

Appendix E: Documentation of the Sustainable Materials Features Included in the Prototype Building Analysis¹

This appendix documents the calculations used to estimate costs and cost savings associated with the sustainable materials features in the prototype building analysis described in Section 2.1:

- Low-emitting paint versus latex paint (Section E.1)
- Recycled latex paint (Section E.2)
- Concrete with slag content (Section E.3)
- Concrete with fly ash content (Section E.4)
- Carpet with recycled content (Section E.5)
- Certified wood options (Section E.6).

E.1 Documentation of Costs of Low-Emitting Paint Versus Typical Latex Paint

Based on cost estimates from the Timberline model (see Appendix B), the 20,000-ft² office building has 70,000 ft² of interior painted surface. The painted surface was assumed to be primed and then painted with a typical contractor-grade latex paint (eggshell).

To provide paint quality comparisons, data on high-end products were also gathered. Sales representatives from three major paint manufacturers were contacted, and primer and topcoat paint prices were provided. In addition, the vendor technical data sheets provided coverage rates (square feet covered per gallon of paint). The calculations for this document assumed the midpoint of the price range and the lower end of the coverage range to offer a conservative comparison of the products.

Low-emitting (no-volatile organic compound [VOC]) paint provides better working conditions at the construction site and may allow painters to work inside the building while other activities are underway. The cost of the paint varies depending on the location of the purchase, volume of paint purchased, and the ability of the local distributor to offer special rates. The specifications for all the low-emitting paints analyzed in this study stated that the VOC content was 0 milligram/liter.

The sales representatives suggested alternative surface preparation techniques (in addition to a traditional primer), but those techniques are not discussed here because the products were too different to offer a fair comparison.

E.1.1 Benjamin Moore Paint Company

A Benjamin Moore sales representative provided price quotes for three types of paint used in commercial buildings: a very high-end latex paint (AquaVelvet), a typical contractor-grade latex paint (SuperSpec), and a low-emitting paint (EcoSpec). The technical data sheets state that the EcoSpec primer has a higher coverage rate than the other paints. Table E-1 shows the ranges quoted by the vendor for the estimated retail price and coverage rates and the values used in the calculations.

¹ This appendix was written by K. Fowler, D. Hostick, and K. Poston, Pacific Northwest National Laboratory.

Table E-1. Prices and Coverage Rates for Benjamin Moore Paints

Paint Type	Price Range (per gal)	Price Assumed for the Calculations	Coverage (ft ² /gal)	Coverage Rate Assumed for the Calculations
Typical contractor latex paint (SuperSpec)				
Primer	\$15.28-\$15.79	\$15.54	400-500	400
Top coat	\$22.80-\$22.99	\$22.90	400-450	400
Very high-end latex paint (AquaVelvet)				
Primer	\$24.88-\$24.99	\$24.94	400-450	400
Top coat	\$29.88-\$29.99	\$29.94	400-450	400
Low-emitting latex paint (EcoSpec)				
Primer	\$21.50-\$22.00	\$21.75	550	550
Top coat	\$28.40-\$28.80	\$28.60	400-450	400

Using the values in Table E-1, the material cost for painting 70,000 ft² of wall area in the 20,000-ft² office building is as follows (assuming one coat of primer and one top coat and a 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline model).

The material cost for SuperSpec is as follows:

$$\begin{aligned}
 \text{Primer coat cost} &= ((70,000 \text{ ft}^2)/(400 \text{ ft}^2/\text{gal})) \times \$15.54/\text{gal} = \$2719.50 \\
 \text{Top coat cost} &= ((70,000 \text{ ft}^2)/(400 \text{ ft}^2/\text{gal})) \times \$22.90/\text{gal} = \$4007.50 \\
 \text{Total material cost} &= \$2719.50 + \$4007.50 = \$6727 \\
 \text{Full cost (inc. adder)} &= \$6727 \times 1.196 = \mathbf{\$8045.49}
 \end{aligned}$$

The same calculation was done for AquaVelvet and EcoSpec, resulting in full costs (inc. adder) of \$11,486.38 and \$9296.72, respectively.

The differences between EcoSpec (the non-VOC paint) and the other two paints are as follows.

The material cost for EcoSpec compared with SuperSpec is as follows. The difference per gallon for the primer is \$21.75 - \$15.54 = \$6.21 (EcoSpec is more expensive by \$6.21 per gallon). The difference per gallon for the top coat is \$28.60 - \$22.90 = \$5.70. The total first cost difference is \$9296.72 - \$8045.49 = \$1251.23 or, by dividing by 20,000 ft² of building floor space, the difference in first cost is \$62.59/1000 ft².

Using the same calculation procedure, the difference in first cost (inc. adder) for EcoSpec compared with AquaVelvet is -\$109.46/1000 ft².

E.1.2 Sherwin Williams Paint Company

A Sherwin Williams sales representative provided price quotes for three types of paint used in commercial buildings: a high-end latex paint (ProMar 400), a typical contractor-grade latex paint (ProMar 200), and a low-emitting paint (Harmony). The technical data sheets state that the

Table E-2. Prices and Coverage Rates for Sherwin Williams

Paint Type	Price Range (per gal)	Price Assumed for the Calculations	Coverage (ft ² /gal)	Coverage Rate Assumed for the Calculations
Typical contractor latex paint (ProMar 400)				
Primer	\$9.50-10.00	\$9.75	350-400	350
Top coat	\$10.50-12.50	\$11.50	350-400	350
Very high-end latex paint (ProMar 200)				
Primer	\$11.00-12.50	\$11.75	350-400	350
Top coat	\$13.00-14.50	\$13.75	350-400	350
Low-emitting latex paint (Harmony)				
Primer	\$13.00-14.50	\$13.75	350-400	350
Top coat	\$15.00-17.00	\$16.00	350-400	350

coverage rates are the same for each product. Table E-2 shows the ranges quoted by the vendor for the estimated retail price and the coverage rates and the values used in the calculations.

