Madison Landmarks Commission # STAFF REPORT

Regarding: **702 East Mifflin Street – Designated Landmark (City Market) - Exterior alteration involving window replacement.**
2nd Aldermanic District.
Contact: Lee Waldhart
(Legistar #26537)

Date: June 11, 2012
Prepared By: Amy Scanlon, Preservation Planner

General Information:

The Applicant is proposing to replace the existing windows and storm units with new vinyl windows. The Applicant has started work without a building permit.

Relevant Sections of the Landmarks Ordinance:

33.19(5)(b) Regulation of Construction, Reconstruction and Exterior Alteration.

4. Upon filing of any application with the Landmarks Commission, the Landmarks Commission shall determine:
   a. Whether, in the case of a designated landmark or landmark site, the proposed work would detrimentally change, destroy or adversely affect any exterior architectural feature of the improvement upon which said work is to be done; and

Staff Comments and Recommendation:

According to the preservation file for this property, the building was "stabilized" for mothballing and security purposes when the City Market was a City owned property. During this work some original window sash may have been removed.

Staff does not support the replacement of original wood window sash with vinyl replacement units in landmark buildings unless every attempt has been made to repair the existing wood windows and add weather-stripping and high quality storm windows to achieve desired energy efficiency. It is unknown if window repair work was attempted before replacement work began.

Because the Applicant was possibly given incorrect information about window replacement work, Staff believes the Landmarks Commission should use this opportunity to educate the Applicant about the importance of window repair in lieu of replacement. An article about the costs of window replacement is attached to this report. Staff informed the Applicant that the City Market is also listed on the National Register of Historic Places and that tax credits may be available for rehabilitation work that would include existing window repair and the installation of weather-stripping and storm windows. Staff has briefly discussed this project with the State and surmises that it is unlikely the Applicant will pursue the tax credit program due to program eligibility requirements.

Staff recommends that the Landmarks Commission not approve the Certificate of Appropriateness at this time and encourage the Applicant to test the window repair, weather-stripping and storm window option on one building elevation (or equivalent) for at least 12 months to determine effectiveness and consider holistic energy efficiency and sustainability practices before pursuing complete window replacement.

If the above suggestion is undesirable and the Landmarks Commission finds that a Certificate of Appropriateness should be granted for window replacement as requested at this time, Staff recommends the following conditions of approval:

1. Only half screens shall be used. The previously installed full screens shall be replaced with half screens.
2. Exterior applied muntin grilles shall be installed on all windows (new and previously installed). The grilles shall be proud of the glass by at least 3/8" and shall not have the flat appearance of "tape".
3. The Applicant shall investigate the use of wood windows with exterior aluminum cladding or fiberglass windows.

What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows

WALTER SEDOVIC and JILL H. GOTTHELF

Sustainability looks even better through a restored window.

	EMBODIED ENERGY	
MATERIALS	MJ/kg	MJ/m3
Aggregate	0.10	150
Straw bale	0.24	31
Soil-cement	0.42	819
Stone (local)	0.79	2030
Concrete block	0.94	2350
Concrete (30 Mpa)	1.3	3180
Concrete precast	2.0	2780
Lumber	2.5	1380
Brick	2.5	5170
Cellulose insulation	3.3	112
Gypsum wallboard	6.1	5890
Particle board	8.0	4400
Aluminum (recycled)	8.1	21870
Steel (recycled)	8.9	37210
Shingles (asphalt)	9.0	4930
Plywood	10.4	5720
Mineral wool insulation	14.6	139
Glass	15.9	37550
Fiberglass insulation	30.3	970
Steel	32.0	251200
Zinc	51.0	371280
Brass	62.0	519560
PVC	70.0	93620
Copper	70.6	631164
Paint	93.3	117500
Linoleum	116.0	150930
Polystyrene Insulation	117.0	3770
Carpet (synthetic)	148.0	84900
Aluminum (recycled)	227.0	515700
NOTE: Embodied energy values based on several international sources - local values may vary.		

Fig. 1. Comparative values of the embodied-energy levels of common building materials. Note that glass and aluminum (i.e., principal components of many replacement windows) are ranked among the highest levels of embodied energy, while most historic materials tend to possess much lower levels. Courtesy of Ted Kesik, Canadian Architect's Architectural Science Forum, Perspectives on Sustainability.

