Fostering the Connection to Nature
Through Urban Elementary School Design

by

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A practicum submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements of the degree of

MASTER OF INTERIOR DESIGN

Department of Interior Design
University of Manitoba

Winnipeg

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Abstract

Nature deficit disorder is a term used to describe an alienation from nature that is impacting urban youth. This alienation has been attributed to several factors including a growing dependence on digital media and television, combined with heightened parental concern about crime and safety. The main focus of this investigation is how the interior design of an elementary school can foster a connection to nature and inspire children to develop a long-term commitment to environmental sustainability. Specifically, bio-inspired and sustainable design is applied in a matrix of age-appropriate direct, indirect and symbolic experiences to create a closer connection to nature and to improve emotional, intellectual and spiritual well-being.

Key Words

nature deficit disorder, alienation from nature, bio-inspired design, sustainable design, experiential learning, place-based education

Acknowledgements

I would like to acknowledge my committee members, specifically Kelley Beaverford, Katherine Isaac and Dietmar Straub, for your generous support and insightful guidance. A special thank you to Kelley Beaverford for your encouragement to pursue this degree to the end.

I would not have been able to complete this practicum without the constant support from family and friends. I would especially like to thank my husband and best friend, Frank, and my children, Alix, France and Brennan. Your unquestioned support and faith in my ability to finish this practicum always provided me with the inspiration to continue towards completion. I would be remiss if I did not thank all my friends for your ongoing support and encouragement to see this practicum through to the end. Thanks to Pat and Brent Miller for sharing their lake images of wildlife. My thanks as well to Tyler Schurko of the Winnipeg School Division for providing drawings of Strathcona School.

Finally, I would like to recognize the funding that I received that supported my graduate studies: the University of Manitoba Roy C. Rettinger Graduate Scholarship and the Stantec Interior Design Fellowship.

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Chapter 1. Introduction

1.1 Purpose

The term, nature deficit disorder, was coined by Richard Louv in 2008 to describe the growing trend of alienation from nature, particularly for urban youth. This alienation was attributed by Richard Louv (2008) and Rhonda Clements (2004) to a growing dependence on digital media and television, combined with heightened parental concerns about crime and safety, and the resulting reluctance to allow children to venture outdoors unsupervised. Since the late 1990s, however, studies have documented the importance of creating a bond with nature for physical, mental and spiritual health for people of all ages. A connection to nature has been found to not only enrich physical, psychological and spiritual health, but also have therapeutic and restorative effects. In the absence of a connection to nature, can the indoor environment be designed to create this connection?

> School buildings are exciting if the inside becomes the outside and the outside becomes the inside. For instance, by studying on benches in the garden or by bringing trees into the school.
>
> Michaela Stegerwald, Architect (Verstegen, 2009)

The purpose of the project is to design an urban elementary school interior environment in which the designed interior fosters a connection to nature and furthermore, inspires children to become stewards of their environment. Research has shown that exposure to nature and the resulting emotional, intellectual and ethical development of biophilic values can be addressed through a matrix of experiences, direct, indirect and vicarious (Kellert, 2005). The intent of the project is to design an interior environment that will offer such a matrix of experiences, resulting in a closer connection to nature, and in improved emotional, intellectual and spiritual well-being.

An additional objective of the project is to meet the Public School Finance Board *School Building Space Standards* (November, 2012). According to the standards, Strathcona School requires a multi-purpose room and a kitchenette, which are currently non-existent. In addition, the library space is undersized and requires expansion. The creation of the Green Commons in a new space will allow Strathcona School to meet the requirements for these spaces, as well as provide an opportunity to meet National Building Code of Canada (2010) requirements for barrier-free access which are currently not met.

The proposed fictional client for the purposes of this practicum is the Winnipeg School Division, which has identified the need to foster a closer connection to nature for the students attending Strathcona School, an elementary school in the inner city of Winnipeg, Manitoba. The Winnipeg School Division in the inner city serves children and families from many diverse backgrounds, cultures and beliefs (Winnipeg School Division, 2013). The school, located at 233 McKenzie Street, is in the William Whyte neighbourhood (Figure 1.1), characterized by a high prevalence of low income families and an elevated population "that are, or had been at one time, landed immigrants in Canada" (Winnipeg School Division, n.d., p. 22). The area surrounding Strathcona School is predominantly residential, with intensive industrial areas, including the Canadian Pacific Railway Yard, located to the southwest of the school.

Figure 1.1. Location of Strathcona School within the William Whyte Neighbourhood in the North End of Winnipeg. Reproduced with permission from OpenStreetMap®, licensed under the Open Data Commons Open Database License (ODbL) by the OpenStreetMap Foundation and the Creative Commons Attribution-ShareAlike 2.0 license (CC BY-SA).

Few natural spaces can be found in in the immediate vicinity of Strathcona School; Taras G. Shevchenko Park, located southeast of Strathcona School, is the only green space (Figure 1.2). There is, however, an abundance of large trees in the urban forest surrounding the school on the north, west and south sides and lining the streets in all directions. In addition, the asphalt surface of the centre courtyard of Strathcona School has been transformed into a Folly Forest, an award-winning forest and play space.

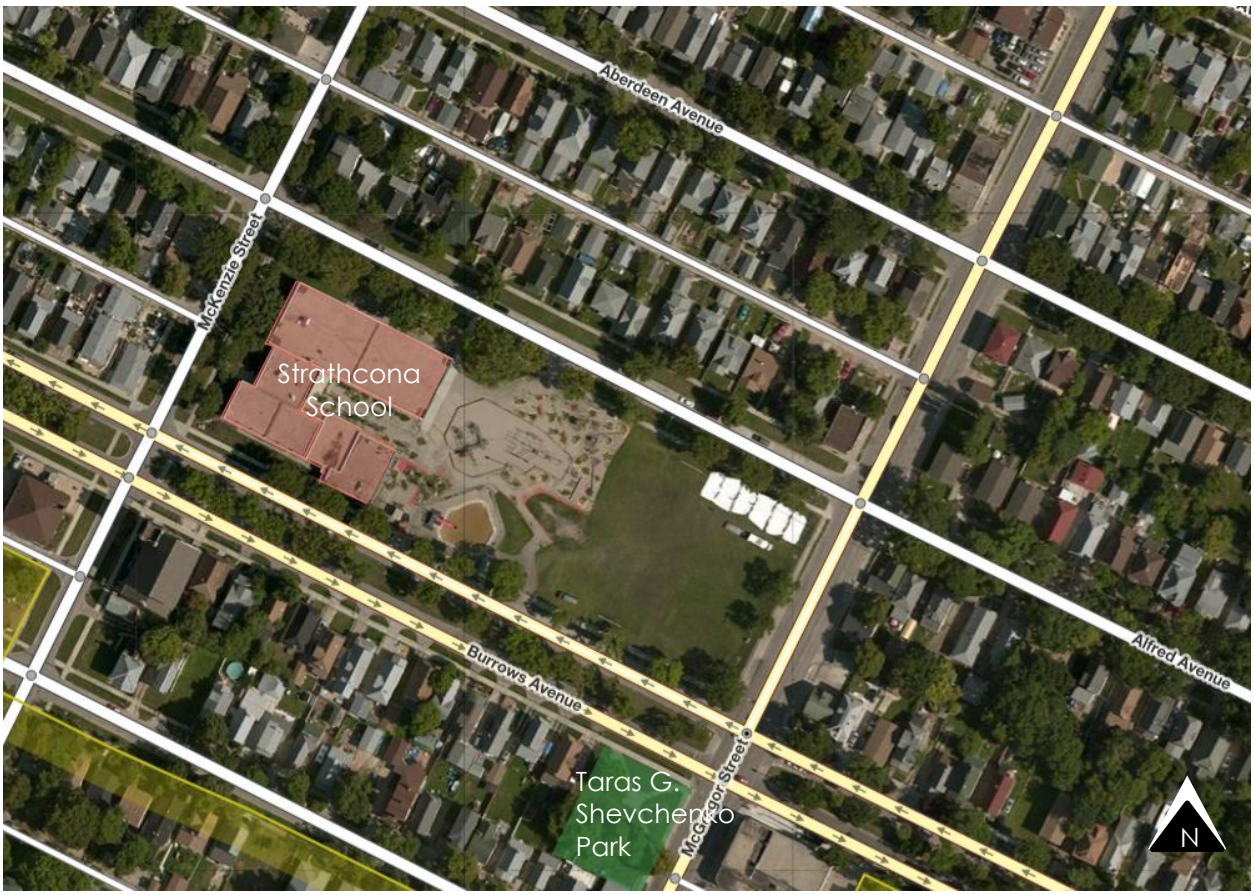


Figure 1.2. Aerial view of Strathcona School and surrounding green space and urban forest. Reproduced with permission from OpenStreetMap®, licensed under the Open Data Commons Open Database License (ODbL) by the OpenStreetMap Foundation and the Creative Commons Attribution-ShareAlike 2.0 license (CC BY-SA).

1.2 Questions of Inquiry and Major Theoretical Underpinnings

To inform and guide the design of the interior of Strathcona School to foster a closer connection to nature, the following research questions will be investigated:

1. What conditions foster interaction and experiences that become embedded in the learning processes of children?
2. In what ways can the interior design of a school help children to learn about nature and help resolve the problem of nature deficit for children in urban environments?
3. How can learning in a classroom environment foster environmental stewardship beyond the classroom?

To manage the scope of the project, the focus was placed on three major theoretical underpinnings to influence the design as follows: nature deficit disorder; development theory and place-based education; and developing pro-environmental attitudes. In designing an interior to foster a closer connection to nature, it was important to understand nature deficit disorder and the resulting impacts to health. Since the project is being undertaken in an elementary school, a basic understanding of development theory and how children learn was also required. In this way, the design elements that encourage learning about nature are age-appropriate to optimize potential learning. The importance of place-based education in learning about nature has also influenced the design of the interior in meeting the project objective. Finally, it is important to not only address nature deficit disorder in the present, but a greater objective was to find a way of incorporating a long-term change of behaviour.

1.3 Key Terms

Nature: "the phenomena of the physical world collectively, including plants, animals, the landscape, and other features and products of the earth, as opposed to humans or human activities" (Nature, 2017)

Nature deficit disorder: alienation from nature (Louv, 2008)

Bio-inspired design: design inspired by the characteristics of natural landscapes and living organisms (Heerwagen, 2003)

Place-based education: a learning process that occurs in the local environment, which can be the home, school or neighbourhood (van Eijck, 2010)

Stewardship of the environment: taking responsibility for the use and protection of the natural environment, conserving its values, through recycling, conservation and restoration (Land Stewardship Centre, n.d.)

1.4 Research Methods

The research methods for this project consisted of a literature review and analysis of theories; an investigation of precedents educational in typology and a brief review of International Style architecture; an acoustical analysis; and light studies. The literature review examined nature deficit disorder, its causes and the health benefits of experiencing nature. Richard Louw, Rachel Kaplan, Steven Kaplan and Robert Ryan conducted research on the growing loss of connectivity to nature and on the physical, psychological and social benefits of experiencing nature. To apply appropriate learning techniques to the reintroduction of nature into the school environment, development theory was examined, particularly as it relates to school-aged children from 5 to 12 years of

age. Jean Piaget, Peter Kahn and Stephen Kellert each examined methods of learning in children's development and the importance of age-appropriate learning experiences. These findings influenced the design to provide learning opportunities for all age groups. Finally, the importance of place-based education as it relates to restoring the natural environment was examined to optimize conditions for learning for all age groups. The Emilia Reggio program and findings from several researchers including Margaret Grose, Elizabeth Prescott, Judith Heerwagen and Gordon Orians, also influenced the design strategies to promote learning about nature in the space through bio-inspired and sustainable design. These design strategies also provided educational opportunities about nature, thereby developing pro-environmental attitudes and creating a life-long appreciation and passion for nature.

1.5 Summary

The interior of Strathcona school will foster a connection to nature and inspire children to become environmental stewards. To inform and guide the design, three research questions were investigated. To address the research questions, the research methods included a literature review and analysis of theories; an investigation of precedents educational in typology and a brief review of International Style architecture; an acoustical analysis; and light studies. The focus was placed on three major theoretical underpinnings that would influence the design: nature deficit disorder; development theory and place-based education; and developing pro-environmental attitudes. The resulting interior

environment offers a matrix of experiences, creating a closer connection to nature, and an improved emotional, intellectual and spiritual well-being for children at Strathcona School.

Chapter 2. Literature Review and Analysis

2.1 Introduction

The term, nature deficit disorder, was introduced by Richard Louv in 2008, to describe the growing alienation from nature for urban youth. To address nature deficit disorder at Strathcona School, a basic understanding of development theory for children from kindergarten to grade 6 was necessary to inform the design of the interior and the types of experiences that can be created to optimize learning of nature principles. It was also important to determine how best to create an environmental ethic and pro-environmental attitudes that would carry beyond the formative years. To achieve the project goals, the document and the design were informed through a literature review and the study of precedents. This information was used to help determine the interior design features that would be most effective in addressing nature deficit.