Using the values in Table E-2, the material cost for painting 70,000 ft² of wall area in the 20,000-ft² office building is as follows (assuming one coat of primer and one top coat and a 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions, based on the Timberline model).

The material cost for ProMar 400 is as follows:

$$\begin{aligned}
 \text{Primer coat cost} &= ((70,000)/(350 \text{ ft}^2/\text{gal})) \times \$9.75/\text{gal} = \$1950 \\
 \text{Top coat cost} &= ((70,000 \text{ ft}^2)/(350 \text{ ft}^2/\text{gal})) \times \$11.50/\text{gal} = \$2300 \\
 \text{Total material cost} &= \$1950 + \$2300 = \$4250 \\
 \text{Full cost (inc. adder)} &= \$4250 \times 1.196 = \mathbf{\$5083}
 \end{aligned}$$

The same calculation was done for ProMar 200 and Harmony, resulting in full costs (inc. adder) of \$6099.60 and \$7116.20, respectively.

The differences between Harmony (the low-emitting paint) and ProMar 400 are as follows. The difference per gallon for the primer is \$13.75 - \$9.75 = \$4.00 (Harmony primer is more expensive by \$4 per gallon). The difference per gallon for the top coat is \$16.00 - \$11.50 = \$4.50. The total first cost difference is \$7116.20 - \$5083 = \$2033.20 or, by dividing by 20,000 ft² of building floor space, the difference in first cost is \$101.66/1000 ft².

Using the same calculation procedure for Harmony compared with ProMar 200 yields a difference in first cost of \$50.83/1000 ft².

E.1.3 Duron Paint Company

A Duron sales representative provided price quotes for four types of paint used in commercial buildings: premium-quality latex paint (Plastic Kote 29-series), top-quality latex paint (Ultra Deluxe 36-series), a typical contractor-grade latex paint (Pro Kote 23-series), and a low-emitting paint

(Genesis 79-series). The technical data sheets state that the coverage rates are the same for each product. The sales representative recommended the same primer regardless of top coat choice.

Table E-3 shows the ranges quoted by the vendor for the estimated retail price and the coverage and shows the values used in the calculations. Note that Duron paint is manufactured in Atlanta, Georgia, and Beltsville, Maryland. Procuring paint for the Baltimore prototype building from the Duron location in Maryland would contribute to local/regional material points in the LEED certification process.

Table E-3. Prices and Coverage Rates for Duron

Paint Type	Price Range (per gal)	Price Assumed for the Calculations	Coverage (ft ² /gal)	Coverage Rate Assumed for the Calculations
Typical contractor latex paint (Pro Kote 23-Series)				
Primer	\$13.85-14.85	\$14.35	350-400	350
Top coat	\$13.65-14.65	\$14.15	400	400
Top quality latex paint (Ultra Deluxe 36-Series)				
Primer	\$13.85-14.85	\$14.35	350-400	350
Top coat	\$18.35-19.35	\$18.85	400	400
Premium quality latex paint (Plastic Kote 29-Series)				
Primer	\$13.85-14.85	\$14.35	350-400	350
Top coat	\$19.25-20.25	\$19.75	400	400
Low-emitting latex paint (Genesis 79-Series)				
Primer	\$13.85-14.85	\$14.35	350-400	350
Top coat	\$20.40-21.40	\$20.90	400	400

Using the values in Table E-3, the material cost for painting 70,000 ft² of wall area in the 20,000-ft² office building is as follows (assuming one coat of primer and one top coat and a 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions, based on the Timberline model).

The material cost for the Pro Kote 23-Series is as follows:

$$\begin{aligned}
 \text{Primer coat cost} &= ((70,000 \text{ ft}^2)/(400 \text{ ft}^2/\text{gal})) \times \$14.35/\text{gal} = \$2511.25 \\
 \text{Top coat cost} &= ((70,000 \text{ ft}^2)/(350 \text{ ft}^2/\text{gal})) \times \$14.15/\text{gal} = \$2830 \\
 \text{Total material cost} &= \$2511.25 + \$2830 = \$5341.25 \\
 \text{Full cost (inc. adder)} &= \$5341.25 \times 1.196 = \mathbf{\$6388.14}
 \end{aligned}$$

Using the same calculation procedure, the full cost (inc. adder) for the other paints is as follows:

- Ultra Deluxe 36-Series: \$7512.38
- Plastic Kote 29-Series: \$7727.66
- Genesis 79-Series: \$8002.74.

The differences between Genesis (the low-emitting paint) and the Pro Kote 23-Series are as follows. There is no difference per gallon for the primer. The difference per gallon for the top coat is \$20.90 - \$14.15 = \$6.75 (Genesis is more expensive by \$6.75 per gallon). The total first cost difference is \$8002.74 - \$6388.14 = \$1614.60 or, by dividing by 20,000 ft² of building floor space, the difference in first cost is \$80.73/1000 ft².

Using the same procedure, the other comparisons yield the following differences in first cost:

- Genesis compared with Ultra Deluxe 36-Series: \$24.52/1000 ft²
- Genesis compared with Plastic Kote 29-Series: \$13.75/1000 ft².

Taking the highest and lowest per gallon differences and the total cost differential that considers the difference in coverage, the following summarizes this sustainable design feature:

- Sustainable design feature: low-emitting paint
- Incremental first cost (\$/unit): -\$3.19 to +\$6.75
- Incremental cost (\$/1000 ft²): -\$109.50 to +\$101.66.

