residential buildings above three stories or ASHRAE 62.2 for single family and low-rise multifamily dwellings.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was changed in 2008 to mandate ASHRAE standards from the 2005 language of 15 cubic feet per minute.

Cost Impacts

Forty-nine projects met this criterion; of these, 18 reported an incremental cost, ranging from $0.02 to $2.85 per square foot, or $20 to $2,300 per unit, with a median cost of $0. Only 10 of the projects following the 2005 guidelines reported a cost, while the remaining eight were projects that followed the 2008 guidelines. The highest and lowest costs were reported within the 2005 dataset by projects meeting the 2005 Criteria. This may be due to the fact that the earlier properties were integrating these strategies for the first time within their developments.

Region, Project Type, and Urban Density

Nine of the projects that reported cost impacts were located in the Midwest, which may indicate that mandatory air exchange levels may not be typically required in local codes for this building type. The costs were spread between mid-rise, high-rise, and clustered unit types. Three of the projects reporting cost impacts were substantial rehabilitations.

Findings and Considerations

While both new and rehabilitation projects reported incremental costs for this criterion, there was a clear distinction in the overall cost. The new projects all had costs of less than $1, most with costs under $0.30, whereas the rehabilitation projects typically had costs in excess of $2. This would appear to indicate that compliance with this criterion should be relatively simple for new construction, while it may be challenging for rehabilitation.

< Criterion 7.7 > **HVAC Sizing** *[Mandatory]*

Size heating and cooling equipment in accordance with the Air Conditioning Contractors of America (ACCA) Manual, Parts J and S, ASHRAE handbooks, or equivalent software, to prevent short-cycling of heating or air conditioning and ensure adequate dehumidification.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Thirteen projects reported an incremental cost, with values ranging from $0.02 to $3.95 per square foot, or $2 to $1,130 per unit. Of these, all but two were for less than $1 per square foot, with the highest reported cost more than twice the next highest value (in dollars per square foot). The median cost for this criterion was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The minimal cost impacts reported by most projects teams may be for designing mechanical equipment to meet the ASHRAE standards and avoiding short cycling of equipment as part of their baseline design standards.

< Criterion 7.8 > Water Heaters — Mold Prevention *[Mandatory]*

Use tankless water heaters or install conventional water heaters in rooms with drains or catch pans with drains piped to the exterior of the dwelling and with non–water-sensitive floor coverings.

Significant Changes Between 2005 and 2008 Criteria

The 2008 version provides more definition on the requirements for drain pans and condensate lines. The condensate lines must now connect to the drain system, so there may be some added costs for system connection between the two versions.

Cost Impacts

Ten projects reported an incremental cost for meeting this criterion. Costs reported ranged from $0.03 to $0.83 per square foot, or $2 to $1,300 per unit, with a median of $0. All but two of the projects met the requirements with a cost under $0.15 per square foot.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Because drain pans and piped condensate drains are typically code minimum in most locations, we would not expect to see cost impacts for these features, with the exception of rehabilitation projects. It is not surprising that the few projects that installed tankless hot water systems did see an incremental cost. During the time that most of these projects were designed and built, tankless hot water technology was not commonly used or cost effective. Now, however, tankless hot water is very affordable, provides great energy and water savings, and avoids the mold issues associated with standard tank water heaters. Going forward, we would expect that projects should be able to meet this criterion with little to no added cost.

< Criterion 7.9a > Materials in Wet Areas — Surfaces *[Mandatory]*

In wet areas, use materials that have smooth, durable, cleanable surfaces. Do not use mold-propagating materials such as vinyl wallpaper and unsealed grout.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 7.9a and 7.9b, (labeled 7.10a and 7.10b for the earlier version), so analysis of this data includes costs for both surface coverings and for tub and shower enclosures. Two projects reported an incremental cost, of $0.06 and $0.11 per square foot, while all the other projects reported no cost impact for meeting this criterion. The median cost was $0.

Projects meeting the 2008 Criteria: One project reported any cost impact for meeting this criterion, at $0.37 per square foot, while all other projects reported no cost impact at all. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

We would not expect to see much, if any, cost impact for meeting the requirements of this criterion, and the data upholds these expectations.

< Criterion 7.9b > Materials in Wet Areas — Tub and Shower Enclosures *[Mandatory]*

Use a fiberglass or similar enclosure, or, if using any form of grouted material, use backing materials such as cement board, fiber cement board, or equivalent (i.e., not paper-faced).

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 7.9a and 7.9b. Analysis of this data is included in the 7.9a section, above.

Projects meeting the 2008 Criteria: Three projects reported an incremental cost, ranging from $0.05 to $0.32 per square foot. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The majority of projects met this criterion with either very little or zero cost impact.

< Criterion 7.10a > Basement and Concrete Slabs — Vapor Barriers *[Mandatory]*

Provide vapor barriers under all slabs.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 7.10a and 7.10b (labeled 7.11a and 7.11b for the earlier version), so analysis of this data includes costs for both vapor barriers and radon-resistant below-slab features. Eight of the projects reported an incremental cost, with costs ranging from $0.10 to $1.43 per square foot, or $100 to $1,500 per unit.