The literature sources were focused in three areas: nature deficit disorder and its impacts; learning and development; and appropriate design for elementary schools. Information from the literature review was used to analyze the precedents and to determine how to apply the design principles to Strathcona School to create a space that would make the children feel connected to, and appreciative of, nature; provide opportunity to learn about nature; and make them life-long stewards of the environment. As stated by David Sobbel (2004)

children must be taught to love nature to develop a life-long environmental protection ethic.

2.2 Nature Deficit Disorder

Louv (2008) maintains that urban youth are not connected to nature today. He describes the evolution of experiencing nature moving within one hundred years from "direct utilitarianism to romantic attachment to electronic detachment" (p. 16). Reduced amounts of leisure time for families, increased access to televisions and computers, and a growing obesity among both adults and children are among the effects observed in numerous studies. In her research, Rhonda Clements (2004) also found that children in the U.S.A. spent less time playing outdoors than previous generations, because of a greater dependence on television and digital media, combined with increased parental concerns about crime and safety.

Studies have shown that exposure to nature can be therapeutic for illnesses and disorders. Rachel Kaplan, Stephen Kaplan and Robert L. Ryan (1998), discuss recovering from mental fatigue, decreased attention span and irritability by experiencing restorative natural environments. They describe the experience with a natural environment broadly, ranging from hiking in a forest, watching wildlife, viewing nature through a window, tending house plants, or gardening. Nancy M. Wells and Gary W. Evans (2003) reported that levels of stress were

reduced and feelings of self-worth were improved in children exposed to nearby natural elements, and a room with a view of nature helped to protect children against stress. Rhonda Clements (2004) also discussed the value of play in nature in alleviating stress in children and improving self-esteem. She ascribes play in nature to several forms including collecting natural items, jumping over small obstacles, or creating hiding places; the key feature is that the imagination is stimulated, choices are self-motivated and there are few or no restrictions on noise or activity. Finally, Frances E. Kuo and Andrea Faber Taylor (2004) conducted a national study of over 450 children in the U.S.A. diagnosed with attention deficit/hyperactivity disorder (ADHD) and concluded that activities in nature appeared to significantly reduce symptoms as compared to other activities. Exposure to nature might be used to augment medication and for those children who cannot tolerate medication, "a regular regime of green views and green time outdoors might offer the only relief from symptoms" (p. 1585).

Kaplan, Kaplan and Ryan (1998) also found that the restorative effects from experiencing a natural environment were more likely to occur when one felt safe and secure in their environment, and could become engaged with the environment, allowing the mind to wander and be quietly fascinated and reflective. This quiet fascination could be achieved from an interior space; as an example, viewing the change of seasons from a window or the antics of squirrels

or birds perched on a tree can engage the mind in a quiet observation of nature. The eye focuses without effort, the mind wanders and reflects, and the viewer has the sense of being in a different space.

Louv (2011) challenges the individual to discover the restorative powers of nature and to establish a more balanced lifestyle in both private and public life. Louv demonstrates how the nature principle and "reconnecting to the natural world is fundamental to human health, well-being, spirit, and survival" (p. 3) results in an improved way of life – at work, at play and at rest. Louv raises awareness about a current issue that society is facing today – our obsession with technology and electronic devices to the detriment of experiencing nature. Research on the senses - auditory, visual, intuition and latent - and the dulling of these senses is associated with continuous partial attention in technological work, contrasted to the full attention of all senses when present in nature.

Louv (2011) identifies seven key concepts about the transformative powers of nature, which can help us reshape our lives, and allow the human race to move into the future. These concepts include:

1. balancing time invested in technology with time in nature;
2. enhancing physical and mental health with daily doses of nature (Vitamin N);
3. utilizing both technology and nature experience to increase creativity and productivity;

4. building human/nature social capital in urban regions;
5. recognizing natural history in our sense of place;
6. integrating biophilic design into our homes, workplaces and communities; and lastly,
7. conserving and creating natural habitat in our homes, schools and places of work and play.

By reconsidering the future of our actions, and collectively recommitting to environmentalism and sustainability, the net effect will be that this will evolve into a larger environmental movement that will impact on every aspect of society, worldwide (Louv, 2011).

Balancing time between technology and nature not only enhances intelligence, but is essential to our ability to be attentive, to focus our thinking, to be productive and creative, as shown in studies of the exposure to nature (Louv, 2011). Initially, Rachel and Stephen Kaplan (1989) reported that exposure to nature improved recovery from mental fatigue, focusing of attention and processing of information. Their definition of nature was broad and not restricted to pristine natural areas such as national or provincial parks. Rather, nature was defined inclusively as follows: "Nature includes parks and open spaces, meadows and abandoned fields, street trees and backyard gardens. We are referring to places near and far, common and unusual, managed and

unkempt, big, small, and in-between, where plants grow by human design or despite it." (p. 2).

Ulrich *et al.* (1991) also studied the physiological responses to stress in different everyday outdoor environments. The researchers found physiological evidence that recuperation was faster and more complete when stressed individuals were exposed to natural settings, as compared to urban settings. The quickness of recovery in the natural setting was found to be particularly significant, since in urban environments, most experiences with nature could be characterized as short-term. Encounters with nature in an urban setting could include viewing trees through a window or having lunch outside. The researchers concluded that "short duration nature exposures might have an important function for many urbanites in facilitating recovery from such stressors as daily hassles or annoyances" (p. 224).

This work was further substantiated in studies by Terry Hartig, Marlis Mang and Gary W. Evans (1991). Their studies provided convincing evidence of the restorative functions of experiences in natural environments. In addition to an immediate salutary effect, recovery from metal fatigue and recovery of attention were noted, even as a result of short-term exposure on site or via simulation.

In her article, "Children and Nature Deficit Disorder", Martha Driessnack (2009) summarizes the current research on studies of the deprivation of direct contact with nature and free play outdoors, substituted by exposure to electronic media for 6.5 hours a day on average. She reports that the growing nature deficit in children contributes to several health problems ranging from obesity to increased stress, anxiety and depression. Conversely, the exposure of children to nature has been found to positively impact personal, intellectual and social development, with the effects persisting long after participation (Kellert, 2005).

2.3 Development Theory

In addition to understanding nature deficit disorder, a basic understanding of development theory is required to apply appropriate learning techniques to different developmental stages. Jean Piaget, a recognized expert in child development and psychology, has found that "children adapt to the world through assimilation and accommodation. Assimilation is the process by which a person takes material into their mind from the environment, which may mean changing the evidence of their senses to make it fit. Accommodation is the difference made to one's mind or concepts by the process of assimilation" (Sully, 2012, p. 72). Piaget further theorizes that learning results when there is an interaction between an individual and his/her experience within the environment (Sully, 2012). This is important for the children of Strathcona School,

who can be taught about nature through the design of, and interaction with, the interior of the school.

For this research project, I focused on the later three stages of development applicable to the school-aged children at Strathcona School: pre-operational stage (five to seven) – limited logical thinking and egocentric; concrete operational stage (seven to eleven) – logical thinking; and formal operational stage (twelve and older) – abstract thinking and deductive reasoning (Bentham, 2004). Bentham also describes several different styles of learning that are applicable to all stages of development - learning can be visual, auditory or kinesthetic (tactile), or combinations thereof; learning can be with supervision or independent; learning can be done alone or in groups (Bentham, 2004). The design facilitates several different styles of learning to accommodate various stages of development.

Peter J. Kahn examined the interaction of children from elementary school to college, in five separate cross-cultural studies, with their physical and social environment (2002). His theoretical approach was centered on a structural development framework theory in which he concluded that interaction with a physical or social environment led to conceptual understandings and values (structures); these early forms of understanding in young children got transformed into more comprehensive understanding and values as children

matured. Kahn's theory is consistent with Jean Piaget's theory of assimilation of information, which leads to accommodation and learning. In his structural development studies, Kahn defined nature as nature that exists within the children's world; in the urban environment, this constituted insects, pets, plants, trees, wind, rain, soil and sunshine. Based on his research, Kahn recommended engaging children in environmental education; maximizing the exploration of nature; and maximizing the interaction with nature, as he defined it. The implication is that if children do not get this exposure early, the basic concepts are not translated into more in-depth understanding with maturity.

Stephen R. Kellert (2002) also studied methods of learning in children's development and the types of experiences that would contribute to learning. He defined cognitive learning as thinking and problem solving; affective learning as emotion and feeling; and evaluative learning as the creation of values. In his research, Kellert found that experiential contact to nature, both direct and indirect, can exert a significant impact on cognitive development. This was especially important during middle childhood and early adolescence. During this stage, children are learning to label, differentiate and classify many features of nature. Observations strengthen a child's ability to observe, examine, to think and problem-solve.

Symbolic contact is also important, which Kellert describes as "insufficiently appreciated and recognized" (p. 123). He uses children's books as an example where images are drawn from nature to name, classify and count. Images are associated with naming and categorizing, which suggests an importance in cognitive learning. Studies by Rachael Wells and Pauline Davey Zeece (2007) also showed that children can learn about the environment through literature, when supplemented with place-based education. They maintain that well-chosen literature can be used by educators to teach children about the linkages between culture and the environment that they experience daily. Age appropriate and scientifically accurate literature can help children understand their place in, and their connection, to nature. Stories and books can also be used to inspire a commitment to environmental protection; however environmental facts must be presented to children in a manner that relates to their way of thinking and learning.

Piaget further discusses the importance of literature in learning. In the pre-operational stage (five to seven years of age), characterized by limited logical thinking and egocentricity, children typically view animals as having anthropomorphic characteristics and feelings (Bettelheim, 1976). At this stage, literature can anthropomorphize an animal, while simultaneously teaching the child about its habitat, an example of symbolic contact.

Cognitive learning was also observed in children's affective development in middle childhood and adolescence. Receiving facts and responding to these facts led to the development of values that became organized into a set of values and beliefs, that is, a philosophy of life (Kellert, 2002). Direct contact with nearby nature allows the child to explore, imagine and discover nature, while simultaneously developing the self and individual identity. Affective learning is not limited to direct contact with nature, but is also enhanced with indirect and symbolic contact with nature. As children enter middle childhood, stories and myths drawn from nature "provide extraordinary opportunities for psychosocial growth and development" (Kellert, 2002, p. 135). Piaget's discussion of learning during concrete operational stage (seven to eleven years of age) discusses how children can apply logical thinking to their analysis of stories and begin to understand that stories can be fictitious (Bettelheim, 1976).

Evaluative learning, the third and final stage in the development of the values of nature, occurs in the age group from 13 to 17 years. In this stage, direct contact with nature through participation in outdoor programs contributes significantly to evaluative learning (Kellert, 2002). Piaget describes this stage as the formal operational stage (twelve years of age and older), whereby literature can also be used to initiate abstract thinking and deductive reasoning about environmental science (Bettelheim, 1976).

The influence of different types of experiences on learning and development are summarized in the chart below:

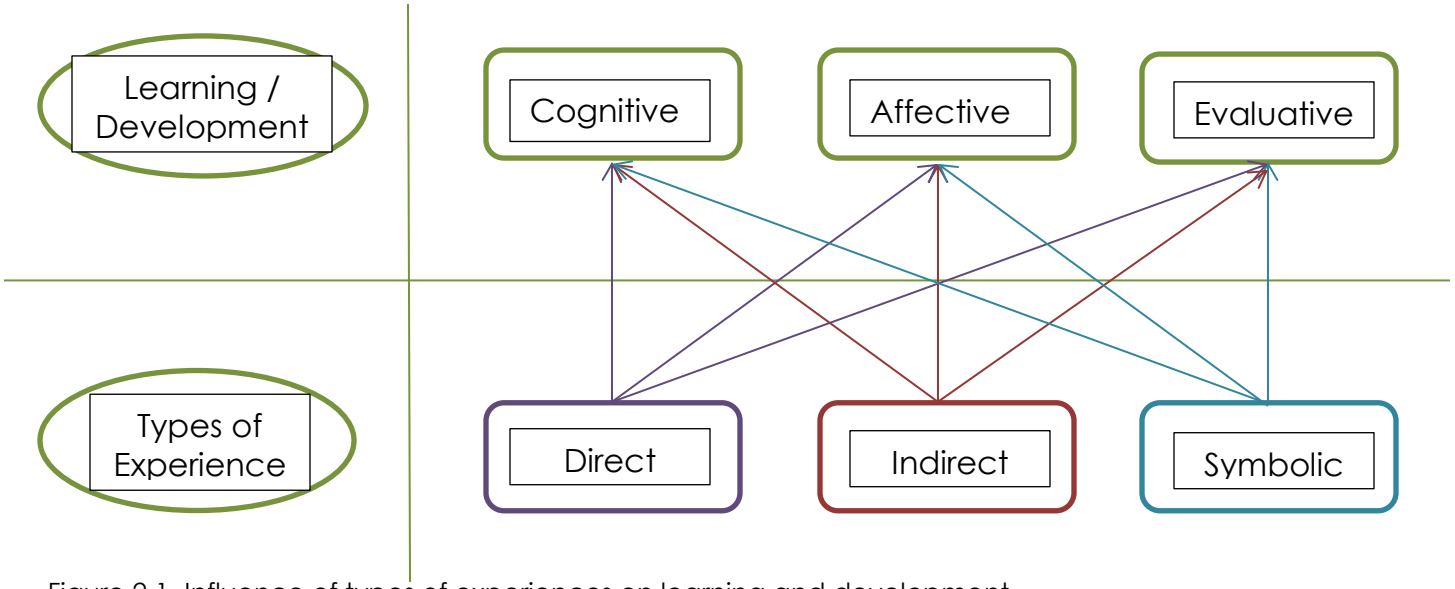


Figure 2.1. Influence of types of experiences on learning and development.