E.2 Documentation of Recycled Latex Paint

Based on cost estimates from the Timberline model, the 20,000-ft² office building has 70,000 ft² of interior painted surface. Recycled content primer was not available, so the cost comparisons below do not include primer costs. The data on typical contractor-grade paint gathered for the low-emitting latex paint options were used as the baseline for this comparison.

Recycled paint is post-consumer latex paint that has been sorted by type, color, and finish and reprocessed for resale. The U.S. Environmental Protection Agency (EPA) through the "Comprehensive Procurement Guideline"² encourages the purchase of latex paint made from post-consumer-recovered materials whenever the paint meets the project's specifications and performance requirements and is available and cost effective. The benefits of recycled paint for sustainable design typically include the following:

- Lower first cost (where the paint is available, it is typically offered at a lower price than virgin paint of a comparable quality)
- Reduced paint disposal needs (using the recycled paint creates a market for the excess paint often found after household and commercial construction projects)
- Decreased waste costs (recycling, rather than disposing of, the excess paint avoids waste disposal costs).

Two suppliers of recycled paint provided quotes for their products. These vendors sell recycled paint and accept excess latex paint for reprocessing and consolidation. Both vendors can ship their products to the Baltimore area. Shipping costs are not included in the cost summary below because the vendors noted that their distribution outlets are increasing and these charges may not be applicable over the long term. Also, both companies offered special rates for large projects and government buildings and under other special circumstances; those reduced rates were not considered for this evaluation.

² Available at URL: <http://www.epa.gov/epg/products/paint.htm>

Table E-4 lists the price and coverage data for each of the paint products and the values used in the calculations. The calculations assumed the midpoint of the price range and the lower end of the coverage range to offer a conservative comparison of the products.

Table E-4. Paint Prices and Coverage Rates

Paint Type	Price Range (per gal)	Price Assumed for the Calculations	Coverage (ft ² /gal)	Coverage Rate Assumed for the Calculations
Typical contractor latex paint				
Benjamin Moore SuperSpec	\$22.80-\$22.99	\$22.90	400-450	400
Sherwin Williams ProMar 400	\$10.50-12.50	\$11.50	350-400	350
Duron Pro Kote 23-Series	\$13.65-14.65	\$14.15	400	400
Recycled paint				
Nu-Blend Paints, Inc.	\$8.50 - \$10.60	\$9.55	350-400	350
E Coat	\$8.99 - \$11.99	\$10.49	250	250

Using the values in Table E-4, the material costs for painting 70,000 ft² of wall area in the 20,000-ft² office building are as follows (assuming one top coat and a 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline. model).

The material cost for Benjamin Moore SuperSpec is as follows:

$$\begin{aligned} \text{Top coat cost} &= ((70,000 \text{ ft}^2)/(400 \text{ ft}^2/\text{gal})) \times \$22.90/\text{gal} = \$4007.50 \\ \text{Full cost (inc. adder)} &= \$4007.50 \times 1.196 = \mathbf{\$4792.97} \text{ (for top coat only)} \end{aligned}$$

Using the same procedure, the following are the full costs (inc. adder) for the other paints:

- Sherwin Williams ProMar 400: \$2750.80
- Duron Pro Kote 23-Series: \$3384.68
- Nu-Blend recycled paint: \$2284.36
- E Coat recycled paint: \$3499.50.

The differences between Nu-Blend recycled paint and the Benjamin Moore SuperSpec latex paint are as follows. The difference per gallon for the top coat is \$9.55 - \$22.90 = -\$13.35 (Nu-Blend is less expensive by \$13.35 per gallon). The total first cost difference is \$2284.36 - \$4792.97 = -\$2508.61 or, by dividing by 20,000 ft² of building floor space, the difference in first cost is -\$125.43/1000 ft².

Using the same procedure, the first cost differences between Nu-blend and the other latex paints are as follows:

- Nu-Blend compared with Sherwin Williams ProMar 400: -\$22.82/1000 ft²
- Nu-Blend compared with Duron Pro Kote 23-Series: -\$55.02/1000 ft².

The differences between E Coat recycled paint and the three contractor-grade latex paints are as follows:

- E Coat compared with Benjamin Moore SuperSpec: $-\$64.67/1000 \text{ ft}^2$
- E Coat compared with Sherwin Williams ProMar 40: $\$37.44/1000 \text{ ft}^2$ (i.e., E Coat is more expensive by $\$37.44/1000 \text{ ft}^2$)
- E Coat compared with Duron Pro Kote 23-Series: $\$5.74/1000 \text{ ft}^2$ (E Coat is more expensive).

Taking the highest and lowest per gallon differences and the total cost differential that considers the difference in coverage, the following summarizes this sustainable design feature:

- Sustainable design feature: recycled paint
- Incremental first cost (\$/unit): $-\$13.35$ to $-\$1.05$
- Incremental cost (\$/1000 ft²): $-\$125.43$ to $+\$37.44$.

E.3 Documentation of Costs of Concrete with Slag Content

Based on estimates provided by vendors, 250 yd³ of 3000 pounds per square inch (psi) concrete would be needed for the 20,000-ft² office building. The baseline product is concrete made from 100% portland cement. The sustainable design option is concrete with a mix of portland cement and iron mill slag.

Blast furnaces producing iron from iron ore also produce a molten slag that at one time was considered a waste product. That slag can now be recycled into ground-granulated, blast-furnace slag cement by grinding the iron blast furnace slag to cement fineness.

NewCem, produced by Lafarge Corporation, was the product that the local vendors referenced when they provided price quotes. NewCem is manufactured locally/regionally at Sparrows Point, Maryland and therefore would contribute to local/regional material points in the Leadership in Energy and Environmental Design (LEED™) certification process. NewCem is a finely ground, granulated blast-furnace slag, manufactured from the byproduct of an iron blast furnace. It is made to meet the specification requirements of Grade 120 concrete, which ensures high uniform strengths. The specifications allow for the slag blend to be from 25% to 70% of the total cementitious materials.