For all the brilliance reflected in efforts to preserve historic buildings in the U.S., the issue of replacing windows rather than restoring them remains singularly unresolved. Proponents on both sides of the issue may easily become frustrated by a dearth of useful data, as well as conflicting information, or misinformation, promulgated by manufacturers. Indeed, it often seems that many preservation practitioners and building owners remain in the sway of advertising claiming that the first order of business is to replace old windows. In the context of preservation and sustainability, however, it is well worth reconsidering this approach.

Sustainability and Authenticity

In considering alternatives to replacing historic windows, one needs to keep in mind two important elements: sustainability and authenticity. Sustainability (building green) and historic preservation are a natural marriage, so long as one remains mindful that sustainability is not just about energy conservation.[1] Preservation and sustainability involve myriad elements that can work in symbiotic and synchronized ways toward a favorable outcome. For example, preservation work is more labor- than material-intensive, which benefits local economies; natural ventilation afforded via operable windows can reduce the size of mechanical equipment, especially of air-conditioning; and salvaging historic materials, such as wood sash, obviates the need to harvest live trees and other natural resources for the manufacture of replacement units.

Similarly, retaining and celebrating authenticity is one key element of an exemplary preservation program. No one should take lightly the option of discarding authentic historic materials — in this case, windows — without fully evaluating the consequences. Once authentic material is lost, it is lost forever. It does not matter how accurate the replacement window, it never reflects the nuances of the original.

Taking the Long View

Historic windows possess aesthetic and material attributes that simply cannot be replaced by modern replacement windows. Like preserving whole buildings, restoring historic windows is a solid step forward into the realm of sustainability. The present approach to sustainability, however, still too often focuses on new construction and issues such as "intelligent" windows and energy efficiency, while overlooking other important, holistic benefits of preserving historic windows, such as the following:

- Conservation of embodied energy (i.e., the sum total of the energy required to extract raw materials, manufacture, transport, and install building products). Preserving historic windows not only conserves their embodied energy, it also eliminates the need to spend energy on replacement windows. Aluminum and vinyl — the materials used in many replacement windows — and new glass itself possess levels of embodied energy that are among the highest of most building materials (Fig. 1).[2]
- Reduction of environmental costs. Reusing historic windows reduces environmental costs by eliminating the need for removal and disposal of existing units, as well as manufacture and transportation of new units. Also, many replacement units are manufactured with such materials as

MISSOURI DEPARTMENT OF NATURAL RESOURCES
ENERGY CENTER - ENERGY LOAN PROGRAM
WINDOW REPLACEMENT WORKSHEET

BUILDING	LOCATION	DATE

To estimate the savings of replacing existing windows with efficiency upgrades, the following information must be known:

The U-Factor of the existing window (See U-Value table below).
The U-Factor of the replacement window (See U-Value table below).
The total area of the windows being replaced (square feet).
The heating energy cost ($/million Btu).
The heating plant efficiency (in percent).

SAVINGS CALCULATIONS

1. Enter the U-Factor of the existing windows .... ________
2. Enter the U-Factor of the replacement windows .... ________
3. Subtract line 2 from line 1 .... ________
4. Add 0.86 to line 3 .... ________
5. Enter the total area of the windows to be replaced .... ________
6. Multiply line 4 by line 5 .... ________
7. Multiply 0.1 by line 6 .... ________
8. Enter the heating plant efficiency (percent divided by 100) .... ________
9. Divide line 7 by line 8 .... ________
10. Enter the energy cost ($/million Btu) .... ________

YEARLY SAVINGS

11. Multiply line 9 by line 10 .... $ ________ /year

PROJECT COST

12. Enter the total cost of the window replacement including material, labor and design .... $ ________

SIMPLE PAYBACK

13. Divide line 12 by line 11 .... ________ years

WINDOW U-VALUE TABLE

Window System Type	U-Factor*
Single Glass	1.10
Single Glass with storm window	0.50
Single Glass, low E coating	0.91
Single Glass, low E coating with storm window	0.44
Insulating Glass (double glass)	0.55
Insulating Glass (double glass) with storm window	0.35
Insulating Glass (double glass), low E coating	0.38
Insulating Glass (double glass), low E coating with storm window	0.32
Insulating Glass (triple glass)	0.35
Insulating glass (triple glass) with storm window	0.25

* U-Factor values adapted from the 1985 ASHRAE Fundamentals Handbook.