However, Kellert (2002) concludes with ambivalence towards the contributions of indirect and symbolic exposure to learning and development. All learning benefits from a mix of the types of exposures to nature, but indirect and symbolic contact to nature do not adequately substitute for direct encounters with nature. Daniel Levi and Sara Kocher (1999) have also studied the impact of experiencing nature virtually. They concluded from their research that exposure to spectacular natural environments increased the level of support for national parks and protected areas, but failed to increase support for local natural areas. The exposure to virtual nature did provide additional benefits to the viewers, including positive psychological effects such as stress reduction. However, Levi and Kocher recommended further study of virtual exposure to nature in a broader setting. This would include the study of children's responses

to technology and virtual nature. A better understanding of the adaptive responses to a technologically dominated world and virtual environments is needed. In the absence of this research, I proposed a combination of direct, indirect and symbolic exposure to nature in the interior environment of Strathcona School.

2.4 The Importance of Place-based Education

Louv (2008) discusses the benefits of place-based education to students, also referred to as environment-based education in his book, in which teaching and learning is conducted in place. This concept, developed by Loris Malaguzzi from 1963 onwards, is known as the Emilia Reggio system, in which spaces for children are recognized as "a fundamental part of the complex development support system which enables young children to learn" (Dudek, 2007, p. 12). The Emilia Reggio model has been recognized as one of the best programs for early childhood education for several reasons. The Reggio program recognizes the importance of the physical environment in creating optimal conditions for learning, also referred to as place-based education. The environment needs to be flexible and adaptable, stimulating, yet comfortable, allowing for a range of interactions from intimate spaces for one or two, to small and large group settings. The spaces need to be designed to display children's artwork and projects. Strong connections between the indoors and the outdoors are further recommended, as well as the use of natural light. In addition, furnishings should

be appropriately scaled. Comfortable and properly-dimensioned furniture is important for both comfort and concentration for school age children. In their research, Jurng, Shin and Amor (2010) have noted the importance of applying anthropometric data to the design of children's furniture in the absence of regulation or standard dimensioning. Applying anthropometric data in design is however complicated due to many factors: firstly, the main source of anthropometric data is over 20 years old, and body dimensions for children have changed over the past two decades; secondly, children have gained more weight in the last decades, resulting in different body proportions; and thirdly, current anthropometric data must consider differences across nationalities. In the absence of regulation, manufacturers of children's furniture have developed guidelines for the design of furniture. The appropriate dimensions for chairs and tables/desks for children of varying ages, as recommended by Capital Area Woodworkers (n.d.) and Community Playthings (2015), are listed in Table 2.1:

Dimensions for Furniture Design			
Child's Age (Years)	5 to 7	8 to 10	11 to 13
Seat Height	305 to 355 mm (12' - 14")	330 to 430 mm (13" – 17")	380 to 460 mm 15" – 18"
Table Height	560 to 635 mm (22" – 25")	610 to 735 mm (24" – 29")	660 to 760 mm (26" – 30")

Table 2.1 Recommended dimensions for children's furniture design

In the Reggio program, architecture is fully integrated with pedagogy. A learning environment that is more complex and varied offers a richer level of understanding and knowledge. Dudek (2007) describes a Reggio school building as an environment that encourages interaction between the user and the space, and becomes a workshop for experimentation and learning. This learning is consistent with Montessori, Waldorf and Foxfire school experiences, all of which are proponents of experiential learning, which has spawned place-based education world-wide.

Michiel van Eijck (2010) more recently described place-based education as a "teaching-learning process that centers on what is considered local – usually students' own "place", that is, their immediate schoolyard, neighborhood, town, or community" (p. 187). Using this teaching approach, improvements have been documented in scholastic scores and problem-solving, critical thinking and decision-making skills. Place-based education has also been found to enhance the feeling of self and the connection to community. Semken and Brandt (2010) state that the connection that is made when making meaning in a place through place-based education is often an emotional attachment that may lead to a desire to preserve or protect the place. Although place-based education has an exterior focus, studies of botany in greenhouses and indoor gardens have also contributed to student gains (Louv, 2008).

Experiential learning in these programs, based on hands-on contact between children and natural elements, has been reported to produce non-linear results that are not immediately visible or measurable. However, extensive studies of children in school spaces with diverse natural elements reported that the children were more physically active, aware of nutrition, displayed greater creativity and were more socially inclusive (Bell and Dyment, 2006). The benefits were not limited to the children, but also extended to teachers who felt renewed teaching in nature.

Margaret J. Grose (2011) discusses new programming, such as the "No Child Left Inside", the "Children and Nature Network", and the "Open Air Laboratories Network", that has been instituted to ensure that children move back into nature. In this type of programming, children get to experience being physical outdoors, benefitting from fresh air and natural environments. Rachael Wells and Pauline Davey Zeece (2007) also recognize that a cognitive transformation is required in early childhood education. Place-based education provides the opportunity in which children develop a better understanding and appreciation of the natural environment in which they live and interact with daily. As noted previously, this position is supported by many educators, including Clifford E. Knapp (2014), who shares the philosophy, which has been widely adopted, that educators need to provide meaningful contextual experiences, in both natural and constructed environments, as a complement to classroom instruction.

Carol Simon Weinstein and Thomas G. David (1987) also shared a belief that the physical dimensions and the design of the classroom had important effects on the students' behaviour and attitudes. To get a better understanding of the impact of the classroom environment on the developmental process, they set about to resolve two questions:

1. How do children interact with the built environment?
2. How can the design of spaces be guided by knowledge of children and the development process?

When studying human development, and particularly, the formation of self-identity, physical settings, *i.e*. spaces and places, must be considered. Place identity, as a substructure of self-identity, consists of the combined thoughts, memories, values, preferences and meanings acquired in relation to a person's physical world in daily life. In addition to the actual experiences with the physical environment, place identity and consequently self-identity, are influenced by the social meanings attached to the physical environment by others.

With the increased number of working parents and single parent households, children are now spending more time in school-like settings from an early age. Although the home setting is instrumental in the development of a child's place and self-identity, the school is both a social and physical setting of considerable importance in place-identity development. The impressions, attitudes and beliefs

respecting the physical conditions required for learning are developed through the child's repeated exposure to the school setting or similar environment over several years. Over successive years, the child learns behavioural strategies to optimize his or her learning style. Children have different requirements for social interaction, social withdrawal, privacy, and movement. It is therefore imperative that the physical space be designed to be sufficiently complex and rich to meet as many different requirements as possible. Proshansky and Fabian (1987) suggest that although the opportunities for exploration, manipulation and innovation in the physical environment are limited in the school setting, schools should be designed to provide spaces that "belong" to a child and allow free movement during certain times. Spaces should be created to allow students to decorate and personalize their classroom spaces.

In the Netherlands, from 1990 to 2008, as learning evolved from lecturing to active learning, the traditional school design of rows of classrooms connected to hallways was found to be unsatisfactory. Dutch architects responded to this shift in education through spatial design that removed the emphasis on teacher and study material, and placed it on the student, geared towards activities (Verstegen, 2009). The increase in activities is expressed in the concept of an open learning environment, with demarcations and overlaps of spaces. As an example, a hallway can function not only as a traffic area, but as a meeting place, a place to socialize and a transition space to learning areas. Verstegen

(2009) maintains that the spatial layout can help to reinforce certain behaviours in a space; a bridge or landing allows students to see and be seen, encouraging more social interaction and increasing the urge to explore the space. This articulated space becomes more informal, moving away from the rigidity of the traditional school with an institutional atmosphere. Perkins (2001) recommended the creation of "activity pockets" (p. 23), whereby low walls, different floor finishes or low storage units could delineate activity areas. Edges could further be defined using furnishings, columns, colours, lighting, ceiling and floor level changes.

The quality of the physical space was also assessed by Elizabeth Prescott (1987); five variables including organization, variety, complexity, amount to do and special problems were examined. Conclusions were reached on three of these variables that have applicability to school spaces, namely organization, variety and complexity. In the first variable, organization, Prescott found that clear and well delineated paths, as well as adequate empty space, were important for children to appreciate and use the space, as were variety, which referred to the number of possible activities in a space (*i.e.* climbing, swinging, building), and complexity, which referred to the ability to manipulate and alter the space. Prescott further concluded that it was important for designers to create settings for children that provided them with the sense of being in nature. This was particularly significant because of the diversity that nature provides and its feeling of

timelessness. These are the places that create memories. As stated by Elizabeth Prescott in her comment about child-rearing environment, "it is not only a place of continuity and stability for children but also a place where adults can remember the enchantments of childhood" (p. 87).

Another factor to consider is that as children begin to move independently and explore place and their environment, they begin to look for spaces that provide safety and protection (Heerwagen & Orians, 2002). This theory was initially proposed by an English geographer, Jay Appleton and referred to as "prospect-refuge theory" (1975). According to Appleton, people preferred spaces where they were at the edge, protected from the rear, and covered, rather than open to the sky. Such spaces would provide overhead refuge with permeable boundaries to allow exterior views, allowing one to be seen without being seen. Appropriate selection of refuge would have been key to survival for early man. Judith H. Heerwagen and Gordon H. Orians (2002) also propose that this behaviour would have allowed the child to play and explore his or her environment while evading predation during the evolution of humans and ensuring the natural survival of the human species. A refuge providing safety would have been of prime importance as the child focused on play rather than on the hazards of the surrounding environment. Therefore, they further propose that young children will naturally seek places of refuge in the environment, whereas older children will naturally create or shape places of refuge. In nature,

this could be a tree with a canopy, or a broad shrub that allows the child to sit within it.

This finding has been supported in research conducted on children's play behaviour in various places, both indoors and out. "Refuge is a recurring spatial motif which weaves its way through childhood. " (Kirkby, 1989, p. 11). MaryAnn Kirkby further states that refuge symbolism can be found in each of Piaget's developmental stages of play – practice games with infants, such as peek-a-boo, in which the blanket or hand briefly creates a sense of refuge; symbolic games with toddlers, such as pretending that a table represents a castle and hence a refuge; and games with rules, such as hide-and-seek by school-aged children, where good hiding places are characterized by their quality as a refuge. The concept of refuge changes as children mature, their skills increase and their territorial range expands. In the preschool setting, children aged four to six prefer to play in small-scale areas that are partially enclosed in groups of two to five (Kirkby, 1989), whereas in later years, this preference provides the foundation for interaction on a large scale.

Based on her research, Kirkby (1989) proposed guidelines for the construction of built environments for pre-school children that offered the sense of refuge being sought by children. Key features for the preferred refuge included a ceiling effect, enclosures with sub-spaces or high degree of complexity, and visual

connections to surrounding spaces. Children also favoured refuges with multiple access points, allowing opportunities to escape and safety, and refuges with a high degree of flexibility and manipulation. Refuges incorporating these features were found by Kirkby to be more responsive to the development needs of young children, with children engaging in more imaginative and dramatic play.

Judith H. Heerwagen and Gordon H. Orians (2002) suggest that older children would prefer to build refuges. Between the ages of seven and eleven, Roger A. Hart (1989) substantiated this finding in his research, concluding that older children spent substantial amounts of time modifying the landscape to build refuges. The building of forts required the collaboration of several children and evolved to include the building of trails for enhanced wayfinding and establishing multiple viewing locations for visual surveillance. However, Heerwagen and Orians (2002) report that preferences exhibited naturally by children for play have not been considered in the design of schools and playgrounds, which have essentially remained the same for the past fifty years. In many schools, children sit in classrooms facing teachers or in clusters of desks.

2.5 Developing Pro-environmental Attitudes

By replicating natural systems, educational opportunities are created to expose students to nature during the school day and to promote a better understanding and appreciation of nature. Sustainable design could be used as

an opportunity to enhance understanding of the impact of buildings and their operation on natural resources and the environment, as well as how an individual can make choices with respect to protecting the environment. This approach is particularly relevant to the growing awareness of environmental issues and the efficient use of natural resources that have led to the movement of sustainable design, use of green building materials and products and environmental certification programs (Kopec, 2009). According to David W. Orr (1994), education that supports and nurtures respect for the environment would help children to become literate about environmental issues and to better understand the importance of ecology on a global scale. With understanding of the linkages between people and nature would come a commitment from an early age of the need to make knowledgeable decisions about the use of natural resources and environmental protection, not only at the local scale, but globally.

