



**Indoor Environmental Quality + Workplace Environment  
UMTC Health Sciences Education Center + Phillips Wangensteen Building  
Renovation (HSEC+PWB)  
Minneapolis, MN**

**January 2022, Minneapolis, MN  
Sustainable Post-Occupancy Evaluation Survey (SPOES)  
B3 Guidelines**

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## 1.0 Overview

The purpose of this report is to examine the connection between sustainable design criteria used in the design and renovation of the UMTC Health Sciences Education Center (HSEC) facility) and the partial design and renovation of the Phillips Wangenstein Building (PWB) and occupants' satisfaction with their work environments located in the facility. This report communicates responses from employees about the overall facility and their workplace (WP). The facility was designed using the B3 Guidelines (formerly known as the Minnesota Sustainable Building Guidelines or MSBG), which were in effect at the time that the new facility was completed for occupancy in March 2020. The B3 Guidelines track specific state funded, B3 buildings as a means of demonstrating real outcomes aimed at the conservation of energy resources, creation and maintenance of healthy environments, and occupants' satisfaction with their work environments. The Sustainable Post-Occupancy Evaluation Survey (SPOES) was developed to assess human outcomes in workplace, classroom, and residence hall settings in compliance with the B3 Guidelines project tracking requirements. This is a report of occupants' (hereafter called employees) responses nearly 20 months post-occupancy. Because of COVID-19, the HSEC+PWB space was used at a reduced capacity until full class schedules resumed in the building in September 2021. The survey was conducted in December 2021.

This SPOES report focuses on employees' satisfaction with the physical environment as related to 26 indoor environmental quality (IEQ) criteria such as lighting, thermal, and acoustic conditions in their primary workspaces, i.e., offices. Employees' satisfaction with the facility (site, building, and interior) and the effect of the facility's physical environment on their perceptions of their work performance and health also are included. Finally, a brief look at employees' commuting and physical activities within the building are reported. The report provides descriptive information about employees' perceptions of the IEQ of their work environments. In addition, this information serves the broader development of knowledge regarding the influence of IEQ on employees.

## 2.0 Method

SPOES consists of a self-administered, Internet-based, questionnaire submitted to and completed by employees. The SPOES questionnaire has been tested for **validity** (measures what it is intended to measure) and **reliability** (repeatability or replicability of findings). Employees rate their level of satisfaction on a **Likert-type scale** (measurement scale) from 1 (very dissatisfied) to 7 (very satisfied) with IEQ of the facility and their primary workspaces. They also rate the influence of their physical environment on their perception of their work performance and health on a scale from 1 (hindered) to 7 (enhanced).

The report provides a descriptive summary of the results stated as a **mean** (average of all responses), **standard deviations** (SD) (how different scores are from each other and the mean), and **number of responses** (N) for each question analyzed. The mean for a 7-point scale is 4.00. Lower or higher means reflect stronger tendencies towards dissatisfaction/satisfaction and hindered/enhanced. Means that are close to the center of the scale (4) are considered to be neither dissatisfied/hindered or satisfied/enhanced.

When interpreting **mean** responses, the following labels were used:

- 1.00 - 3.50 dissatisfied (or hindered)
- 3.51 - 4.50 neither dissatisfied (or hindered) nor satisfied (or enhanced)
- 4.51 - 7.00 satisfied (or enhanced)

An IEQ Score is also calculated for employees' satisfaction with IEQ criteria in their primary workspaces. This is a statistical combination of all category-level (explained below) IEQ scores, which results in a single IEQ score for all respondents and is reported in an IEQ Scorecard.

## 2.1 Description of the Questionnaire

Employees first rate their level of satisfaction with the facility (site, building, and interior) and the influence of their physical environment on their perception of their work performance and health. Then they respond to questions about their satisfaction with their primary workspaces in relation to IEQ criteria from the B3 Guidelines. Additionally, employees' demographic, physical activity, and commuting practice data are collected to provide context for the study.

In the SPOES questionnaire, the 26 IEQ criteria listed below are evaluated. There are two levels of criteria, categories and attributes. As shown in the list, the 'overall' criteria are boldfaced and called 'categories' or 'category level' criteria. A category is broader or more general such as Overall View Conditions or Overall Indoor Air Quality. Some categories have 'attributes' or 'attribute level' criteria and provide greater detail about the category. For example, Overall Thermal Conditions is a category level question, and there are four attribute level questions related to thermal conditions such as adjustability, air velocity (draft), humidity, and temperature. Overall Acoustic Conditions is a category with attributes of employees' ability to hear desired sounds and their ability to limit undesired sounds. There are 12 category-level and 14 attribute level questions. Means are calculated and reported for all category and attribute-level criteria.

An IEQ Satisfaction Score is also calculated for employees' satisfaction with IEQ in their primary workspaces. This is a statistical combination of the 12 category-level criteria only and results in a single, mean IEQ Satisfaction Score for all employees' satisfaction with the physical conditions of their primary workspaces. Attribute-level criteria are not included in the IEQ Score because unequal weight would be given to criteria that have both category and attribute-level questions.

In the following list, **category (boldface)** criteria are listed in alphabetical order. If a category has attributes, they are listed with the category.