Three projects had appreciably higher prices than the main group. One of these indicated that the cost was attributable to radon mitigation. The indicated incremental cost was $0.79 per square foot. The other two provided no specific data, but are in areas where radon mitigation is likely to have been necessary. The indicated incremental costs for these two projects were $0.42 and $1.43 per square foot.

The remaining five projects that reported an incremental cost were able to meet this criterion for less than $0.30 per square foot, while the highest cost reported was nearly twice that of the second highest ($0.79 per square foot). The median cost was $0.

Projects meeting the 2008 Criteria: Only two of the projects reported any cost impact, ranging from $0.04 to $0.17 per square foot. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Costs for this criterion should be sensitive to project density. Since the required work affects only the footprint of the building, building height will affect both cost per square foot and cost per unit.

Findings and Considerations

As vapor barriers are required for most local building codes, the data reflects what we would expect to see, which is that projects should be able to meet this criterion for little or no additional cost.

< Criterion 7.10b > Basement and Concrete Slabs — Radon *[Mandatory]*

In EPA Zone 1 and 2 areas, install passive radon-resistant features below the slab along with a vertical vent pipe with junction box available, if an active system should prove necessary. For substantial rehabilitation, test the homes or building for presence of radon. If elevated levels of radon exist, introduce radon-reduction measurements.

Significant Changes Between 2005 and 2008 Criteria

This criterion was only required for new construction within the 2005 guidelines, while the 2008 guidelines were updated to require radon testing (and then if necessary, radon-reduction measures) for substantial rehabilitation projects, and expanded to include areas falling in EPA Radon Zone 2. Radon testing and any subsequent mitigation could trigger substantial costs for rehabilitation projects.

Cost Impacts

Projects meeting the 2005 Criteria: The 2005 data set contained only combined cost data for Criteria 7.10a and 7.10b (labeled 7.11a and 7.11b for the earlier version), so analysis of this data includes costs for both vapor barriers and radon-resistant below-slab features. Analysis of this data is included in the 7.10a section, above.

It should be noted that in the 2005 data set, three projects had appreciably higher prices than the main group. One of these indicated that the cost was attributable to radon mitigation. The indicated incremental cost was $0.79. The other two provided no specific data, but are in areas where radon mitigation is likely to have been necessary. The indicated incremental costs for these two projects were $0.42 and $1.43.

Projects meeting the 2008 Criteria: Of the 13 projects in the data set that are in EPA regions 1 and 2, only three projects reported any cost impact, with costs ranging from $0.06 to $0.68 per square foot, or $50 to $410 per unit. The median cost was $0.

Region, Project Type, and Urban Density

Of the projects that reported an incremental cost, two were substantial rehabilitations, while the remaining four substantial rehabilitation projects reported no cost impact at all.

Costs for this criterion are very sensitive to both location and urban density. EPA regions 1 and 2 cover approximately 60 percent of the country. EPA also recommends testing for ground radon in Zone 3. Since the required work affects only the footprint of the building, building height will affect both cost per square foot and cost per unit. The project with the highest apparent cost was a single-story building.

Findings and Considerations

Passive radon collection systems, which include both a vapor membrane and collection/vent piping, should have a noticeable cost. However, more codes are requiring these measures, and so it is possible that the projects reporting no cost viewed this as a standard practice, not a premium due to the criterion.

< Criterion 7.11 > Water Drainage *[Mandatory]*

Provide drainage of water to the lowest level of concrete away from windows, walls, and foundations.

Significant Changes Between 2005 and 2008 Criteria

The 2008 version provides more detail on how projects are to meet this requirement. Language addressing house-wrap material and detailed flashing direction may have added cost impact to the updated version.

Cost Impacts

Only eight projects reported any cost impact, ranging from $0.01 to $1.22 per square foot, or $10 to $1,800 per unit. Of these, six were for $0.31 or less per square foot. The two highest-cost projects reported costs at $0.99 and $1.22. These two highest costs should be considered outliers,

due to the fact that they are appreciably higher than the other projects, and higher than what would normally be expected for this work. Median cost for this criterion was $0. One project noted the need for long downspouts away from buildings and foundations, while another noted the need for a storm water retention tank to collect runoff from roof and surface parking deck.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

For most projects this criterion should have little or no incremental cost. The requirements are increasingly accepted as standard good practice, and most are now part of the current model code, although not all jurisdictions have adopted this. Since 42 of the 52 projects were able to meet this requirement with no cost impact, it is clear that the use of roof, wall, and window flashing is part of the baseline design for most of these developers. The greatest numbers of construction lawsuits are generated from leakage issues, and inadequate moisture protection is very expensive to repair.

