RELATING HEALTH CARE ENVIRONMENT DESIGN TO HEALTH QUALITY OUTCOMES:

POST OCCUPANCY EVALUATION OF THE WARD OF THE 21ST CENTURY

FINAL REPORT

PREPARED BY:

FRIESEN, S.

TROJAN, L.

SUTER, E.

FEBRUARY 2008

INVESTIGATIVE TEAM

Esther Suter (Principal Investigator), Research & Evaluation Consultant, Health Systems and Workforce Research Unit, Calgary Health Region

Steven Friesen (Project Coordinator), Research Associate, Health Systems and Workforce Research Unit, Calgary Health Region

Debbie White Professor, Faculty of Nursing, University of Calgary

Barry Baylis Clinical Co-Leader, Ward of the 21st Century, Calgary Health Region

Ron Wardell Professor, Faculty of Environmental Design, University of Calgary

Kathryn Gowling Executive Director, Planning and Capital Development, Calgary Health Region

Janice Cullen Director, Planning and Capital Development, Calgary Health Region

Salvador Ibarra Director, Capital Programs, Alberta Cancer Board

Nora Shea Manager, Capital Projects Division, Alberta Infrastructure and Transportation

Lana Trojan (Project Staff), Analyst, Health Systems and Workforce Research Unit, Calgary Health Region

ACKNOWLEDGEMENTS

Our team gratefully acknowledges the following:

- Health Quality Council of Alberta for funding this project
- Calgary Health Region for in-kind contributions
- W21C Health Care Providers and Unit Staff for their participation and interest in the project
- Sonja Morrison (Patient Care Manager, W21C) for all of her guidance and support in completing this study
- Shandra Kimpton (Project Manager, W21C Initiative), Rhonda Niebrugge (Assistant Patient Care Manager, W21C), Gerry Giesbrecht (Clinical Educator, W21C) and Ivy Jeffery (RN, W21C) for their efforts in supporting our data collection activities on the unit

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

The surge in health care facility development across the province stresses the need for evidence based design and for a better link of physical design to outcomes of the health care environment. Post occupancy evaluation (POE) is an environment evaluation methodology that examines the impact of the designed environment on human users. Used as a feed forward process, POE can support evidence based design throughout planning and implementation of new and existing facilities.

This project aimed to advance the POE approach with the ultimate goal to effectively integrate health care facility evaluation as a key component of future physical design projects. Using the Alberta Health Quality Matrix helped link the impact of physical design to health quality indicators. The POE methodology was tested in a newly renovated health care environment, the Ward of the 21st Century (W21C) at the Foothills Medical Centre, Calgary.

Specific objectives of this evaluation were 1) to identify how the objectives of the W21C were realized through physical design 2) to identify how physical design impacts the quality of the health care environment 3) to identify environmental design performance measures or indicators for safety, effectiveness and efficiency that respond to changes in the built environment and 4) to identify planning and design strategies for future health care facilities that incorporate indicators of design performance into decision making.

Data was collected through key informant and occupant interviews, document review, direct observations, administrative data, and environmental surveys. User satisfaction was examined within the context of efficiency, effectiveness and safety to gain a better understanding of how well (e.g., functional performance) the built environment meets the original vision (e.g., the intention and expectation of design elements) of a health care environment. Performance indicators were developed through an iterative process of collecting and analysing the data.

W21C's vision for safe patient care, improved patient flow, flexibility, research innovation and a leading edge environment in clinical education for all health care professionals was reflected in the following key design features: safe patient care was addressed through infection prevention strategies such as increased proportion of single patient rooms; increased research and innovation were accommodated by appropriate levels of physical space and unit resources; technology in clinical practice was a critical component of the leading edge design of the W21C.

The design of the W21C impacted five major areas -*Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication*. These performance indicators captured distinct performance aspects of the built environment that **impacted** the safety, effectiveness and efficiency of the W21C. While overall satisfaction with the W21C was high, complex interactions between design elements affected job satisfaction:

- Staff identified technical resources such as space, equipment and supplies as important aspects of the W21C design. While the increased access to equipment and technology at the point of care has increased timeliness of patient information, it has decreased overall interaction among staff. Increasing available space on the unit supported implementation of dedicated office space and multiuse meeting space, which improved access to staff resources (e.g., staff educator, medical teaching staff, allied health staff and unit management). However, the unit layout has increased travel time and overall workload for staff.
- Staff stated that the design had the flexibility and technical capacity to accommodate changing medical needs of patients (e.g., negative air pressure, medical gases and

standardized room equipment). The higher proportion of single patient rooms supports flexibility in patient care (patient isolation capacity, opportunity for private assessment and consultation). However, when used in overcapacity (i.e., multiple occupants in single patient rooms) single patient rooms cannot ensure privacy and staff report some negative feedback from patients/families.

- The increased proportion of single patient rooms, in combination with the removal of the paging system from inside the patient room, impaired staff communication. Staff felt there was a lack of technology and interactions to support appropriate monitoring and communication which poses an increased patient risk with single patient room design.
- While the benefits of the increased privacy for the patients were expressed, the increased social isolation for both staff and patients was a concern. The increased number of single patient rooms and the floor layout restricts visual contact between staff, creating a feeling of disconnection. Similarly, staff commented that some patients could benefit from social interaction opportunities or security a shared patient room would provide. This was identified as being of specific concern for patients without families or the elderly patients who are waiting to be discharged or transferred and who are not as acute as other patients.

These data demonstrate trade offs, for example, between enhanced patient privacy of single patient rooms with increased staff workload, staff and patient isolation and decreased overall communication. This indicates that interpreting design performance requires an understanding of the interrelationship between design elements and how the implementation of individual design elements affects overall performance. Through the process of identifying and developing design performance indicators we were able to document interrelationships between design elements and how these reflect an intended vision for the design.

The POE has highlighted areas in the design **process** that contributed to the success of the implemented design. They relate to leadership and evolving vision, stakeholder engagement, and early and ongoing implementation of design solutions.

- *Strong leadership* in the development and implementation of the design helped to strengthen the visions and create ongoing opportunities for transforming not only the quality of the patient care environment, but also the quality of the health professionals' work environment.
- *High involvement of user groups* in a multi-level committee structure during the planning and implementation process enhanced users' understanding of the design intent and positively impacted their satisfaction with the current design.
- *Early and ongoing implementation* of design features on the old unit (Unit 61) helped clarify operational and procedural changes and facilitated later implementation on W21C. It also contributed to openness for ongoing implementation of health technology.

The POE has also pointed to some **gaps** in the current planning and implementation process:

- There is a need for more comprehensive documentation of context at the time of planning and implementation, of design expectations and of how decisions are being made. The lack of detailed information limited the evaluation's ability to fully understand and consider the impacts of design decisions.
- This evaluation was conducted two years after building occupancy which did not allow for immediate feedback into the design process. It is important to establish an evaluation process as a key implementation strategy that recognizes design as an ongoing iterative process with a feedback loop that enhances communication across design stakeholders.

This requires ongoing work with key regional and provincial stakeholders in establishing a health design evaluation process and tools.

The POE approach used is **superior** to traditional POEs that typically focus on technical elements of the built environment:

- Examining user satisfaction within the context of efficiency, effectiveness and safety provided a deeper understanding of how well (e.g., functional performance) the built environment meets the original vision (e.g., the intention and expectation of design activities) of a health care environment. The mixed methods, multi phased approach increased the validity of the findings.
- Each of the five indicators developed -*Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication*- captures unique performance aspects of the built environment. Using these indicators allows discussing both positive and negative outcomes of the W21C design and health facilities in general.
- Focusing on functional and behavioural aspects of user satisfaction in addition to technical aspects highlighted the interrelationship between design elements and how they affect overall design performance (e.g., effectiveness and efficiency). This distinction may be useful for designing remedial strategies or setting future priorities.

In summary, the POE highlighted impacts of different design elements on the delivery of patient care. Advancing evidence-based design requires thoughtful and practical evaluation approaches such as POEs that link environmental factors to outcomes that can then be related back to the design. The approach used in this project has the potential to add considerable value to the planning and implementation of new health care facilities.

In order to ensure that evaluation results are meaningful for a context greater than an individual project, the process of developing, performing and integrating POE into the design of health care facilities must engage a range of stakeholders. POE needs to link the facility users (i.e., patients, families or caregivers), designers, builders, funding agencies, organizational leaders, and staff (clinical and non-clinical) in designing and reporting building performance evaluations. Using performance indicators (e.g., *Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication)* will help focus the planning and evaluation towards desired outcomes. Attention needs to be paid to strong leadership to create a clear vision, and to careful documentation of decision processes, design intents and context. In this way, health care design will support innovative and sustainable health care environments that contribute to an increased quality of life for both the health care recipients and providers.

1.0 INTRODUCTION

Although Canada's health care spending is reported to be comparable to other western countries, there is a growing public concern about increasing costs and decreasing quality of health services (Commission on the Future of Health Care in Canada, 2002). Recent reports state problems that need to be addressed within the current health care system (e.g., exploding costs, actual and projected health provider shortages, increasing demands for health care services) and offer recommendations for a sustainable and high quality future health care system (Canadian Health Services Research Foundation, 2004; Commission on the Future of Health Care in Canada, 2002; Premier's Advisory Council on Health, 2001).

Increasing the quality of working conditions represents a central recommendation for recruitment and retention as well as for quality of services. Shamian and El-Jardali (2007) summarize the current evidence in stating that "healthy workplaces improve recruitment and retention, worker's health and wellbeing, quality of care and patient safety, organizational performance and societal outcomes" (Shamian & El-Jardali, 2007). Although quality workplace and worklife research has primarily focused on policy and practice issues, there is increasing attention paid to the physical environment as an important factor. The Quality Worklife-Quality Healthcare Collaborative (QWQHC) has recently defined a healthy health care workplace as "a work setting that takes a strategic and comprehensive approach to providing the physical, cultural, psychosocial and work/job design conditions that maximize health and wellbeing of health providers, quality of patient/client outcomes and organizational performance" (QWQHC, 2007).

Evidence Based Design: Environmental design in health care represents a complex process of planning, designing, constructing and implementing the built environment. Environmental design research emerged in the 1960s and entails the systematic application of research principles when examining relationships between human behaviour and building design (Preiser, Rabinowitz & White, 1988). It integrates relevant knowledge from the arts and sciences in ways that facilitate the development of high quality health care facilities to enhance patient and family satisfaction, clinical outcomes and organizational performance. Extensive reviews of published literature examining the influence of health care environments on provider and patient outcomes have identified attributes of the built environment that describe 'healing environments'. Healing environments consider views of the natural environment, lighting and noise levels and overall air quality as important design components (Devlin & Arneill, 2003; Gilpin, 2005; Joseph, 2006; Ulrich & Zimring, 2004).

Evidence-based design applies the best available knowledge on how the physical or built environment can support or interfere with activities of patients, families and staff, and how the setting can contribute to a caring, effective, safe and patient-centred environment (Hamilton, 2003; Hamilton, 2004; Ulrich & Zimring, 2004). Preiser's (1984) Habitability Framework emphasizes the importance of research in examining the relationships between people and their surroundings. The Habitability Framework proposes to evaluate the built environment and occupant needs along hierarchical scales (e.g., community, facility, building, room, etc.) with reference to habitability levels (Preiser, 1984):

> **Health and safety level:** Preventing accidents and injury, disease and hazardous situations in the built environment
>
> **Functional and task performance level:** Providing conditions conducive to the efficient performance of a job; for the proper functioning of living environments

> **Psychological comfort and satisfaction level:** Providing environmental conditions conducive to territorial integrity; speech and casual privacy; access to valued resources; expression of individuality; status; identity "

The Habitability Framework can be applied to the evaluation of the built environment (Preiser et al., 1988).

Post Occupancy Evaluation: Post occupancy evaluation (POE) describes built environment evaluation methodology utilized to examine the impact of the designed environment on human users. POE can be defined as "the process of systematic data collection, analysis and comparison with explicitly stated performance criteria pertaining to occupied, built environments" (Preiser et al., 1988). POE compares "actual building performance with explicitly stated human performance needs" (Cooper, Ahrentzen, & Hasselkus, 1991).

In conducting evaluation of the built environment three levels of POE are commonly identified (Preiser, 2002). Preiser's et al (1988) POE model proposes increasing level of evaluation effort. The first level provides a preliminary indication of the successes and failures of a building's performance while the second level represents a more detailed study of the building performance items and what needs to be done to address current performance issues. A third level POE correlates the physical, environmental, and behavioural indicators to better understand various performance criteria (Vischer, 2002). This final POE level requires the highest effort and resources with a focus not only on informing a particular facility but a building type. Initial POE data collection and themes assist in the development of further evaluation questions and appropriate sampling considerations in a more formal research methodology.

Presented as a feed forward process, POE is proposed to be useful in the fine tuning of existing facilities and for informing the planning and design of new facilities (Kennon, Bauer, & Parshall, 1988). Kennon et al. (1988) discussed this type of evaluation as commonly overlooked thus not recognizing potential benefits for organizations and for designers. Rigorous evaluation of health care facilities should be considered important for justifying actions and expenditures, measuring design quality and educating past and future participants about the design process (Stichler, 2007). Green and Moss (1998) identified POE as a critical component to organizational learning where the design of the physical environment is not a 'finite process' and organizations must be constantly aware of the changing demands on the built environments. Focusing on commonalities across settings versus the uniqueness is an important consideration for the generalization of the results.

Internationally, POEs have been conducted sporadically across the public and private sectors (Cohen, Standeven, Bordass, & Leaman, 1999; Fowler et al., 1999; Friesen, Newton, Boughen & Hewitt, 1996; Kennon, et al., 1988; Kotaka & Manildo, 1999; Lackney & Zajfen, 2005; Zagreus, Huizenga, Arens, & Lehrer, 2004). Role ambiguity and issues related to accountability continue to challenge the establishment of a successful POE program (Cooper, 2001). The segregation of designers and users of the built environment has been suggested to further contribute to difficulties in successfully informing design through environment-user interactions (Pati, 2005). Current National, Provincial and Regional approaches to evaluating space and building performance provide varying information on health environment design with limited transferability and communication of the results.

POE in Alberta: In 1984, the Alberta Provincial government produced the 'Blue Book' as guide and reference for planning departments responsible for the processes involved in initiating and leading capital projects in health care (Alberta Hospitals and Medical Care, 1984). The Blue Book describes evaluation as a final stage completed after the facility is fully operational with the purpose "to identify areas for improvement in the process used in planning and construction of

hospitals and nursing homes and to identify new and particularly successful ideas discovered during the process" (Alberta Hospitals and Medical Care, 1984, p. 87). With a surge in facility design and development in health care organizations across the province, an increasing need for evidence-based design has been recognized. Key issues currently impacting the planning, design and implementation of health facilities include the following (Friesen, 2006):

- Currently projects are being completed and new projects are starting up without benefiting from all the learnings of previous projects; "only the deep cuts are remembered".
- No mechanisms exist for knowledge transfer within and across organizations/ health regions.
- Outcomes and impacts of an environment need to be captured to understand the value to clients and to provide evidence to support future projects.
- An increased understanding is needed on how new health facilities are being impacted by new approaches to deliver health services; e.g., how do we know if the right model/design is being built and what the expected outcomes are.

Through Alberta Infrastructure's Health Facilities branch an Alberta POE working group identified generic POE guidelines for health care facilities in order to develop a consistent approach to capture and disseminate building design information for the benefit of capital projects across Health Regions in Alberta (Friesen, 2006).

A POE was completed on a recently renovated mental health care facility in the Calgary Health Region with the intent to start developing a template that could guide future building evaluation processes while at the same time addressing some of the issues identified by the Alberta POE working group. The POE identified the need for planning and design strategies to work towards a shared vision that should be clearly articulated and communicated to all staff. Information examined through the course of the evaluation reinforced that an understanding of how the vision for an environment relates to its design requires an understanding of the various influences on design decisions (Friesen, Wardell, Suter, Cullen, & Scott, 2006). Clear documentation and communication of the design decisions become important tools for understanding impacts on building occupants and their satisfaction with the built environment. Existing processes do not currently support this kind of documentation. However examining capital projects using a POE methodology created opportunities for the development and integration of communication and collaboration mechanisms throughout the planning and implementation of design.