Some of the benefits that have been noted for slag cement mixes include improved workability and pumpability for the unhardened concrete. For the hardened concrete, using slag content increases the 28-day strength, reduces permeability and heat of hydration, increases sulphate resistance, and controls the alkali silica reaction. During hot weather, slag concrete set times are lengthened; and during cold weather, the impact on set time had one of the local vendors stating that they did not use it during the winter.

Sales representatives at several Baltimore area vendors provided price quotes of ready-mix concrete. Table E-5 shows the ranges quoted by the vendor for the estimated retail price and shows the values used in the calculations. Note that not all the vendors that offered 100% portland cement concrete also offered concrete with slag content. The cost variances are due to the different vendors rather than product variations. In addition to vendor quotes, Lafarge Corporation, the manufacturer of the NewCem product being quoted by the vendors, was contacted. Lafarge explained that initially concrete made with the NewCem mix was much cheaper, but increases in product demand resulted in very little cost difference between 100% portland cement and NewCem/portland cement mixes. The purchase of slag content concrete depends on local availability. The prices will vary based on current demand and availability of the product.

Table E-5. Prices for Concrete

Concrete Type	Price Per Cubic Yard	Price Range Assumed for the Calculations
100% portland cement concrete		\$63.95 - \$85
Quote 1	\$63.95	
Quote 2	\$85	
Quote 3	\$67.10	
Quote 4	\$78	
Quote 5	\$64.50	
Slag content		\$63.45 - \$85
Quote 1 (25% NewCem)	\$63.45	
Quote 2 (50% NewCem)	\$85	
Quote 3 (mix not specified)	\$67.10	

Using the values in Table E-5, the material costs for 250 yd³ of concrete are as follows (assuming 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline model).

100% Portland Cement Concrete

Least expensive quote = 250 yd³ x \$63.95/ yd³ = \$15,987.50
 Cost including adder = \$15,987.50 x 1.196 = \$19,121.05
 Most expensive quote = 250 yd³ x \$85/yd³ = \$21,250
 Cost including adder = \$21,250 x 1.196 = \$25,415
 Price range = **\$19,121.05 to \$25,415**

Slag Content Concrete

Least expensive quote = 250 yd³ x \$63.45/yd³ = \$15,862.50
 Cost including adder = \$15,862.50 x 1.196 = \$18,971.55
 Most expensive quote = 250 yd³ x \$85/yd³ = \$21,250
 Cost including adder = \$21,250 x 1.196 = \$25,415
 Price range = **\$18,971.55 to \$25,415**

The differences between 100% portland cement and slag content cement are as follows. The difference per cubic yard of concrete ranges from \$63.95 – \$63.45 = -\$0.50 (concrete with slag content costing \$0.50 less than 100% portland cement concrete) to \$85 - \$85 = \$0 or no cost difference between the two products. The range of the total first cost difference is (\$19,121.05 - \$18,971.55) = -\$149.50 to (\$25,415 - 25,415) = \$0 or no cost difference. By dividing by 20,000 ft² of building floor space, the difference in first cost is -\$7.48/1000 ft² to \$0/1000 ft².

Taking the highest and lowest cost differences and the total cost differential, the following summarizes this sustainable design feature:

- Sustainable design feature: concrete with slag content
- Incremental first cost (\$/unit): -\$0.50 to \$0
- Incremental cost (\$/1000 ft²): -\$7.48 to \$0.

E.4 Documentation of Costs of Concrete with Fly Ash Content

Based on estimates provided by vendors, 250 yd³ of 3000 psi concrete would be needed for the 20,000-ft² office building. The baseline product is concrete made from 100% portland cement. The sustainable design option is concrete with a mix of portland cement and fly ash. Fly-ash-content concrete is not readily available in Baltimore; typically, it is only available on the West Coast. However, the summary in this section includes fly-ash-content cement to compare products and prices.

Concrete is traditionally made using 100% portland cement, aggregate, and water. Concrete made with portland cement has well-established mixing and setting properties and therefore does not require any extra instruction for use on a construction site. Concrete with fly ash means that some portion of the portland cement was replaced with fly ash. Fly ash was first used in the United States to reduce the quantity of portland cement needed for the Hoover Dam in 1929. Fly ash is a fine powder recovered from coal-fired electric power generation. Millions of tons of fly ash are produced every year by U.S. power plants. Two types of fly ash are generated in the U.S., Class C and Class F. Class C, produced from Western coal (low sulfur), is the one most typically used for structural concrete because it has a higher percentage of calcium oxide. Class F is produced from Eastern coal.³

Using concrete with fly ash content has the following qualitative benefits:

- Uses a waste product as a material, eliminating the fly ash from being sent to a landfill
- Requires less water
- Has lower embodied energy than portland cement material
- Is less likely to crack because it uses less water, decreasing replacement costs
- Is easier to use in cold weather than 100% portland cement
- Has workability advantages
- Offers water retention advantages
- Offers strength advantages depending on the recipe and set time
- Reduces the risk of expansion because of sulfate attack.

The following are some issues to consider when using fly-ash-content concrete:

- Smaller contractors may not be familiar with the product, potentially resulting in higher labor costs.
- Fly ash is generated at a variety of sources; therefore, the mineral makeup of the product is not 100% consistent, which could potentially result in quality control issues.
- If used as a complete replacement for portland cement, fly-ash content has issues related to freeze/thaw performance and a tendency to effloresce.
- Because of requirements in the Clean Air Act, some coal-fired electric power plants are generating a high-carbon fly ash that has to be reprocessed before it can be used as a replacement for portland cement. This could potentially result in less availability of fly ash in the future.