< Criterion 7.12 > **Garage Isolation** *[Mandatory]*

Provide a continuous air barrier between the conditioned (living) space and any unconditioned garage space to prevent the migration of any contaminants into the living space.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Criteria language in 2008, but there was no significant change that would result in a cost difference between the two versions.

Cost Impacts

Twenty-seven projects indicated that this was relevant to their particular situation, and, of these, only six projects reported an incremental cost, ranging from $0.02 to $0.33 per square foot, or $25 to $630 per unit. The highest cost was over three times as high as the next highest project. This was a clustered townhouse project, while all but one of the others were high-rise. It is not unreasonable to expect that the cost of providing isolation at townhouses would be appreciably higher per unit than at a high-rise development.

Region, Project Type, and Urban Density

Low-rise and low-density developments are likely to be more affected by this criterion, if they provide enclosed garages within the main building footprint. For mid-rise and high-rise projects, the isolation work is typically less expensive per unit, as the parking is more centralized.

Findings and Considerations

We would not expect to see any cost impact for this criterion as the elements included are typically code minimum. The exception to this assumption would be CO_2 sensors, which are gaining code acceptance but may not be required in all locations yet. As there was no distinction by region on the costs that were noted, we must assume that these were for the items directly, but not necessarily the increased impact due to this criterion.

< Criterion 7.13 > **Clothes Dryer Exhaust** *[Mandatory]*

Clothes dryers must be exhausted directly to the outdoors.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Five projects reported an incremental cost for meeting this criterion. Costs ranged from $0.01 to $0.17 per square foot, and the median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

This is code minimum in almost every major municipality in the county, and we would not expect to see any cost impact for exterior dryer venting.

< Criterion 7.14 > Integrated Pest Management *[Mandatory]*

Seal all wall, floor, and joint penetrations with low-VOC caulking to prevent pest entry. Provide rodent- and corrosion-proof screens (e.g., copper or stainless steel mesh) for large openings.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Only six projects reported an incremental cost. Costs ranged from $0.02 to $0.30 per square foot, and half were for $0.05 or less. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

The harmful impact of rodents and insects in housing has been widely studied and reported. Vermin expose people to both pathogens and allergens. Higher exposure to allergens is linked to higher rates of asthma and asthma-related conditions.

Sealing units to guard against pests is a code requirement in most municipalities. As such, we would not expect to see any cost impact for using low-VOC sealants, as they are readily available on the market and have been accepted as industry standards. Copper or stainless steel mesh may be an upgrade for some developers, but the overall cost of pest screens is a minor project cost, and the upcharges would not impact the project budget overall.

< Criterion 7.15 > Lead-Safe Work Practices *[Mandatory]*

For properties built before 1978, use lead-safe work practices during rehabilitation, painting, and demolition.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

This criterion, while mandatory, affects only rehabilitation projects or new construction involving demolition. Thirty-five projects indicated compliance with this criterion. Of these, only one reported an incremental cost, of $0.05 per square foot. The median was $0. A majority of rehabilitation projects noted that the appropriate environmental impact reports were completed and that projects followed the code required guidelines.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

This requirement is code-mandated and should not generate any costs beyond those already assumed by the developer. For most locations in the country, environmental testing and lead removal are part of the permit process, and developers have most likely assumed the overall impacts as part of the general project cost, or the lead was removed prior to the sale of the property.

< Criterion 7.16 > Healthy Flooring Materials — Alternative Sources *[Optional 5 points]*

Use non-vinyl, non-carpet floor coverings in all rooms.

Significant Changes Between 2005 and 2008 Criteria

The Criteria language was not changed between the two versions.

Cost Impacts

Twenty-four projects indicated an intention to comply with this criterion. Of these, 12 projects reported an incremental cost, ranging from $0.20 to $3.49 per square foot, or from $200 to $4,000 per unit. The highest reported cost was nearly double that of the next highest, and nine of the projects that reported an incremental cost were able to meet this criterion for less than $0.90 per square foot, or $1,000 per unit. For the four projects with higher cost impacts, this was largely due to material selection, for example, using wood and ceramic tile in lieu of a less expensive non-carpet option. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Non-carpet, non-vinyl flooring alternatives have been available in the market for quite some time, and at competitive pricing. Where there could be an incremental cost, however, is when looking for alternatives that meet the hard or water-resistant surface requirements for rooms such as bathrooms and kitchens. In addition, there did seem to be some discrepancy in how projects indicated that they met this criterion, as some noted, at least initially, that they would still be installing carpeting in bedrooms and living rooms. In addition, while the developer might not install carpet, tenants might still choose to cover floors with large area rugs in specific rooms such as bedrooms and living rooms.

< Criterion 7.17a > Smoke-Free Building *[Optional 2 points]*

Implement and enforce a "no smoking" policy in all common and individual living areas of all buildings. Common areas include rental or sales offices, entrances, hallways, resident services areas and laundry rooms.

Significant Changes Between 2005 and 2008 Criteria

This criterion was not included in the 2005 Green Communities Criteria.