### **Overall Acoustic Quality**

- Ability to hear desired sounds
- Ability to limit undesired sounds

### **Overall Appearance (aesthetics)**

### **Overall Cleaning and Maintenance**

### **Overall Daylighting Conditions**

- Amount of daylighting
- Adjustability of daylighting

### **Overall Electric Lighting Conditions**

- Amount of electric lighting
- Adjustability of electric lighting
- Adjustability of task lighting

### **Overall Furnishings**

- Function of furnishings
- Adjustability of furnishings

### **Overall Indoor Air Quality**

### **Overall Privacy**

### **Overall Technology**

- Access to electric outlets

### **Overall Thermal Conditions**

- Adjustability of thermal conditions
- Air velocity (drafty/stagnant)
- Humidity (dry or moist)
- Temperature (hot or cold)

### **Overall Vibration and Movement**

### **Overall View Conditions**

## 2.2 Limitations

Employees' participation is voluntary, and responses are self-reported. As is true with all survey research, the responses indicate employees' perceptions. There were no physical measurements, e.g., temperature, humidity, or lighting levels of the environment taken. This study is limited to employees' perceptions.

## 3.0 Sample Description

### 3.1 Description of Building

The HSEC+PWB facility resides at 116 Church Street SE, Minneapolis, MN. The HSEC facility (see Figure 1) connects to the Phillips Wangensteen Building (PWB) located at 516 Delaware Street SE. Four floors (2, 3, 5, and minimal space on 4) of the PWB (55,283 square feet [SF]) were renovated as part of this project. The HSEC is a seven-story, 148,231 SF building. It is comprised of a sub-basement and basement below grade and of the five floors above grade. This building provides workspace (9,500 square feet) for faculty and staff. To support faculty and staff, the workplace also includes conference and meeting space, and other support areas.



Figure 1. HSEC+PWB (Photo courtesy of Peter Sieger)

### 3.2 Project Team

The relevant project team members to the SPOES process for HSEC+PWB was comprised of the owner, design team, commissioning agent, and general contractor. They are identified below, relative to their capacity and involvement.

Owner	Regents of the University of Minnesota
Architect	Perkins+Will (architect-of-record) with SLAM
Mechanical and Electrical Engineer	LKPB Engineers
Interior Designer	Perkins+Will
Landscape Architect	Perkins+Will
Commissioning Agent	University of Minnesota
General Contractor	JE Dunn Construction Group, Inc.

**3.3 Description of Respondents**

This survey was administered to 78 employees with workspace in the facility near the end of the fall semester 2021. The response rate to the questionnaire was approximately 42%. Of those responding, 71% were female, 22% were male, and nearly 2% responded as ‘other.’ The mean age of respondents was 40 years, with a range from 39-53 years of age.

The HSEC+PWB renovation was completed and ready for operation in March 2020. The HSEC+PWB is a workplace with enclosed private or shared offices; shared or dedicated open workstations (cubicles) with or without a partition(s) or other types of primary workspaces. Newly adopted university design guidelines required a move to fewer private offices to promote collaboration amongst employees. This was a pedagogical change/shift in officing strategy for the University Health Sciences Department employees in the HSEC+PWB facility.

Since March 2020, over 7% of the respondents reported that they worked in HSEC+PWB facility for more than two years, 59% of the respondents reported that they worked at the HSEC+PWB facility for 1-2 years, and over 33% of the respondents spent less than one year at this facility. Relating to hours worked during a typical week at the HSEC+PWB, nearly 8% of the employees reported they spend 40+ hours a week in the facility, 19% spend 30-40 hours a week at the HSEC+PWB, nearly 8% spend 20-29 hours at the facility, and over 65% work there less than 20 hours per week.

Relating to the time employees spend per week in their primary workspace, 26% of the employees reported they spend more than 75% of their weekly time in their primary workspace; over 7% spend 51-75% of their time in their primary workspace; 22% spend 25-50% of their time in their primary workspace; and over 44% spend less than 25% of their time in their primary workspace. These responses indicate the amount of time employees are exposed to IEQ conditions in their workplace environment.

Over 48% of employees indicated that their primary workspaces were located within 15 feet of an exterior window, nearly 41% of the employees were not within 15 feet of an exterior window, and 11% were unsure about their distance to an exterior window.

**4.0 Findings and Discussion**

**4.1 HSEC+PWB Facility (Site, Building, and Interior): Overall Satisfaction, Work Performance, and Health**

Employees responded to questions concerning the HSEC+PWB facility (site, building, and interior) and their overall satisfaction with the facility, overall perceptions of their work performance in relation to the facility, and their overall perception of their health in relation to the facility. Table 1 shows the

means and standard deviations of their responses as well as how the responses are interpreted. Figure 2 is a graph that shows the mean for each question, which is identified with a blue mark. The standard deviation is shown by the green/red vertical bar with green representing satisfied (or enhanced) and red representing dissatisfaction (or hindered). Gray represents the 'neither/nor' range of responses. In cases where there were no dissatisfied responses, the bar may be all green or gray and green. This graph is simply a visual image of the findings from Table 1.