David W. Orr (1994) further proposes that first-hand knowledge of nature would fuel the passion that is required to want to protect biological diversity. This can be achieved by integrating environmental considerations in architecture and design of educational institutions, such as water purification systems, energy conservation, material selection, etc. As stated by Stephen J. Gould (1991), "We cannot win this battle to save species and the environment without forging an emotional bond between ourselves and nature as well – for we will not fight to

save what we do not love". It is only reasonable that this passion for nature be developed as soon as possible, and early education provides such an opportunity.

Richard Louv (2011) also proposes new paths for reconnecting with nature, maintaining that a reconnection to nature also leads to an awareness of environmental issues and is key to growing an informed and committed environmental movement. Louv maintains that encouraging personal reconnection with nature leads to more engagement with global environmental issues. He states: "Passion is lifted from the earth itself by the muddy hands of the young; it travels along grass-stained sleeves to the heart. If we are going to save environmentalism and the environment, we must also save an endangered indicator species: the child in nature" (Louv, 2008, p. 159). Although hands-on experience of nature is one way of connecting to nature, Louv (2008) also encourages the reading of nature inspired literature, as do Rachael Wells and Pauline Davey Zeece (2007), as an important influence that can rekindle enthusiasm for the natural world.

Janine M. Benyus (2002) is also of the opinion that re-immersion in the natural environment is required to reconnect and to recreate the "spontaneous environmental rapport" (p. 288) that was characteristic of our ancestors. Benyus notes that children today are immersed in the virtual world and may never

experience the discovery of natural treasures in the natural environment. This discovery in a natural environment does not need to take place in a park or forest, but can simply be a place where nature can be observed – a playground with trees, a garden plot, a lawn. Allowing children to have unstructured blocks of time where they can experience the natural world, making mud pies, discovering insects and worms, finding bird nests, prepares them for the creation of environmental rapport and a realization that we are all part of the natural world.

With this understanding comes a commitment to stewardship of the environment and the preservation of the diversity of life on the planet. Benyus (2002) states that our partial knowledge of nature, combined with a humility about how little is known about natural systems, should prompt us to embrace stewardship and sustainable use of natural products. Learning about the natural world and becoming enthralled with its workings and intricacies will result in a longing to be reconnected with and respectful of nature. Chickasaw author Linda Hogan (1996) also calls for a healing between humans and nature, which can be achieved through a reconnection of humans with nature; this reconnection begins by reconsidering how humans see themselves in context to the rest of nature. In the essay, "The Kill Hole", from her book *Dwellings,* Hogan states: "Caretaking is the utmost spiritual and physical responsibility of our time, and perhaps that stewardship is finally our place in the web of life, our work, the

solution to the mystery of what we are" (p. 115). Addressing nature deficit in children is the first step in creating this reconnection with nature; as the child discovers with awe nature's mysteries and develops a respect for nature, a life-long steward of the environment who understands the place and role of humans in nature, is born. In his research, David Sobel (2004) also found that for children to develop an environmental protection ethic, they must first be taught to love nature.

Proponents of place-based education are expanding their thinking to the construction of "green schools", in which the construction of the school itself can be used as a lesson in ecology, energy conservation, water conservation, or other environmental benefit as appropriate (Louv, 2008, p. 221). Green schools have been described as living laboratories, whereby exposure daily to sustainable design and practices results in thinking and acting environmentally as a way of life. In addition to promoting occupant health, comfort, well-being and productivity, the U.S. Green Building Council states that a green school can help students connect to their environment and serve as a teaching tool (USGBC, 2009). In their project management guide, the U. S. Green Building Council establishes standards in relation to existing schools, such as Strathcona School, for sustainable sites, water efficiency, energy performance, water management, materials and resource management and indoor air quality. These standards can serve as a tool for hands-on learning about the

environmental and economic benefits of sustainable practices, putting into practice the concepts of experiential learning promoted by Peter Kahn, Stephen Kellert, Richard Louv, Margaret Grose, Maria Montessori, and many other educators.

2.6 Addressing Nature Deficit Disorder through Bio-inspired Design

If children and adults can be stimulated to learn through an exposure to nature, how can school buildings and grounds be designed to optimize learning and performance? As shown in the theoretical framework (Figure 2.2), the design and sustainability of Strathcona School encourages learning and experiences that address nature deficit disorder and create a connection to nature.

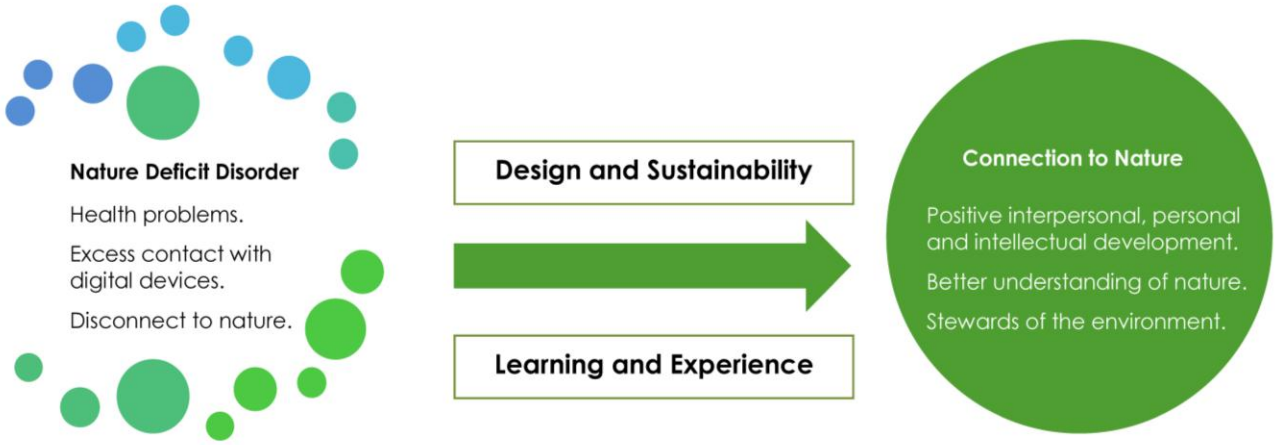


Figure 2.2. Theoretical framework for fostering the connection to nature.

One design option proposed by Louv (2011) is for practitioners of restorative design to bring the outside in. Practical tips include the use of birch trees in interior design, reproducing nature sounds, integrating stuffed animals, posters of wildlife and plants. Louv describes incorporating vertical gardens or living walls indoors, the use of natural decorations, energy conservation features and earth-friendly materials; the creation of good views from the inside; and re-thinking the yard, encouraging the concept of urban agriculture. He further recommends that we should "tune down the decibels, turn down the lights and turn on the senses" (p. 181) to resist some of the barriers to our connection with nature.

Studies by Roger S. Ulrich *et al.* (1991) found that individuals that were stressed returned to baseline conditions within ten minutes in natural settings, suggesting that even short-term exposure to nature in an urban environment, such as viewing trees through a window, could provide "restoration". Even viewing images of nature or watching fish in an aquarium made people relax, like the effects of experiencing natural environments. Daniel Levi and Sara Kocher (1999) also investigated the use of virtual nature in experiencing nature in a simulated environment. They reported that even still photographs elicited psychological responses like the responses experienced by exposure to actual nature. They further concluded that the desire to experience nature "may be partially satisfied through the use of virtual nature" (p. 209). Design options could therefore include images of nature and aquariums.

Stephen Kellert examined children from middle childhood to early adolescence to assess the developmental impacts of direct, indirect and vicarious or symbolic exposure to nature (Kellert, 2002). In his research, Kellert defined direct exposure as "actual physical contact with natural settings and non-human species" (p. 118). This exposure is usually unplanned and can be characterized by spontaneous play outdoors, which can be a back yard, a forest or a park. Indirect exposure was defined as "actual physical contact but in far more restricted, programmed, and managed contexts" (p. 119). Examples would include trips to zoos, aquariums, nature centres, natural science museums, and exposure to pets and domesticated animals, plants, gardens, crops and orchards. Symbolic or vicarious exposure to nature included "representations or depicted scenes of nature that sometimes are realistic but that also …can be highly symbolic, metaphorical, or stylized characterizations" (p. 119). Symbolic exposure can occur through communication media, *i.e*. television, film and computers, but also through print media such as books and magazines. Direct exposure to plants and gardens, and symbolic exposure through communication can be integrated into the design.

According to David W. Orr (1994), classrooms should encourage ecological awareness and creativity with materials, light, sound, water, spatial configuration, plants, animals and views to the exterior; these elements would provide good educational environments for learning. This would translate into

spaces that are appropriately scaled, and that combine nature with interesting architecture, natural lighting and the sounds of nature – an indoor place that feels like you are in nature. The interior environment of the school is designed to allow an interaction and an experience that also creates and teaches children in various developmental stages about the value of nature and instills a life-long passion for nature.

> *"the schoolhouse should not fight the forces of nature; it should work with nature to provide comfort"*
>
> *"the schoolhouse should not be divorced from nature; it should harmonize with and take advantage of all that nature has to offer"*
>
> *(Caudill, 1954, p. 54)*

Suzanne Scott (1992) and Heerwagen (2003) also found that preferred settings mimicked nature with organic shapes and curvilinear spaces defined by soft, rounded forms and irregular layouts. Heerwagen referred to design which incorporates the forms and attributes of nature as "bio-inspired design". In addition to opportunities for refuge and organic shapes, bio-inspired design would include natural daylight and views to the outdoors. Just as refuge was important to early man, Heerwagen suggests that preference for natural daylight also was key to information gathering and survival. This continues to be relevant today for many reasons: identifying objects, indicating time and weather. She states the importance of natural light as follows:

> "To summarize, light provides information for orientation, safety and surveillance, interpretation of social signals, identification of resources, and

> awareness of hazards. Whether it is the changing color of light associated with sunset or storms, the movement of fire or lightening, the brightness in the distance that aids planning and movement, or the sparkle of light off of water – all of these aspects of light have played a role in helping our ancestors make decisions about where to go, how to move through the environment, what to eat, and how to avoid dangers" (p. 5).

Other elements and attributes of nature that can be incorporated into bio-inspired design include heraclitean movement; complexity; repetition of natural forms; and multi-sensory experiences (Heerwagen, 2003). An interior that incorporates heraclitean movement, motion that is constant but predictable and therefore calming, could feature an aquarium, or views of clouds. Complexity could be achieved by providing sub-spaces or zones that encourage sensory exploration and multi-sensory experiences (sight, touch, odor, sound and taste).

2.7 Addressing Nature Deficit Disorder through Sustainable Design

Environmentally responsible or sustainable design can be used to complement bio-inspired design. Torres-Antonini and Vatralova (2012) recommend several options for green schools: increasing natural and mechanical ventilation; improving indoor-outdoor connections through daylight and views; enhancing acoustical performance; and using of environmentally friendly materials for paints and coatings, flooring and furniture, as well as selecting ecologically certified products.

2.7.1 Increasing Natural Ventilation

Natural ventilation has been documented as improving productivity, learning and health, and can be a sustainable and energy-efficient means of providing natural ventilation to occupants (Morton, 2015). Natural ventilation results in a more environmentally friendly building, with lower energy consumption and lower costs, as well as increased occupant satisfaction, making it a viable alternative (Maldonado, 1998). An additional benefit to natural ventilation is the improvement of air quality, reducing potential VOCs and CO_2 concentrations. In addition, the use of natural ventilation during the daytime helps to maintain thermal comfort by providing a direct cooling effect over the body through convection and evaporation (Allard, 1998).

Shading devices should be specified to allow airflow, taking into consideration the direction of the prevailing winds. Drafts can be controlled by designing windows with multiple openings or that can be partially opened. User knowledge can be addressed by ensuring teachers and students are able and willing to open and close windows in response to changes in indoor and outdoor conditions.