Cost Impacts

Of the 17 projects in the 2008 data set, only four indicated that they intended to meet this optional criterion, and, of these, only one reported a cost ($0.07 per square foot). One other project indicated an intention to enforce a no-smoking policy in public areas.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

We would not expect to see any cost impact for this criterion, with the possible exception of some building signage. In fact, there could be some cost savings for building owners, in terms of operations and maintenance, as detailed in a 2009 report from the National Center for Healthy Housing. For example, apartment turnover can be significantly less costly, as the cost to rehabilitate a smoking unit can be nearly six times as much as a non-smoking unit. In addition, developments that are designated smoke-free could be eligible for discounts in insurance. There are non-financial benefits as well; a number of studies have shown that the majority of potential tenants (up to 75 percent) would prefer to live in a smoke-free building, making smoke-free housing developments more desirable (and thus sometimes easier to rent). Keeping the buildings smoke-free can also improve tenants' health, as smoke escaping through open windows, or through ventilation systems, exposes the other tenants to the hazards of secondhand smoke.

< Criterion 7.18 > Combustion Equipment — Includes Space and Water Heating Equipment *[Mandatory]*

Specify power vented or combustion-sealed equipment.

Significant Changes Between 2005 and 2008 Criteria

This criterion was not included in the 2005 Green Communities Criteria.

Cost Impacts

Thirteen projects indicated an intention to comply with this criterion. Of these, five reported an incremental cost, ranging from $0.16 to $0.60 per square foot. The median cost for this criterion was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

This criterion is almost always code-mandated, and we would not expect to see any cost impacts.

8. Operations and Maintenance

The benefits of integrating green building features into a project are maximized only if building systems are well maintained and residents understand how their use of the home and surrounding space can affect not just their utility bills, but also their own health and the environment. Also, a property's maintenance staff is the link between a property designed and built with green features, and a building that will continue to be green and realize the associated benefits.

Incremental Cost Overview

Over half of the projects reported no cost for this group of criteria. Of those that did, the maximum reported was $0.22 per square foot, or 0.15 percent of Total Development Cost. Where costs were reported, they were for development of the owner and tenant manuals, and the costs were all less than $10,000.

< Criterion 8.1 > Building Maintenance Manual

[Mandatory]

Provide a manual that includes the following: a routine maintenance plan; operations and maintenance guidance for all appliances, HVAC operation, water-system turnoffs, lighting equipment, paving materials and landscaping, pest control, and other systems that are part of each occupancy unit; and an occupancy turnover plan that describes in detail the process of educating the tenant about proper use and maintenance of all building systems.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Green Criteria language in 2008, but there was no significant change that would drive a cost difference between the two versions.

Cost Impacts

Of the 52 projects in the data set, 15 projects reported an incremental cost for meeting this criterion. Total costs reported ranged from $174 to $5,383. Six of the 15 reported that the cost was less than $1,000, and 12 of the 15 reported costs less than $2,200. Median cost for this mandatory criterion was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

Operations and maintenance manuals are usually specified in the construction documents general conditions requirements, and their collection and turn over to the maintenance and management team is generally included in the cost management budget. That said, some effort must be made beyond the typical maintenance manuals to develop information and criteria for the optimal upkeep of green building features. We might assume that those projects with little or no cost impacts may

have previously developed maintenance education plans. The costs to develop this, as reported, were minor, while the potential cost benefits would be large for developers who intend to retain ownership of their properties.

< Criterion 8.2 > Occupants' Manual *[Mandatory]*

Provide a guide for homeowners and renters that explains the intent, benefits, use, and maintenance of green building features, along with the location of transit stops and other neighborhood conveniences and features, and that encourages additional green activities such as recycling, gardening, use of healthy cleaning materials, alternative measures to pest control, and purchase of green power.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Green Criteria language in 2008, but there was no significant change that would drive a cost difference between the two versions.

Cost Impacts

Of the 52 projects in the data set, 21 projects reported an incremental cost for meeting this mandatory criterion. Total costs ranged from $174 to $6,435. Of these, eight were less than $1000. The median cost was $0.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

While there could be some minor project cost to develop this manual, we assume that the larger number of projects reporting cost impacts for this criterion, as compared to those reporting impacts for the general operations manual in Criterion 8.1, suggests that a tenant manual was not a standard practice for these developers until this criterion was mandated. Once the format and plans for tenant education are developed, minor updating for specific projects would cause minimal cost impacts. Enterprise Green Communities provides a number of training resources focused on educating residents on the green measures incorporated into their homes (*www.enterprisecommunity.com/solutions-and-innovation/enterprise-green-communities/resources/operations-and-maintenance-toolkit*).

< Criterion 8.3 > Homeowner and New Resident Orientation *[Mandatory]*

Provide a comprehensive walk-through and orientation to the homeowner or new resident using the Occupants' Manual that reviews the building's green features, operations, and maintenance, along with neighborhood conveniences that may facilitate a healthy lifestyle.