1.1 Evaluation Objectives

The project aimed to advance POE as a key approach for health care facility evaluation. The methodology built on recommendation from a recent task force report (Friesen, 2006) and on experiences from three other POEs conducted by the investigators. A newly renovated health care environment, the Ward of the 21st Century (W21C) at the Foothills Medical Centre, Calgary, was used a the test case. Intended as an exemplary leading edge medical unit, the W21C provides a unique opportunity to explore how the physical environment relates to quality indicators for health care, specifically to safety, effectiveness and efficiency in the health care environment.

The objectives of this evaluation were to:

- Describe how the objectives of the W21C are being addressed by the redesigned environment.
- Determine what environmental design strategies affect the delivery of health care and outcomes for patients, providers and the health system.
- Identify potential performance measures or indicators for safety, effectiveness and efficiency that respond to changes in environmental design.
- Make recommendations for future planning and design activities of health care facilities to incorporate POE methodology.

2.0 METHODS

2.1 Study Design

The POE was conducted in two phases. The first phase of the POE assessed stakeholders' broad perceptions of what the design is and what is working or not working. This "Revealing the Design" stage highlights how well the individual design elements meet the day-to-day requirements of the building occupants. It also identifies any outstanding priority environmental design issues. The second phase focuses more resources on determining impact of the overall intent of the design. "Perceiving the Design", or phase II, examines how physical design components currently support the building performance objectives. Data from Phase I and preliminary data from Phase II were explored for common themes. These themes informed the final data collection strategies in Phase II and the development of health care quality indicators (Health Quality Council of Alberta, 2006). These performance indicators build the foundation for a third POE phase, "Applying the Design", which examines the impact of specific elements in the environmental design on patient and provider outcomes. However, this third phase was beyond the scope of this project.

2.2 Data Collection

Across Phase I and Phase II, data was collected through quantitative and qualitative methods. The tools and approaches to data collection for both phases were pilot tested in a previous POE of a psychiatric health care facility (Friesen et al., 2006). The following is an overview of the data collection methods, data sources and time frames.

i. ***Document review:*** Key planning and design documents such as the programming information, architectural and engineering consultant report, meeting minutes and other design and planning documents related to the W21C were examined to identify the project's goals and objectives as well as planning and implementation information. This allowed for the comparison of the original design intent or vision to the current performance of the designed space. The document review took place over the course of the project (Appendix 1.0).

ii. ***Direct observations:*** Guided walk-through of the W21C environment provided relative first hand experience in identifying and describing the design to help clarify comments, issues, deficiencies, initial list of documents for review, etc. Direct observations occurred at the beginning of the project, prior to the distribution of the first survey in May 2006.

iii. ***Environment surveys:*** Structured surveys provided an opportunity for all staff to report on the functional adequacy of the environment at varying levels (e.g., unit level, room or building system level). Unique surveys were developed for each phase. The Phase I survey was developed as a general work environment survey to obtain broad feedback on W21C staff's satisfaction with aspects of the work (e.g., team, role) and physical environment (e.g., layout, building systems). In Phase II, a more detailed survey provided specific feedback on various elements contributing to the physical environment that included overall layout, building systems, furnishings and equipment, interior finishes, window and doors, vertical traffic and way finding, and site grounds. Demographic information was collected in both surveys. Completed surveys were returned in sealed confidential envelopes to the Unit desk or returned through the Calgary Health Region internal mail. Phase I survey was distributed in June 2006, Phase II in October 2006.

iv. ***Key informant interviews:*** In Phase I key informant interviews were conducted to capture the design team's perceptions of the environment. Semi-structured interview

guides focused on planning and design process with prompted further elaboration on physical design issues identified in the general work environment survey (Phase I Survey). All interviews were taped and transcribed. Phase I interviews were conducted in June 2006.

v. ***Occupant interviews:*** Individual and group interviews with staff were conducted during Phase I and II. Phase I interviews were used to validate information from the Phase I surveys. Some of the same participants were included in the key informant and occupant interviews. Phase II interviews explored issues identified in Phase I in more depth. More specifically, Phase II Interviews examined how the physical design supports functional performance for health care providers and supporting health care and service roles. All interviews were taped and transcribed. Phase II interviews were conducted in April 2007.

vi. ***Administrative data:*** Calgary Health Region administrative data including engineering and maintenance, and health services utilization data were extracted to describe contextual factors of the W21C such as patient bed numbers, staff mix, flow of patients (admissions, transfers, discharges). Administrative data for Unit 61 and the W21C (Unit 36) were reviewed following analysis of Phase II interviews.

The two phased, mixed methods approach allowed for each of the data collection steps to inform the development of subsequent data collection. The preliminary site observation was conducted first which initiated a document review that helped identify the W21C design intent and shaped the Phase I survey development. Subsequently, the Phase I survey and key interview results informed the finalization of the Phase II survey.

The Phase II survey was developed through a review of existing international, national and provincial health facility evaluation tools (Alberta Infrastructure and Transportation, 2004; Green Guide for Health Care, 2005; Health and Welfare Canada, 1992). Analysis of the Phase II survey results helped to further refine and confirm Phase I results and together with Phase II survey themes were used to structure Phase II interviews with staff and to develop indicators describing the design performance of W21C. The six dominant themes became the topics of the Phase II interview questions.

The Research Team prepared and distributed two newsletters directly to the Unit Staff and through the study Investigate Team. These newsletters provided an update of completed and anticipated project activities including preliminary findings, as well as served to increase the awareness of the POE project prior to data collection periods (Appendix 2.0).

2.3 Participant Recruitment

Phase I participation focused on key design team members associated with the planning, design, implementation or current operation of the W21C. In both phases, all health care providers, administrators and building services staff who are responsible for supporting or providing health care on the W21C were recruited for survey participation and a representative sample of W21C staff were recruited for group or individual interviews.

W21C Unit level administration/management and the W21C Initiative Project Manager assisted with staff recruitment. The W21C design project team was recruited directly by the Evaluation Team. Phase I group interviews were conducted during scheduled lunch breaks; resources for staffing relief were provided to conduct Phase II interviews. In both phases, survey completion took 5-10 minutes and interviews did not exceed one hour.

Ethics approval was received from the Conjoint Health Research Ethics Board of the University of Calgary and all subjects that were interviewed or completed the survey provided informed consent.

2.4 Data Analysis

Quantitative data analysis (administrative data, surveys) was supported by various statistical software packages (Microsoft Excel 2003, SPSS 15.0 and STATA 9.0).

Descriptive statistics (frequencies, means) were reported for Phase I and II surveys. Qualitative data including open ended responses from Phase I surveys were imported into QSR N6 (Version 6.0) for thematic analysis. Positive and negative work environment comments were aggregated and validated or further clarified through Phase I staff group interviews.

Data from both the Phase I and II survey was categorized within the Health Quality Council of Alberta quality framework (Health Quality Council, 2006). Specifically, each data element describes the work environment and physical design of the W21C was reviewed according to the safety, effectiveness and efficiency dimensions of the quality framework. With the focus of the evaluation on functional performance, the dimensions of effectiveness, efficiency and safety of the quality framework were deemed most relevant within physical design. These quality dimensions were applied to each data element by first evaluating if the effectiveness of a design feature could be determined (i.e., does the design provide for the successful achievement of the intended goals). If yes, the data element was further examined for how efficiently these design goals were being met (i.e., how well does the design provide for achievement of the intended goals). Thus, effectiveness must be attained prior to discussing efficiency. Safety was determined if the data could provide information on how the design element was mitigating risks to avoid unintended or harmful results. Using this approach, six broad level themes, *Resources*, *Maintainability*, *Flexibility*, *Privacy*, *Communication* and *Usability*, were identified describing staff perceptions of what worked well or did not work well with the design of the W21C. Further elaboration and discussion of the six themes became the focus of the Phase II interview questions and ultimately formed the basis for our indicator development.

2.5 Development of Design Indicators

Coding of Phase II interview data was completed independently by two reviewers using QSR N6 software (Version 6.0). Each transcript was reviewed and coded to the six themes identified from the surveys. Subsequently, information coded in each theme was further coded to one of the built environment evaluation categories, *technical*, *functional* and *behavioural* originally proposed in Preiser's Habitability Framework (Preiser, 1984; Preiser et al., 1988). Specifically, transcript text described design elements that could be characterized as the physical characteristics of the built environment that provide for the performance of building systems such as mechanical and electrical systems, as well as factors related to durability, acoustics or lighting levels were coded as *technical* design elements. Text describing the fit between the Unit and the occupants' activities were coded as *functional* design elements. Lastly, text describing the psychological and social aspects of an occupants' satisfaction and needs in relation to the Unit design were coded as *behavioral* design elements. Agreement of common subthemes within each component of Preiser's framework was identified by the reviewers.

Preliminary analysis of the Phase II interview data revealed substantial overlap between *Usability* and the other five themes (i.e., text was coded to both *Usability* and another indicator). The working definition of *Usability* was intended to capture the quality of human interactions with design. However, each of the other five themes was also capturing user interaction. As a result, *Usability* was removed during this process and data was reanalyzed accordingly (i.e. interview text coded to *Usability* and a second indicator remained coded under that second theme; text coded only to *Usability* was recoded into existing themes). Analysis of two remaining interviews proceeded once the final indicator definitions were refined and served as validation of the overall

indicators. Table 2.1 provides the definitions used for the final five indicators *Resources*, *Maintainability*, *Flexibility*, *Privacy*, *Communication* that emerged from this process. Table 2.2 describing the template that was used to apply the Health Quality Council's Dimensions to the five indicators.

Table 2.1 Environmental Design Indicator Definitions

Indicator	Definition
Resources	Environmental design features that ensure adequate service capacity, including amount and access to supplies, physical space, equipment, technology, training, knowledge, expertise and access to staff/people.
Maintainability	The built environment's ability to minimize the need for, or provide ease of, modifications and repairs
Flexibility	The built environment's ability to adapt to or anticipate new or changing requirements and needs.
Privacy	The built environment's ability to support individuals' dignity, and need for integrity and personal autonomy.
Communication	Processes and structures that support the exchange of thoughts, ideas, information and knowledge within the built environment.

Table 2.2 Applying Health Quality Council's Dimensions to Indicators

	Effectiveness	Efficiency	Safety
	Are design elements successfully achieving or attaining results (outcomes), goals or objectives	***How well are design elements (inputs) brought together to achieve results (outcomes)***	***Mitigate risks to avoid unintended or harmful results***
Themes			
Resources	Does design provide for the right ***resources***?	How well does design provide for the right ***resources***?	Does design provide ***resources*** that mitigate risks and that help to avoid unintended or harmful results?
Maintainability	Does design provide for the right ***maintainability***?	How well does the design support ***maintainability***?	Does design provide ***maintainability*** that mitigates risks and that helps to avoid unintended or harmful results?
Flexibility	Does the design provide for ***flexibility***?	How well does design provide for ***flexibility***?	Does design provide ***flexibility*** that mitigates risks and that helps to avoid unintended or harmful results?
Privacy	Does design provide for the right levels of ***privacy***?	How well does the design provide for ***privacy***?	Does design support ***privacy*** levels that mitigate risks and that help to avoid unintended or harmful results?
Communication	Does design provide for the right ***communication***?	How well does the design support ***communication***?	Does design provide ***communication systems*** that mitigate risks and that help to avoid unintended or harmful results?

3.0 RESULTS

3.1 Revealing the Design

3.1.1 History of the Ward of the 21st Century

The W21C had a strong vision for innovation within a new medical teaching unit:

> The Ward of the 21st Century, will provide an opportunity to create a physical and technological environment conducive to providing excellence in patient care of this population, and will enhance a more effective team functioning, with higher work satisfaction and better learning. The unit will have different levels of medical, nursing and allied health students, providers and academic appointees. In addition to the diversity of medical learners, the unit will also be the focus for medical and interdisciplinary collaborative research. (Reyes, 2003, p.1)

The history of the W21C began with a broader scope of renovations identified for the Special Services Building (SSB) at the Foothills Medical Centre in Calgary. The renovation of the SSB was in response to growing demands for inpatient acute care beds. Reassigning the continuing care beds in patient care units on SSB Levels 3 and 4 into four new acute care units was an opportunity to address Regional capacity issues (The Cohos Evamy Partners, 2001). While the SSB was not originally designed for acute care, the patient rooms are larger in this space than in other impatient units, and, as such, the main focus of the SSB redesign was to develop a generic design for inpatient units (The Cohos Evamy Partners, 2001).

SSB renovations had already begun when the idea of designing a W21C was presented to a Calgary Health Region Executive Committee. These W21C physical planning and design discussions began in 2003 and the project was approved in April of that year. The intent of this new unit was to explore innovation in health care as an in-patient medical teaching unit. The new unit was also to address capacity constraints in health care environments identified with the 2003 SARS outbreak in Toronto and curb nosocomial infections in hospitals.

Planning and designing a medical ward of the 21st century was described as setting higher expectations for health care providers and administrators in how evidence based design innovations could address health care quality and safety issues. For example, the risk of transmitting infections could be reduced with increased isolation capacity and number of hand washing facilities (Dettenkofer et al., 2004). The W21C was the Region's first hospital unit to integrate a number of physical design components identified in evidence based design literature.

3.1.2 Designing the Ward of the 21st Century

Facility planners and designers faced early challenges due to the existing building structure with direct cost implications (Please refer to Appendix 3, Building the Ward of the 21st Century, for Unit Profile, Summary of Unit 36 Renovations and Overall Unit Design descriptions). The existing physical layout divided Unit 36 up into four corridors; three corridors extended from a central location while the fourth corridor was disconnected by the location of the elevators (Appendix 3.0 Figure A3.1). In addition, the W21C's location of the unit on the third floor required existing services (e.g., plumbing) to be retained as is.

The facility planning and design team worked closely with frontline health care providers and leaders to explore how environmental design could address clinical and operational needs in a new innovative medical teaching unit within the constraints of the existing building and

infrastructure. The design solutions had to present a best fit with the existing space which required a great deal of discussion and user involvement throughout the planning and design of the W21C.

Planning processes were developed to enhance staff involvement throughout the development, identification and implementation of the design solutions. In addition to regular planning meetings, a number of ad hoc committees were formed to strategize solutions for various workflow issues. This added staff participation was a unique aspect to the planning process and proved beneficial to the planning team. For example, the need to support toileting activities in the tub room was identified by clinical staff; however, this need had not been identified in earlier design discussions. Consequently, the tub room design changed to better address staffs needs to support toileting in both the tub room and the observation room. An addition example of increased staff involvement was when staff were given an opportunity to play a direct role in determining the interior design of the space acknowledging how a staff room can provide staff with an important informal space to gather.

> We had a broad representative group, which was unusual too. Because we had often times, maybe 20 people in a room, representing physicians, residents, nursing staff, support services. And they came on a regular basis to provide input. (Design Team Participant 1)

Participating in the planning and design gave Unit 61 staff an opportunity to look at what they would like to change both in the physical environment and in the processes related to patient care.

> It was an opportunity to really dream big and to say what don't you like now that we can change in the future? (Design Team Participant 4)

W21C Planning Structures

Staff had the opportunity to provide input through four sub-committees (Figure 3.1). Each sub-committee was represented on the Leads committee which ultimately supported decision making within the Steering Committee.