³ May 7, 2002. ToolBase Services (see <http://www.nahbr.org/tertiaryR.asp?TrackID=&DocumentID=2072&CategoryID=72>).

Table E-6 summarizes the costs for 100% portland cement concrete and concrete containing 20% fly ash as encouraged by the EPA's Affirmative Procurement Program. These costs are representative of cement walls and/or flooring for a 3000 psi mix delivered to the construction site.

Table E-6. Prices for Concrete

Concrete Type	Price Per Cubic Yard
100% portland cement concrete	\$68.75
Fly ash content	\$67.75

Only one price quote is offered to show as a comparison of fly ash costs vs. slag vs. 100% portland cement. The baseline price quote is from a West Coast vendor of ready-mix concrete. Several other vendors were contacted; and although they wouldn't provide a price quote, they stated that the 100% portland cement and 20% fly-ash-content concrete cost the same. All of the West Coast vendors contacted explained that initially concrete made with fly-ash content was much cheaper; but because of increases in demand for the product and changes in availability of quality fly ash, very little cost difference exists between 100% portland cement and fly ash/portland cement mixes. The purchase of fly-ash-content concrete depends on local availability. The prices will vary based on current demand and availability of the product.

Using the values in Table E-6, the material costs for 250 yd³ of concrete are as follows (assuming 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline model).

100% Portland Cement Concrete

Concrete cost = 250 yd³ x \$68.75/yd³ = \$17,187.50
 Cost including adder = \$17,187.50 x 1.196 = \$20,556.25

20% Fly-Ash-Content Concrete

Least expensive quote = 250 yd³ x \$67.75/yd³ = \$16,937.50
 Cost including adder = \$16,937.50 x 1.196 = \$20,257.25

The differences between 100% portland cement and 20% fly-ash-content cement are as follows. The difference per cubic yard of concrete ranges from \$67.75 to \$68.75 = -\$1.00 (concrete with fly ash content costs \$1 less than 100% portland cement concrete). The range of the total first cost difference is \$20,257.25 - \$20,556.25 = -\$299. By dividing by 20,000 ft² of building floor space, the difference in first cost is -\$14.95/1000 ft².

Taking the highest and lowest cost differences and the total cost differential, the following summarizes this sustainable design feature:

- Sustainable design feature: concrete with fly ash
- Incremental first cost (\$/unit): -\$1.00
- Incremental cost (\$/1000 ft²): -\$14.95

E.5 Documentation of Costs of Carpet with Recycled Content

Based on cost estimates from the Timberline model, the 20,000-ft² office building has 2,000 yd² of interior carpet. A range of environmentally preferable carpet products is currently available on the carpet market. Product examples include refurbished used carpet and new carpet made from old carpet and carpet scraps, carpet backing, auto parts, soda bottles, and flooring materials. For this study a simple comparison was conducted of carpet made from 100% virgin material versus carpet with recycled content. The percentage of recycled content and the source of the recycled content are not specified for this comparison because the products of similar quality vary so dramatically in design, but the costs do not vary as significantly. The EPA, through the "Comprehensive Procurement Guideline," encourages the purchase of carpet with recycled content when it is available, doesn't compromise quality, and is cost effective.

Eight national and Baltimore area carpet vendors were contacted for prices on products. Only two of the vendors provided a complete set of prices for different carpet styles. The installation prices include the cost of adhesives.

C&A Floorcoverings' Habitat and Ecotone products are both solution-dyed nylon, which is fade resistant and has the same maintenance requirements as typical carpet. Both of these products are about 82% recycled content by weight. Explorer, Expedition, and Wayfarer carpets are typical contractor-grade carpets that are also solution-dyed and are manufactured with 100% new face yarn and a recycled backing (resulting in about 31% recycled content by weight). Product pricing for products made with 100% virgin materials was not available because all of C&A Floorcoverings' carpet backing has recycled content.

The sales representative at the Carpet Fair Commercial Division was not aware of any products made with recycled content and therefore only offered quotes for carpets with virgin material. The sales representative at Dupont Flooring Systems stated that the product cost differences are the result of performance requirements, patterns, color, etc., rather than whether a product has recycled content.

Mohawk Commercial Carpet produces a wide variety of both recycled content and virgin content carpets. Their recycled content carpets are made of nylon that can be recycled into carpet again, and the products that were discussed also are made with nonlatex-based backing. The sales representative provided prices for both patterned and nonpatterned solution-dyed carpets, which are fade resistant. The sales representative said that the general rule of thumb for Mohawk carpets is that equivalent quality carpet made of virgin materials usually costs about \$1/yd² more than the recycled content carpet. Maintenance requirements for the recycled content versus virgin content carpet do not differ.

Table E-7 lists the price of carpet made from virgin materials and from recycled materials. The calculations assumed the midpoint of the price range to offer a conservative comparison of the products.