Morton (2015) suggests that since passive ventilation is difficult to introduce as a retrofitting option, a less costly renovation is to introduce operable windows, provided that certain elements do not compromise air quality or energy costs. The first consideration is climate, since operable windows are best suited to moderate climates. Although Winnipeg does experience severe cold during many months of the year, there are sufficient days when the weather would permit opening of windows. Long-term historical averages based on climate data from 1981 to 2010 show that Winnipeg enjoys, on average,13 days per year with temperatures over 30 degrees Celcius, 110 days per year with temperatures over 20 degrees Celsius, and 184 days per year with temperatures over 10 degrees Celcius. If July and August are excluded to account for school closure during the summer, there remains 4 days with temperatures over 30 degrees Celcius, 53 days with temperatures over 20 degrees Celcius, and 122 days with temperatures over 10 degrees Celcius, distributed as follows:

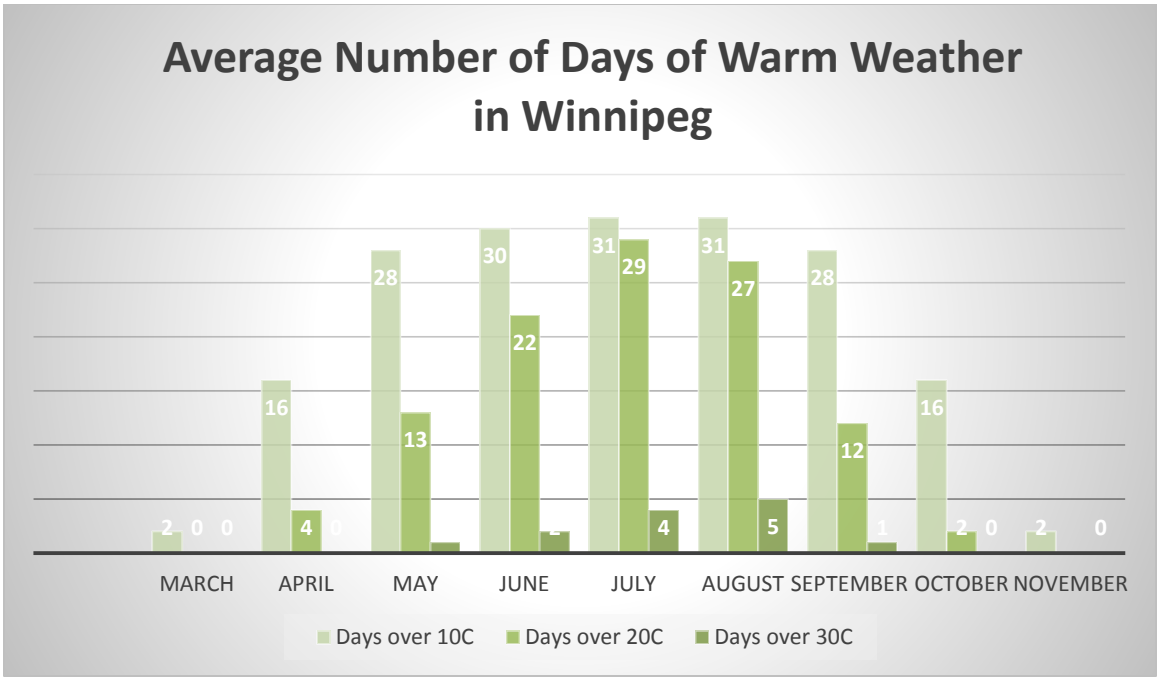


Figure 2.3. Climate data for Winnipeg showing average number of days per month exceeding 10◦, 20◦ and 30◦ Celsius (Current Results, 2015).

In addition to climate, outside air quality is another determinant as to the suitability of operable windows. The Province of Manitoba reports that recent monitoring for air quality in Winnipeg shows that the health risks associated, as measured by the Air Quality Health Index (AQHI), average three or lower. The AQHI is based on the risk of three combined air pollutants, ground level ozone, particulate matter and nitrogen dioxide, on a scale from 1 to 10. AQHI values of 1 to 3 present low health risks and ideal air quality values for the general population (Government of Manitoba Environmental Programs & Strategies, n.d.).

Maldonado (1998) also identifies several critical barriers that are unrelated to thermal performance, but may nevertheless impact negatively on natural ventilation strategies. These include barriers during operation of the building such as safety, noise, shading, drafts and user knowledge. These concerns can however be mitigated through a few solutions which are outlined by Maldonado. Safety can be addressed by protecting windows with bars appropriately spaced, screening, placement height of windows, by limiting the size of the opening or using laminated glass.

Priolo (1998) also discusses design guidelines and technical solutions for natural ventilation, which includes the site location and orientation; the building form; the size and location of openings; and the design and operation of openings and screens. Since air flows created by natural ventilation are dependent on wind pressure and temperature changes, Morton (2015) also discusses the need to evaluate the site for cross-wind and the stack effect to determine which façade will receive the most wind and result in the most benefits. Windows and openings need to be strategically located in the building envelope to get natural ventilation. In addition, draft-inducing chimneys in the roof, extensions or fins to increase pressure differentials in windows may be required to maximize ventilation. To optimize natural ventilation, operable windows need to be located on the façade perpendicular to air flow patterns from the prevailing winds and on the opposite façade to allow for cross-ventilation airflow.

Morton (2015) also states that operable windows only benefit spaces that are close to the perimeter, unless mechanical assistance, such as ceiling fans, is provided. Open plans facilitate air movement, and automated systems can help to control opening and closing of windows. However, since cost is an issue, full automation of the operable windows will not be pursued. In this case, Morton recommends relying on occupants to open and close windows, ensuring that the windows are within reach and easily accessible, easy to operate and not blocked from access. Manual controls will allow occupants to choose the most appropriate settings and to implement them when required. According to Maldonado (1998), occupants who manually control natural ventilation usually accept a wider variation of conditions, a key factor since airflows in buildings will vary over a wide range with climactic change.

Finally, Maldonado (1998) provides recommendations with respect to the position and the size of operable windows as follows: outlet openings should be the same size or larger than inlet openings; openings should be placed at occupant height for occupant cooling; and openings should be placed closer to the walls, ceilings or floors for structural cooling, with cooling of the ceilings more effective than cooling of the floors.

Priolo (1998) also discusses the importance of landscaping in controlling air movement and optimizing natural ventilation. Vegetation can provide shelter

from wind and can funnel and accelerate air and air conditioning. The placement of high-stem trees along a façade will decrease air velocity at the canopy level of the trees and allow the airflow to pass and accelerate near the ground, then enter the building. In addition to increased air movement below the canopy, the quality of air as it travels beneath the canopy is conditioned. The heat content of air crossing a barrier of vegetation is decreased and the humidity is increased, inducing a cooling effect.

2.7.2 Improving Daylight and Views

Research has shown that performance in classrooms is improved by 20 to 25 percent with daylight (Dudek, 2007; Karlen and Benya, 2004). Views to the exterior and natural surroundings are also important, as they have been shown to result in positive effects on mental, physical and emotional health. In an open learning environment with a variety of activities, it might be necessary to create different lighting strategies for different activities. Perkins (2001) also reported on the importance of lighting as a crucial factor in a school environment, not only in terms of energy costs, but also because of its effect on learning and performance. Boubekri (2007) also reported on the direct correlation between the presence of daylight, circadian rhythm and the performance of students, stating that studies showed that "the presence of daylight in the classroom was crucial to the preservation of this rhythm and the body's natural clock" (p. 34). The presence of daylight was found to trigger the release of certain hormones

at certain times that help learning. In addition, children who were in windowless classrooms for entire school days were found to suffer from restlessness and irritability, symptoms of Seasonally Affective Disorder. Finally, Boubekri (2007) found that properly designed schools with adequate daylighting reported fewer absences and greater productivity in students than poorly designed schools, an indicator of the importance of daylighting for students.

In a school, optimal lighting will allow for change depending on the activity and the time of year (Perkins, 2001). Recommended illumination levels in school range from 30 foot-candles (323 lux) for reading of print material to 100 to 200 foot-candles (1076 – 2153 lux) for special exhibits; if higher levels are needed for specific activities such as shops or sewing, task lighting can be used to increase the illumination. The average light reflectance value (LRV), defined as the measurement of a material's ability to reflect light, should be in the range of 50 to 60%. Furniture and equipment typically have LRV values in the range of 40 to 50%, floors in the range of 20 to 30%, and ceilings in the range of 90 to 100%. Perkins also recommends uniform brightness ratios (the difference between average light emitted, transmitted or reflected from surfaces and the visual field) be low and not exceed 3 to 1 between a task and adjacent surroundings. This ratio will provide the maximum visual comfort and minimize eye strain. Perkins also suggests that the colour of walls can help to relieve eye strain and glare, recommending colours in the cool range of greens and blues.

Karlen and Benya (2004) recommend daylighting, the utilization of natural light to its fullest, as an excellent light source for schools and spaces requiring lots of light. The amount of natural light varies with the time of day, time of the year, weather and pollution. Although the maximum amount of daylight available on a sunny day is in the order of 10,000 foot-candles (107,639 lux), only about 5%, or 500 foot-candles (5,382 lux), should be allowed into a building to avoid heat generation and need for cooling. To optimize the use of daylighting, there are several factors that need to be considered such as the orientation of a building to optimize solar exposure; selecting fenestration to permit the proper amounts of light to enter depending on the season, weather and solar cycles; using shading devices to allow occupant control; and designing proper lighting controls. To harvest the energy saving benefits of daylighting, occupants need to be able to either switch off or dim electric lights.

According to Karlen and Benya (2004), top lighting (*i.e.* skylights and clerestory windows) is one of the most common ways of introducing daylight. The best option is to introduce clerestory windows along the north façade to prevent direct solar radiation and associated heating problems as would occur with a southern exposure; the aperture can be quite large to permit abundant daylight in the space. Top lighting can be supplemented with side lighting to introduce natural light. The effective area that can be day lighted by a window is

approximately twice the width of the window and 2 to 2.5 times its height. Karlen and Benya (2004) state that although side lighting can cause glare, this is offset by the benefit of views to the outside. In addition, low-e glazing in commercial windows reflect infrared energy while allowing the visible portions of the sun's energy to pass, minimizing solar heat gain. Solar shading can also be used to prevent direct solar radiation from entering the space, both on the exterior and the interior of the building.

In the interior, blinds, curtains and shades can provide solar shading. However, interior solar shading on the east and west façades required in the early morning or late in the day in the summer months will block views to the exterior (Karlen and Benya, 2004).

2.7.3 Improving Acoustic Control

Good acoustic control in a space is important for many reasons: unwanted or disturbing sounds are attenuated; desired sounds are heard properly; and reverberation, defined as "the persistence of sound after the cause of sound has stopped" (p. 156) is short to avoid echo, yet long enough for sound blending (Perkins, 2001; Caudill, 1954). Baumann and Niederstätter (2007) discuss sensory perceptions and the importance of good acoustics as follows: "Rooms with excessive sound insulation may induce breathlessness, unease and fatigue because perceptible spatial dimensions have been lost…Seldom do we

consciously perceive acoustics unless they are unpleasant" (p. 28). Sound triggers emotions as various parts of the brain are activated. Good acoustics may produce "a liberating and invigorating effect" that promotes communication and concentration, a principal factor in a school environment where children actively explore their acoustic environment.

Background noise levels and reverberation can both be controlled through design. For the best reception of sound (speech and music) within a frequency range of 60 to 40,000 Hertz, the ideal reverberation time is 0.7 seconds for speech, and 0.4 to 1.2 seconds for music (Baumann and Niederstätter, 2007). The use of moveable absorptive surfaces such as reflecting or absorbing partition walls, upholstered seating or curtains, can create a multi-use space that can accommodate speech and music. Perkins (2001) recommends the application of acoustic control to the surface that is closest to the occupants at all times. For example, when the length or width of the space is greater than the height of the ceiling, then acoustic control should be placed on the ceiling, since the ceiling is the surface that is closest to the occupants at all times. In this example, an acoustical ceiling tile with a noise reduction coefficient (NRC) of 0.7, at a minimum, would provide the required acoustic control.

Caudill (1954) discusses the impacts of architectural shape on noise. Concave walls focus sounds to certain parts of a room. Parallel walls and parallel floors

and ceilings cause sound to bounce back and forth between the surfaces. Caudill therefore recommends a few measures to improve hearing: tilt chalk boards and bulletin boards; use and shape walls to reflect and disperse sound; install sound boards hanging from the ceiling; and enclose performance stages.

2.7.4 Material Selection

In a school environment, material selection is critical. Not only should materials selected be durable and easy to maintain, they need to be able to provide an environment that is conducive to learning. Institutional settings such as schools are often associated with vinyl tile floors, painted concrete block walls and fluorescent lighting (Perkins, 2001). Although these materials are durable and easy to maintain, they do not convey feelings of home. Contemporary materials can provide more desirable design options, combining more beautiful aesthetics with durability to withstand years of abuse and yet, be designed with sustainability in mind. Sustainable products on the market feature the integration of recycled content, low or non-volatile organic content, use of natural products. The materials selected must also meet the fire code regulations for fire separations and fire-rated construction. Fire rating requirements for floors and walls, ceilings and vertical circulation paths must be adhered to. Finish material selection must be based on flame-spread rating of the material based on the fire code recommendations. The use of sustainable materials also provides an opportunity for staff to integrate lessons on sound environmental practices to

complement existing lesson plans on protecting the environment. The "Red List" of materials created by the International Living Institute (2014) should be avoided unless no substitute can be found. As recommended by the International Living Institute, all wood products should be certified by the Forest Stewardship Council. Locally constructed materials should be sourced when possible to contribute to the local economy.

2.8. Summary

The issue/opportunity that has been identified is nature deficit disorder, which is characterized by a disconnect to nature, excess contact with electronic media and a range of health problems including stress, anxiety and depression. The desired outcome is to foster a renewed connection to nature, defined by positive interpersonal, personal and intellectual development, a better understanding of nature and pro-environmental attitudes, which will also create a desire for stewardship of the environment. Through the design of the interior space of Strathcona School, which will include direct, indirect and symbolic experiences with nature, combined with the application of sustainability practices when possible, the children will connect to nature.