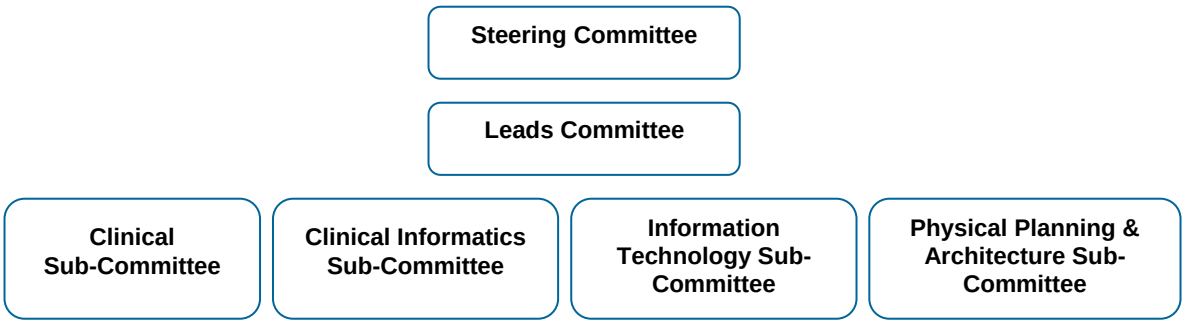


Figure 3.1 W21C Steering, Leads & Sub-Committee Structure

The Steering Committee provided senior level leadership on key issues throughout the design process and included representation from the Calgary Health Region and the University of Calgary. Broader design ideas like the use of technology were identified as an overall design direction at the Steering Committee level with the specific implications for realizing the design intent discussed within sub-committees. For example, sub-committees explored innovation in technology as design intent related to impacts on clinical service.

> We're not going to be known for technology; we're going to see how can technology support the work that we do. (Design Team Participant 2)

Clinical Sub-Committee

The role of the clinical sub-committee was to look at innovation in health care service delivery and operational processes with implications for implementing in the design of the W21C. In early design discussions, there was a need identified for broad discipline representation on the clinical sub-committee. All disciplines working on the unit (e.g., physicians, senior residents, nurses, patient care managers, nursing assistants, unit clerks, and allied health professions) as well as all other hospital departments (e.g., housekeeping, engineering and maintenance) were invited to participate in the clinical committee planning discussions. The committee was an important dimension of the design process as it enabled multidisciplinary interactions and discussions that considered a user's perspective of workflow and operations of the new unit.

Clinical Informatics & Information Technology Sub-Committees

Determining the role of health technology was primarily the function of the Clinical Informatics & Information Technology Sub-Committees. A primary objective of the sub-committees was to enhance clinical documentation and improve health professional access to patient care information to enhance point of care (Reyes, 2003). Some key strategies within the existing electronic clinical documentation system (TDS 7000) used by the Region (Reyes, 2003) were discussed:

- Explore enabling point of care technology that integrates nurse call systems
- Maximize access to information through the number and location of network drops on the unit
- Develop networked satellite workspaces with close proximity to patient rooms and the central unit reception desk
- Integrate telehealth technology in the unit to support rural physician access to Regional patient information, and
- Enhance health care provider access to knowledge databases including the University of Calgary Faculty of Medicine's Curriculum Information Systems

Planning Principles and Guidelines

Regional guidelines for Capital Projects within acute care sites had recently proposed to reduce the risk of patient infections by incorporating as many single rooms as possible and other measures such as controlling unit airflow. Specifically, Infection Prevention and Control (IPC) guidelines specify that hand washing sinks must be in every patient room, patient bathroom, every anteroom and one hallway sink for every 2-4 patient rooms. The guidelines for medical/surgical units further specify that 80% of patients should have a private bathroom. Air quality guidelines indicate a minimum of 6 air changes per hour (ACH) with 12 ACH in Airborne Isolation rooms; and that 10% of patient rooms must have both negative pressure ability and an anteroom.

Increasing the amount of single patient rooms would result in an overall decrease in the number of patient beds from the existing Unit's bed count. Although a reduction of patient beds was approved with the move from Unit 61 to Unit 36 (W21C), the design ensured flexibility to accommodate additional bed capacity if needed.

In addition to existing Regional guidelines for acute care in-patient units, W21C planners and designers created a vision for a medical ward of the 21st century that was expressed within a set of planning principles, which were stated as follows (Gescher, 2004; Hutchinson Architects, 2003a; Reyes, 2003):

Safe patient care

- Improving patient and clinicians' documentation
- Focus on infection prevention
- Medication error reduction through the use of technology tools
- Fall prevention through patient and staff education and fall alert mechanisms

Improved patient flow

- Integrated care delivery models
- Access to clinical information at the point of care

Flexibility

- Moveable walls to create a high observation Unit as needed
- Ability to create an environment for a group of highly infectious patients on demand through the provision of an isolation wing

Research Innovation

- Pilot site for emerging clinical applications within the Region
- Pilot site for advancing care delivery models
- Integrating evidence based guidelines into day to day practice

Leading edge environment in clinical education for all health care professionals

- Access to knowledge databases at the time of clinical decision-making
- Use of videoconferencing technology for teleconsultation

The creation of a physical environment that promotes learning for all health care providers was a strong theme in W21C design discussions. Specifically, the design intended to create a quality teaching environment for everyone by maximizing education space and resources and by centralizing medical patients on the new unit. Changing the proportion of medical teaching patients had other implications related to the proximity and accessibility of medical teaching teams. Prior to W21C, approximately two thirds of medical teaching patients were being accommodated across Unit 61 and 62, with the rest being distributed throughout the hospital. Centralizing more medical teaching patients on W21C would require residents and medical teaching teams to allocate more time to the unit.

> Well the fact that this is a medical teaching Unit made it unique, because there is not too many. Although the education component is applicable to all Units. This was a real teaching Unit, so they had a huge teaching component. (Design Team Participant 1)

The relocation of acute medical teaching patients from the main building to the SSB caused some concerns relating to the decreased proximity to supporting hospital departments, such as the ICU or laboratory and rehabilitation services. This required careful consideration of resource allocation to manage a highly acute patient population that is now farther from hospital support.

In reviewing existing documents that were produced during the proposal and development of the W21C, there was little clarification and elaboration of the common vision for the W21C outside of general guidelines. Information illustrating how intentions for the design were to be expressed in the final implemented environment was not clearly documented or easily translated into useful information for the evaluation of the built environment.

3.1.3 Building the Ward of the 21st Century

Unit 36 operated as a continuing care 45 bed unit prior to its redesign into the W21C. As the W21C, the unit was designated to provide acute care inpatient services for patients who are on average are over 65 years of age and stay on the unit approximately 9 days. 47% of patients have their entire length of hospital stay on the unit, with 53% being transfers from or to another unit.

The size (i.e., gross area) of the unit has increased with the move from unit 61 to the W21C by approximately 45%. Although this included a 36% increase in the size of the typical patient room, the overall number and type of patient care and support spaces has increased with the move. For example, the proportion of single patient rooms with dedicated patient washrooms has increased with a four bed high observation room as the only multiple patient bed room. Office and meeting space has increased to support education and research on the unit. (For more detail on the W21C's built environment, please refer to Appendix 3.0.)

3.1.4 Implementing the Ward of the 21st Century

Once the planning process began, it was discovered that there were design ideas that could be implemented prior to the move onto the new unit. For example, centralizing medical patients was introduced on Unit 61 and later continued on the W21C. This changed the flow of medical patients on Unit 61 as the number of medical teaching patients slowly increased from approximately 10% to about 50% (Design Team Participant 2). Implementing this design intent prior to the move was perceived as a very positive change: "*by the time we left 61, we were doing the same things as when we changed over. So it couldn't have been much different*" Design Team Participant 4.

Closer proximity of health care providers to their patient was another important design intention. Changes on Unit 61 began by examining clinical documentation processes occurring at the nursing station on Unit 61 and placing a large table nearby to provide a workspace to record patient care information. This resulted in the centralization of clinical staff into a small physical space created a busy and noisy environment. As such, the function of the nursing station was reconsidered to reduce noise and distraction. Nursing notes were removed from patients' charts at the nursing station and relocated closer to the point of care in specialized charting boxes outside the patient rooms. This was the first step in what resulted in completely rethinking charting activities for nursing staff on the unit.

> We talked about having the nurses where the patients could see them better, but we took the nursing notes and we put them in a little binder... we built these boxes in the wall, threw the binder in there, put stools and a drop-down thing and they can sit there and do their charting. (Design Team Participant 2)

The implementation of design solutions for Unit 61's "nursing station" provided a clearer vision of how redesigning the health care environment could better support the needs of all health providers.

> We built space for people to find everything they needed to make it easy, quick and accessible for nurses. So we're already doing that. Let's make this more user friendly; let's make this fit the work that we do. (Design Team Participant 2)

The second step in reorganizing nursing charting activities was to re-examine the existing electronic clinical documentation system used throughout the Region. There was a need to centralize patient information for all clinical staff to address efficiency and accessibility issues in managing patient care information across health professions. Therefore, the Region's Information Technology department was approached to design and implement a new application in the existing software that allowed nurses and allied health professionals to exchange patient care information. Prior to this change, the software was primarily focused on managing patient's medical treatment and diagnosis information as used and created by physicians (i.e., nurses and other clinical staff did not direct input and access electronic patient chart information).

An implementation strategy emerged that began to describe the W21C as a living laboratory for the development and implementation of technology that supports flexible, "state of the art" solutions to Unit design problems. However, resource limitations and availability of appropriate technology limited the extent to which design ideas could be implemented. In response to resource constraints, the planning and design team sought additional funding sources that could help ensure the inclusion of various design components. For example, volunteer services provided funding to support the implementation of dedicated patient care equipment in patient rooms:

> We really wanted to have dedicated patient care equipment; we wanted state of the art equipment and only had---we were only able to achieve that through additional funding from Volunteer Resources. (Design Team Participant 1)

In some cases, the current state of technology could not yet support the vision, which meant that the implementation of the W21C continues as technology is made available.

> You want to make it electronic; you want to make it state of the art. You want to have the state of the art smart beds, which were on the cusp of that development. Now, I think the technology is finally catching up. (Design Team Participant 1)

Fine tuning of design and changes to the physical environment after occupancy are typically vetted through existing organizational systems, such as facility management work orders. As such, these systems can be used as an indicator of occupant satisfaction following implementation. Facility management work order data collected following the move to the W21C (2005-2006) showed a decrease in the number of light bulb replacements, floor repairs and painting when compared to Unit 61 data (2002-2003). This data also indicated an increase in the number of requests to address equipment related issues such as overhead paging and nurse call system issues and patient bed repairs.

3.2 Perceiving the Design

3.2.1 Perceptions of the Ward of the 21st Century Design

Surveys were completed by staff two years after occupying the W21C. In Phase I, surveys were completed by 36 respondents. Eighty percent of the total respondents identified themselves as having a clinical service role (nurses, physicians, allied health staff). The remaining respondents described their role as being administrative support (clerical, management, unit clerk), building services (housekeeping, maintenance, security) or clinical support (nursing aides, rehabilitation assistants, orthopedic technician). Eight key informant interviews and 2 group interviews (8-10 participants in each) were conducted with various clinical and administrative staff as well as planning and design team members. In Phase II, surveys were completed by 46 respondents (34 staff nurses, 8 other health care providers and 4 members of the design team). A total of ten individual interviews were conducted including staff nurses (n=5) , other health care providers (n=4) and unit staff (n=1).

In the phase I survey, staff were asked what was working well or not working well with the W21C design of the unit. Out of the 36 responding staff, the majority of participants responded that they were satisfied with their overall work environment (92%), their jobs (97%), team collaboration (100%) and their ability to use their professional knowledge and skills (83%). The majority of participants stated that they were satisfied with the general physical layout of the unit (89%) and with the overall maintenance and physical condition of the work environment (89%).

The performance of tools and systems to support communication in the work environment was identified as an overall design issue negatively impacting staff and patients. Although the majority of respondents were satisfied or very satisfied with communication on the unit, approximately 1/3 of the participants were dissatisfied with how design supports both staff and patient communication. In the open ended survey responses and group interviews staff identified a relatively short list of specific issues they felt were related to or could be addressed within the physical design of the unit. For example, some health professions identified a lack of workspace and access to computers (this was noted prior to the implementation of a regional electronic charting system that increased the number of computers); concerns regarding water leaking from patient showers; and difficulty hearing overhead pages and call bells in patient rooms.

In the Phase II survey, staff (n=46) rated aspects of the design of the unit on a scale from 1 (very dissatisfied) to 5 (very satisfied) and most responses were very positive. For example, the number and location of public (X=1.82) and staff (X=2.91) washrooms represented one of the few items with notable dissatisfied responses. The adequacy of outdoor areas (X= 2.90) and ergonomics of computer workstations (X=2.93) were the other two items where staff indicated some level of dissatisfaction.

When asked specifically about aspects of the built environment, staff generally reported that the W21C was the same or better than other health care environments. However a high proportion of staff (>70%) identified that privacy and the overall aesthetics are better on the W21C. Most staff (> 70%) also felt the design provides better supports for education and in-house training, bedside care and better addresses the basic needs of patients. However, many staff (20%-30%) felt that the number and location of staff and visitor washrooms as well as water temperature and pressure were worse on the W21C compared to other units. Most respondents (> 75%) indicated a comparison with another unit at FMC (e.g. Unit 61).

3.3 Design Indicators of Functional Performance

Exploring the performance of the built environment requires an understanding of how various elements in its design provide for the needs of occupants. Preiser's (1984) framework for evaluating the performance of design identifies *technical*, *functional* and *behavioral* elements in the design. This framework was applied to analyze the qualitative data and to report qualitative themes for Phase II interviews. Themes are not presented in any specific order.

Themes identified in occupant interviews often span more than one of the design performance indicators for technical, functional or behavioral design elements. These are presented as overlapping design performance indicators.

3.3.1 Technical Design Elements

Technical Elements are those physical characteristics of the built environment that contribute to the performance of basic building systems such as mechanical, electrical and fire safety systems, as well as other building elements related to acoustics, lighting and durability. Not all technical aspects of the W21C design are necessarily represented within the text as functional performance was the primary focus of data collection in this study.

Resources

Overall W21C Design: Clinical staff indicated the wider corridors and storage space for stretchers and linen carts alleviated hallway untidiness. However, some of the smaller designated storage spaces, such as the utility room, do not provide for adequate space to store equipment.

Building Systems: Facilities Management indicated that most of the building systems operating on the W21C were not unique, but rather the changes made to the W21C's building systems were normal upgrades that would occur on any older building renovation. Upgrades included changes to: air supply/duct size; plumbing, heating and cooling systems; fire protection; and medical gas supply systems. Temperature and air supply/volume in single patient rooms can be individually controlled, and all systems in the patient rooms can be monitored by a remote computer. The controlled airflow to patient rooms and the ability for some single patient rooms to be interconnected (through movable walls) were identified as an important technical feature for airborne infection prevention and control.

Unique building systems in the W21C include the exhaust and temperate water systems. There is a general exhaust system for the rooms and washrooms, and an independent exhaust system for the isolation rooms, which allow for controlling negative or positive room air pressure. Water supply systems for the unit provide tempered water (43C degrees) for safe and efficient use of hand wash sinks, tubs and showers.

Maintainability

Building Systems: Facilities Management staff indicated that the tempered water system operates more efficiently than other water supply systems from the user perspective, but it is costly to install and maintain as the system has to be annually sanitized and de-scaled.

Another concern identified was the ceiling access points which are not ideally located for repairs or maintenance procedures. For example, the air supply fan and the water cooling system ceiling access are located in common areas or within patient rooms. Repair work within these areas has guidelines to limit the dust exposure to patients/staff which requires additional enclosure set ups to isolate a ceiling access area.

Flexibility

Patient Room Design: Clinical staff reported that the patient rooms have the necessary technical capacity to accommodate changing monitoring and medical needs of patients (i.e., patients being admitted with more complex and more acute conditions have higher monitoring needs.

Privacy

Patient Room Design: The W21C design incorporated a greater proportion of single occupancy rooms, which increases the level of privacy for patients in contrast to shared accommodations.