Table E-7. Prices for Recycled Content and Virgin Carpet

Carpet Type	Price Per Square Yard	Price Per Square Yard Installed	Price Assumed for the Calculations	Percentage Recycled Content
C&A Floorcoverings				
Habitat	\$18.80	\$28.80-\$30.80	\$29.80	82%
Ecotone	\$19.95	\$29.95-\$31.95	\$30.95	82%
Explorer	\$22.00	\$32.00-\$34.00	\$33.00	31%
Expedition	\$24.00	\$34.00-\$36.00	\$35.00	31%
Wayfarer	\$26.00	\$36.00	\$36.00	31%
Carpet Fair Commercial Division				
Broadloom 100% virgin nylon carpet	NA*	\$18.00-\$20.00	\$19.00	0%
Virgin carpet tiles	NA	\$23.00-\$26.00	\$24.50	0%
Dupont Flooring Systems				
Recycled content face yarn and backing	NA	\$35.00	\$35.00	30-80%
Carpet made with virgin materials	NA	\$35.00	\$35.00	0%
Mohawk Commercial Carpet				
Performer 28 (no pattern)	\$12.00-\$16.00	\$18.00-\$22.00	\$20.00	0%
Collegiate (no pattern, budget carpet)	\$6.00-\$10.00	\$14.00-\$18.00	\$16.00	0%
Surreal (no pattern)	\$12.00-\$16.00	\$18.00-\$22.00	\$20.00	50%
Virgin patterned carpet	\$18.00-\$22.00	\$24-\$28	\$26.00	0%
Graphic Edge (pattern)	\$12.00-\$16.00	\$18.00-\$22.00	\$20.00	50%
Maritage Collection (4 to 5 products with pattern)	\$17.00-\$21.00	\$23.00-\$27.00	\$25.00	50%
Tracks (pattern)	\$13.00-\$17.00	\$19.00-\$23.00	\$21.00	50%
Feathergrid (pattern)	\$13.00-\$17.00	\$19.00-\$23.00	\$21.00	50%
Structures (pattern)	\$13.00-\$17.00	\$19.00-\$23.00	\$21.00	50%
* NA = not available.				

Using the values in Table E-7, the material costs for carpeting 2000 yd² of floor space in the 20,000-ft² office building are as follows (assuming 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline model) with Habitat carpet:

$$\begin{aligned} \text{Product cost} &= 2000 \text{ yd}^2 \times \$29.80/\text{yd}^2 = \$59,600 \\ \text{Full cost (inc. adder)} &= \$59,600 \times 1.196 = \$71,282 \end{aligned}$$

Using the same calculation procedure, the full costs (inc. adder) for the other products are as follows:

• Ecotone	\$74,032
• Explorer	\$78,936
• Expedition	\$83,720
• Wayfarer	\$86,112
• Broadloom 100% virgin nylon carpet	\$45,448
• 100% virgin carpet tiles	\$58,604
• Recycled content face yarn and backing	\$83,720
• Carpet made with 100% virgin materials	\$83,720
• Performer 28 (no pattern)	\$47,840
• Collegiate (no pattern, budget)	\$38,272
• Surreal (no pattern)	\$47,840
• Virgin patterned carpet	\$62,192
• Graphic Edge (pattern)	\$47,840
• Maritage Collection (4 to 5 products, pattern)	\$59,800
• Tracks, Feathergrid, and Structures (pattern)	\$50,232.

The difference between Habitat and the 100% virgin carpet (broadloom) is as follows. The difference per square foot for the installed carpet is $\$29.80 - \$19 = \$10.80$. The total first cost difference is $\$71,281.60 - \$45,448 = \$25,833.60$ or, by dividing by 20,000 ft² of building floor space, the difference in first cost is $\$1291.68/1000 \text{ ft}^2$.

Using the same calculation procedure, a comparison of the first cost of Habitat to the others is as follows:

- Habitat compared with 100% virgin carpet tiles: $\$633.88/1000 \text{ ft}^2$
- Habitat compared with carpet made with 100% virgin materials: $-\$621.92/1000 \text{ ft}^2$
- Habitat compared with Performer 28: $\$1172.08/1000 \text{ ft}^2$
- Habitat compared with Collegiate (budget): $\$1650.48/1000 \text{ ft}^2$
- Habitat compared with virgin patterned carpet: $\$454.48/1000 \text{ ft}^2$.

The differences between Ecotone and the 100% virgin carpets are as follows:

- Ecotone compared with broadloom 100% virgin nylon carpet: $\$1429.22 \text{ per } 1000 \text{ ft}^2$
- Ecotone compared with 100% virgin carpet tiles: $\$771.42/1000 \text{ ft}^2$
- Ecotone compared with carpet made with 100% virgin materials: $-\$484.38/1000 \text{ ft}^2$
- Ecotone compared with Performer 28: $\$1309.62/1000 \text{ ft}^2$
- Ecotone compared with Collegiate (budget): $\$1778.02/1000 \text{ ft}^2$
- Ecotone compared with virgin patterned carpet: $\$592.02/1000 \text{ ft}^2$.

The differences between Explorer and the 100% virgin carpet products are as follows:

- Explorer compared with broadloom 100% virgin nylon carpet: $\$1674.40/1000 \text{ ft}^2$
- Explorer compared with 100% virgin carpet tiles: $\$1016.60/1000 \text{ ft}^2$
- Explorer compared with carpet made with 100% virgin materials: $-\$239.20/1000 \text{ ft}^2$
- Explorer compared with Performer 28: $\$1554.80/1000 \text{ ft}^2$

- Explorer Compared with Collegiate (budget): \$2033.20/1000 ft²
- Explorer Compared with virgin patterned carpet: \$837.20/1000 ft².

The differences between Expedition and the 100% virgin carpet products are as follows:

- Expedition compared with broadloom 100% virgin nylon carpet: \$1913.60/1000 ft²
- Expedition compared with 100% virgin carpet tiles: \$1255.80/1000 ft²
- Expedition compared with carpet made with 100% virgin materials: \$0/1000 ft²
- Expedition compared with Performer 28: \$1794.00/1000 ft²
- Expedition compared with Collegiate (budget): \$2272.40/1000 ft²
- Expedition compared with virgin patterned carpet: \$1076.40/1000 ft².