Significant Changes Between 2005 and 2008 Criteria

There were some minor clarifications to the Green Criteria language in 2008, but there was no significant change that would drive a cost difference between the two versions.

Cost Impacts

Of the 52 projects in the data set, 13 projects reported an incremental cost for meeting this mandatory criterion. Total costs reported ranged from $174 to $4500, with a median cost of $0. The highest cost reported, however, was nearly twice as much as the next highest.

Region, Project Type, and Urban Density

No differentiation was noted between project cohorts.

Findings and Considerations

While there may be some minor project cost to develop an owner manual, we would assume that the costs would be absorbed within the construction management budget.

TABLE A.1

Summary Table of Project Characteristics

Project Name / Developer	Total Square Footage	Building Type*	Site Location	Construction Type	Property Type	Total Units	Total Development Costs (TDC)	Green Premium	Green Premium %/TDC
California									
Armstrong Place Senior Housing, San Francisco BRIDGE Housing Corp.	127,665	High-rise	Urban	New	Rental	116	$39,000,000	$727,988	1.9%
Arnett Watson, San Francisco Tenderloin Neighborhood Development Corporation/ Community Housing Partnership	66,357	High-rise	Urban	New	Rental & supportive	83	$34,436,919	$220,076	0.6%
Bishop Swing Community House, San Francisco Episcopal Community Services of San Francisco	88,500	High-rise	Urban	New	Rental & supportive	135	$35,000,000	$1,392,984	4.0%
City Green Residences, Los Angeles Enterprise Home Ownership Partners LA	21,910	Single family	Urban	New	For-Sale	14	$5,330,000	$110,850	2.1%
Fox Courts, Oakland Resources for Community Development	134,420	High-rise	Urban	New	Rental & supportive	80	$34,446,000	$726,100	2.1%
Madison & 14th Street Apartments, Oakland Affordable Housing Associates	81,370	High-rise	Suburban	Substantial rehab	Rental & supportive	79	$32,000,000	$434,400	1.4%
Madrone Plaza, Morgan Hill South County Community Builders	161,440	Clustered townhouses	Suburban	New	For-Sale	95	$39,931,793	$232,925	0.6%
Sara Conner Court, Hayward Eden Housing, Inc.	82,013	Mid-rise	Urban	New	Rental	57	$20,817,000	$125,000	0.6%
The Essex, San Francisco Mercy Housing California	38,500	High-rise	Urban	Substantial rehab	Rental	84	$26,578,964	$414,850	1.6%
Colorado									
Central Park at Stapleton, Denver Northeast Denver Housing Center	17,541	Clustered townhouses	Urban	New	Rental & supportive	18	$4,369,170	$225,500	5.2%
Renaissance Riverfront Lofts, Denver Colorado Coalition for the Homeless	96,406	High-rise	Urban	New	Rental & supportive	100	$17,252,273	$671,800	3.9%

*High-rise buildings have over four stories; mid-rise buildings have under four stories.

TABLE A.1 *(continued)*

Project Name / Developer	Total Square Footage	Building Type*	Site Location	Construction Type	Property Type	Total Units	Total Development Costs (TDC)	Green Premium	Green Premium %/TDC
District of Columbia									
Galen Terrace, Washington DC NHT/Enterprise Preservation Corp.	86,276	High-rise	Urban	Moderate rehab	Rental	83	$12,788,599	$358,089	2.8%
Georgia									
Sustainable Fellwood Phase I, Savannah Progressive Redevelopment, Inc.	107,140	Mid-rise	Urban	New	Rental & supportive	110	$15,541,000	$100,000	0.6%
Illinois									
Schiff Residences, Chicago Mercy Housing Lakefront	45,000	High-rise	Urban	New	Rental & supportive	96	$18,000,000	$684,000	3.8%
Rosa Parks Limited Partnership, Chicago Bickerdike Redevelopment Corp.	130,342	Mid-rise	Urban	New	Rental	94	$27,147,184	$324,447	1.20%
Massachusetts									
1460 House, Dorchester Fields Corner Housing Corp.	43,000	Mid-rise	Urban	New	Rental	43	$13,000,000	$408,000	3.1%
Trolley Square, Cambridge Homeowner's Rehab, Inc.	75,747	Clustered townhouses	Urban	New	Rental	40	$14,198,000	$1,002,000	7.1%
Maryland									
Sierra Woods, Columbia Enterprise Housing Corp.	162,909	Mid-rise	Suburban	Moderate rehab	Rental	159	$19,355,481	$179,600	0.93%
Michigan									
Agnes Street Housing, Detroit Agnes Street Housing	29,110	Mid-rise	Urban	New	Rental	24	$4,686,254	$44,167	0.9%
Kingsbury Place, Walker Genesis Non-profit Housing	41,650	Mid-rise	Suburban	New	Rental & supportive	44	$7,326,210	$162,000	2.2%
Westland Meadows, Kalamazoo American Community Developers, Inc.	121,200	Mid-rise	Suburban	Substantial rehab	Rental	150	$9,312,448	$749,331	8.05%
Minnesota									
New San Marco, Duluth Center City Housing	45,998	High-rise	Urban	New	Rental & supportive	70	$6,733,442	$291,500	4.3%

*High-rise buildings have over four stories; mid-rise buildings have under four stories.