Communication

Overall W21C Design: Staff commented on the noise reduction and attributed it to technical aspects of the W21C design, such as the construction of private patient rooms and removal of overhead paging systems from inside patient rooms. However, the removal of the paging system from inside the patient room limits staff's ability to clearly hear overhead pages while they are in the patient rooms (i.e., overhead pages are only clearly audible in the hallways).

W21C Equipment and Supplies: Clinical staff indicated that the W21C design provides adequate technology for electronic charting. As part of the original design intent to support point of care with technology, the W21C implemented an electronic charting system at the time of occupancy that increased the amount and type of computer systems available to clinical staff. This systems was replaced in 2007 by a new portable Region-wide, electronic charting system that is electronically linked to Regional resources through a wireless network.

3.3.2 Technical Indicators Overlap

Resources with Flexibility

Overall W21C Design: The W21C design was described as being large and flexible enough to adapt well to the implementation of the new electronic charting system. While with the new electronic charting systems the number of computers was increased, the W21C corridor design does not accommodate the additional need for electrical outlets to charge the current number of wireless computers.

3.3.3 Functional Design Elements

Functional Elements are those design factors that deal with the fit of the built environment with the activities it was designed to support. Staff interviews primarily focused on what was working well or not working well in the unit's design. As such the majority of interview data identifies functional design elements.

Resources

Overall W21C Design: Allied clinical staff commented on the W21C design and layout of the corridor space that provides for a greater flexibility and quality of patient care activities. For example, the increase in the size and accessibility of corridors on the W21C is useful for many patient rehabilitation activities. For all W21C staff, the education space has increased the opportunities to gather together in an educational session or other group meeting. Additionally, the staff room functions as an important social space for W21C staff. The importance of having this social space on the W21C was notable as was the type of resources provided (e.g., fridge, microwave, furnishings) for staff.

The overall layout of the W21C has increased the distance clinical staff (primarily nursing staff) must walk to access supplies and washrooms. In addition, the increase of single patient rooms has increased the amount of overall walking to provide patient care.

> Nursing [is] putting on way more miles on our feet in that eight-hour shift, because of the individual rooms. You know when you had two beds, then you could do things ten feet apart. Whereas now you're going forty or fifty or sixty feet and back and forth again. So I think its good, but it's also not ideal. (Unit Staff Participant 1)

W21C Equipment and Supplies: Many clinical staff expressed that they have all the equipment they need and, in many cases, felt that they have more equipment than in other patient care units. Staff also felt supported by management to request more or different equipment. Decentralizing medication distribution from a single medication room to portable medicine carts was reported as working effectively. The storage of some unit supplies was discussed negatively. For example, the corridor storage areas were either poorly located and/or inconsistently stocked with supplies. It was also suggested to better label the contents of the equipment storage room to improve organization.

> ... just frustrating things. You go to get an oxygen canister and look, they're all empty, but nobody has replaced them. Or you go to get supplies, especially down the one wing that is by itself, the supply room is very inadequately stocked. It would almost be better not to have it stocked at all, because then you would know there's no point looking there. (Unit Staff Participant 1)

When caring for infectious patients, clinical staff described challenges in both the single patient rooms and the observation room to store, sort and use supplies for an isolation patient. These functional design inadequacies are described as presenting an increased level of infection risk.

> ... we don't have any tables, we don't have anything to put [equipment and supplies on]--- the patients are very sick, so they need like a suction, everything, dressing, everything like that. And we have no space to keep them. And it looks so messy ... And you end up spreading the germs. (Unit Staff Participant 3)

Patient Room Design: Many clinical staff commented on the advantages of the patient room design in accommodating the volume and type of patient care equipment needed. Primarily, the headboard, with dedicated patient care equipment mounted on each one, was identified as positively contributing to good bedside care. Within each of the patient rooms, the headboard allowed for increased consistency in the access and use of specific equipment required to support patients. However, there were a few specific suggestions as to how to improve the headboard's utility for nursing care:

> The ultrasound monitor is just right there, but what I find is that sometimes the wires that come along with all of those things, sometimes it takes me just as long to get them untangled, just to get them to a place where I want them to be. (Unit Staff Participant 4)

> Whatever you need is on the top of the patient...The blood pressure stuff you get. That is very nice set-up, but those blood pressure machines, sometimes they are heavy...They could be lower or they could be somewhere, you know? For example, we're coming out with the thermometer to measure the temperature. It's really heavy, it's tight in the wall and when it's forced, there is a chance to hit somebody. So maybe they will come out with something different. (Unit Staff Participant 6)

One clinical staff remarked that the closets in patient rooms are not adequate to accommodate clothes and store all of the patients' belongings. Some staff identified functional issues with the patients' night tables. The tables are mobile enough to be repositioned around the patient bed. However, it is difficult for the patient to safely reposition the table for their own use.

Washroom Design and Location: From the rehabilitation staffs' perspective, the portable toilets in the observation room present an increased level of risk for staff and patients when transferring patients to the low toilets. Further, as the low toilets are not representative of home/domestic toilets, it is difficult to conduct assessments on patients' ability to function at home. There are some other human factors issues related to single patient room washroom design. For example, the placement of handrail bars in single patient room washrooms does not support patients in gaining independence for home washroom use. It was suggested to include a rehabilitation therapist in future design processes.

> How could you set-up someone's room, so it's similar to home and to get their independence? You've got the little demented patient, who gets confused and the bar is in the wrong spot and they reach for it in the wrong place and they fall over, you know... I think that if they want someone to really go home, then they should make it a feasible place where we can do our assessments. So the toilets are a big

> one; the showers with the little lip are a huge fall risk. Just stuff like that or making sure that commodes fit over the toilet or that wheelchair can go under the sink. Very basic things that might get lost in the design concept. And it wouldn't hurt for them in the future to consider having someone from rehab help with the design. To help increase patient safety and potentially, make the whole rehab portion of it a little faster and maybe get people out faster. (Unit Staff Participant 9)

Patient Education Resources: Clinical staff identified having adequate resources on the W21C to support their patient education role. This includes access to teaching material and information resources. The additional resource space for patient education and families was seen as a positive design feature. Also, with the implementation of the new clinical charting system, the new portable computers enhanced clinical staffs' access to information at the bedside.

Access to other Staff as Resources: Clinical staff commented on the increased visibility of and access to the staff educator, medical teaching staff, allied health staff and Unit management. Specifically, the staff educator is located on the W21C full time, which was a change from the previous unit. Also, the central location of the management office and allied health office with respect to the unit reception desk increases the proximity of these staff members with other staff.

Maintainability

Overall W21C Design: Facilities Management identified a number of issues on the W21C. While they recognized that the W21C offers the health care staff and patients some new technology, many of the building systems and W21C design features required additional work to maintain.

> I'm more interested in the basic building, because this is the newest. They've got all new technology... you've got everything. Excellent. I'm not interested in that. Because I'm interested in maintaining the building to be more efficient. [The design] creates a lot of maintenance for us. (Design Team Participant 4)

Facilities Management staff provided an example such as the long-term maintainability of the floor covering which is a high cost maintenance issue. The flooring installed on the W21C was difficult to repair due to the detailed, elaborately cut pattern that includes materials that may not always be available for matching in repairs.

Housekeeping staff provided examples such as steam clean machines, observation room bedside tables, single patient room showers, dust from dry erase boards that discolour the floor, that are difficult to keep clean which increases their workload. Similarly, the material used on the hallway walls is painted drywall which is not durable enough to withstand contact with stretchers and beds. As a result, the walls require maintenance to address the damage to the finishes related to day-to-day use. Housekeeping staff offered that it would improve their ability to keep the walls clean if the walls had added plastic protection. As an example, the wall coverings near the bio-bin/sharp buckets and medication carts are continuously getting splashed, and if a plastic coating was used instead of painted drywall, it would be easier to keep this area clean.

W21C Equipment and Supplies: Many chairs supplied on the W21C cause damage to the floors, increasing overall floor maintenance. Quick deterioration of hoses in the patient showers and poor quality mounting of toilet paper dispenser in the staff washroom were commonly identified maintenance issues.

The type and accessibility of resources was positively reported, but there were some concerns with keeping these maintained or replaced. A key barrier identified was the lack of a designated person to monitor the condition of equipment and identify maintenance needs.

> I think probably the only thing that we could say is that the equipment that we have is good, but it always needs to be maintained and its difficult to maintain some of the equipment, in that it gets used to much and somebody might not notice that, like a wheelchair, for instance, is missing its legs or something...So if I find something broken, it should be my responsibility to send it to maintenance to get it fixed. Does that happen? No...You know it's everybody's role to maintain everything and that doesn't always happen. (Unit Staff Participant 1)

Flexibility

Patient Room Design: The W21C was designed to include a higher proportion of single patient rooms while at the same time maintaining the capacity to add patient care beds if needed. However, staff identified that the single patient room design does not easily accommodate multiple patients.

> ... every now and again we go to double over capacity or whatever it is, and that makes two people in one room and they weren't made---initially, the rooms were two if there's a disaster or something like that. ---two beds are kind of too big for the room. So that---it's nice again, but when it comes down to reality and the crunch comes on when the patient needs a bed, it doesn't make our work easier. (Unit Staff Participant 4)

> I love the private rooms. I don't like over capacity though. These rooms are not ready for over capacity. (Unit Staff Participant 5)

Washroom Design and Location: Clinical staff commented that there was an issue of a poorly marked staff bathroom. Without the proper signage on the bathroom door demarking staff use only, patients and visitors were using it. However, the issue has since been resolved.

Privacy

Overall W21C Design: In response to the Calgary Health Region's privacy policy, the W21C no longer posts patient information which associates health care providers to patient names on a centrally located whiteboard. Although the change increased patient privacy, it created some difficulty for clinical staff to easily identify patients. For example, the nursing assistants do not have access to the electronic patient information and since the white board no longer posts patient names, they have to make a point of learning the patient's name directly from the patient. Other staff are using patient names less and identify patients by diagnosis and room number (e.g., "the pneumonia in room 14").

Patient Room Design: The single patient rooms were described as important in providing patients with opportunities to privately discuss care with their health professionals as well as their families.

> Well, all of our rooms here are mostly private rooms, which I think is yeah, really good. And they're big enough to have family meetings that we're trying to plan. (Unit Staff Participant 2)

While single patient rooms increased patient privacy, they prevent the simultaneous observation of multiple patients. This was perceived as increasing overall workload. In multi occupancy rooms, nursing staff can observe more than one patient at the time.

> I'm in one room, but I'm really assessing two patients. Whereas I have to, you know, we finish here and then go next door and then you go to the next one. So an example for me is the observation room with four beds. Like you know it's for

> observation, but it is wonderful, because you are observing four patients at one time. (Unit Staff Participant 4)

It was also pointed out that roommates can alert staff of issues such as falls or other emergencies.

> I know in the eight room, if there was someone who fell out of bed and the nurse didn't know it, it was actually the patient who was waving the nurse down next to them. So the patient in the next bed was waving or something; someone fell. So safety in that sense and help if you need it. (Unit Staff Participant 9)

Washroom Design and Location: Patient autonomy and dignity issues related to the design and use of current patient bathrooms were clearly identified by staff. Patient bathrooms cannot easily accommodate the use of equipment to assist patients in toileting (e.g., commodes) or accommodate patient care equipment such as IV poles. In many cases the door to the washroom cannot close or it is very awkward for staff to assist patients while maintaining their privacy.

Communication

Overall W21C Design: With increased distance between wings, especially between Hallway D and the other wings, staff indicated that this physical distance poses a communication barrier: "I don't know what happened in D wing. And who is there and what happened because it's so far away." (Unit Staff Participant 8)

There is a patient lounge area, but staff suggested it is not meeting the needs of patients. The lounge is located at the end of a busy corridor and beside the kitchenette and pop/ice machine. Clinical staff commented that this does not provide a favourable space for patients to engage in social interaction with other patients.

W21C Equipment and Supplies: The W21C bulletin boards located in the staff washroom and staff room functions well for the dissemination of information to staff members. Technology and equipment (e.g., computer access) was discussed as a facilitator of communication between staff. Communication improved with increased access to computers that enhanced access to internet based information and lab/diagnostics information. Nurses identified that the electronic charting system increased access and sharing of patient care information across all health providers.

> Yeah, because it's a lot easier to access everyone else's comments about the patient. Whereas years ago, when you had to go to the chart, it was quite cumbersome and it takes you back to the desk and you know, you've got to make an effort to get there. Whereas when your little flags pop up, you know somebody has written something and you take quick glance at it and it makes it quite easy to read what they input. (Unit Staff Participant 8)

There were also negative effects of the new reporting system on staff communication. Due to the change in the reporting process (i.e., now, nurses no longer do a face-to-face report at the beginning of each shift to exchange information rather nurses read each patients' electronic report), as well as the physical layout, there are less coming together of staff as a group during their shift and between shifts. This decreased interaction impacts nursing staff's communication with each other and with the unit clerk.

> Well I know initially when we started, in the way of communication... when we come in to receive report, you know we used to be in the report room... and we would all be in there in the morning. And to me, that was just a way of all of us communicating together as staff. Well, that has changed now, with [portable charting computers. (Unit Staff Participant 4)

However, nurse attendants did not feel communication with nurses had been negatively impacted with portable charting computers.

The intercom was criticized for being difficult to hear (due to poor quality) in addition to not being annunciated in patient rooms, which was intentional in the design. While not having the intercom calls go into the patient rooms does benefit the patient, it is difficult to relay patient care information from unit reception to the nurses.

> But unfortunately, when the nurses are in the room caring for a patient and if they have the door shut, they can't hear me when I page, because the sound just doesn't carry into the room. If the door is open, most times the nurse can hear me, and she will say: "[Nurse's name], I'm in room 30 or [Nurse's name], what do you want?" She hears and she'll respond. But if the doors are shut, they can't hear me. So I can page them until I'm blue in the face, and they just don't call me back. And I'm never quite sure whether it's because they've got their hands up to their elbows in something that they can't call me, or whether they just don't hear me. So I'm never 100% sure. So I guess communication with the nursing staff is sort of quite negative on this Unit, for me, because I never know for sure if they get my messages. (Unit Staff Participant 10)

The single patient room bed alarms let staff know when patients have fallen out of bed and therefore enhance patient observation.

Some staff use the patient board in the staff room to mark patient status, however rarely is there more than one staff member in the room; and because not all staff use it, the patient board is not a reliable information source. Similarly, there is also inconsistent use of the whiteboard in the patient rooms.

> I think our whiteboard idea in the room is good. In a general sense, I think it could be improved in that I don't know if something more specific could be put on it. Some people use it; some people don't. Maybe if we were---if there was more consistency and we knew that there was information there that we could actually use and rely on. (Unit Staff Participant 8)

3.3.4 Functional Indicators Overlap

Resources with Communication

Overall W21C Design: While different staff have allocated office space (e.g., resident/doctors have an area, allied health staff have an area), most clinical staff still gather at the nursing station and this causes concerns regarding noise levels in particular at shift changes.

Resources with Flexibility

Washroom Design and Location: The isolation corridor does not have a staff washroom which was identified as a concern if it needs to be completely isolated from the rest of the Unit. Thus, while this corridor has flexibility to become an isolated wing, without the appropriate staff washroom resources there is concern for maintaining isolation.

3.3.5 Behavioural Design Elements

Behavioural Elements are those design components that primarily capture the psychosocial aspects of the environment that relate to the perceptions and psychological needs of the users.

This requires an in depth understanding of how design elements are positively or negatively contributing to levels of occupant satisfaction and wellbeing.

Resources

Patient Room Design: One interview identified concerns about a few patient rooms on the Unit where the rooms do not have windows with natural views, which is negatively impacting patient wellbeing.

Maintainability

Overall W21C Design: While there were some comments on beginning deterioration of the W21C, there were also comments from staff regarding their strong personal satisfaction and pride towards the W21C. Furthermore, one staff member perceived that the good condition of the W21C contributes to her motivation at work and could also have the potential to contribute to patients' satisfaction on the Unit. However, another staff member was unimpressed by overall design and felt that the painting of the walls could be improved by being a brighter or different color.