The differences between Wayfarer and the 100% virgin carpet products are as follows:

- Wayfarer compared with broadloom 100% virgin nylon carpet: \$2033.20/1000 ft²
- Wayfarer compared with 100% virgin carpet tiles: \$1375.40/1000 ft²
- Wayfarer compared with carpet made with 100% virgin materials: \$119.60/1000 ft²
- Wayfarer compared with Performer 28: \$1913.60/1000 ft²
- Wayfarer compared with Collegiate (budget): \$2392.00/1000 ft²
- Wayfarer compared with virgin patterned carpet: \$1197.50/1000 ft².

The differences between recycled content face yarn and backing and the 100% virgin carpet products are as follows:

- Recycled content face yarn and backing compared with broadloom 100% virgin nylon carpet: \$1913.60/1000 ft²
- Recycled content face yarn and backing compared with 100% virgin carpet tiles: \$1255.80/1000 ft²
- Recycled content face yarn and backing compared with carpet made with 100% virgin materials: \$0/1000 ft²
- Recycled content face yarn and backing compared with Performer 28: \$1794.00/1000 ft²
- Recycled content face yarn and backing compared with Collegiate (budget): \$2272.40/1000 ft²
- Recycled content face yarn and backing compared with virgin patterned: \$1076.40/1000 ft².

The differences between Surreal and the 100% virgin carpet products are as follows:

- Surreal compared with broadloom 100% virgin nylon carpet: \$119.60/1000 ft²
- Surreal compared with 100% virgin carpet tiles: -\$538.20/1000 ft²
- Surreal compared with carpet made with 100% virgin materials: -\$1794.00/1000 ft²
- Surreal compared with Performer 28: \$0/1000 ft²
- Surreal compared with Collegiate (budget): \$478.40/1000 ft²
- Surreal compared with virgin patterned carpet: -\$717.60/1000 ft².

The differences between Graphic Edge and the 100% virgin carpet products are as follows:

- Graphic Edge compared with broadloom 100% virgin nylon carpet: \$119.60/1000 ft²
- Graphic Edge compared with 100% virgin carpet tiles: -\$538.20/1000 ft²
- Graphic Edge compared with carpet made with 100% virgin materials: -\$1794.00/1000 ft²
- Graphic Edge compared with Performer 28: \$0/1000 ft²

- Graphic Edge compared with Collegiate (budget): \$478.40/1000 ft²
- Graphic Edge compared with virgin patterned carpet: -\$717.60/1000 ft².

The differences between the Maritage Collection and the 100% virgin carpet products are as follows:

- Maritage Collection compared with broadloom 100% virgin nylon carpet: \$717.60/1000 ft²
- Maritage Collection compared with 100% virgin carpet tiles: \$59.80/1000 ft²
- Maritage Collection compared with carpet made with 100% virgin materials: -\$1196.00/1000 ft²
- Maritage Collection compared with Performer 28: \$598.00/1000 ft²
- Maritage Collection compared with Collegiate (budget): \$1076.40/1000 ft²
- Maritage Collection compared with virgin patterned carpet: -\$119.60/1000 ft².

The differences between Tracks, Feathergrid, and Structures and the 100% virgin carpet products are as follows:

- Tracks, Feathergrid, and Structures compared with broadloom 100% virgin nylon carpet: \$239.20/1000 ft²
- Tracks, Feathergrid, and Structures compared with 100% virgin carpet tiles: -\$418.60/1000 ft²
- Tracks, Feathergrid, and Structures compared with carpet made with 100% virgin materials: -\$1674.40/1000 ft²
- Tracks, Feathergrid, and Structures compared with Performer 28: \$119.60/1000 ft²
- Tracks, Feathergrid, and Structures compared with Collegiate (budget): \$598.00/1000 ft²
- Tracks, Feathergrid, and Structures compared with virgin patterned carpet: -\$598.00/1000 ft².

Taking the highest and lowest per square yard differences and the total cost differential, the following summarizes this sustainable design feature:

- Sustainable design feature: recycled content carpet
- Incremental first cost (\$/yd): -\$15 to +\$20
- Incremental cost (\$/1000 ft²): -\$1794.00 to +\$2392.00.

E.6 Documentation of Costs of Certified Wood Options

The following baseline materials would be replaced with certified wood products:

- 72 wood doors: 3 ft x 6 ft, 8 in. x 1 ¾ in. 5-ply particle core with birch faces (stained)
- 3060 linear feet of vinyl baseboard trim.

A certified wood product is a product that originates from a forest that has been certified as well managed. Typically, certified wood products are labeled by one of the organizations that set the standards for responsible forest management. There are two international certified wood product standards organizations – Forest Stewardship Council and the International Standards Organization – and four North American organizations – American Tree Farm System, Canadian Standards Association International, Forest Stewardship Council, and Sustainable Forestry Initiative.

Certification provides an independent assurance that a forestry operation meets the standards set by the certification organization. The standards look for environmentally, socially, and economically

responsible management practices that ensure the long-term health and productivity of forests for timber production, wildlife habitat, water quality, and community employment.

Acquiring cost-competitive certified wood products for a construction project might require considerable lead-time depending on the product. To acquire the quotes provided in Table E-8 (cost of doors) and Table E-9 (cost of baseboard trim), local vendors of doors and baseboard were asked about the baseline product as well as certified wood products. Most of the vendors who sell typical contractor-grade products were not able to provide accurate information about certified wood products.

Table E-8. Costs of Doors

Door Type	Price Per Door	Product Description
Certified wood doors		
Quote 1	\$192-\$200	Particle board core
Quote 2	\$168-\$176	Particle board core
Quote 3	\$175-200	Particle board core
Quote 4	\$250-\$300	Solid pine
Quote 5	\$400	Solid hardwood
Traditional wood doors		
Quote 1	\$160	Particle board core
Quote 2	\$160	Particle board core
Quote 3	\$165	Particle board core
Quote 4	\$372	Solid birch
Quote 5	\$300-400	Solid birch

The Sustainable Forest Products Resource ForestWorld Marketplace⁴ and the Certified Forest Products Council⁵ were the easiest sources of information regarding available certified wood products. The certified wood products vendors stated that the price and quality of certified wood products depended dramatically on how much time they have to locate the desired product.