Table 1 HSEC+PWB facility - overall satisfaction, work performance, and health

Overall	Mean	SD	N	Interpretation
Satisfaction	5.64	1.43	33	Satisfied
Work Performance	4.91	*1.78	33	Enhanced
Health	4.76	1.13	33	Enhanced

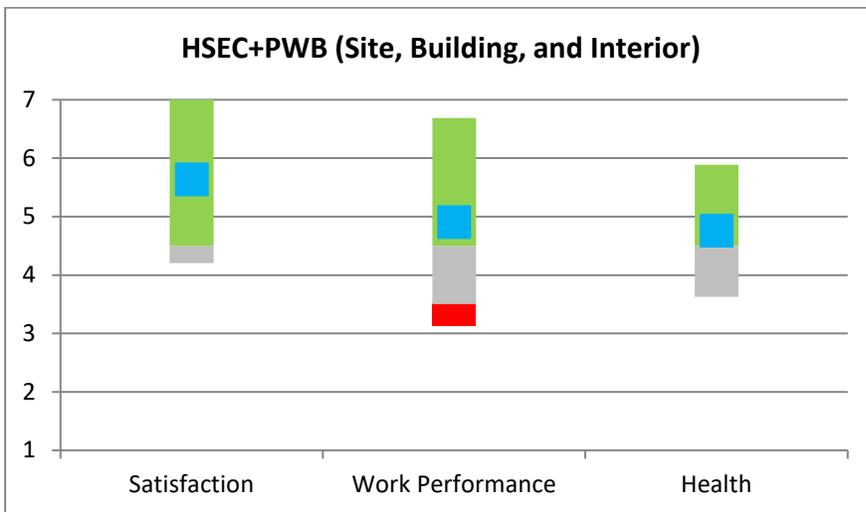


Figure 2. HSEC+PWB facility - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 5.64)** with the physical environment of the HSEC+PWB facility (building, site, and interior) and reported that their overall work performance was **enhanced (M = 4.91)** by the facility. Employees reported that their overall health was **enhanced (M = 4.76)** by the facility. \*Note: the higher standard deviation (SD) relative to work performance indicates more variation in employees' perceptions about that factor (greater dispersal of data points).

#### 4.2 Primary Workspace: Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning their overall satisfaction and overall perceptions of their work performance and health as related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 2 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 3 is a visual image of the findings from Table 2; an explanation of the graph was given for Figure 2.

Table 2. HSEC+PWB primary workspace – overall satisfaction, work performance and health

Overall	Mean	*SD	N	Interpretation
Satisfaction	4.69	1.84	29	Satisfied
Work Performance	4.45	1.94	29	Neither Hindered nor Enhanced
Health	4.48	1.69	29	Neither Hindered nor Enhanced

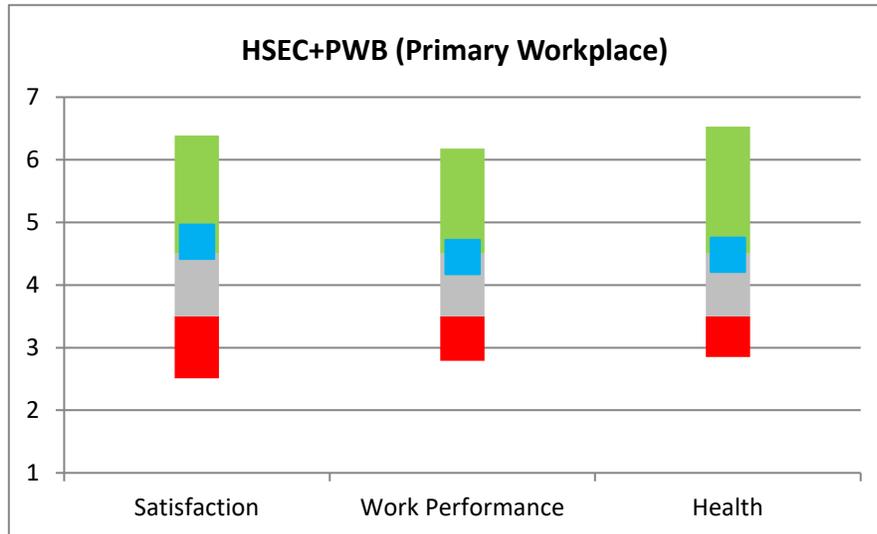


Figure 3. HSEC+PWB primary workspace - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 4.69)** with their primary workspace, their overall work performance was **neither hindered nor enhanced (M = 4.45)** by their primary workspace, and their overall health was **neither hindered nor enhanced (M = 4.48)** by their primary workspace.

\*Note: the higher standard deviations (SD) relative to the three measures (satisfaction, work performance, health) indicate more variation in employees' perceptions about those factors (greater dispersal of data points).

#### 4.3 Primary Workspace: Satisfaction with Indoor Environmental Quality (IEQ)

Employees responded to questions concerning their satisfaction with IEQ categories (thermal conditions, indoor air quality, acoustic conditions, etc.) related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 3 shows the means and standard deviations of their responses from highest to lowest mean, as well as how the responses are interpreted. Figure 4 is a visual image of the findings from Table 3; an explanation of the graph was given for Figure 2.