Flexibility

Patient Room Design: The flexibility of single patient rooms in supporting patient-family interaction (e.g., family member could stay overnight) was discussed as very positive design feature that reinforces the importance of providing opportunities for patient care that may not necessarily only be medical, but may help with psychological and emotional supports for patients.

Privacy

Overall W21C Design: The clinical staff felt that the reduction of noise in the patients' room (i.e., no overhead intercom announcements in patient rooms) may create a less clinical or 'hospital' like environment for patients, and therefore increase patients' satisfaction. Other staff commented very positively that the increased level of overall privacy is important to their provision of patient care (e.g., performing cognitive assessments).

Washroom Design and Location: The staff bathroom was discussed as not allowing for appropriate levels of privacy. The toilet is located right beside the door to the hallway and staff expressed their concerns and uneasiness about the level of sound proofing between a main corridor and the washroom.

Additionally, some clinical staff very strongly commented about embarrassment felt for patients' lack of privacy using the bedside toilets in the observation room.

> And whoever is in the observation room, if they use the toilet, I will tell you sorry for them. Other three patients, if they have breakfast or lunch and one uses the toilet, can you eat?... I put myself in there, you know I'm lying there sick. Its okay, I don't know anything. That is fine with me. But I feel so embarrassed for the patients, honestly. (Unit Staff Participant 3)

Communication

Overall W21C Design: The face to face communication during centralized charting at the Unit desk created an overall awareness or sense of "how the W21C is" on any particular day. However, with the decentralization of the charting process, there is less coming together of staff and subsequently this has impacted staff's ability to informally determine the overall emotional condition of the staff.

> I don't know what kind of day they're having, unless I can hear in their voice when I'm talking to them. Whereas before, you used to be able to see it and try and help in some little way if you could. ...Yeah, I really feel that difference now; I don't have that close communication at the desk with the nursing staff anymore. Or the NAs, the nursing staff, yeah....I really miss that. ...It's a big broken link, I think. But I don't know how we can fix it. I know we have to adapt, we have to change when we're a new Unit and a new way of nursing with the SCM [electronic charting system] and stuff like that. But wow! That's a lot of adaptation in the last three years, let me tell you. (Unit Staff Participant 10)

The implementation of portable electronic charting system on the W21C has also impacted nursing satisfaction. Nursing staff miss the opportunity to come together at shift change and the formal and informal interaction this previously provided.

> So that has changed which for me, personally, that was a loss for me. Because I do---because in the morning, just coming in and getting your assignment and just go on your little corner, I miss that coming together in the morning and probably just change---its changed thoughts in the way of communicating. (Unit Staff Participant 4)

3.3.6 Behavioral Indicators Overlap

Privacy with Communication

Patient Room Design: While the benefits of the increased privacy for the patients' experience were expressed, the increased social isolation for both staff and patients was frequently discussed as a disadvantage of the single patient room design. Both the increased number of single patient rooms and the floor layout restricts staff from gaining visual contact easily with other staff, creating a disconnection between staff. Similarly, there were comments made that some patients are not benefiting from social interaction opportunities or security a shared patient room would provide. This was identified as being of specific concern for patients without families or the elderly patients who are waiting to be discharged/transferred and are not as acute.

> Well [private rooms] definitely provides privacy for the patient and doing patient care and all that. The private rooms, they are wonderful, but they're also not for every patient. I find that some of the patients are lonely and it's wonderful to have your own bathroom and you know, you cut down some of the problems in other areas, but then, you develop other problems...I just feel that the loneliness is not as profound [in shared rooms]. But I find it's wonderful, and I'm not, you know its okay to have a private room, but also it depends on how sick a patient really is and what the needs are. Because you will find two people who will visit and their mind will be occupied with other things and they're not just sitting there, waiting for someone to come in. (Unit Staff Participant 4)

> Some [patients] do [feel more isolated]. Definitely some do, and some would prefer to be in a shared room and have stated that. And we have, at times, moved a patient into a shared room, just because they're feeling---I don't know what isolated is the right word, but just kind of off by themselves and if they don't have a lot of family coming in, then, like I said, its long days for them. If they're well enough that we don't need to be in there every few minutes, and you have somebody really sick in the next room, they could go long stretches of time without seeing a face. (Unit Staff Participant 1)

Some of the social isolation felt by the patients is alleviated by switching room assignments to have better pairings of shared room patients and single room patients.

Privacy with Flexibility

Patient Room Design: In the observation room (quadruple bed room), clinical staff were concerned that the use of bedside toilets does not allow for adequate privacy during use, especially for patients who are less acute and who have to use the toilet in the presence of other visitors and patients in the room.

> I just find that most of the patients that are in that room, the majority of them that are in that room don't want to use those toilets. Because like who wants to sit on a toilet with all these other people around?... They are alert and well enough to say: "Well I'm not going to sit there with all these visitors in that room." So it means getting them a commode chair and taking them all to the tub room. (Unit Staff Participant 4)

This results in patients being transported to a different room across the corridor to use a private toilet. As such, privacy for patients in the observation room is not easily addressed with toileting activities and impacts the use of the tub room facilities as well as overall workload of staff.

In multiple occupancy rooms that were originally designed to be private rooms (i.e., overcapacity single patient rooms), co-ed occupancy make some clinical staff and their patients uncomfortable when providing patient care. It is difficult to create privacy in this arrangement and there has been some negative feedback from older patients/families.

> Some of the older patients really don't like it [co-ed rooms]. Sometimes nursing has a little bit of a difficult time with the patient that might have something fairly private. I mean they're all private in there, but some things are more intimate. And then having the opposite sex just on the curtain on the other side, it could be a little bit disconcerting. And if it becomes an issue, then we'll move the patient. We'll either move the one into a private room or else we'll switch, so that they're both the same sex. (Unit Staff Participant 1)

The privacy issue is worsened by the fact that the single patient rooms do not have extra provisions in place to hang a privacy curtain when the room is used in overcapacity.

Resources with Communication

Overall W21C Design: Designated allied health space has moved from the end of one of the W21C hallways to a space near the unit desk. This change in space allocation has positively impacted some allied health staff's activities and satisfaction with the physical space as well as enhanced their professional identity and/or job satisfaction.

> And so for me to have that space, I feel more important. I don't know, it makes my role feel more welcomed and part of the team... If they [nursing or medical staff] have a question, they just migrate over. "Oh I need to talk to you." And it works better. And even some of the doctors, who want to brainstorm, they'll walk in and say: "I have a question for you." And they'll say it generally to anyone who is in the room. Usually there is one or two of us in there when we're charting and actually maybe you should talk to this person or that person. So for me, it's more of a professional identity or job satisfaction. Yeah, it's amazing; just a little space to acknowledge that you're important to the team will do it. (Unit Staff Participant 9)

4.0 DISCUSSION

The quality of the health care environment relates to both staff and patient outcomes (Ulrich & Zimring, 2004; Devlin & Arneill, 2003). Our two-phased, mixed method evaluation approach allowed for multiple data sources to inform an overall understanding of the design of the W21C built environment and to develop an evaluation process that can appropriately address the iterative nature of health care facility design. The POE enhanced the understanding of the W21C design process and identified specific design performance themes or indicators that contribute to occupant satisfaction. These design performance indicators demonstrate an application for the Health Quality Council's Quality Framework (Health Quality Council, 2006) and Preiser's (1994) Habitability Model in determining the impact of environmental design in health care.

4.1 Revealing the Design

The W21C was one of the first in-patient units to be constructed according to newly established planning and design standards and principles guiding Calgary Health Region facility development (Calgary Health Region, 2005; Gescher 2004). The need to fit within an existing physical environment (rather than creating a new building) while at the same time meeting the newly established guidelines posed some challenges. Despite the desire to create something innovative, it is not clear how unique the physical design features of the W21C are in comparison to other units. However, the POE identified some unique aspects of the planning and implementation process of the W21C that have contributed to the overall success of the unit's design. They relate to the evolving vision, leadership and stakeholder engagement and early and ongoing implementation of design solutions.

Evolving vision: During the initial brainstorming stages of the W21C vision it was identified that medical education, health care research and technology innovation were all important aspects of the design that could enhance the quality of health care services. However, in many ways, the planning and design of the W21C evolved beyond the physical renovation project. It became an opportunity to transform not only the quality of the patient care environment, but also the quality of the health professionals' work environment. The pursuit of this vision for the W21C has continued well after occupancy and continues to develop and progress within a unique culture on the unit. While having an evolving vision is one of the unique aspects of the W21C, it has made the W21C environment difficult to clearly define and evaluate. This highlights the need for more inclusive documentation detailing the vision and implementation of design.

Leadership and stakeholder engagement: The W21C's design emerged as a unit renovation project within a larger building renovation project. Involvement and leadership at multiple levels of the organization supported the planning and design activities of a diverse group of professions. Representing diverse clinical viewpoints, user groups were responsible for establishing a vision and setting priorities for the design of an innovative and modern medical Unit. This level of user engagement in a multi-level committee structure was both unique and advantageous to the initial design process of the W21C. Staff report high levels of satisfaction with both the design of the W21C's health care environment and their roles within it, and perceive the W21C's design as new and innovative, even after three years of moving in.

Early implementation: The W21C's planning and design processes could be described within three stages: a pre-implementation/planning stage, an implementation/procurement stage and post-implementation/post occupancy. Prior to moving into the new unit (W21C/Unit 36) the existing unit (Unit 61) began putting into practice some of the operational/procedural changes that would later be implemented as part of the W21C design. For example, one aspect of the

W21C's design intent focused on improving workflow. This design intent could already be implemented on Unit 61 using small scale changes that addressed opportunities or constraints within the physical environment. Redesigning work processes in response to physical constraints reflected both a pre and post-implementation strategy that contributed to the evolving vision of W21C. Beginning to realize the W21C design intent's operational objectives in the pre-implementation stage appears to have positively contributed to the subsequent stages of planning and design.

Ongoing implementation: It is important to note that some of the original technological intentions of the design have not been fully implemented due to insufficient resources to develop existing space, as well as the limited availability and accessibility of required health care technology (e.g., limited wireless point of care technology). As such, technology and resources have been implemented as they become available. This ongoing process has contributed to openness for implementing health technology and seeking innovation in health design. Staff satisfaction with the overall functional performance and work environment suggests that operational objectives are being realized and successfully implemented.

4.2 Perceiving the Design

This evaluation sought a variety of users' perspectives of what contributes to the success of the physical environment of the W21C by identifying broad and specific features of design impacting user satisfaction. To assist in evaluating the quality of health design, the Health Quality Council's (HQC) framework dimensions, *efficiency*, *effectiveness* and *safety* were used to identify common themes that could discuss functional performance in the built environment. The importance of safety as an indicator in the design of health care facilities is clearly recognized. A primary objective of building commissioning is to ensure the safety of the occupant (Holtz, 2005). Safety in facility planning and design is integrated within industry standards, regulations and organizational policies (e.g., infection prevention and control) to ensure the design and construction of safe facilities (Calgary Health Region, 2005; Health Canada, 2001). However, less attention is being paid to levels of efficiency and effectiveness in the built environment.

As a result of this study, five indicators contributing to the physical performance of the W21C design were identified: *Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication*. Each design indicator can independently describe broad aspects of design performance that provide a foundation to discuss both positive and negative outcomes of the W21C design specifically and of health facilities in general.

The application of Preiser's Habitability Framework (1984) to the five indicators allowed for distinction between issues related to technical, functional and behavioural elements in design. Technical elements were relatively easy to identify in the indicator data and related mainly to storage issues, building systems and technical problems with communication devices. It was however more difficult to distinguish between functional and behavioural design elements (i.e., how the nature of the user's interactions or *functions* within the built environment are impacted versus the nature of the user's response or *behavior* is impacted by the built environment) as they often addressed similar issues. The majority of the indicator data fit within the *functional* element due to the nature of our data collection that predominately focused on users' perspectives of the functional performance of the designed space. The main functional concerns were communication and maintenance of equipment, while generally positive comments were made about resources (availability of equipment and access to professional staff). The single patient rooms received mixed reviews. With increased information as to how the built environment impacted satisfaction, some design elements could be understood as *behavioural* elements. Privacy was the most important issue emerging as a behavioural element.

While each indicator and each level (*technical*, *functional*, *behavioural*) can be used individually, determining the overall performance of the design requires simultaneous interpretation of all these indicators and levels in order to fully understand the impact of specific design elements. For example, applying this indicator framework revealed a number of key tradeoffs in the design: while the design may provide adequate *resources*, it may not be *flexible* enough to meet the changing needs of the users over time.

Particularly noteworthy are the tradeoffs associated with single patient rooms. One W21C design intention was to increase the proportion of single patient rooms, and it is not surprising that elements related to private patient rooms emerged across each design indicator. However, the many doubtful or negative staff responses to the single patient room design were not anticipated. Specifically, while the single room design addresses the ability to control and address privacy for patients and contribute to infection prevention, staff felt that not all patients value the disconnection from social interactions associated with sharing a patient room. Behavioural indicators suggest that single patient rooms may be negatively impacting satisfaction of unit occupants. Additionally, the increase in the number and size of single patient rooms in the unit layout (e.g. distribution of patient beds) has increased the travel distance for the staff (e.g., in single patient room nurses cannot 'multi-task' with patient care as they would be able to in multiple patient rooms), affecting work efficiencies. It has also created some barriers for interactions between health care professionals when providing care (e.g., nurse to nurse communication, unit clerk to nurse communication). Overall, while the single patient room design on the W21C created a sense of *privacy*, it posed constraints to *flexibility* and *communication*.

This example demonstrates that interpreting design performance requires an understanding of the interrelationship between design elements and how the implementation of individual design elements affects overall performance. Through the process of identifying and developing design performance indicators, we were able to document interrelationships between design elements and how these reflect an intended vision for the design. Although the strongest themes emerging from this open ended, iterative approach resulted in the identification of five design performance indicators, these overall themes do not precisely parallel the documented design guidelines and principles.

4.3 Future Application of the Design Indicators, Preiser's Framework and the HCQ Matrix

The physical design of a health care environment needs to be responsive to the complex nature of addressing individual health care needs in the context of a dynamic health care system. POE provides an indication of the quality of interactions between occupants and physical components of design, and how they affect overall building performance.

This POE consisted of a comprehensive, mixed methods, multi-phased approach that supported triangulation of design performance data across many design elements in the built environment. By examining users' satisfaction levels within the context of efficiency, effectiveness and safety we gained a deeper understanding of how well (e.g., functional performance) the built environment provides a response to an original vision (e.g., design intent) of a health care environment.

An iterative process of data collection and analysis allowed the development of five design indicators (*Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication*) that capture different performance aspects of the built environment. Overlaying Preiser's Habitability Framework (1984) to the five indicators allowed further distinction between performance issues related to technical, functional and behavioural components. This distinction may be useful for

designing remedial strategies or setting future priorities. Examining the issues associated with each of the indicators and levels revealed complex interrelationships between design elements that need to be kept in mind for future projects. For example, reporting behavioural design elements typically reflected the strongest implications for design performance, drawing together the implications of interacting elements in design indicators.

The design indicators developed in this POE may be best used to identify and discuss building level design performance. They can provide opportunities for a greater understanding of the contribution of individual design elements to overall design performance. The broad range of themes captured by the five indicators would suggest that they have applicability for a range of facilities and environments. Additional design indicators may need to be considered for highly specific building functions. For example, if the designed space had a different setting or purpose, such as a mental health unit, the need for an indicator such as *Security* may emerge (Friesen, 2006).

Indicators can be used at various stages in the design process. In addition to providing a basis against which to evaluate overall success, these design indicators can help ensure that those involved in planning, design, implementation and ongoing occupancy of a built environment examine the broader implications of specific design decisions in the context of a desired outcome. Although this study did not directly examine health, health care service delivery or health system outcomes related to design, the resulting indicators support further investigation of specific outcomes of design in health care. Understanding outcomes of design is the key objective of a third level of POE referred to as 'Applying the Design'.