Note that the baseline for the building assumes particle core doors. If certified wood particle core doors replace the baseline doors, it is possible that action would not meet the LEED requirements for getting a certified wood credit. The particle core doors are made with a very small quantity of certified wood (5% to 10% of the door); most of the door is made from recycled content. Therefore, solid wood doors were also considered in this analysis.

Using the range of values in Table E-8 and E-9 (excluding the data for the solid mahogany doors), the material cost for replacing 72 contractor-grade 3 ft x 7 ft x 1 ¾ in. 5-ply particle core door with birch faces with certified wood products is as follows (assuming 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline model).

⁴ Available at <http://www.forestworld.com>.

⁵ Available at <http://www.certifiedwood.org>.

Table E-9. Baseboard Trim

Trim Type	Price Per Linear Foot	Product Description
Certified wood baseboard trim		
Quote 1	\$1.50	Ash
Quote 2	\$1.13	Willow
Quote 3	\$1.59	Oak
Vinyl trim		
Quote 1	\$0.356	Black
Quote 2	\$0.383	Brown
Quote 3	\$0.407	Off-white
Quote 4	\$2.50	Polyurethane molding
Quote 5	\$0.82	Rubber back
Quote 6	\$0.80-\$1	Vinyl trim installed
Quote 7	\$1-1.2	Vinyl-rubber blend installed
Wood trim		
Quote 1	\$0.49	Ranch pine
Quote 2	\$1.18	Wood molding

The material cost for the contractor-grade 5-ply particle core door is as follows:

Product cost = 72 doors x \$160 to \$165/door = \$11,520 to \$11,880
 Full cost (inc. adder) = \$11,520 to \$11,880 x 1.196 = \$13,778 to \$14,208

Using the same approach, the full cost ranges (inc. adder) of the other products are as follows:

- Certified wood particle core door: \$14,467 to \$17,222
- Contractor-grade solid door: \$25,834 to \$34,445
- Certified solid wood door: \$21,528 to \$34,445.

The differences between the contractor-grade particle core door and the certified wood products are as follows.

Contractor-Grade 5-ply Particle Core Door Compared with Certified Wood Particle Core Door

The difference per door is (\$160 to \$165/door) - (\$168 to \$200/door) = -\$8 to \$40/door. The total first cost difference is (\$13,778 to \$14,208) - (\$14,467 to \$17,222) = \$259 to \$3444, or by dividing by 20,000 ft² of building floor space, the difference in first cost ranges from \$12.95 to \$172.20/1000 ft².

Solid Wood Door Compared with Certified Solid Wood Door

The difference per door is (\$300 to 400/door) - (\$250 to \$400/door) = -\$150 to \$100/door. The total first cost difference is (\$25,834 to \$34,445) - (\$21,528 to \$34,445) = -\$12,917 to \$8611, or by dividing by 20,000 ft² of building floor space, the difference in first cost ranges from -\$645.85 to \$430.55/1000 ft².

Taking the highest and lowest differences and the total cost differential, Table E-10 summarizes this sustainable design feature.

Table E-10. Summary of Certified Wood Options

Sustainable Design Feature	Incremental First Cost (\$ per unit)	Incremental Cost (\$/1000 ft²)
Certified wood particle core door vs. contractor-grade particle core door	\$3 to \$40	\$12.95 to \$172.20
Certified wood solid wood door vs. solid wood door	-\$150 to \$100	-\$645.85 to \$430.55

The assumed baseline material is 3060 linear feet of vinyl baseboard trim with alternative certified wood products being solid ash, willow, and oak baseboard trim. The differences in product quality, appearance, and durability have not been included in the cost comparisons. Noncertified wood trim first costs were also gathered to offer a more equivalent comparison from a product quality perspective.

Using the range of values in Table E-9 (excluding quotes 4 through 7 because they offer higher-end products or included installation costs), the material cost for replacing 3060 linear feet of vinyl baseboard trim with certified wood products is as follows (assuming 19.6% adder for sales tax, contractor bonds and insurance, profit and overhead, and general conditions based on the Timberline model).

The material cost for the contractor-grade vinyl baseboard trim is as follows:

$$\begin{aligned} \text{Product cost} &= 3060 \text{ linear feet} \times \$0.356 \text{ to } \$0.407/\text{linear foot} = \$1089 \text{ to } \$1245 \\ \text{Full cost (inc. adder)} &= \$1089 \text{ to } \$1245 \times 1.196 = \$1302 \text{ to } \$1489 \end{aligned}$$

Using the same calculation approach, the full costs (inc. adder) for the other products are as follows:

- Contractor-grade wood baseboard trim: \$1793 to \$4319
- Certified wood baseboard trim: \$4136 to \$5819.

The difference between the contractor-grade vinyl baseboard trim and the certified wood baseboard trim is as follows. The difference per linear foot of vinyl trim is (\$0.356 to \$0.407/linear foot) - (\$1.13 to \$1.59/linear foot) = \$0.72 to \$1.23/linear foot. The total first cost difference is (\$1302 to \$1489) - (\$4136 to \$5819) = \$2647 to \$4517, or by dividing by 20,000 ft² of building floor space, the difference in first cost ranges from \$132.35 to \$225.85/1000 ft².

The comparison between the contractor-grade solid wood baseboard trim and the certified wood baseboard trim yields a range of -\$9.15 to \$201.30/1000 ft².