Chapter 3. Design Precedents: Investigation and Analysis

3.1 Introduction

To complement the literature review, four precedents were selected to inform the design of Strathcona School based on several criteria as follows:

- Educational typology;
- Design elements included form, line, use of light, pattern and space;
- Design principles included balance, harmony, scale, proportion, rhythm, emphasis, unity and variety arranged to meet both functional and aesthetic needs;
- Spatial attributes including arrangement of space, zoning, and circulation patterns optimized the connection to nature;
- Theoretical relevance in relation to the project goals, *i.e.* providing opportunities for learning about nature through exploration and socialization.

The precedents selected are:

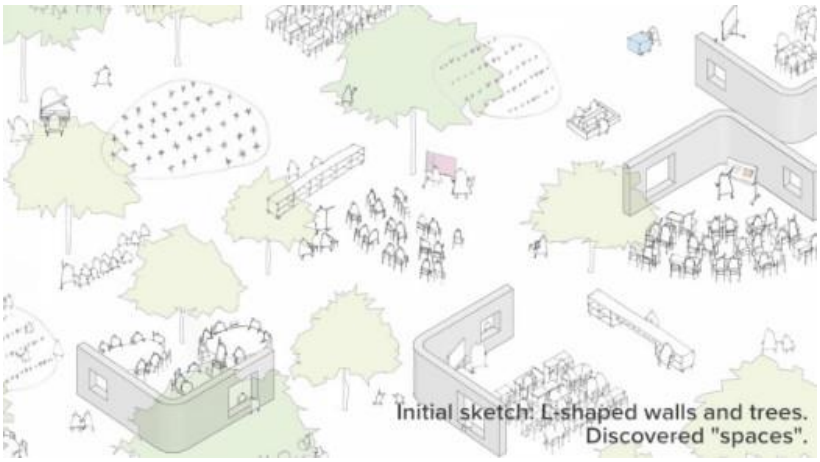
1. Uto Elementary School, Japan
2. Corlaer 2 College, The Netherlands
3. Vilhelmsro Primary School, Denmark
4. Buffon School, France

In addition, since Strathcona School was built in 1962 and the International Style influences are apparent in the design of its earlier construction phases, the influence of select architects and their design practices will be examined for inspiration.

3.2 Precedents: Why and How They Inform Design

Precedent 1. Uto Elementary School, Japan

Uto School, like Strathcona, is an elementary school. It is similar in size and functional program. Aesthetically beautiful, the unusual arrangement of Uto's interior spaces and circulation patterns, are especially interesting and aesthetically pleasing. Each of the classrooms is open and accessible to a courtyard filled with trees (Figure 3.1).



Client:
Uto City
Architect:
CAt/ Coelacanth and Associates
Type of Project:
Elementary School
Location:
Uto, Japan
Year of Completion:
2011
Square Footage:
92,247 square feet

Figure 3.1. Uto Elementary School. Reproduced with permission from Karissa Rosenfield. "Video: Uto Elementary School / CAt" 31 Dec 2012. *ArchDaily*. Accessed 7 Jan 2016 from http://www.archdaily.com/313066/video-uto-elementary-school-cat.

Public Japanese school classrooms are typically like North American classrooms, with classrooms typically located on both sides of the shared hallway. Uto Elementary School was designed differently. As seen in Figure 3.2, the 753 square-foot classroom is semi-enclosed, organized on a 9-foot-square grid and partitioned by open-ended, L-shaped walls with large openings, blurring the

classroom space with the corridor, and, blurring the interior space with the outdoors (Pollock, 2013). The classrooms open onto the circulation area and to smaller adjacent spaces for small group sessions of learning and for informal assemblies of students. Teachers are encouraged to arrange their space freely since the classrooms have been designed with no predetermined orientation. The furniture is easily movable and the blackboards are on wheels to maximize flexibility. This arrangement provides the complexity and richness which provide opportunity for exploration, manipulation and innovation that optimizes learning, as suggested by Proshansky and Fabian (1987).

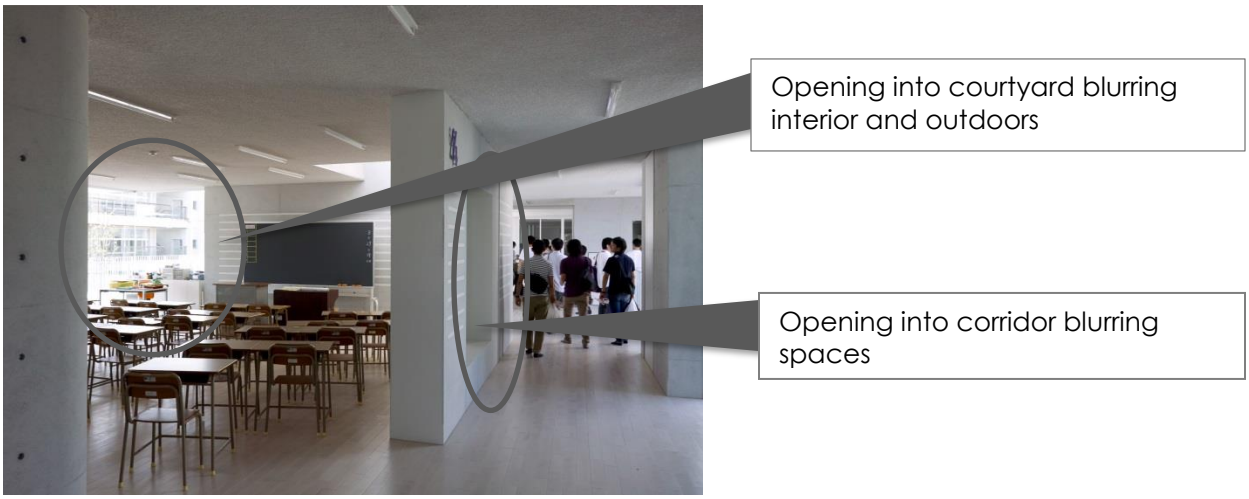


Figure 3.2. Uto Elementary School classroom. Reproduced with permission from "Creative Commons Uto Elementary School" by Kenta Mabuchi, used under CC BY2.0.

The school also incorporates operable clerestory windows that draw fresh air up through the school. Operable clerestory windows eliminate the need for air-conditioning, working with the courtyard to bring in cooler air into the building. In addition to the clerestory windows, the building was designed with full-height,

folding window walls that can be easily pushed aside, connecting the classroom directly to the courtyard which feature five connected gardens, each established with a distinctive character. These spaces have been made child-friendly with outdoor tables and built-in benches. As noted by Kaplan and Kaplan (1989), access to, and views of nature, throughout the school serves as a model for establishing connections to nature. Through the connections established to the courtyard by the extensive glazing throughout, the inside and outside spaces are blurred and connections to nature are created.

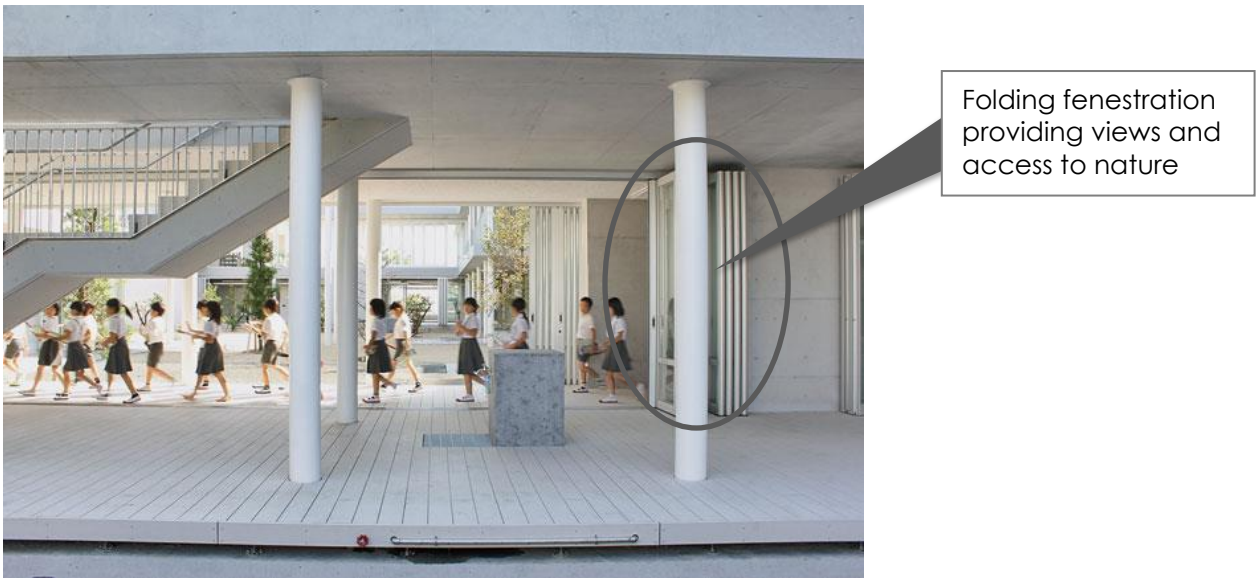


Figure 3.3. Uto Elementary School window walls providing access to courtyard. Reproduced with permission from "Creative Commons Uto Elementary School" by Kenta Mabuchi, used under CC BY2.0.

Figure 3.4. Uto Elementary School courtyard with trees. Reproduced with permission from "Creative Commons Uto Elementary School" by Kenta Mabuchi, used under CC BY2.0.

Precedent 2. Corlaer 2 College, The Netherlands

Corlaer 2 College was selected as a precedent for different reasons than Uto Elementary School. Although Corlaer 2 is a high school, certain elements of the design including the use of form, line, light and space are inspiring.

Figure 3.5. Corlaer 2 College. Interior photo by Rob't Hart Fotographie. Reproduced with permission from Dorothee Pape, Architectuurplaquette. Copyright permission obtained June 5, 2015.

Corlaer 2 College has been designed with an open and spacious interior as can be seen in Figure 3.5. Large amounts of daylight flood this space, linking the two halves of the building (Verstegen, n.d.). As described by Michaela Stegerwald, Architect for the project: "School buildings are exciting if the inside becomes the outside and the outside becomes the inside…Ask people and they remember their school building. The rooms, the light" (Verstegen, n.d., p. 128). As well as contributing to a better understanding of the natural world through the visual

connection to the outside, the natural lighting in the interior spaces contribute to improved health (Kaplan and Kaplan, 1989). Looking outside can help clear the mind, create an internal quiet and allow one to feel integrated and connected.

In Corlaer 2 College, a central staircase connects the split-levels of flooring. This arrangement creates a physical setting for socialization and consequently, place identity and self-identity, as discussed by Weinstein and David (1987). The staircase creates an informal space where students can congregate while enjoying views to the exterior and the resulting restorative benefits.

Precedent 3. Vilhelmsro Primary School

This third precedent was chosen for its programmatic features which align well with the intended program for Strathcona School; the project, its users and clients, are educational in typology and target the same age group as Strathcona School. The theoretical relevance of Vilhelmsro Primary School is also aligned with the intent of the project for Strathcona School; similar environmental project goals influenced the design of Vilhelmsro and can inform the design of Strathcona. Key features include the opportunities to learn from the built environment through exploration and the sustainable design.

Figure 3.6. Replicating local topography in roofline. Reproduced with permission from Aiden Bowman, BIG Architecture. Copyright permission obtained June 5, 2015.

Client:
Fredensborg Municipality
Architect:
BIG architects, Copenhagen
Type of Project:
Education
Location:
Asminderoed, Denmark
Year of Completion:
2010
Total Square Footage:
7000 m^2

Figure 3.7. View of exterior of Vilhelmsro Primary School. Reproduced with permission from Aiden Bowman, BIG Architecture. Copyright permission obtained June 5, 2015.

The design by BIG Architects for the Vilhelmsro Primary School matches the academic facility's focus on nature and sustainability. The design used the undulating hillside of the site for inspiration, creating a series of bands which bend, fold and crisscross to merge with the surrounding topography (Figure 3.6). Outdoor green spaces and courtyards were created between the buildings (Figure 3.7). The roofline is experienced from both the interior and the exterior as can be seen in Figure 3.8. All the buildings are only one-storey high, but the alternating peaks and valleys of the roof allow natural daylight to flood the classrooms.