MO 780-1363 (5-98) DNR/TAREQV 3.5 (5-98)

Fig. 2. Many excellent worksheets are available for calculating payback of replacement windows; this one is produced by the Missouri Department of Natural Resources. Results of payback calculations often reveal grossly overstated claims. Courtesy of the Missouri Department of Natural Resources.

vinyl and PVC, whose production is known to produce toxic by-products. So, while energy savings is green, the vehicle toward its achievement — in this case, replacement windows — is likely to be the antithesis of green.[3]

- Economic benefits. Restoration projects are nearly twice as labor-intensive as new construction, meaning more dollars spent go to people, not materials. This type of spending, in turn, has the beneficial effect of producing stronger, more dynamic local economies.[4]
- Ease of maintenance. "Maintenance-free" is a convenient marketing slogan; many replacement windows, in reality, cannot be maintained well or conserved. Vinyl, fiberglass, sealants, desiccants, and coating systems all degrade, and they are materials that remain difficult or impossible to recycle or conserve.[5]
- Long-term performance. While manufacturers' warranties have been lengthened in the past few years (they are now generally from 2 to 10 years), they still pale in comparison to the actual performance life exhibited in historic windows, which can reach 60 to 100 years and more, often with just minimal maintenance.

Clearly, sustainability takes into account more than just the cost of energy savings. It also promotes salient social, economic, and environmental benefits, along with craftsmanship, aesthetics, and the cultural significance of historic fabric. Still, the issue of energy savings is often used to justify replacement over restoration, but just how valid is this argument?

Energy Savings

If the foremost goal for replacing historic windows is energy savings, beware of "facts" presented: they very likely will be — intentionally or not — skewed, misinformed, or outright fallacious. Window manufacturers universally boast about low U-values (the measure of the rate of heat loss through a material or assembly; a U-value is the reciprocal of an R-value, which is the measure of resistance to heat gain or loss). For example, U-values are often misleadingly quoted as the value for the entire window unit, when in fact it is the value through the center of the glass (the location of the best U-value), not that of the sash nor the average of the entire unit.[6] To be sure that data are being presented appropriately, request the U-values published by the National Fenestration Rating Council (NFRC), which rate whole-window performance.[7]

When U-values are offered for the entire window assembly, they often are significantly worse (i.e., higher) due to infiltration around the frame and rough opening.[8] In cases where replacements tend to warp and bow over time (and they do), this factor becomes ever more crucial.[9] It is also important to watch for comparative analyses: some replacement-window manufacturers compare their window units to an "equivalent" single-pane aluminum window. Clearly, this is an inappropriate analogy since these types of windows are not likely to be found in a preservation context.

Infiltration of Outside Air

Infiltration of outside air — rather than heat lost through the glass — is the principal culprit affecting energy; it can account for as much as 50 percent of the total heat loss of a building.[10] When retrofit windows are installed over or within the existing window frame, the argument for preservation already exists: restoring the integrity of the fit between the frame and building wall should be the first component of a preservation approach.

Sash pockets, pulleys, and meeting rails are areas prone to air infiltration in double-hung units. Yet, several weatherproofing systems for existing windows can overcome these heat-sapping short circuits.[11] Replacement-window manufacturers themselves admit that even among replacements, double-hung units present the greatest challenges for controlling heat loss because infiltration occurs most frequently at sash-to-sash and sash-to-frame interfaces, which are highly dependent on the quality of the installation.[12] The energy efficiency of restored windows incorporating retrofit components (weatherstripping and weatherseals combining pile, brush, bulb, or "Z" spring seals) can meet and even exceed the efficiency of replacement units.[13] This approach is suggested as the first alternative among green-building advocates.[14]

Payback

Focusing on windows as the principal source of heat transfer may lead to the conclusion that windows are more important than, say, insulating the attic, foundation, or walls. While data vary somewhat, up to 25 percent of heat may be lost through doors and windows.[15] But when the aforementioned potential 50 percent loss through infiltration is taken into account, the total effective percentage of heat loss attributed to the window units themselves would be only 12.5 percent. That is a relatively small percentage for a potentially large investment, especially when other options are available.