Applying the design is the final POE phase that addresses outstanding questions related to the impact of design. Shifting focus from the overall design performance in the previous two phases, the final POE phase focuses on specific outcomes related to design. For example, what is the impact of single patient rooms on the health of patients? In addressing this question it is important to understand the intention and current level of implementation of the room's design.

A prerequisite for examining outcomes of design is having clear documentation of the design intent against which successes or failures of planning and design can be discussed. This may require clarification and further definition of many intentionally broad terms used in general design guidelines. Design indicators can then be used both to evaluate the success of a design approach and the functional performance of design elements contributing to the built environment. This POE was conducted two years after the procurement and occupation of the unit. However, it is recommended that these design indicators be considered in early design processes (i.e., no later than the schematic design phase). This will help identify criteria for evaluating performance as well as provide consistency of the evaluation process throughout the design implementation and occupancy stages.

In summary, the indicators developed during this POE can be used to guide future planning and implementation processes for built environment. Furthermore, the five indicators provide a template for building evaluation that captures in a comprehensive way the complex interactions between design elements and their impact on building performance and user satisfaction.

5.0 SUMMARY AND CONCLUSIONS

This multiphase, iterative POE process has documented **impacts** of the design on the effectiveness and efficiency of the W21C with the following key findings:

Overall W21C Design

- Staff have a strong personal satisfaction and pride towards the W21C which contributes to their motivation at work. Staff commented positively on the increased overall space, wider corridors with alcoves for equipment storage that alleviate hallway untidiness and facilitate patient rehabilitation activities, workstations in close proximity to patient rooms, education space, designated allied health space and the staff room. Staff commented negatively on the patient lounge which does not provide a favourable social space for patients.
- Organization wide implementation of an electronic patient information system decentralized charting on the W21C. While the overall layout is flexible enough to accommodate the decentralized charting equipment, there is a shortage of electrical outlets to charge the wireless workstations. Decentralized charting in combination with the increased physical distance poses a communication barrier for staff. Nursing staff miss the formal and informal interaction at shift change which no longer takes place.

Building Systems

- Most W21C's building systems were normal upgrades. However, unique building systems include the independent exhaust system for the isolation rooms and the provision of tempered water (43C degrees) for the increased number of hand wash sinks and showers. The controlled airflow to patient rooms and the ability for some single patient rooms to be interconnected (through movable walls) is an important technical feature for airborne infection prevention and control. However, the tempered water system is costly to install and maintain.

Patient Room Design

- The greater proportion of single occupancy rooms increases the level of privacy for patients with opportunities to privately discuss care with their health professionals and families. They also reduce noise (in particular through the removal of overhead paging systems from patient rooms) which creates a less clinical or 'hospital' like environment for patients.
- The increase of single patient rooms has increased the distance clinical staff are walking to provide care and to access resources. Single patient rooms also prevent the simultaneous observation of multiple patients, further increasing overall workload. Increased social isolation for both staff and patients was frequently discussed as a disadvantage of the single patient room design.
- Patient rooms have the necessary technical capacity to accommodate changing patient needs; the dedicated patient care equipment mounted on the headboard allows for increased consistency in the access and use of specific equipment. The bed alarms were positively noted as enhancing observation abilities. Negative comments relate to the small closets in patient rooms, difficulties for patients to safely position the night table for their own use, and the lack of windows in some patient rooms.
- The single patient room design does not easily accommodate multiple patients due to the lack of privacy curtains. Additionally, co-ed occupancy makes some clinical staff and their patients uncomfortable when providing patient care.

W21C Equipment and Supplies

- Staff were satisfied with the equipment on the W21C and felt they had adequate resources to support their patient education role. Communication improved with increased access to computers. This enhanced access to internet based information and lab/diagnostics information as well as increased the sharing of patient care information across all health providers.
- The increased visibility of and access to the full time staff educator, medical teaching staff, allied health staff and unit management is positive. The central location of the management office and allied health office with respect to the unit reception desk increases the proximity, and thus interaction of these staff members with other staff.
- Decentralizing medication distribution from a single medication room to portable medicine carts is reported as working effectively, however, some corridor storage areas were either poorly located and/or inconsistently stocked with supplies.
- Some concerns emerged regarding maintenance e.g., chairs that damage the floors, quick deterioration of hoses in the patient showers and poor quality mounting of toilet paper dispenser in the staff washroom.

Washroom Design and Location

- Some issues emerged around the patient washrooms: Patient bathrooms cannot easily accommodate the use of equipment to assist patients in toileting (e.g., commodes, IV poles); the door to the washroom cannot close or it is very awkward for staff to assist patients while maintaining their privacy; the portable toilets in the observation room present an increased level of risk for staff and patients when transferring patients to the low toilets. Some clinical staff strongly commented on the embarrassment felt for patients' lack of privacy when using the bedside toilets in the observation room.
- The staff bathroom was discussed as not allowing for appropriate levels of privacy (concerns and uneasiness about the level of sound proofing between a main corridor and the washroom). Also, the isolation corridor does not have a staff washroom.

The POE has further highlighted areas in the planning and implementation process that contributed to the **success** of the design. They relate to leadership and evolving vision, stakeholder engagement, and early and ongoing implementation of design solutions.

- *Strong leadership* in the development and implementation helped move the planning and design of the W21C beyond the physical renovation project. It became an opportunity to transform not only the quality of the patient care environment but also the quality of the health professionals' work environment.
- *High involvement of user groups* in a multi-level committee structure during the planning and implementation process enhanced users' understanding of the design intent and positively impacted their satisfaction with the current design.
- *Early and ongoing implementation:* Some design intents were implemented with staff prior to the move to W21C. This helped clarify operational and procedural changes and facilitated later implementation on W21C. It also contributed to openness for ongoing implementation of health technology as new technologies become available.

However, the POE also has identified some **gaps** in the current planning and implementation process:

- There is a need for more comprehensive documentation of context at the time of planning and implementation, design expectations and how decisions are being made. The lack of detailed information limited the evaluation's ability to fully understand and consider the impacts of design decisions.
- This evaluation was conducted two years after building occupancy which did not allow for immediate feedback into the design process. It is important to establish an evaluation process as a key implementation strategy that recognizes design as an ongoing iterative process with a feedback loop that enhances communication across design stakeholders.. This requires ongoing work with key regional and provincial stakeholders in establishing a health design evaluation process and tools.

The POE approach used is **superior** to traditional POEs that focus on technical elements of the built environment:

- Examining user satisfaction within the context of efficiency, effectiveness and safety provided a deeper understanding of how well (e.g., functional performance) the built environment meets the original vision (e.g., design intent) of a health care environment. The mixed methods, multi-phased approach increased the validity of the findings.
- Each of the five indicators developed—*Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication*—captures unique performance aspects of the built environment. Using these indicators allows discussing both positive and negative outcomes of the W21C design and health facilities in general. However, these indicators require validation in different health care settings and in different stages of design. It is anticipated that additional indicators may be identified with their definition shaped over time.
- Focusing on functional and behavioural aspects of user satisfaction in addition to technical aspects highlighted the interrelationship between design elements and how they affect overall design performance (e.g. effectiveness and efficiency). This distinction may be useful for designing remedial strategies or setting future priorities.

In summary, the POE highlighted impacts of different design elements on the delivery of patient care. The approach used in this project has the potential to add considerable value to the planning and implementation of new health care facilities. For POE to be most effective, it needs to be integrated into the planning and implementation process to allow for ongoing feedback and adjustment of the design if needed. Using the five indicators—*Resources*, *Maintainability*, *Flexibility*, *Privacy* and *Communication*—will help focus the planning and evaluation towards desired outcomes. Attention needs to be paid to multi-stakeholder involvement including users and patient/families, strong leadership to create a clear vision, and comprehensive documentation of context, decision process and design intents.

APPENDIX 1.0 DOCUMENT REVIEW

Table A1.1 Key Milestones and Documentation Related to the Planning and Design of the W21C

Project Stage	Timeline	Milestone[1]			Summary
		Document Name		Prepared By	
	2000 Aug	*As part of the Foothills Medical Centre site's master plan, Alberta Infrastructure funds renovations to Special Services Building*			
	2001 Dec	Foothills Medical Centre Special Service Building: Conversion from Auxiliary to Acute Beds		The Cohos Evamy Partners	This documents an architectural, mechanical and electrical review to determine a "generic" concept design with cost estimates for renovations to the inpatient units on level 3 and 4 of the special services building to propose modifying the existing continuing care patient units to acute care inpatient units.
Planning	*2002 Dec*	*A governance structure and planning committees for the Ward of the 21st Century are established*			
Planning to Occupancy	2003 Jan - 2004 Apr	W21C Lead Meeting Minutes		Medical Inpatient Services	These minutes document the discussions, actions, and decisions made in the W21C Lead Meetings which focus mainly on the physical aspect of the W21C; functional technology, clinical needs, and planning issues across the sub-committees.
Planning to Occupancy	2003 May-2006 Apr	W21C Steering Committee Minutes		Medical Inpatient Services	These minutes document early discussions, actions, and decisions made by the W21C Steering Committee. The committee first focused on organizing, fundraising, and deciding on an organizational structure for the W21C. As the ward was built and occupied, the focus shifted from design implementation to the research and collaborative aspects of the Ward.
Planning	*2003 Apr*	*Executive Committee grants approval to increase the scope of the SSB renovations to accommodate the Ward of the 21st Century*			
Planning	2003 Apr	Ward of the 21st Century: IM/IT Project Charter		L. Reyes, Clinical Informatics	The project charter identities goals and objectives related to information management and information technology on the W21C. The document outlines guiding principles objectives, goals, scope of the project, tasks, key stakeholders, timelines and cost predictions.

[1] www.w21c.org, accessed June 23, 2007

Project Stage	Timeline	Milestone[1]			Summary
			Document Name	Prepared By	
Programming	2003 Apr		Inpatient Unit 36 Functional Program	Hutchinson Architects Inc	This functional program provides a brief summary of requirements from the "Medical Teaching Unit user group". A list of space requirements is identified in response to the user group information.
Design	*2003 Jun*	*Architectural design for the Ward of the 21st Century receives approval*			
Design	2003 Jun		Foothills Medical Centre SSB Unit 36 Renovation: Design Report	Hutchinson Architects Inc	The design report documents the scope of work for renovation project with detailed schematics and technical documents describing the architectural, mechanical and electrical components of the unit's design.
Construction	*2003 Jul*	*Construction on Unit 36 begins*			
Construction	*2004 Apr*	*Official opening of the Ward of the 21st Century*			
Occupancy	2004 Jun		Design Principles and Post Occupancy Evaluation	J. Gescher, Planning and Capital Development	This planning document centralizes unit planning principles, user group information and space requirements documented in the functional program and capital project budget information. Staff comments to the design team regarding the physical design 6 weeks post occupancy are documented with an action plan identified for each outstanding design issue.

APPENDIX 2.0 NEWSLETTERS

Post Occupancy Evaluation of the Ward of the 21st Century

August 2006 NEWSLETTER

Study Investigators

Esther Suter,
Research Consultant
Calgary Health Region

Debbie White,
Assistant Professor
Faculty of Nursing

Steven Friesen,
Research Associate
Calgary Health Region

Barry Baylis,
Clinical Co-Leader
Ward of the 21st Century

Ron Wardell,
Associate Professor
Faculty of Environmental Design

Salvador Ibarra,
Director of Capital Programs
The Alberta Cancer Board

Nora Shea,
Manager, Alberta Infrastructure and Transportation

Kathryn Gowling,
Executive Director
Planning and Development
Calgary Health Region

Janice Cullen,
Director Health Facility Planning
Calgary Health Region

Funding for this study has been provided by the Health Quality Council of Alberta

The purpose of the study is to examine the Ward of the 21st Century (W21C) renovation project to better understand the outcomes related to the design of the W21C and to assist the development of a health care design evaluation approach..

This study intends to:

- Describe and define the intended goals, objectives and outcomes of the renovations to Unit 36
- Identify design characteristics in the physical environment that are currently impacting the functional performance of the W21C

What is the W21C POE Study?

Post occupancy evaluation (POE) is a common term used in architecture that describes a process of examining the functional performance of the built environment. POEs provide an opportunity to examine design solutions that may have worked really well or environmental design issues that may need some fine tuning. What is important about POE methodology is that the perceptions of those that occupy the space are rigorously explored and carefully considered.

For the W21C, the POE will be conducted in two phases. The first phase will explore and describe the design of the W21C and identify any high priority issues impacting staff satisfaction. The second phase will focus on evaluating the overall functional performance of the design.

W21C Evaluation- Updates

- Ethics application for the Post Occupancy Evaluation (POE) received final approvals from the Conjoint Health Research Ethics Board –April, 2006
- Data collection for Phase I began with the distribution of the General Environmental Survey to all staff – June, 2006
- Preliminary analysis has informed the development of follow up interview questions- July, 2006
- Interviews are currently in progress- July, 2006
- Thank you for your participation in Phase I. We appreciate all your time and contributions to this study!

W21C Research Program- How does the POE fit?

The current POE study represents one of many research projects supported within the research focused environment on the W21C. Many of the research projects are considering innovation in health care however, Dr. Jean Wallace's study "Innovations and Health Care Providers' Well Being" and this POE are specifically examining impacts of the environment on staff. Dr. Wallace's study is examining the impact of technical and organizational innovation on health care providers while this study is examining the impact of the physical design. Both of these studies will add to a growing body of knowledge in examining how to best contribute to quality work environments.

Why is this study important?

The W21C was designed to improve safe patient care, improve patient flow, and allow for increased flexibility in an environment that cultivates and fosters research innovation and clinical teaching.

Discussions at a provincial level have identified a need to evaluate health facility projects in order to explore opportunities to inform future design and planning. Building performance evaluation is becoming a growing interest as research continues to link health care outcomes to environmental design.

This project presents an opportunity to explore an approach to capture important learnings to fine tune existing facilities and design future ones and our region has taken a keen interest in including research as complementary process to health facility design.

What are the next steps?

Phase I

- Follow up interviews are currently being conducted with staff, designers, planners and program administrators to further elaborate on various design elements and explore identified issues at the W21C.
- Preliminary analyses and reporting of Phase I results are anticipated to be completed by September.

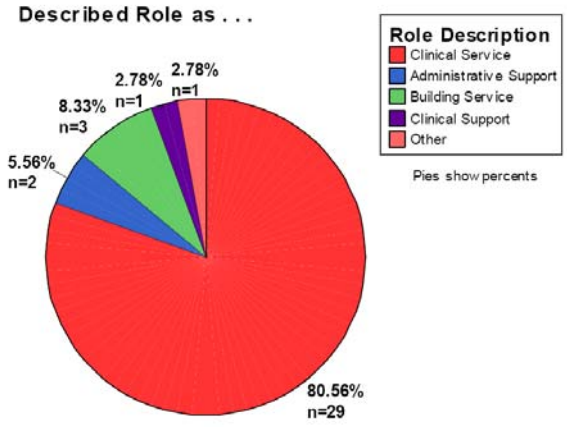
Phase II

- Information gathered from Phase I is currently informing Phase II of the project which will consider outcomes and measures for health care design.
- Phase II data collection is anticipated to commence later this fall with a second survey and round of interviews.