Table 3. HSEC+PWB primary workspace - satisfaction with IEQ criteria

#	IEQ Criteria (1-26) (Category level criteria are <b>bold face</b> )	Mean	*SD	N	Interpretation (D = Dissatisfied) (S = Satisfied)
<b>1</b>	<b>Overall vibration and movement</b>	<b>5.63</b>	<b>1.25</b>	<b>27</b>	<b>Satisfied</b>
2	Air velocity (drafty or stagnant)	5.48	1.52	27	Satisfied
3	Ability to hear desired sounds	5.48	1.60	27	Satisfied
<b>4</b>	<b>Overall daylighting</b>	<b>5.48</b>	<b>1.64</b>	<b>27</b>	<b>Satisfied</b>
<b>5</b>	<b>Overall indoor air quality</b>	<b>5.41</b>	<b>1.64</b>	<b>27</b>	<b>Satisfied</b>
6	Function of furnishings	5.41	1.52	27	Satisfied
7	Humidity (dry or moist)	5.37	1.49	27	Satisfied
<b>8</b>	<b>Overall appearance (aesthetics)</b>	<b>5.37</b>	<b>1.64</b>	<b>27</b>	<b>Satisfied</b>
9	Amount of daylighting	5.30	1.76	27	Satisfied
<b>10</b>	<b>Overall furnishings</b>	<b>5.26</b>	<b>1.67</b>	<b>27</b>	<b>Satisfied</b>
<b>11</b>	<b>Overall thermal conditions</b>	<b>5.22</b>	<b>1.52</b>	<b>27</b>	<b>Satisfied</b>
12	Adjustability of furnishings	5.22	1.62	27	Satisfied
13	Temperature (hot or cold)	5.19	1.63	27	Satisfied
<b>14</b>	<b>Overall cleaning and maintenance</b>	<b>5.15</b>	<b>1.51</b>	<b>27</b>	<b>Satisfied</b>
15	Amount of electric light	5.11	1.55	27	Satisfied
<b>16</b>	<b>Overall technology conditions</b>	<b>5.07</b>	<b>1.49</b>	<b>27</b>	<b>Satisfied</b>
17	Access to electric outlets	5.07	1.68	27	Satisfied
<b>18</b>	<b>Overall acoustic quality</b>	<b>4.81</b>	<b>2.06</b>	<b>26</b>	<b>Satisfied</b>
<b>19</b>	<b>Overall electric lighting conditions</b>	<b>4.70</b>	<b>1.78</b>	<b>27</b>	<b>Satisfied</b>
20	Adjustability of thermal conditions	4.63	2.15	27	Satisfied
21	Adjustability of daylighting	4.63	1.81	27	Satisfied
<b>22</b>	<b>Overall view conditions</b>	<b>4.19</b>	<b>1.94</b>	<b>27</b>	<b>Neither S nor D</b>
23	Ability to adjust electric lighting	4.07	2.05	27	Neither S nor D
24	Adjustability of your task lighting	4.07	1.84	27	Neither S nor D
25	Ability to limit undesired sounds	3.93	2.19	27	Neither S nor D
<b>26</b>	<b>Overall privacy (sound and visual privacy)</b>	<b>3.48</b>	<b>2.03</b>	<b>27</b>	<b>Dissatisfied</b>

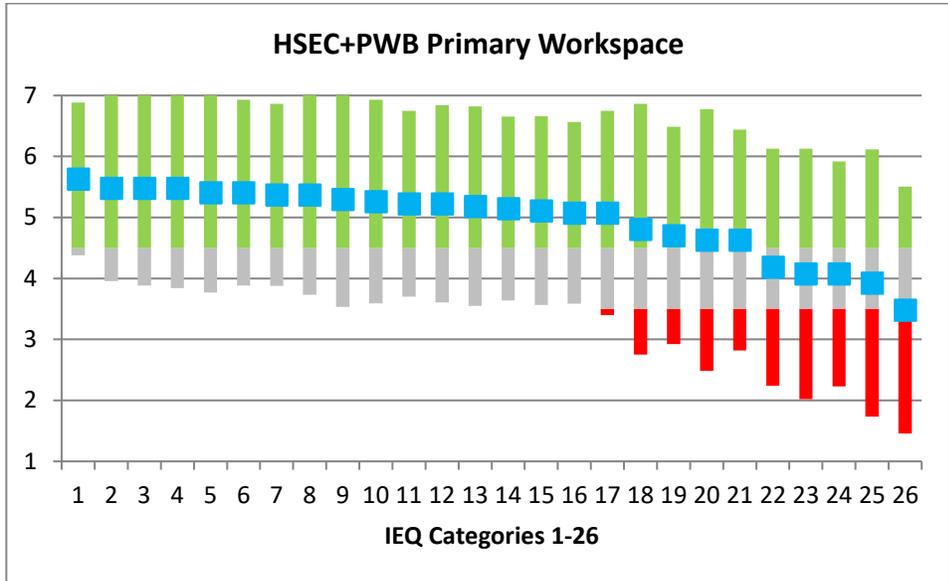


Figure 4. HSEC+PWB primary workspace - satisfaction with IEQ criteria (IEQ 1-26 refer to Table 3)

Results indicate that employees were **satisfied** with 21 of the IEQ criteria in their primary workspaces, i.e., means at or above 4.50. Satisfied means ranged from **5.63** (Overall vibration and movement) to **4.63** (adjustability of daylighting). Employees were **neither satisfied nor dissatisfied** with four (4) IEQ criteria, ranging from a mean of **4.19** (Overall view conditions) to **3.93** (ability to limit undesired sounds). Employees were **dissatisfied** with one (1) of the IEQ criteria, **3.48** (Overall privacy, sound and visual). \*Note: the higher standard deviations (SD) relative to nearly all the IEQ criteria measures indicate more variation in employees’ perceptions about criteria (greater dispersal of data points). The exceptions are Overall vibration and movement (SD = 1.25) and humidity (SD = 1.49). Specific primary workplace location and immediate, surrounding environmental conditions are likely the cause for these degrees of greater variation (SD > 1.50).