TABLE A.1 *(continued)*

Project Name / Developer	Total Square Footage	Building Type*	Site Location	Construction Type	Property Type	Total Units	Total Development Costs (TDC)	Green Premium	Green Premium %/TDC
Minnesota (continued)									
Park Avenue Apartments, Minneapolis Lutheran Social Service of MN	85,311	High-rise	Urban	Substantial rehab	Rental & supportive	48	$11,313,433	$502,000	4.4%
Ripley Gardens, Minneapolis Aeon	77,519	Mid-rise	Urban	Substantial rehab	Rental & supportive	60	$14,389,432	$121,500	0.8%
Viking Terrace Apartments, Slayton Southwest Minnesota Housing Partnership	47,860	Mid-rise	Rural	Substantial rehab	Rental & supportive	60	$4,689,917	$535,200	11.4%
Cherry Ridge, Mankato Southwest Minnesota Housing Partnership	95,984	Mid-rise	Rural	Substantial rehab	Rental & supportive	50	$5,016,332	$254,750	0.00%
Orness Plaza, Mankato Southwest Minnesota Housing Partnership	65,610	High-rise	Rural	Substantial rehab	Rental & supportive	102	$9,862,653	$1,092,800	11.08%
New Jersey									
Ewing Independent Living, Ewing Rely Properties	71,000	Mid-rise	Suburban	New	Rental & supportive	72	$14,566,000	$825,025	5.7%
New Mexico									
Chuska Apartments, Gallup Supportive Housing Coalition of New Mexico	32,216	Clustered townhouses	Suburban	New	Rental & supportive	30	$6,828,098	$537,431	7.9%
Downtown @ 700, Albuquerque Supportive Housing Coalition of New Mexico	39,048	High-rise	Suburban	New	Rental & supportive	72	$12,613,115	$236,274	1.87%
New York									
David and Joyce Dinkins Gardens, New York Jonathan Rose Companies / HCCI	75,190	High-rise	Urban	New	Rental & supportive	85	$19,223,481	$185,000	1.0%
Decatur Green, Bronx Fordham Bedford Housing Corporation	17,023	High-rise	Urban	New	Rental	18	$5,650,000	$44,000	0.8%

*High-rise buildings have over four stories; mid-rise buildings have under four stories.

TABLE A.1 *(continued)*

Project Name / Developer	Total Square Footage	Building Type*	Site Location	Construction Type	Property Type	Total Units	Total Development Costs (TDC)	Green Premium	Green Premium %/TDC
New York (continued)									
Rheingold Heights One Apartments, Brooklyn Ridgewood Bushwick Senior Citizens Council, Inc.	75,155	High-rise	Urban	New	Rental	58	$18,001,275	$83,470	0.5%
Amherst Station, Buffalo Cazanovia Recovery Systems	45,685	Mid-rise	Urban	Substantial rehab	Rental & supportive	24	$8,059,635	$217,228	2.70%
Fox Point, Bronx Palladia, Inc.	54,381	High-rise	Urban	New	Rental & supportive	48	$14,196,346	$1,072,289	7.55%
Tapestry, New York Homes for New Yorkers Inc. and Jonathan Rose Companies	186,612	High-rise	Urban	New	Rental	185	$65,173,954	$37,000	0.06%
Ohio									
Cogswell Hall, Cleveland Cogswell Hall, Inc.	39,419	Mid-rise	Urban	New	Rental & supportive	41	$7,496,067	$26,500	0.4%
Cornerstone Apartments, Cleveland NRP Group, LLC	61,470	Mid-rise	Urban	New	Rental	50	$9,819,894	$330,000	3.0%
Commons at Buckingham, Columbus National Church Residences	60,791	Mid-rise	Urban	New	Rental & supportive	100	$7,260,078	$535,000	7.37%
Renaissance Senior Apartments, Toledo National Church Residences	62,983	High-rise	Suburban	Substantial rehab	Rental	55	$11,248,065	$207,200	1.84%
Oregon									
Living On Track, Medford Tracking Opportunities	55,661	Single Family	Urban	New	Rental & supportive	63	$7,776,397	$164,818	2.1%
Rain Garden, Wilsonville Caritas Community Housing Corp.	21,243	Single Family	Suburban	New	Rental & supportive	30	$5,253,575	$135,390	2.58%
Pennsylvania									
Powelton Heights, Philadelphia 1260 HDC	41,092	High-rise	Urban	New	Rental & supportive	48	$9,118,000	$684,900	7.5%
Connelly House, Philadelphia Project H.O.M.E.	64,770	High-rise	Urban	New	Rental & supportive	79	$23,744,379	$589,281	2.48%

*High-rise buildings have over four stories; mid-rise buildings have under four stories.