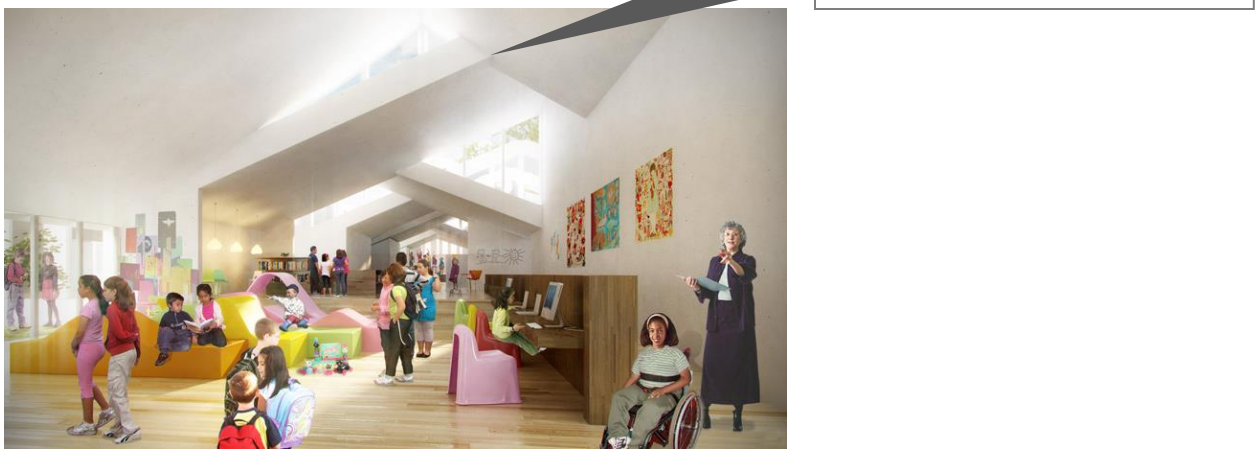


Figure 3.8. Bending, folding and crisscrossing of roof as seen from interior. Reproduced with permission from Aiden Bowman, BIG Architecture. Copyright permission obtained June 5, 2015.

The design of Vilhelmsro provides a matrix of experiences and exposure to nature from direct exposure through the outdoor green spaces and courtyards, and from indirect exposure using sustainable technology (sod roof, natural ventilation, day lighting and natural materials). The spatial arrangement of the school integrates the interior and the exterior using circulation patterns; outdoor green spaces and courtyards adjacent to and accessible from each classroom encourage teachers and students to experience nature easily. In this arrangement, the restorative effects of experiencing nature in place-based

education at the school can occur for both students and teaching staff (Louv, 2011). The various levels of the building and walkways that are accessible, as can be seen in Figure 3.7, also provide opportunities for climbing and exploration as recommended by Proshansky and Fabian (1987) in developing a sense of place and self-identity.

As can be seen in Figure 3.9, the sod roof mitigates for the heat island effect, acting as both a thermal mass and providing evaporative cooling. Rain water is collected and stored for non-potable use, reducing the amount of run-off. These sustainable design elements create an educational opportunity to expose students to nature, and promote a better understanding and appreciation of nature. Students can learn about the environmental impacts of the school and its operation, as well as how to mitigate these impacts. This learning promotes a connection to nature and can lead to a long-term commitment to stewardship of the environment (Benyus, 2002). The selection of materials throughout the school also facilitates the connection to nature with natural wood floors, a sustainable aesthetic and extensive glazing.

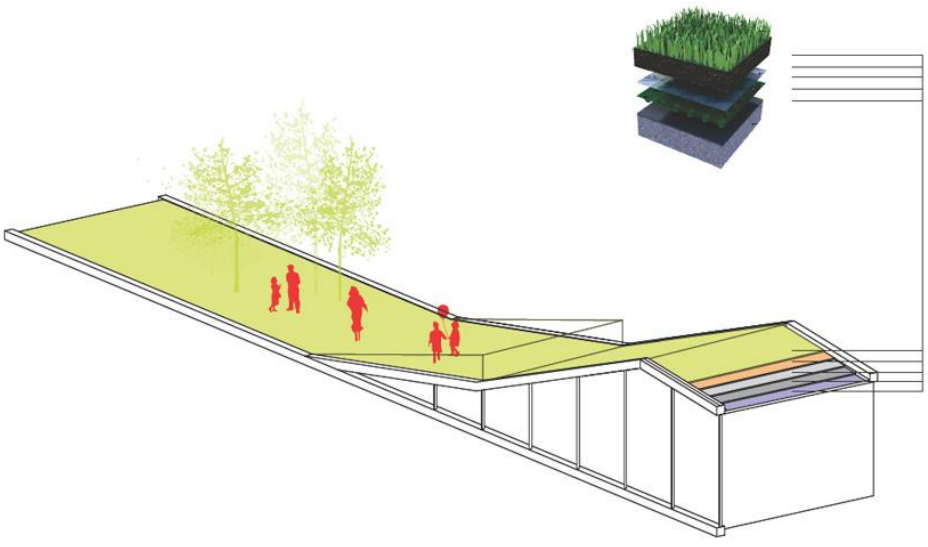


Figure 3.9. Roof design of Vilhelmsro Primary School. Reproduced with permission from Aiden Bowman, BIG Architecture. Copyright permission obtained June 5, 2015.

As can be seen in Figure 3.10, floor-to-ceiling operable windows and overlapping openings allow for natural cross-ventilation. Similarly to previous precedents, access to and views of nature from the extensive fenestration throughout the school help to establish connections to nature, blurring the inside and outside (Kaplan and Kaplan, 1989).

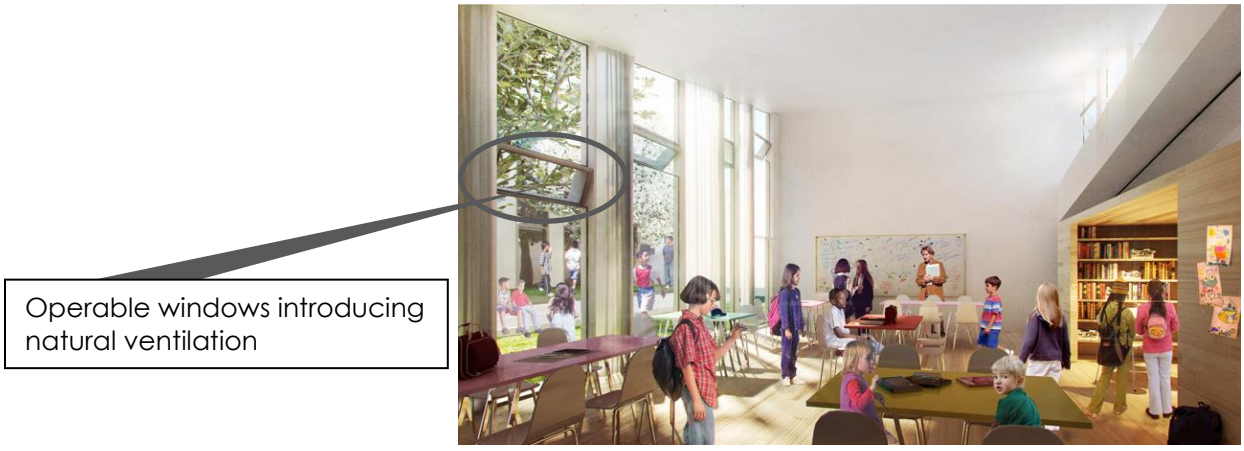


Figure 3.10. Floor-to-ceiling glazing with operable components. Reproduced with permission from Aiden Bowman, BIG Architecture. Copyright permission obtained June 5, 2015.

Precedent 4. Buffon School, Thiais, France

This project involved the renovation and extension of Buffon Kindergarten School. In the project, the architects played with the composition of the existing school, adding to it a third, long volume. Rather than building a new wing perpendicular to the existing building on the ground floor, a long thin structure was designed that stretches over the main building. The structure, over 35 metres long, is cantilevered, allowing "for the volume to hang in the neighboring

trees", as seen in Figures 3.11 and 3.12. The architectural structure co-exists with the canopy of the existing trees, allowing the students and teaching staff to view nature through the windows and providing the restorative benefits of an encounter with nature (Ulrich *et. al.,* 1991).

The trusses were designed in a tree-like form, an arborescence that blends with the neighbouring trees (refer to Figure 3.13). This design blurs the boundary between the interior and the exterior. Following this same theme, the flanges of the truss "evoke a child's drawing" (Maison Edouard François, 1996). This is an example of symbolic exposure to nature, which, according to Levi and Kocher (1999), addresses the human need to experience nature. Similarly, Figure 3.14 shows the interior decoration on the ceiling, in which the botanical illustrations reinforce the concept of being in nature and further eliminate the boundary between the interior and the exterior. Patricia Pérez (2006) described this type of architecture as consciously incorporating vegetal strategies based on observations of nature in general, and more specifically, of the plant kingdom. These are both examples of symbolic exposure to nature which according to Levi and Kocher (1999), is effective in providing positive psychological effects, including stress reduction, to the viewers.

Client:
Municipalité de Thiais
Architects:
Maison Edouard François, YRM - ANTONY HUNT & associés
Type of Project:
Kindergarten School
Location:
Thiais, France
Year of Completion:
1996
Total Square Footage:
1100 m^2

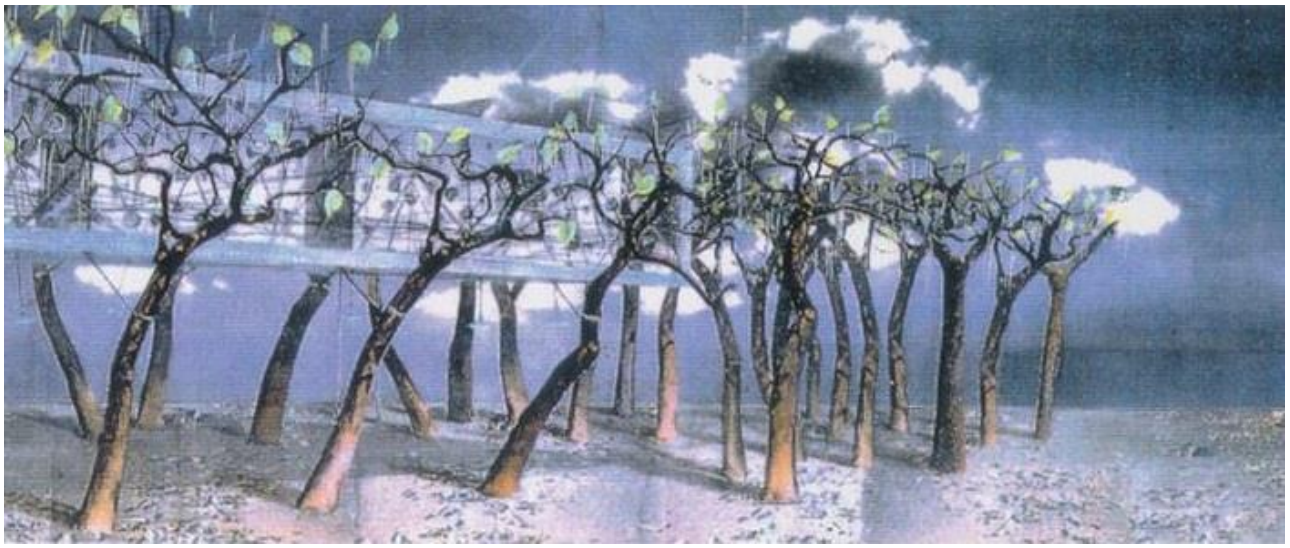


Figure 3.11. Buffon School schematic volumetric addition. Reproduced with permission from Eglantine Desmoulais, Maison Edouard François. Copyright permission obtained February 10, 2015.

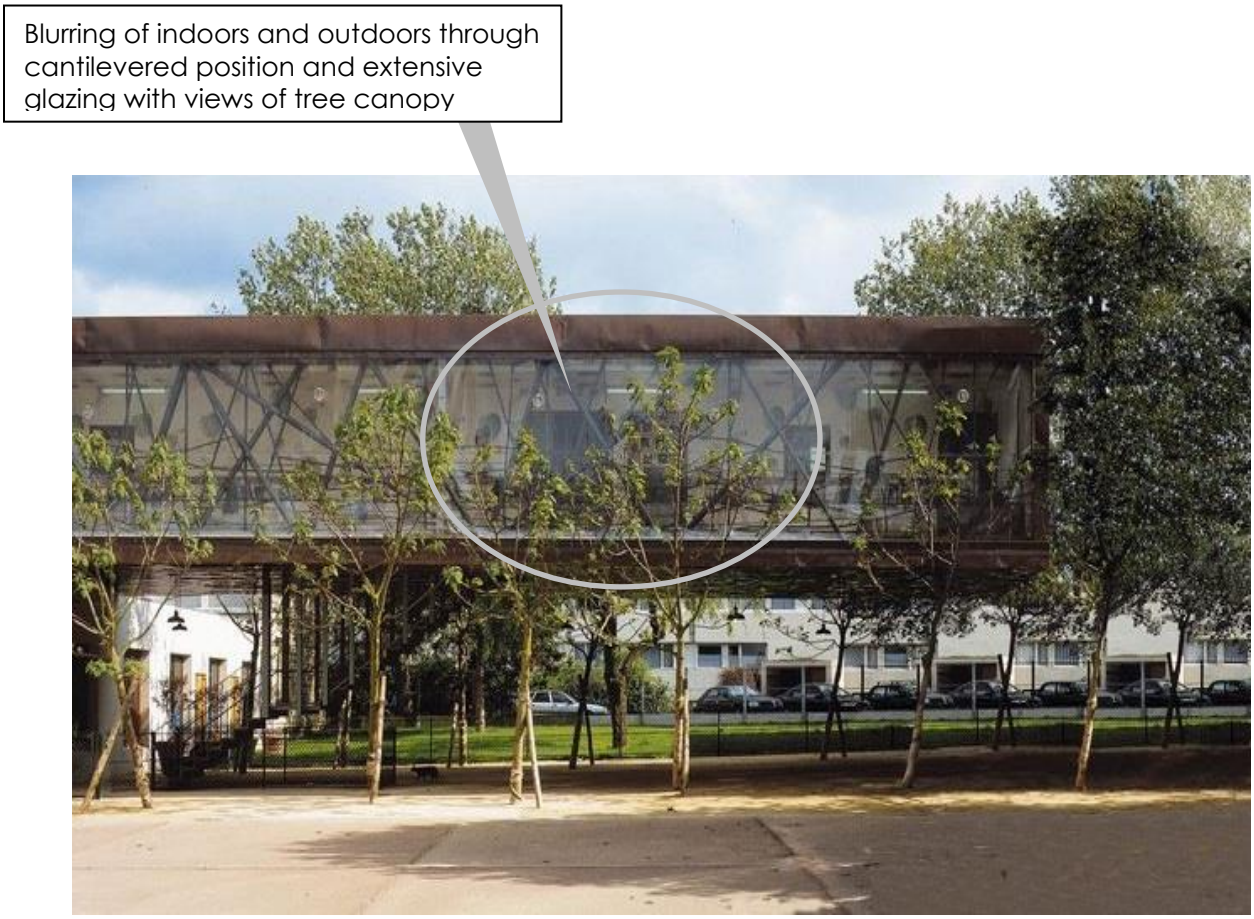


Figure 3.12. Cantilevered volumetric addition of Buffon School. Reproduced with permission from Eglantine Desmoulais, Maison Edouard François. Copyright permission obtained February 10, 2015.