The criteria in the ‘neutral’ satisfaction range should be considered for change in addition to that in the dissatisfied range; together they comprise five (5) of the 26 IEQ criteria. Potential for change will be addressed in Section 6.2 Recommendations. Further explanation of these scores also can be found in Appendix A. Open-Ended Responses.

#### 4.4 IEQ Satisfaction Scorecard

The IEQ Satisfaction Score is determined by calculating a mean of the 12 ‘Overall’ category level IEQ criteria. At this time, criteria are weighted equally in this calculation as little evidence exists that provides rationale for weighting some criteria heavier than others. The IEQ mean is representative of a fair overall IEQ score and can serve as a benchmark of employees’ satisfaction with the physical environment of their primary workspace. As shown in Figure 5, the **IEQ Satisfaction Score** for the HSEC+PWB is **4.98**, in the **satisfied** range.

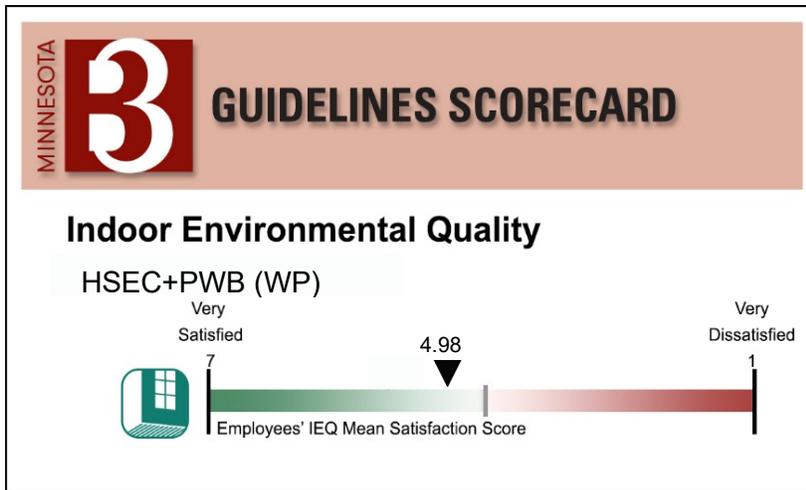


Figure 5. HSEC+PWB primary workspace - IEQ Satisfaction Score

As shown in Table 3, satisfaction with the Overall vibration and movement, Overall daylighting, Overall indoor air quality, and Overall appearance (aesthetics) were the categories with the highest satisfaction means (5.37 or higher), in the satisfied mid-range. In combination with the remaining six (6) somewhat lower mean scores (5.26 – 4.70), the satisfied scores were successful in pulling the IEQ Satisfaction Score in a positive direction. One (1) of the remaining two (2) mean scores was in the neutral range, 4.19 (Overall view conditions) and the remaining mean score fell into the dissatisfied range, 3.48 (Overall privacy, sound and visual). Please note that the IEQ Satisfaction Score only uses the category level criteria (those labeled ‘Overall’; see section 2.1, paragraph 3 for explanation).

### 5.0 Physical Activity Engagement and Commuting Practices

In the final section of the survey, employees responded to questions regarding their overall physical activity while at HSEC+PWB (site, building, and interior) and their commuting practices.

#### 5.1 Physical Activity Engagement

Providing employees with opportunities for alternative paths of travel around the workplace, e.g., taking stairs as opposed to the elevator, provides opportunities to engage in additional types of physical activities. Engaging in physical travel throughout the work environment can be associated with healthier lifestyles.

Table 4. Overall physical activity (walking, stair use, etc.) affected by the HSEC+PWB facility

HSEC+PWB (site, building, and interior)	Mean	SD	N	Interpretation
Overall physical activity (walking, stair use, etc.)	5.11	1.47	27	Enhanced

Results indicate that employees felt that HSEC+PWB **enhanced (M = 5.11)** their physical activities (walking, stair use, etc.).

#### 5.2 Commuting Practices

The HSEC+PWB facility resides in the center of the East Bank of the Twin Cities campus of the University of Minnesota. It is accessible via the Northrop Mall, Church Street Pedestrian Mall, or the Gopher Way Tunnel, with campus transportation via the East Bank Circulator on either Washington Avenue or

Pillsbury Drive SE. Secure bicycle storage is available and vehicle parking at on-campus parking garages and parking lots. Note that the overall percentages may not total 100%, due to rounding.

Table 5 provides results on employees’ primary mode of transportation; Table 6 summarizes commuting distances between home and the HSEC+PWB facility; and Table 7 summarizes employees’ ability to commute using alternative choices (walk, public transit, bike, van, or carpool, etc.). These results, although not related to IEQ, do offer insight into employees’ commuting behaviors and opinions. These data can provide important information about commuting practices that can reduce transportation energy consumption.

Table 5. Commuting Practices – HSEC+PWB Primary mode of transportation

Primary Mode of Transportation (N=27)	Drive Alone (or w/children <16)	Public Transit	Bicycle	Walk	Tele-Commute	Other
Commuting to HSEC+PWB	52%	26%	4%	4%	7%	7%

Related to primary modes of transportation, 52% of employees drive alone (or with children under 16), 26% of employees use public transportation, and 4% either bicycle or walk, Telecommuting employees constitute 7% of the occupants, while 7% use modes of transportation other than those listed. No employees used a carpool/vanpool or motorcycle or moped to get to work.