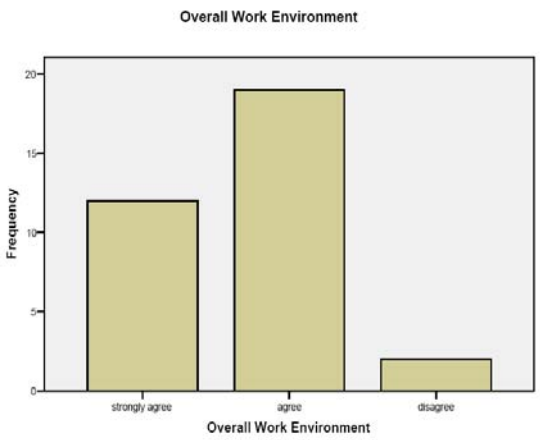
Some Preliminary Phase I Survey Results

Although many staff identified various design and technical elements, over 90% indicated that overall they were satisfied with their work environment. Some of the design aspects that were most commonly reported as working well were the patient care environment, and infection control devices.

A total of 36 staff completed the General Environmental Survey



Satisfaction with the Overall Work Environment



Post Occupancy Evaluation of the Ward of the 21st Century Newsletter

Study Investigators

Esther Suter,
Research Consultant
Calgary Health Region

Debbie White,
Assistant Professor
Faculty of Nursing

Steven Friesen,
Research Associate
Calgary Health Region

Barry Baylis,
Clinical Co-Leader
Ward of the 21st Century

Ron Wardell,
Associate Professor
Faculty of Environmental Design

Salvador Ibarra,
Director of Capital Programs
The Alberta Cancer Board

Nora Shea,
Manager, Alberta Infrastructure and Transportation

Kathryn Gowling,
Executive Director
Planning and Development
Calgary Health Region

Janice Cullen,
Director Health Facility Planning
Calgary Health Region

Funding for this study has been provided by the Health Quality Council of Alberta

Issue 2 **March 2007**

The purpose of the study is to examine the Ward of the 21st Century (W21C) renovation project to better understand the outcomes related to the design of the W21C and to assist the development of a health care design evaluation approach.

This study intends to:

- Describe and define the intended goals, objectives and outcomes of the renovations to Unit 36
- Identify design characteristics in the physical environment that are currently impacting the functional performance of the W21C

What is the W21C POE Study?

Post occupancy evaluation (POE) is a common term used in architecture that describes a process of examining the functional performance of the built environment. POEs provide an opportunity to examine design solutions that may have worked really well or environmental design issues that may need some fine tuning. What is important about POE methodology is that the perceptions of those that occupy the space are rigorously explored and carefully considered.

For the W21C, the POE will be conducted in two phases. The first phase will explore and describe the design of the W21C and identify any high priority issues impacting staff satisfaction. The second phase will focus on evaluating the overall functional performance of the design.

Acknowledgments

The W21C POE Study would like to extend a thank you to all of our participants to date. We appreciate your time taken to complete our surveys and to meet for an interview. A special thanks to Sonja Morrison and Shandra Kimpton for all their efforts in coordinating our data collection activities on the unit.

The W21C POE Study welcomes a new Research Team Member. On January 15th, Lana Trojan joined the Calgary Health Region, Health Systems and Workforce Research Unit. Lana will be assisting with the W21C POE Study's final data collection, analysis and dissemination.

W21C POE Progress To Date

April 2006	*Funding Awarded*	The **Alberta Health Quality Council** awarded funding to successful proposals addressing indicator development, access to health care and health care safety.
	Ethics Approval	**Conjoint Health Research Ethics Board**
May 2006	*Preliminary Site Observations*	**Direct site observations** • General observations informed Phase I data collection
June 2006	*Phase I Survey*	**General Environment Survey** (N=36) • Preliminary results reported in August Newsletter • Over 90% of respondents reported overall satisfaction with both positive and negative comments on the specific work environment
July 2006	*Phase I Interview Development*	**Phase I Survey Analysis informed development of interview questions**
	Phase I Interviews	**Key Informant interviews and focus groups were conducted with staff, designers, planners and program administrators** • 8 individual interviews and 2 unit staff focus groups
August 2006	*Phase I Interview Analysis*	**Preliminary coding/analysis of interview data to inform the development of Phase I survey questions** • Interview data analysis has began to identify general themes related to performance outcomes, design intent and implementation, and planning processes.
	Phase II Survey Design	**Interview themes further explored in Phase II survey** • Survey II examined overall design effectiveness and efficiency as well as various specific components the physical design (e.g., layout, building systems, furnishing and equipment, interior finishes, etc).
Oct - Nov 2006	*Phase II Survey*	**Phase II Survey** (N=46) • Most participants agreed that the overall design considers privacy, safety, and security. However, both positive and negative specific design factors were identified. • Most participants generally agreed that the overall design contributes to the effectiveness and efficiency of the unit.
Dec – Feb 2007	*Preliminary Analysis*	**Data analysis has informed final data collection strategies**
NEXT STEPS :		
March–May 2007	*Final data collection strategies*	• Secondary data sources: Facility Management System & Administrative Databases • Structured Unit Observations • Semi-Structured Interviews
June 2007- March 2008	*Data analysis and final reporting*	

For more information, please visit
Health System and Workforce Research Unit at www.calgaryhealthregion.ca/hswru

APPENDIX 3.0 BUILDING THE WARD OF THE 21ST CENTURY

Unit Profile

The W21C is an acute care medical teaching inpatient unit and emphasizes education and research. The unit has 36 patient beds on the third floor of the Special Services Building at the Foothills Medical Centre. The average occupancy rates exceed 95% (Calgary Health Region, 2003-2005) and the average annual unit admissions and transfers over the past 3 years exceeded 1400 patients (Calgary Health Region, 2003-2005).

Approximately half of the patients on the unit are over the age of 65, where the average age has slightly decreased since the move from unit 61. On average, patients on the W21C spend two weeks in the hospital. The average stay on the W21C, however, has decreased from 10.6 days to 9.2 days since the move to unit 36, with over half of all patients on the unit continuing to be discharged to their home. Overall number of patients admitted and discharged has decreased by 17% with the move to the W21C while the number of patients transferred from the W21C and discharged from another unit has increased by 10%. There was also a slight increase in the total number of ICU stays of patients staying on the unit after the move to W21C.

Summary of Unit 36 Renovations

Unit 36 in the SSB operated as a continuing care 45 bed unit prior to renovations. Transforming the unit into a medical teaching acute care unit meant significant changes to the physical infrastructure. For example, architectural mechanical and electrical activities to develop the unit were to include (amongst others) the following activities (Hutchinson Architects, 2003b, p. 1):

- Convert the majority of existing two bed inpatient rooms into private inpatient rooms
- Provide dedicated washrooms to all inpatient rooms
- Replace the existing continuing care patient lounge with inpatient bed rooms, patient care staff offices and a staff locker/kitchen/lounge area
- Renovate the existing nurse station and support areas to maximize efficiency, safety and care delivery
- Upgrade the floor, wall and ceiling finishes
- Upgrade HVAC to current acute care code requirements
- Provide new washrooms for all inpatient rooms
- Provide new standard medical gas panels to all inpatient beds
- Upgrade power and data to current code requirements, and
- Provide new lighting to public corridors and renovated areas

The Region contracted Hutchinson Architects Inc. as the primary design consultant for the W21C. The design team identified the following key goals (Hutchinson Architects, 2003a, p. 4):

- Provide a flexible unit design to accommodate possible future change
- Increase the number of private inpatient rooms
- Provide all inpatient rooms with washrooms

- Provide an appropriate unit bed count for patient care
- Improve infection control measures
- Maximize/improve efficiency of health care support space

The project's building permit was issued on October 8, 2003 and less than seven months later the construction phase ended with the W21C officially opening on April 29, 2004.

Overall Unit Design

Unit 36 has a gross area of approximately 2050m^2 (not including classroom areas), which is an increase of approximately 45% (or 925m^2) from Unit 61. The type and number of dedicated spaces on the W21C represent a change from what existed in the physical environment both on Unit 61 on Unit 36 before the renovations. The following is a description of the functional areas in the W21C with comparisons to Unit 61. Complete floor layout diagrams of Unit 36 and Unit 61 are available in Figures A3.1 and A3.2 (see pp. 44 and 45).

1. Inpatient Rooms

The typical patient room is approximately 26.5 m2, an increase of 36% (or 9.5m2) from unit 61. The proportion of single patient rooms on W21C is one of the most commonly identified unique design feature compared to standard acute care facilities in the region. Of the 36 beds on W21C, 28 beds are in private rooms, 4 in semi-private, and 4 beds are in a multi-occupancy high observation room (Figure A3.3). The proportion of private rooms has significantly changed with the move from unit 61 to the W21C. Table A3.1 provides a summary and comparison.

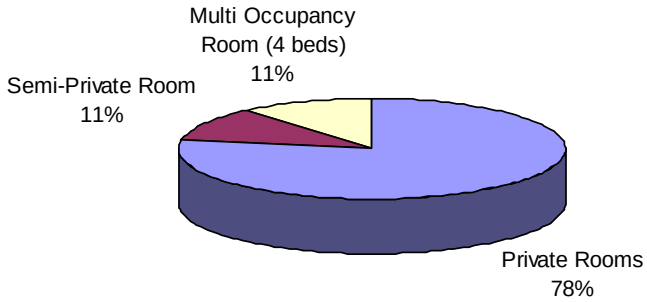


Figure A3.3 Unit 36(W21C) Patient Bed Distribution

Table A3.1 Summary and Comparison of Patient Beds on Unit 61 and Unit 36 (W21C)

	Unit 61		Unit 36 (W21C)		Difference
	Room Count	Bed Count	Room Count	Bed Count	Bed Count
Private Inpatient Rooms	6	6	28	28	79% Increase
Semi-Private Inpatient Rooms	6	12	2	4	67% Decrease
Multiple Bed Inpatient Rooms	5	20	1*	4	80% Decrease
Totals	**17**	**38**	**31**	**36**	

**four-bed high observation room*

Increasing the number of private rooms was a design feature meant to reduce infection risks in association with the ability to physically isolate airborne contaminants using mechanical systems to control unit airflow. The four-bed high observation patient room is designed for increasing patient care needs, an important new design feature for the W21C. Mechanical systems were designed to provide a slight negative air pressure in patient rooms relative to the corridors with the north corridor having an increased capacity to manage air exchanges. The corridor is segregated from the rest of the unit by the elevators (see Figure A3.4), and can increase air exchange rates to provide 12 air changes per hour when the room is in isolation mode (Hutchinson Architects, 2003b). However, the decision to maximize the

number of single patient rooms in this isolation corridor limited implementation of support features such as a housekeeping room or a staff washroom.

Figure A3.4 Isolation Corridor

1a. Dedicated Patient washroom

In response to Regional IP&C guidelines, there was an increase in the proportion of patient toilets to one patient per toilet (Calgary Health Region, 2006) (Table A3.2). This required changing the location of existing toilets and installing additional toilets. While accommodating the 1:1 ratio in the private rooms was possible, the four bed observation room posed a unique challenge. The solution found was to include retractable bedside toilets.

One tub room is provided on the W21C, which meant the loss of one tub room with the move from Unit 61. However a toilet was installed in the tub room on the W21C, whereas previously (on Unit 61) patients had to be transported to the closest washroom outside the tub rooms.

Table A3.2 Summary and Comparison of Washrooms on Unit 61 and Unit 36 (W21C)

	Unit 61		Unit 36 (W21C)		Difference between Units 61 and 36	
	Room Count	Toilet Count	Room Count	Toilet Count	Room Count	Toilet Count
Dedicated Patient Room Washrooms	6	6	28	28	79% Increase	79% Increase
Shared Patient Room Washrooms	8	16	3	3*	63% Decrease	81% Decrease
Totals	13	22	31	31		

** Four bedside toilets provided in the four bed observation room are not included in total; However, toilet in tub room is included*

2. Support Space

Corridors are intentionally wider to provide for hand wash sinks and alcoves to accommodate the computer workstations and increase storage capacity (Figure A3.5). Overall the layout of the corridors is meant to prevent much of the cluttering of hallways experienced in the other buildings on the site. The overall layout and size of the unit is commonly discussed as a unique feature.

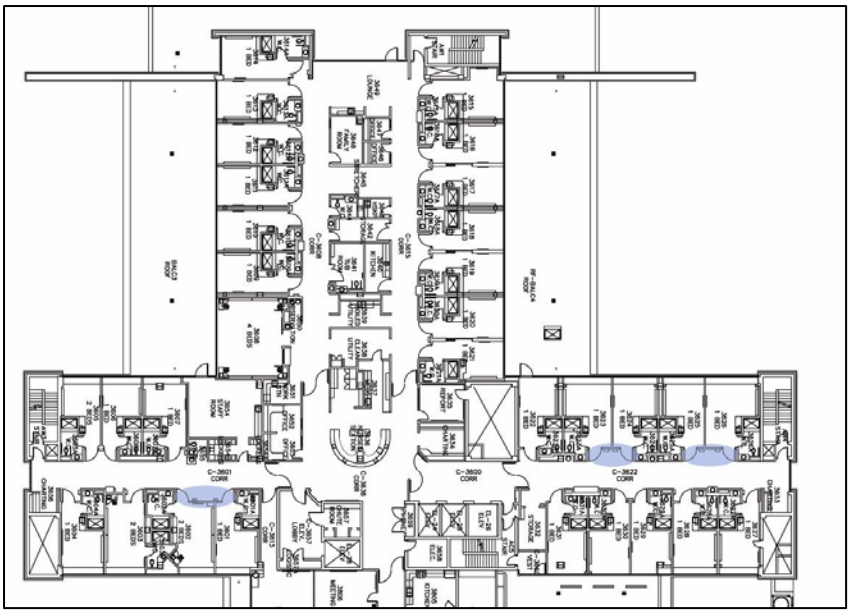


Figure A3.5 Alcoves

With the exception of the charting area utilized by medical teams, charting areas are decentralized and located down each of the unit corridors to locate health care staff closer to the point of care delivery. Figure A3.6 shows the unit charting areas and clinical support space.

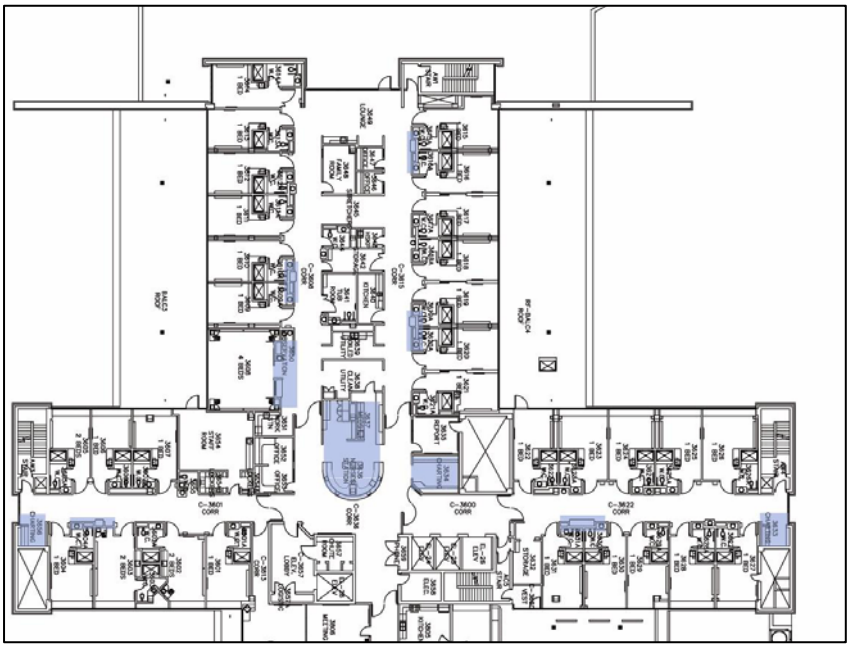


Figure A3.6 Unit Charting and Clinical Support Space

3. Office and Meeting Space

The proximity of and amount of dedicated office and meeting space has increased with the move to the W21C from Unit 61 (Figure A3.7). This has facilitated access to members of the health care team and increased capacity as a medical teaching unit.