In actuality, typical window-replacement systems offer payback periods that are often nowhere near manufacturers' claims: the payback of a typical unit could take as long as 100 years (Fig. 2).[16]

Heat Loss/Heat Gain

Heat loss is often discussed, but what about heat gain? In summer, heat gain can add significantly to the energy costs associated with cooling a building.[17] Long waveforms within the daylight spectrum that enter through the glass must be able to exit, or else they degrade to heat that then must be overcome by the building's cooling system.[18] Low-emittance ("low-e" or "soft low-e") glass handles this task best, improving thermal performance by virtually eliminating infrared (long-wave) radiation through the window.[19] It accomplishes this task by allowing short-wave radiation through and reflecting long-wave heat back to its source, while at the same time providing an appearance that is virtually clear.[20]

Low-e glazing can be substituted into existing units that are only single-glazed and still achieve important energy savings. Single-pane low-e glass can provide a virtually equivalent level of combined energy savings as a standard new double-glazed unit when used in concert with an existing single-paned sash (e.g., as a storm or interior sash).[21] Replacing panes of glass, then tightening up the sash and frame, is a very simple and cost-effective way to achieve the desired whole-assembly U-value without having to modify visible light, mullions, or sash weights.[22]

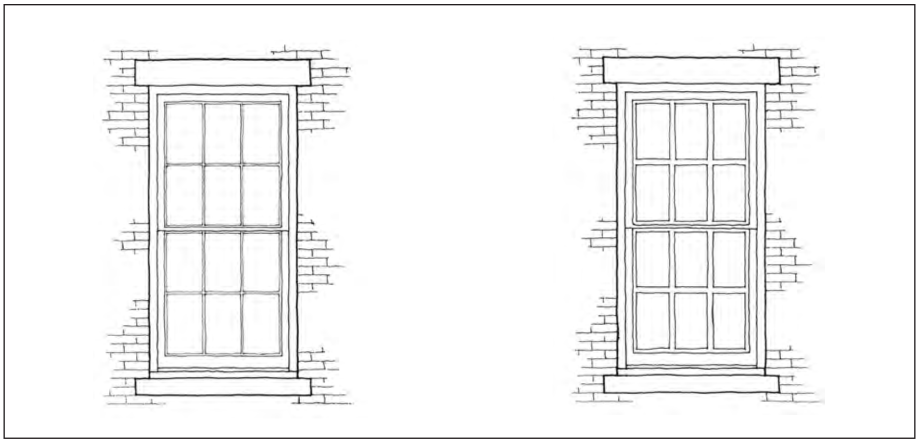

Fig. 3. At left is a drawing of a typical late-nineteenth- to early-twentieth-century six-over-six, double-hung window. At right is a modern "equivalent" replacement. The considerably thicker mullions and frame of the replacement unit (necessitated by the use of insulated glass) result in a nearly 15 percent reduction of visible light and views. Drawing by Walter Sedovic Architects.

Insulated Glass

Replacement windows nearly always incorporate insulated glass (IG) units. The effectiveness of an IG unit is greatly dependent on the depth of the airspace between inner and outer panes, as well as on the nature, type, and amount of desiccant and seals employed around the unit perimeter.[23] While manufacturing techniques for IG units have continued to improve, when IG units fail, they are difficult and time-consuming to replace.[24]

The additional weight and thickness of IG units preclude their use as retrofits in historic sashes of either wood or metal. Indeed, to compensate for their heft, virtually all IG replacement window mullions, sash, and frames are bulkier than their historic counterparts. The result is that visible daylight levels are reduced by 15 percent or more and views are interrupted.[25] Reducing daylight and negatively affecting views are explicitly not consistent with a sustainable approach (Fig. 3).