Table 6. Commuting Practices – HSEC+PWB Commuting distance traveled

Miles Traveled (N=27)	0-5	6-15	16-30	31-45	>45
Home-to-HSEC+PWB (One-way)	33%	41%	19%	7%	0%

Results indicate that 33% of employees commute 0-5 miles one-way between home and the HSEC+PWB, followed by 41% who commute 6-15 miles, 19% who commute 16-30 miles and 7% who commute 31-45 miles. None of the employees commuted more than 45 miles. These are one-way miles.

Table 7. Commuting practices – HSEC+PWB location and alternative commuting behaviors

Alternative Commuting	Mean	SD	N
Ability to commute in alternative ways	4.55	*1.66	27

Results indicate that location of the HSEC+PWB **enhanced (M = 4.55)** employees’ ability to commute to work in alternative ways, e.g., walk, bicycle, public transit, van or carpool, etc. \*Note: the higher standard deviation (SD) indicates more variation in employees’ perceptions about this factor (greater dispersal of data points).

## 6.0 Conclusions

### 6.1 Summary

A post-occupancy evaluation was conducted of employees of the HSEC+PWB at approximately 20 months after its initial occupancy in March 2020. About 42% of faculty and staff responded to the survey, reporting their satisfaction with the physical environment of the facility and their primary workspace. Results indicate that nearly 27% of employees spend more than 30 hours per week in the HSEC+PWB facility, and over 33% of employees spend more than 50% of their time at the HSEC+PWB in their primary workspace.

The survey included questions related to employees' satisfaction with the facility (site, building, and interior) and influence of the facility on their work performance and health. Employees were **satisfied** with the facility (**M = 5.64**); they found the facility **enhanced** their work performance (**M = 4.91**) and **enhanced** their health (**M = 4.76**). In addition, similar results were reported when employees were asked these same questions about their primary workspaces (private offices, shared offices, workstations, etc.). They reported **satisfaction** (**M = 4.69**) with their primary workspaces, that their work performance was **neither hindered nor enhanced** (**M = 4.45**), and their health was **neither hindered nor enhanced** (**M = 4.48**) by their primary workspace. As the range of scores was from 1-7, the majority of scores showed a moderate level of satisfaction with the facility and a lower moderate level of satisfaction with the primary workspace. (The satisfaction/enhancement range is 4.51-7.00, whereas the neutral range is 3.51-4.50.) Also, except for employees' satisfaction with the facility and its influence on their health, the other factors (facility work performance, primary workspace satisfaction, work performance, and health) had means with higher standard deviations ( $SD = 1.69-1.94$ ), indicating a broader variation in their responses (greater dispersal of data points).

Most of the survey questions related to employees' satisfaction with the IEQ criteria in their primary workspaces (private office, workstations, etc.). Employees' responses showed they were **satisfied** with 21 of the 26 IEQ criteria. The mean satisfaction scores ranged from **5.63** (Overall vibration and movement) to **4.63** (adjustability of daylighting). Again, this shows a moderate positive level of **satisfaction**. Employees responded **neither dissatisfied nor satisfied** to four (4) IEQ criteria, with mean satisfaction scores ranging from **4.19** (Overall view conditions) to **3.93** (ability to limit undesired sounds). The remaining one (1) IEQ criteria fell within the dissatisfied range at **3.48** (Overall privacy, sound and visual). Again, there was variation among responses that drove up the standard deviations ( $SD = 1.51-2.15$ ), indicating greater dispersal of data point among 23 of the 26 IEQ criteria scores. This was also true of the IEQ criteria category scores that comprised the IEQ Scorecard, discussed below.

From employees' responses, an IEQ Score was developed and shows respondents' moderate satisfaction with the majority of all IEQ category level criteria. For the HSEC+PWB, the IEQ Satisfaction Score was **4.98**. This score reflects the influence of the moderate satisfaction level of 10 of the 12 categories, neither dissatisfied nor satisfied level of one (1) of the 12 IEQ categories, as well as the dissatisfied level of the one remaining IEQ category. Finally, employees reported that the HSEC+PWB **enhanced** (**5.11**) their physical activity, which is one of the sustainable design criteria that influences occupant behavior.

It seems obvious that employees' satisfaction can be improved by addressing the categories that had 'neither dissatisfied nor satisfied' or 'dissatisfied' scores. However, the rest of the criteria would benefit from some attention as well. The following recommendations can help address change in these criteria

to further improve employees' satisfaction. Exploring these areas in more detail and making adjustments may increase overall satisfaction at the primary workspace. It must be noted that the expense of building and operating a facility is second only to employee-related expenses over the life of the building. Therefore, maintaining or improving employees' satisfaction is a sound investment, which, in turn affects their performance and their health.

This study investigated employees' satisfaction with the facility and primary workspaces. IEQ satisfaction is individual, but the results of the survey show a central tendency of moderately lower satisfaction with the facility and most of the IEQ categories. The results can be used as a diagnostic tool to aid in improving IEQ conditions for employees and to set the benchmarks from which improvement can be measured in the future.