Figure A3.7 Office and Meeting Space

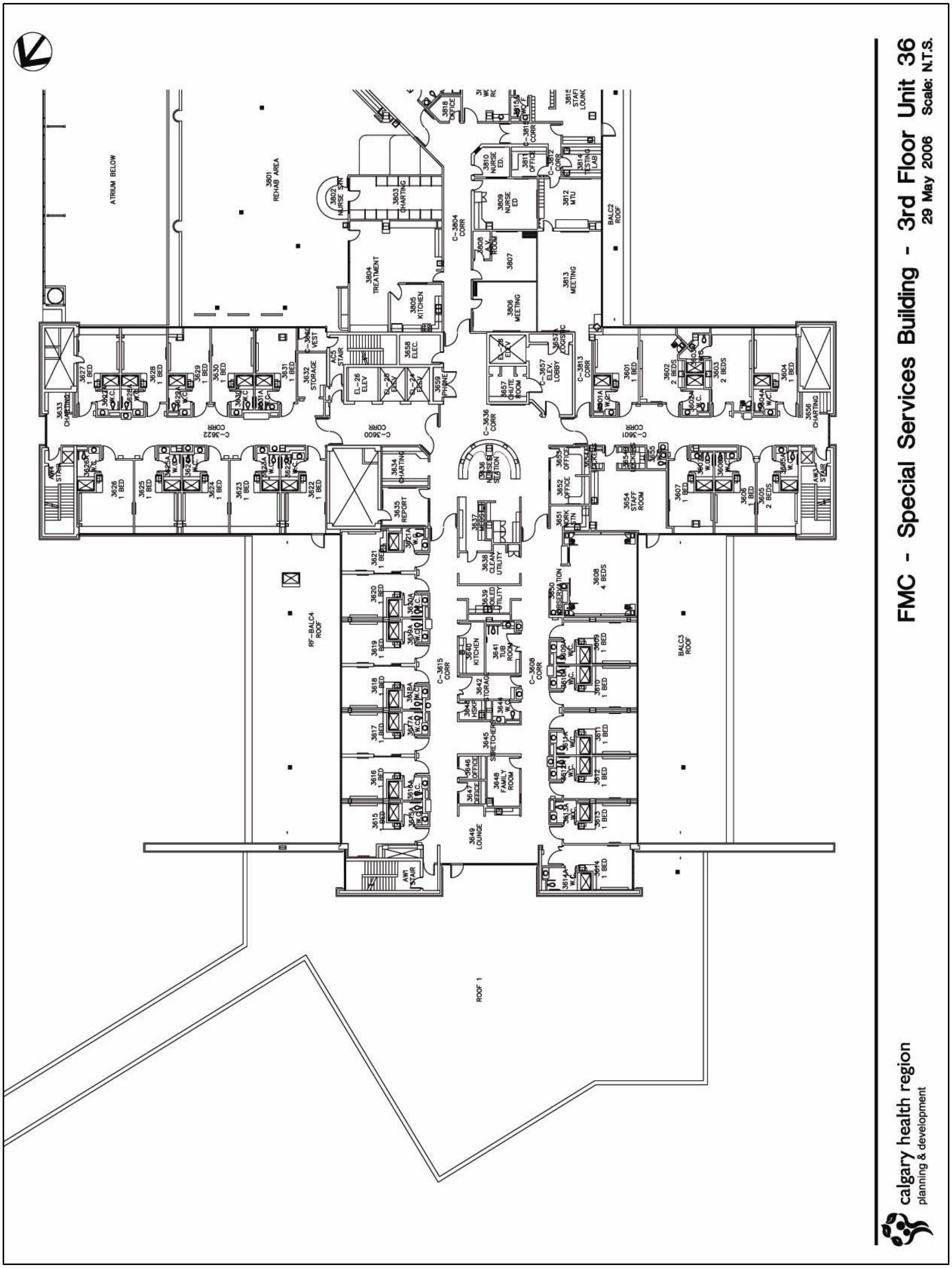


Figure A3.1 Unit 36 (W21C) Floor Layout

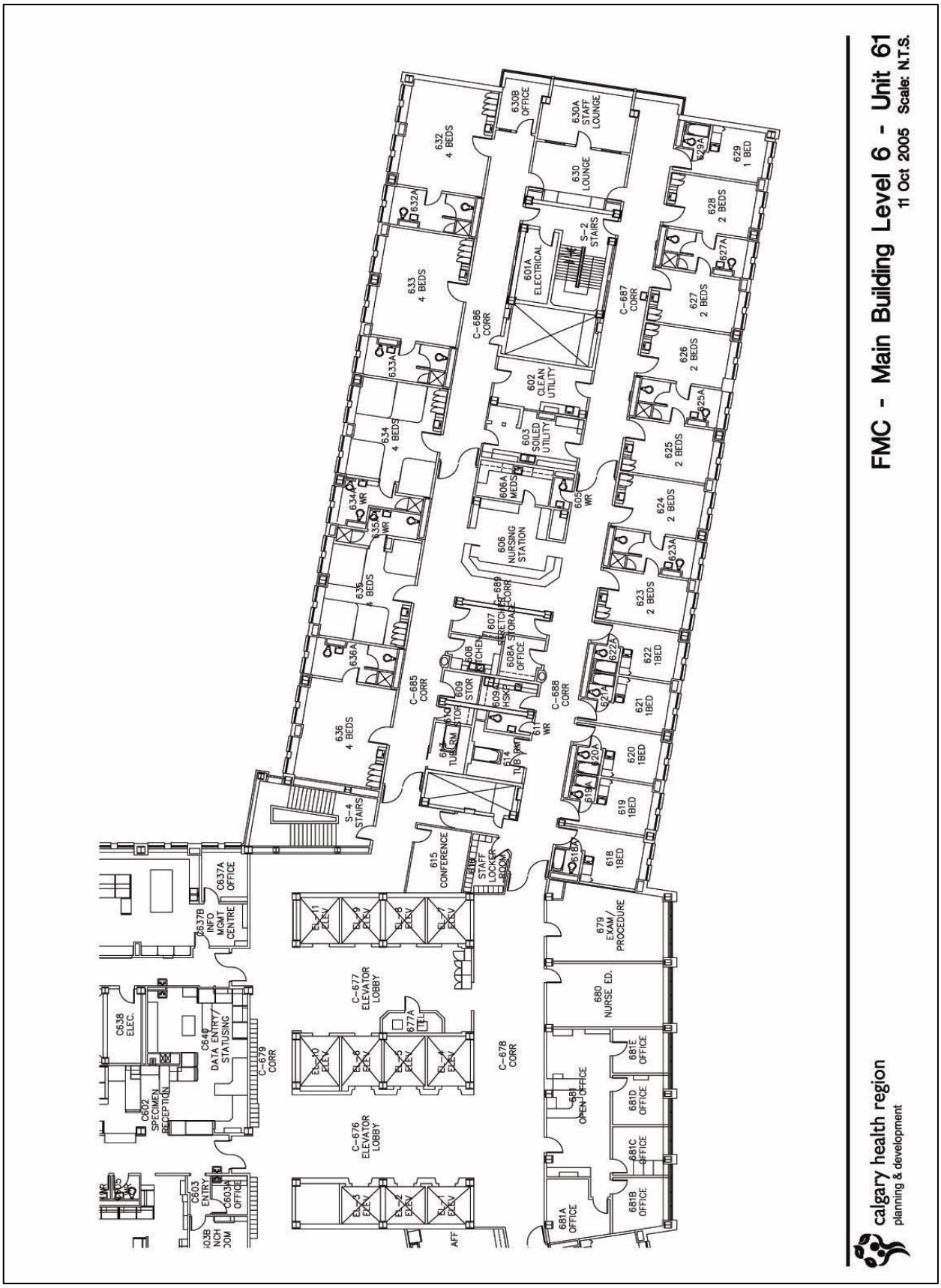


Figure A3.2 Unit 61 Floor Layout

REFERENCES

Alberta Health and Wellness (2005). *Health capital planning manual: The planning and approval process for health major capital projects*. Retrieved July 10, 2006, from http://www.health.gov.ab.ca/regions/Health_Capital_Planning_Manual.pdf

Alberta Hospitals and Medical Care (1984). The planning process for capital projects (2nd ed.). Edmonton, AB: Alberta Hospitals and Medical Care.

Alberta Infrastructure and Transportation (2004). *Integrated health facility information system*. Version 3.031. Edmonton, AB.

Calgary Health Region (2003-2005). Patient care unit activity reports. Retrieved August 8, 2007, from Quality Safety and Health Information, Performance Reporting at http://iweb.calgaryhealthregion.ca/qshi/pu/bed_pcu_reports/bed_pcu_rural_reports.htm

Calgary Health Region (2005). Infection prevention and control: General design guidelines/standards for Calgary Health Region capital projects. Retrieved April 21, 2007, from http://iweb.calgaryhealthregion.ca/ipc/ipc_policies.htm

Canadian Health Services Research Foundation (2004). *Listening for directions II: A national consultation on health services and policy issues for 2004-2007*. Ottawa, ON.

Cohen, R., Standeven, M., Bordass, B., & Leaman, A. (1999). Final report 1: Review of the PROBE process. Retrieved October 20, 2006, from http://www.usablebuildings.co.uk

Commission on the Future of Health Care in Canada (2002). *Building on values: The future of health care in Canada* (Romanow Report). Commission on the Future of Health Care in Canada.

Cooper, B., Ahrentzen, S., & Hasselkus, B. (1991). Post-occupancy evaluation: An environment-behaviour technique for assessing the built environment. *Canadian Journal of Occupational Therapy. Revue Canadienne d Ergotherapie, 58*, 181-188.

Cooper, I. (2001). Post-occupancy evaluation - where are you? *Building Research and Information, 29*, 158-163.

Dettenkofer, M., Seegers, S., Antes, G., Motschall, E., Schumacher, M., & Daschner, F. (2004). Does the architecture of hospital facilities influence nosocomial infection rates? A systematic review. *Infection Control & Hospital Epidemiology, 25*(1), 21-25.

Devlin, A. & Arneill, A. (2003). Health care environments and patient outcomes: A review of the literature. *Environment and Behavior, 35*, 665-694.

Fowler, E., MacRae, S., Stern, A., Harrison, T., Gerteis, M., Walker, J. et al. (1999). The built environment as a component of quality care: Understanding and including the patient's perspective. *Journal on Quality Improvement, 25*, 352-362.

Friesen, R., Newton, J., Boughen, G., & Hewitt, P. (1996). The operating room: Perceptions of a change in working environment. *Today's Surgical Nurse, 18*(4), 9-18.

Friesen, S. (2006). Functional performance evaluation guidelines for capital projects in health care. Alberta Infrastructure and Transportation, Post Occupancy Evaluation Task Force. Edmonton, AB.

Friesen, S., Wardell, R., Suter, E., Cullen, J. & Scott L. (2006, November) Post occupancy evaluation of the southern Alberta forensic centre: A case study. Unpublished report. Calgary Health Region. Calgary, AB.

Gescher, J. (2004). Ward of the 21st Century: Design principles and post occupancy evaluation planning and capital development. Calgary Health Region. Calgary, AB.

Gilpin, L. (2005). Twenty-five years of Planetree design. *Health Care Design*, September 28.

Green Guide for Health Care (2005). *A best practices guide for healthy and sustainable building design, construction and operations*. Version 2.1, September 2005. Retrieved November 2, 2005, from http://www.gghc.org

Green, S. & Moss, G. (1998). Value management and post-occupancy evaluation: Closing the loop. *Facilities*, *16*, 34.

Hamilton, K. (2004). Hypothesis and measurement: Essential steps defining evidence-based design. *HealthCare Design*, *4*, 43-46.

Hamilton, K. (2003). The four levels of evidence-based practice. *HealthCare Design*, *3*, 18-26.

Health and Welfare Canada (1992). *Hospital post occupancy evaluation methodology*. Institutional and Professional Services Division Health Services Directorate Health Services Branch. Ottawa, ON: Health and Welfare Canada.

Health Canada (2001). *Construction-related nosocomial infections in patients in health care facilities*. Canada Communicable Disease Reports (2752). Retrieved April 21, 2007, from http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/01vol27/27s2/index.html

Health Quality Council of Alberta (2006). *Health quality framework*. Retrieved April 14, 2006, from http://www.hqca.ca/

Holtz, M. (2005). Phase 4: Construction – commissioning. In Preiser W. & Vischer J. (Eds), *Assessing Building Performance* (pp.62-71). Burlington, MA: Elsevier.

Hutchinson Architects Inc. (2003a). *Inpatient Unit 36 - SSB Foothills Medical Centre functional program*. Calgary, AB.

Hutchinson Architects Inc. (2003b). *Foothills Medical Centre SSB Unit 36 renovation: Design development report.* Calgary, AB.

Joseph, A. (2006). The role of the physical and social environment in promoting health, safety, and effectiveness in the healthcare workplace. *Center for Health Design*, 3. Retrieved September 4, 2007, from http://www.healthdesign.org/resources/pubs/

Kennon, P., Bauer, J. & Parshall, S. (1988). Evaluating health care facilities. *Journal of Health Administration Education*, *6*, 819-831.

Kotaka, F. & Manildo, F. (1999). The importance of worker, staff and patient participation in hospital evaluation. *World Hospitals and Health Services, 35,* 20-23.

Lackney, J. & Zajfen, P. (2005). Post occupancy evaluation of public libraries. *Library Administration and Management, 19* (1), 16-25.

Pati, D. (2005). Maximizing the benefits of courtroom POEs in design decision support and academic inquiry through a unified conceptual model. Doctoral dissertation, Georgia Institute of Technology (UMI No. 3170094).

Preiser, W. (2002). The evolution of post-occupancy evaluation: Toward building performance and universal design evaluation. In *Learning from Our Buildings: A State-of-the-Practice Summary of Post-Occupancy Evaluation*, Federal Facilities Council Technical Report No. 145 (pp. 9-22). Washington, D.C.; National Academy Press.

Preiser, W. (1984). The habitability framework: A conceptual approach towards linking human behaviour and physical environment. *Design Studies*, *4* (2), 84-91.

Preiser, W., Rabinowitz, H., & White, E. (1988). *Post occupancy evaluation*. New York: Van Nostrand Reinhold Company Inc.

Premier's Advisory Council on Health (2001). *A framework for reform: A report of the Premier's Advisory Council on Health* (Mazankowski Report). Edmonton, AB.

Quality worklife quality healthcare collaborative (2007). Within our grasp: A healthy workplace action strategy for success and sustainability in Canada's healthcare system. Retrieved on December 4, 2007, from Canadian Council on Health Services Accreditation at http://www2.cchsa.ca/QWQHC/files/2007QWQHC-WithinOurGrasp.pdf

Reyes, L. (2003, April). IM/IT project charter: Ward of the 21st Century clinical informatics. Calgary Health Region.

Shamian, J. & El-Jardali, F. (2007). Healthy workplaces for health workers in Canada: Knowledge transfer and uptake in policy and practice. *Healthcare Papers*, *7*, (*Spec No)*, 6-25.

Stichler, J. (2007). Using evidence-based design to improve outcomes. *Journal of Nursing Administration*, *37* (1), 1-4.

The Cohos Evamy Partners (2001). Foothills Medical Centre Special Service Building: Conversion from auxiliary to acute beds. Calgary, AB.

Ulrich, R. & Zimring, C. (2004). *The role of the physical environment in the hospital of the 21st century: A once in-a-lifetime opportunity*. Report to the Center for Health Design for the Designing the 21st Century Hospital Project, 1-69.

Vischer, J. (2002). Post-occupancy evaluation: A multifaceted tool for building improvement. In *Learning from Our Buildings: A State-of-the-Practice Summary of Post-Occupancy Evaluation*, Federal Facilities Council Technical Report No. 145 (pp.23-34). Washington, D.C.: National Academy Press.

Zagreus, L., Huizenga, C., Arens, E., & Lehrer, D. (2004). Listening to the occupants: A web-based indoor environmental quality survey. *Indoor Air Supplement*, *14* (Supplement 8), 65-74.