TABLE A.1 *(continued)*

Project Name / Developer	Total Square Footage	Building Type*	Site Location	Construction Type	Property Type	Total Units	Total Development Costs (TDC)	Green Premium	Green Premium %/TDC
Texas									
Spring Terrace, Austin Foundation Communities	69,845	Mid-rise	Urban	Moderate rehab	Rental & supportive	145	$5,230,000	$232,144	4.4%
M Station, Austin Foundation Communities	172,134	High-rise	Urban	New	Rental	150	$21,907,170	$78,500	0.36%
Virginia									
Roanoke and Lee Street, Christiansburg Community Housing Partners Corp.	16,399	Single family	Rural	New	For-sale	14	$3,307,175	$207,050	6.3%
Mary Marshall House, Arlington Arlington VOA Assisted Living Residence, Inc.	40,640	Mid-rise	Suburban	Substantial rehab	Rental & supportive	52	$8,221,370	$1,231,327	14.98%
Washington									
Pear Tree Place, Yakima Next Step Housing	27,940	Clustered townhouses	Rural	New	Rental	26	$4,803,035	$126,798	2.6%
Riverwalk Point II, Spokane Spokane Neighborhood Action Programs (SNAP)	51,268	Clustered townhouses	Suburban	New	Rental	51	$8,949,468	$190,812	2.1%
Johnson Hill, Issaquah St. Andrew's Housing Group	40,337	Mid-rise	Suburban	Moderate rehab	Rental	37	$8,662,984	$32,000	0.37%
Wisconsin									
Parmenter Circle I, Middleton Parmenter Circle I LLC	69,480	High-rise	Urban	New	Rental	50	$6,333,719	$466,700	7.4%

*High-rise buildings have over four stories; mid-rise buildings have under four stories.

TABLE A.2

Incremental Cost to Meet Enterprise Green Communities Criteria ($/Sq. Ft.)