## **6.2 Recommendations**

Several IEQ criteria satisfaction scores are in the positive direction, however, improvement on the 'neutral' and 'dissatisfied' criteria may be possible. For IEQ categories that can be physically measured (e.g., thermal, acoustic, and lighting), it is recommended that these measurements be taken in the primary workspaces. Specific recommendations for the most common areas of occupants' concern follow:

### **Acoustic Conditions**

- Identify acoustic criteria for overall requirements.
- Determine if any task areas differ now from their original spatial layout/use (i.e., collaborative workspaces now located adjacent to focused work areas, individual workstations).
- Develop specialized acoustical performance requirements to support functional programming employees' tasks (e.g., sources of recurrent noise that need to be controlled, special user populations that may have distinct auditory performance limitations, or multiple uses of building spaces that may have different acoustic criteria). Identify and apply appropriate acoustics modeling software for the project.
- Calibrate and adjust sound masking systems in place to ensure they are functioning as desired for privacy, and determine need for any additional masking equipment and/or visual screening depending on the nature of any complaints.
- Measure acoustic performance onsite with full building systems (heating, ventilation, and air conditioning) running.
- Identify employees' privacy concerns via focus groups and/or log complaints relative to acoustical conditions for further evaluation.
- Consider employees' tasks within shared spaces to determine if spatial layout changes can be made for increased acoustic control.

### **Lighting Conditions**

- Identify employees' lighting performance criteria that are to be met to achieve goals by conducting onsite measurements of existing illumination and compare them to standards for employees' tasks as identified by the Illuminating Engineering Society (IES).
- Determine if any task areas differ now from original intent to be sure illumination level and quality of lighting are not impeded by physical changes to the space (i.e., walls, ceilings, furnishings, fixtures, or equipment).

- Develop additional quality lighting criteria as needed for special facility (e.g., influence of daylight quality or quantity) or employee (e.g., age, task duration) issues.
- Log complaints related to lighting conditions for further evaluation.
- Identify poor lighting conditions in the workspace caused by a lack of control over daylighting, which can cause glare and eyestrain.

### **Personal Adjustability**

- Determine what adjustability issues arise with temperature, lighting, or furnishings via a focus group.
- Identify personal, individual problem areas and relate them to other IEQ issues via a log of complaints relative to adjustability.
- Provide education to employees about any existing/achievable adjustment options (e.g., furnishings, air diffusers, lighting, temperature control, etc.)

### **Privacy Conditions**

- Identify employees' privacy concerns via focus groups or log complaints relative to privacy to determine if visual or audio privacy is most affected.
- Determine if any task areas or responsibilities differ from original intent and develop alternatives or modifications.
- Consider adding noise masking equipment and/or visual screening depending on the nature of the complaints.
- Document and compare acoustic privacy problem areas with acoustic measurements to pinpoint specific problem areas.

### **Thermal Conditions**

- Measure thermal performance conditions on site.
- Log complaints related to thermal conditions for further evaluation.
- Determine special thermal comfort requirements or problems that may be encountered in the building due to physicality of work activities, duration of sitting, or design/layout considerations. Focus groups can be useful in identifying problem locations.
- Determine if any employees' task areas differ now from original layout to determine if air flow is meeting systems design intent.
- Review conditions that affect thermal comfort using the applicable version of ASHRAE Standard 55, or Human Factors Design Handbook (see B3 Guidelines). For additional information, consider reviewing Human Factors and Ergonomics Design Handbook, Third Edition (2016), by Barry Tillman, published by McGraw-Hill, NY.

## **Appendix A. Open-Ended Responses**

Employees had the opportunity to raise specific concerns on the overall facility and their primary workspaces. Important information can be gleaned from the open-ended survey responses. The HSEC+PWB employees raised many general and very specific concerns and positive comments related to acoustics and privacy, amenities, appearance (aesthetics), daylighting/electric lighting and lighting controls, furnishings, indoor air quality (IAQ)/ventilation, operations and cleaning/maintenance, spatial layout, and thermal conditions and control. Generally, the comments are shown exactly as written.

### **Overall Positive/Negative**

- Overall, I think the building itself is great.
- Overall, the space is very nice, love being above ground and having so many windows.
- I love it - I was facing a concrete block wall with terrible lighting in Diehl before.
- It is a beautiful space, and I feel privileged to work in the HSEC.
- The grand staircase is a nice design, but noise filters from 7th floor down to 5th floor, impeding concurrent activities.

### **Acoustic Quality and Privacy**

- The white noise/noise cancelling technology across the workspace is helpful, I think.
- Our shared cubicle space is nice. However, there are several open, cubicle workstations, leaving little privacy and causing more noise disruption.
- It's disruptive to hold a phone conversation, small office discussion or Zoom meeting at one's cubicle. Many of us move into the nearby breakout spaces for this. Having to leave our dual screens, other cubicle conveniences and carry our laptops, phones, papers, etc. to have meetings is inefficient. Eventually when more staff utilize the cubicles and offices, there will be less nearby space to do this.
- The narrow, floor to ceiling window to the general team workspaces next to my door allows light from windows on the other side of the cubes to reach my office, [but] it provides no privacy. Since my office is adjacent to the door to the office suite/staff cubes, I'm constantly distracted by people walking by the door. We're looking into window privacy film that allows light.

### **Amenities**

- The cement floors are physically hard on my body; I need to abandon professional work shoes and wear gym shoes.

### **Appearance (Aesthetics)**

- The building is beautiful and modern.
- The color scheme is awful... the orange is not pretty, and the orange and the red are too similar to provide any distinguishing information to users, as was intended.