Laminated Glass as an Alternative

Laminated glass remains an often-overlooked alternative to IG units, perhaps because of the industry's focus on marketing it as "safety" glass. While laminated glass cannot compete with technologically advanced, complex IG units, it does offer enhanced U-values for monolithic glass without having to materially alter the mullions of the historic sash into which it is being fitted.[26] It is important to recognize, though, that a U-value is not the only criterion that determines the relative thermal efficiency of a window. Solar and light transmittance also affect performance, and they may be benefit when low-e laminated glass is selected.[27] The benefits of laminated glass, though, go much further when considered part of a comprehensive program to restore and thermally upgrade historic sash:

- Laminated glass offers significantly higher levels of noise abatement than IG.
- Historic glass may be laminated, offering energy and noise benefits while maintaining an authentic finish.
- Laminated glass is far easier and less expensive to procure and install and allows for field cutting.
- It offers superior safety and security features.
- Laminated glass may be equipped with low-e glazing to help offset heat gain.
- Historic sash, both metal and wood, can be outfitted with laminated glass without modifying or replacing mullions and frame elements (something that would be required by the installation of significantly thicker IG units).
- Condensation is reduced as a result of the internal thermal break of laminated glass.
- A variety of features (UV protection, polarization, translucency, etc.) can be incorporated as layers within laminated glass. Efforts to achieve the same results in IG units through the use of applied films (as opposed to an integral layer within the glass) has been shown to greatly reduce the life of double-glazed units by inhibiting the movement of their seals.[28]

Performance and Material Quality

A hallmark of sustainability is long-term performance. Intrinsic within that premise are issues about material quality, assembly, and conservability. As noted above, some material choices (e.g., PVC) incorporated into replacement-window units are inherently not able to be conserved.[29] When the material degrades, it then becomes necessary to replace the replacement.[30]

One of the great virtues of historic windows is the quality of the wood with which they were constructed. Historic windows incorporate both hardwoods and softwoods that were often harvested from unfertilized early-growth stock. Such wood has a denser, more naturally occurring grain structure than what is generally available today from second-growth stock or fertilized tree farms. Also, historically, greater concern was given to milling methods, such as quarter- or radial sawing. The resulting window performs with greater stability than its modern counterpart. This alone has far-reaching benefits, from minimizing dimensional change, to holding a paint coating, to securing mechanical fasteners.

No amount of today's staples, glue, finger-splices, and heat welds can match the performance of traditional joinery.[31] Similar comparisons could be made of the quality of hardware employed in replacement windows, such as spring-loaded balances and plastic locking hardware; they cannot compete with the lasting performance and durability of such historic elements as pulley systems and cast-metal hardware.

Ease of Maintenance

For cleaning windows, traditional single- and double-hung windows are often outfitted with interior sash stops that may be removed readily, allowing for full access to the interior and exterior, as well as to the pulley system. Both casement and pivot windows are inherently very easy to clean inside and out.

Replacement windows incorporating tilt-in sash — a feature that on its surface appears enticing — require that there is no interior stop, increasing the potential for air infiltration around the sash. Compressible jamb liners that allow for the tilt-in feature are often constructed of open-cell foams that, once they begin to degrade, lose both their compressibility and sash-to-frame infiltration buffer.

The ability to readily disassemble historic wood windows also allows for selectively restoring, upgrading, and adapting individual components of a window throughout its life. Most replacement-window systems cannot make that claim.

Aesthetics and Authenticity

Nuances in molding profiles, shadow, line, and color of windows, along with quality and appearance of the glass, contribute greatly to the overall building aesthetic and generally emulate the stylistic details of the building as a whole. Even what might seem like small changes in these elements can and does have a noticeable and usually detrimental effect on many historic facades. Outfitting historic buildings with modern replacement windows can and often does result in a mechanical, contrived, or uniformly sterile appearance. Worse, when historic windows are replaced, authenticity is lost forever.

Value and Cost

Repairs of historic windows should add to the value of the property, as an authentically restored automobile would command greater value than one "restored" with plastic replacement parts.

While there is a dearth of cost-comparative analyses between a replacement window and its restored, authentic counterpart, empirical knowledge based on field experience covering a wide variety of window types suggests that restoration is on a par, cost-wise, with a middle-of-the-road replacement. Corollary conclusions are that:

- cheap replacement windows will always exist to superficially counter the cost-basis argument for restoration; and
- high-quality equivalent replacement units have been shown in practice to cost as much as three times that of restoration.