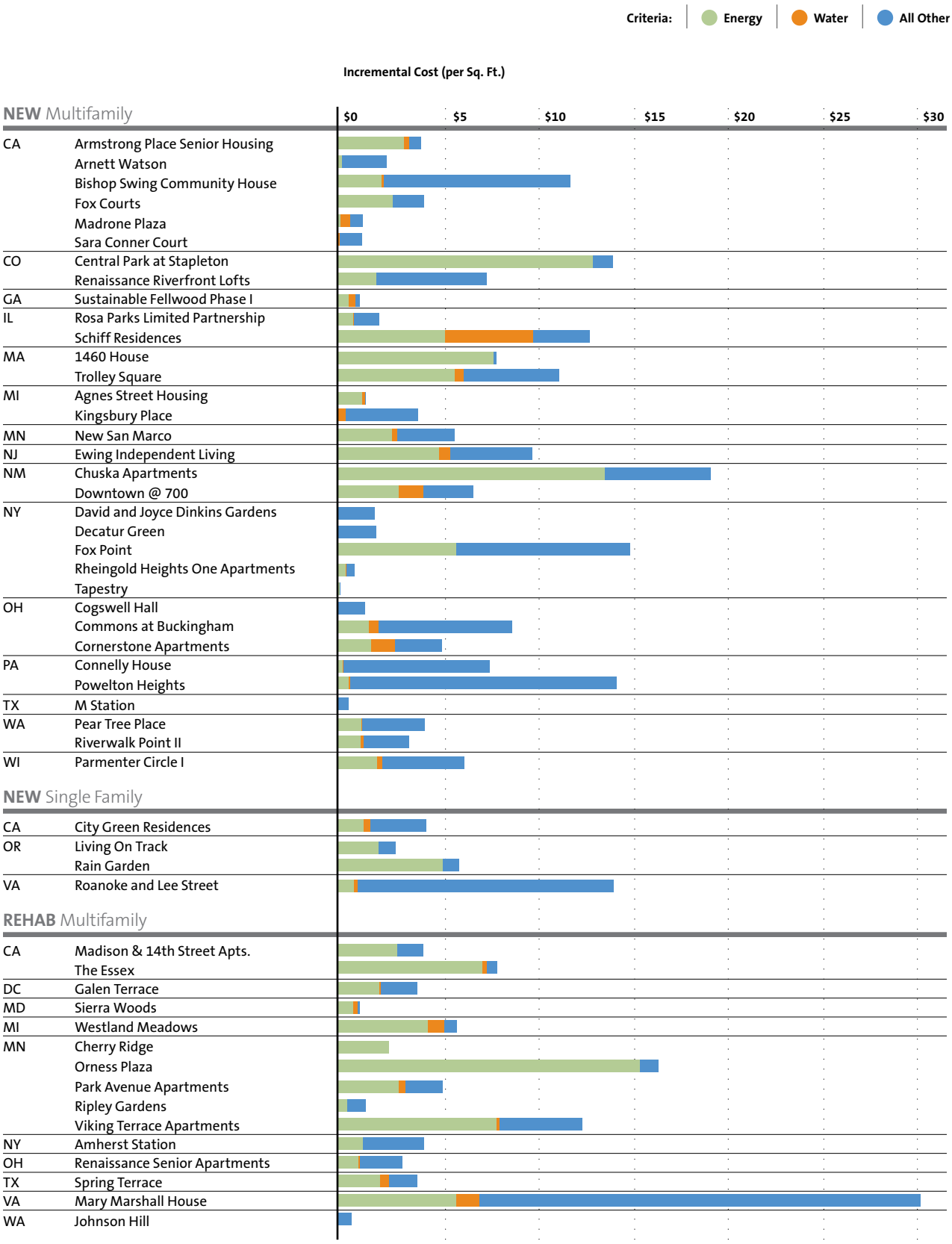


TABLE A.3

Normalized Annual Energy Costs

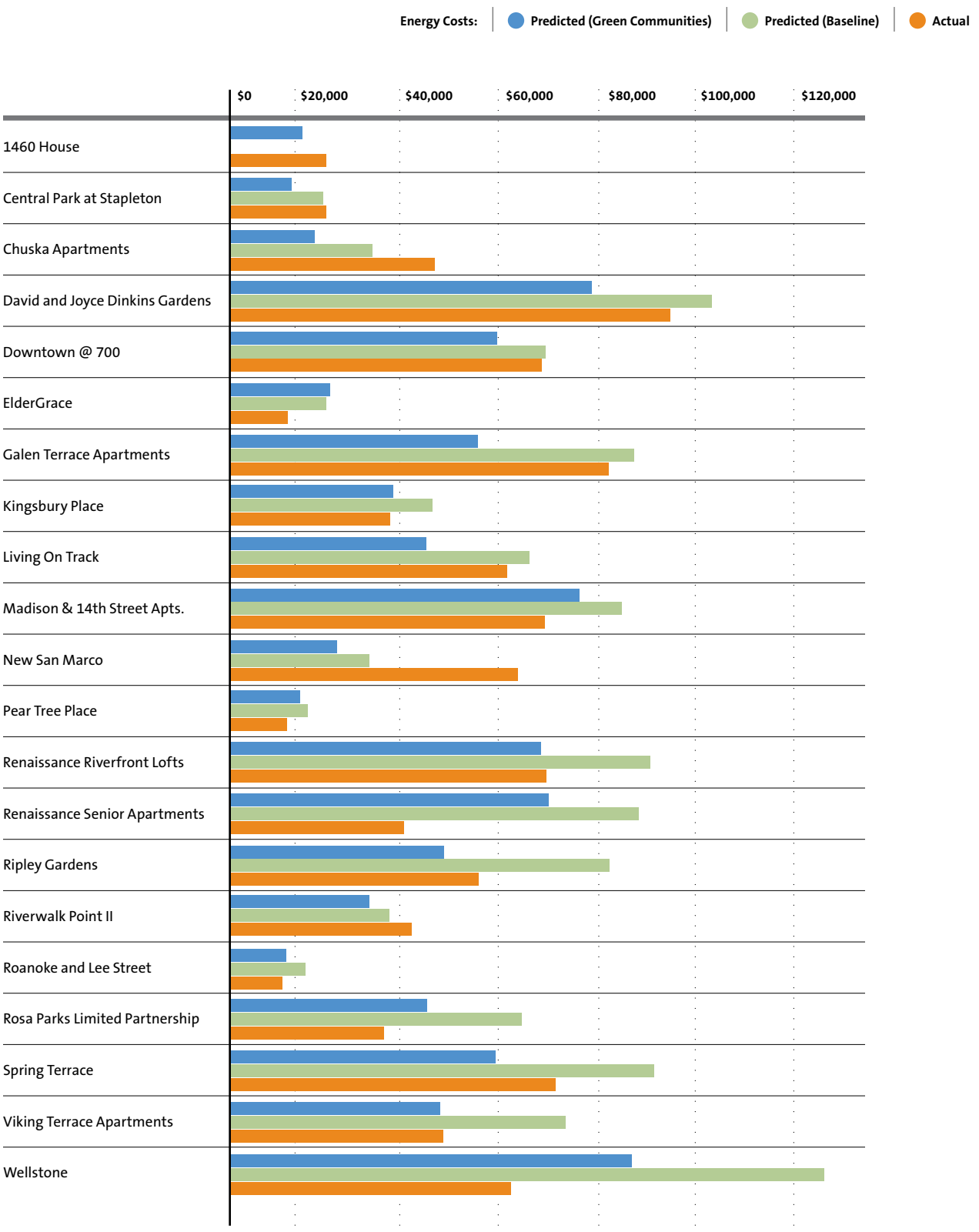


TABLE A.4

Annual Interior Water Costs