### **Daylighting/Electric Lighting and Lighting Controls**

- The daylighting is really nice.
- I like the amount of natural light coming into the building generally, and we have beautiful views of trees and campus. However, facing east, the morning sun and glare off the floor is, literally, blinding in places that do not have blinds.

- I have a narrow, floor to ceiling window to the general team workspaces next to my door; this is helpful in allowing light from windows on the other side of the cubes to reach my office.
- There is not much daylight in my space. Although it is nice to be able to look out windows.
- No daylighting in office space.
- I get a minimal amount of natural light from the exterior windows located across the workspaces outside my office. It is not enough to be helpful or to really make me feel connected to the outside (it is, however, better than previous basement environments that had no outside window light).
- I have no daylight in my workspace.
- There is no 'task lighting' provided; I have personally bought 3 lamps to provide appropriate lighting. Consider lighting conducive to Zoom.
- Overhead lighting is behind me and creates backlighting in online meetings. I have added additional task lighting to adjust the backlighting.
- The overhead lighting is too harsh, so I do not use it. Instead, I rely on 3 of my own lamps that I have purchased.
- Fluorescent lights often give me headaches and sometimes migraines, so having no ability to adjust the overhead fluorescent lighting in my cubicle is not ideal.
- I don't have any control over the lighting in my space.
- I've encountered more frequent headaches at work in my HSEC space than my previous office (a few times I wish that I could dim the lights but can't in the shared space).
- I get headaches and sometimes migraines from fluorescent lighting, so working in a large space with several cubicles and no adjustability for the overhead lights isn't ideal for me. However, I spend most of my time working from home, so it isn't a huge issue for me at this time.
- With all the technology in HSEC, it is surprising that the light switches throughout the building are so difficult to consistently operate; they honestly require instruction guides for everyone.
- The lighting control situation is pretty bad. No one seems to be able to fix problems like the lights turning off automatically.
- The light switches in individual spaces are very inconsistent in their functioning.
- I still can't figure out the switches... how to get lights to be a certain brightness and stay on.
- The light sensors are my biggest place of concern.
- The control switches on the overhead lights are surprisingly difficult to control; they are not intuitive and don't seem to stay at desired setting. I think the under-shelf light, but it is unreliable to turn on--sometimes the hand sensor is easily activated, but other times I can't get it turned on. Additionally, the light very easily detaches from the fixture (magnet is not strong enough).
- I really wish the lights on 3rd floor PWB cubicle area were on a motion sensor or could be turned off. I have never been there when they are off - 6am weekdays, 6pm weekdays, Saturdays, Sundays.

### **Furnishings**

- The "focus booths" we need to use to attend meetings (which are all default on Zoom) or teach (on Zoom) are very poorly furnished with no monitors or table spaces. This workspace was designed without our work in mind.
- My desk space is small, and I wish I could push my monitors back, but can't.

### **IAQ/Ventilation**

- I have doubts about the effectiveness of the environmental systems to keep us safe from airborne viruses, namely COVID-19 and its more infectious omicron variant. I don't yet feel safe working on campus full-time.
- I'd like to know more about the ventilation situation in HSEC 5-101, since I don't understand it yet.

### **Operations and Maintenance/Cleaning**

- I ranked overall cleaning and maintenance poorly because I do this all myself in my workspace.
- Once a month vacuuming in staff office areas is not enough.
- The paint is very cheap and is damaged by the simplest of adhesives.
- Doors are consistently having locking/unlocking issues. Some of these issues are very troublesome.

### **Spatial Layout**

- Majority of my colleagues were assigned cube spaces that are not conducive to health and productivity; they deserve the same private workspace that I am afforded.
- I mostly work from home, but when I am in the office, being stuck in a large room full of cubicles, noise, and fluorescent light just isn't the ideal workplace setting for me personally.
- It's a nice space, but it's an open office so I have to spend a lot of my day in other rooms for Zoom meetings, so I mostly work at home.
- The open office format is very challenging.

### **Thermal Conditions and Control**

- A tutorial on how to adjust temperature with the thermostats would be helpful.

## Appendix B. Glossary

### **Descriptive statistics**

Statistics used to summarize large sets of data (i.e., means, frequencies, medians). Descriptive statistics describe only the sample under consideration and are not intended to infer results to the larger population.

### **Frequency**

A descriptive statistic that provides information about how many of a particular response or measurement is observed.

### **Likert-type scale**

A measurement technique, employed in questionnaires and interviews, that utilizes a range of standardized response categories such as strongly agree, agree, etc.

### **Mean**

The average score of a set of data calculated by adding all scores together, then dividing by the number of scores.

### **N**

The number of subjects or participants responding to the questions, or a single question, in the study.

### **Reliability**

The repeatability or replicability of findings; the same results are produced each time. Instruments and procedures should produce the same results when applied to similar people in similar situations, or on a second occasion.

### **Standard deviation**

A statistic used to measure the variability of a group of scores (how different scores are from each other and the mean). For example, if the range of scores is 1-7 and the mean (average) is 5.0 with a standard deviation of 1.0, then the scores are closely clustered around the mean, i.e., there is one unit of variation among all scores. If the mean was 5.0 and the SD was 3.0, there is a broader range of variation among the scores...a smaller SD means the scores are similar and the mean score is likely to be more accurate and more useful (this is better!).

### **Validity**

The extent to which an instrument or procedure measures what it is intended to measure (internal validity). The generalizability of results to another population (external validity).