Windows are a critical element of sustainability, but sustainability is not just about energy. It is about making environmentally responsible choices regarding historic windows that take into account the spectrum of associated costs and effects. The choice of whether to replace or restore requires embracing a more encompassing definition of sustainability. The answer is not as simplistic as some would have us believe.

WALTER SEDOVIC, the principal and CEO of Walter Sedovic Architects, works in historic preservation and sustainable design. His work and firm are recognized for integrating green-building approaches and ideologies into preservation projects.

JILL H. GOTTHELF is an associate at Walter Sedovic Architects, providing project management, design, and construction administration. She has extensive experience in integrating sustainable building technologies into preservation projects.

Notes

1. Walter Sedovic, "History's Green Genes" (Greenbuild 2003, The 2nd International Conference on Sustainability, U.S. Green Building Council, Pittsburgh, Pa., November 12-14, 2003).

2. Ted Kesik, "Embodied Energy Comparative Values," Canadian Architect, Architectural Science Forum, Perspectives on Sustainability, January 2002, http://www.canadianarchitect.com/asf/perspectives_sustainibility/measures_of_sustainablity/measures_of_sustainablity_embodied.htm (accessed November 1, 2005).

3. "Windows," Global Green USA, Public Housing Authority Toolbox, http://www.globalgreen.org/pha-energytoolbox/tech_windows.htm (accessed November 1, 2005).

4. Don Rypkema, "The Economics of Preservation" (keynote address, Preservation 360°, Saratoga Springs Preservation Foundation, Saratoga Springs, N.Y., March 18, 2005).

5. Paul Fisette, "Understanding Energy-Efficient Windows," *Fine Homebuilding* 114 (1998): 68–73.

6. Ibid.

7. National Fenestration Rating Council, http://www.nfrc.org.

8. Andrew M. Shapiro and Brad James, "Creating Windows of Energy-Saving Opportunity," *Home Energy* 14, no. 5 (1997).

9. Fisette, 68–73.

10. Ibid.

11. Shapiro and James.

12. Bill Mattinson, Ross DePaola, and Dariush Arasteh, "What Should I Do About My Windows?" *Home Energy* 19, no. 4 (2002).

13. The growing market for retrofit seals has resulted in an ever-increasing supply of high-quality weatherstripping products manufactured in a variety of materials and configurations for application in both typical and non-typical applications.

14. Shapiro and James.

15. Hastings Borough Council, "Have You Got Money to Burn?" http://www.hastings.gov.uk/energy_efficiency/heat_every_home.aspx#money_to_burn (accessed November 1, 2005).

16. Shapiro and James.

17. Fisette, 68–73.

18. Ibid.

19. The National Energy Foundation, "Energy Advice: Saving Energy: Insulation," http://www.nef.org.uk/energyadvice/insulation.htm (accessed September 16, 2005). A. Roos and J. Karlsson, "Performance Criteria for Coated Glazings in Windows," in *Proceedings from Glass Processing Days, Tampere, Finland*, 653–656 (Uppsala, Sweden: Dept. of Material Science, Angstrom Laboratory, Uppsala University, 2001). See also http://www.glassfiles.com/library/23/article440.htm (accessed November 1, 2005).

20. Roos and Karlsson, 653-656.

21. Mattinson, DePaola, and Arasteh.

22. Shapiro and James.

23. "Product Information: Insulating Glass," PPG Industries, Inc., http://www.ppg.com/gls_residential/share/res_ins.htm (accessed November 1, 2005).

24. James Piper, "Windows: Repair or Replace?" *Building Operating Management* (Jan. 2004).

25. Chad Randl, *Preservation Tech Notes, Windows*, No. 19, *Repairing Steel Casement Windows* (Washington, D.C.: U.S. Department of the Interior, National Park Service, Cultural Resources, 2002).

26. California Glass Bending Corporation, "Static-Exchange Correlation-Polarization (SECP) Tables," http://www.calglassbending.com/secptabl.htm (accessed November 1, 2005).

27. Roos and Karlsson, 653–656.

28. James Piper, "Avoiding Common Window and Window Film Mistakes," *Building Operating Management* (Oct. 2004).

29. Fisette, 68–73.

30. John M. Corbett, "A Last Look at Historic Wood Windows," *Traditional Building* 14, no. 6 (2001).

31. Fisette, 68–73.