Figure 3.13. Buffon School design of trusses. Reproduced with permission from Eglantine Desmoulais, Maison Edouard François. Copyright permission obtained February 10, 2015.

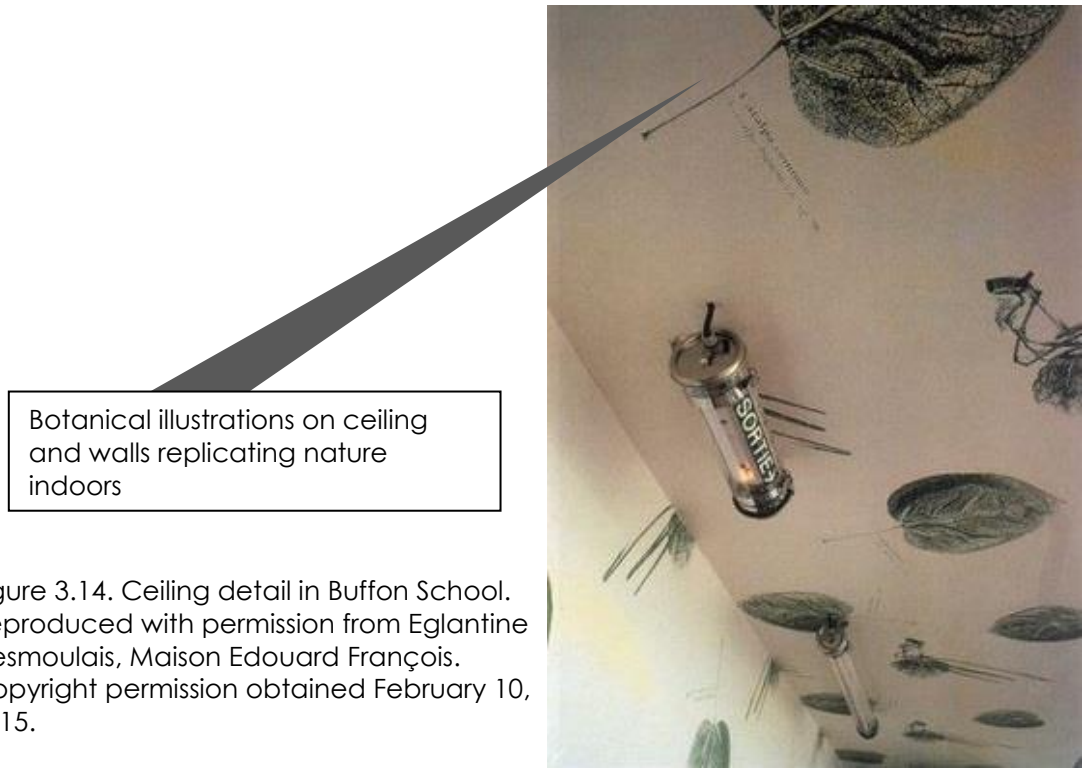


Figure 3.14. Ceiling detail in Buffon School. Reproduced with permission from Eglantine Desmoulais, Maison Edouard François. Copyright permission obtained February 10, 2015.

3.3 Other Influences

In addition to the precedents, architecture from the twentieth century was studied briefly to identify elements to improve connectedness to nature. This included work by architects Frank Lloyd Wright, John Lautner, Mies van der Rohe and Le Corbusier. As can be seen in the collage of work by these architects (Figures 3.16 to 3.26), open spaces, clean lines, flat planes, changes in elevation, expansive walls of glass, integration with nature, outdoor views, the importance of outdoor rooms and materials doing the work, are all examples of elements associated with International Style architecture.

In the first row of images, Frank Lloyd Wright's design of Taliesin was consistent with the design principles of the Prairie School; it follows the flatness of the prairies and the natural limestone outcroppings in Wisconsin (Figure 3.16). The indoor spaces are made more dramatic with sloping roof planes that extend views towards the sky, natural woods, and window areas in continuous bands connecting the interior with the exterior. The second image, Fallingwater, projects over a stream and waterfall, providing open views open to the surrounding woods and using natural stone and woods, integrated with the natural surroundings (Figure 3.17). The sounds of the stream and waterfall are always present and the changes in season can be viewed through the strip windows. The Johnson Wax Building, where glass tubing skylights introduce natural light to the environment, is another example of connectivity to nature

(Figure 3.18). The dendriform shape of the columns mimics nature, yet allows soft lighting to descend between the overhead canopies. The exterior walls of the open space are red brick, the brick allowed to do its work, uncovered with other materials (Pile, 2009; Marcus, 2005).

John Lautner, a student of Frank Lloyd Wright's, is also known for creating architecture that responds intimately with its site, seamlessly blending into the natural landscape. Throughout his career, he maintained "an ongoing quest to create unity between nature and architecture" (Matuscak, 2012). He took advantage of the natural vistas in his designs as can be seen in his designs. The Goldstein house was built into a hillside and was designed to look outwards, embracing nature and the views (Figure 3.19). The Elrod house is representative of his vision – looking outwards but fully integrated with the site, with the rocks on the site cutting right through the walls into the interior (Figure 3.20). The simplicity of form and materials is evident in the images of both of his buildings.

Mies van der Rohe's architecture also blurred the boundaries between the interior and the exterior as seen in the Barcelona pavilion (Figure 3.21). He achieved this effect by the arrangement of floor to ceiling glass and marble planes in a rectilinear pattern, some of which extended into the exterior. The colours and textures of the natural materials provided the only ornamentation, true to the concept of allowing the materials do to the work (Pile, 2009). These same concepts were applied to both the Tugendhat House and the Farnsworth

House, where open floor plans and floor-to-ceiling glass walls extend the views from different interior perspectives into the surrounding landscape, making one with nature (Figures 3.22 and 3.23 respectively).

Le Corbusier's architecture also demonstrates the ideas associated with International Style architecture. He based his design on five principles as follows:

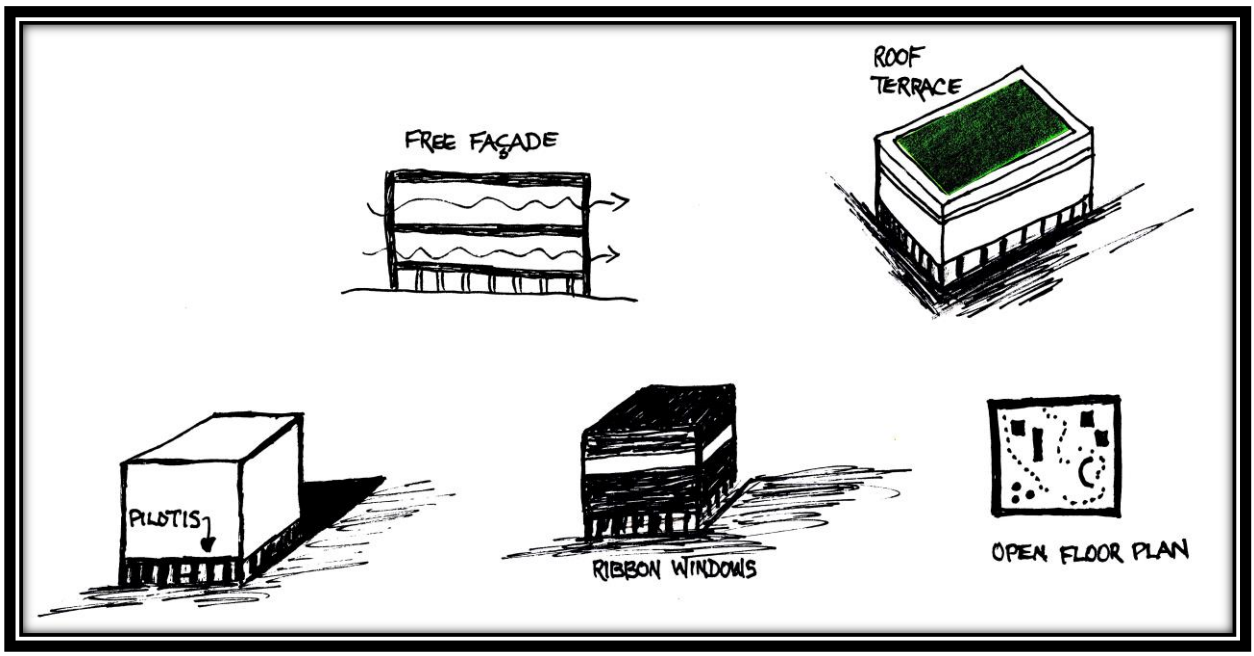


Figure 3.15. Le Corbusier's architectural principles for modernism. Image by S. Therrien-Richards.

The pilotis brought a classic order to the structure, with the columns organized in a grid, bringing classic order to his modern design. The free façade allowed for openings independent of the structure, arranged according to occupant requirements; the ribbon windows allowed light and air to penetrate the interior and created direct contact with the landscape by framing views. The open

floor plan made partitions independent of structure and allowed meandering paths through the space, reminiscent of a walk outside. The roof terrace spoke to sustainability, restoring the footprint of the ground covered by the building, and bringing nature to the house. These elements are all displayed in Le Corbusier's Villa Savoye (Figure 3.24), the Convent of St. Marie de la Tourette (Figure 3.25) and Villa la Roche Jeanerette (Figure 3.26).

Fig. 3.16

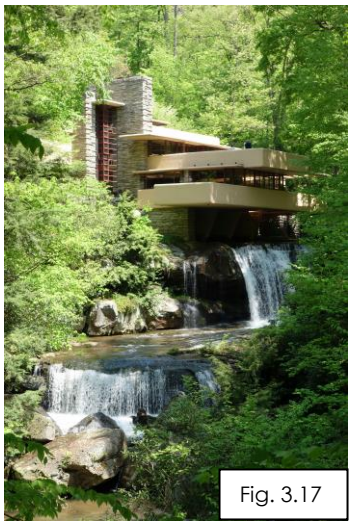


Fig. 3.17

Fig. 3.18

Fig. 3.19

Fig. 3.20

Fig. 3.21

Fig. 3.22

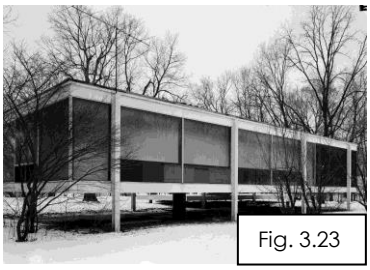


Fig. 3.23

Fig. 3.24

Fig. 3.25

Fig. 3.26

Figure 3.16. Taliesin 1, taken in the winter of its construction in 1911-12, Southwest elevation. Author: Henry Fuermann and Sons. Date: 11 October 2013. Reproduced with permission from Wisconsin Historical Society: http://www.wisconsinhistory.org/whi/fullimage.asp?id=83133.

Figure 3.17. Fallingwater exterior (Kaufmann Residence) by Frank Lloyd Wright. Image by Daderot. Date: May 17, 2013. Reproduced with permission from Wikipedia Commons CC1.0. Universal, https://commons.wikimedia.org/w/index.php?curid=29163818.

Figure 3.18. Work area at the Johnson Wax Building, headquarters of the S.C. Johnson and Son Co., Racine, Wisconsin. Photographer: Carol M. Highsmith. Date: Between 1980 and 2006. Reproduced with permission from Library of Congress Prints and Photographs Division Washington, D.C. 20540 USA, http://hdl.loc.gov/loc.pnp/pp.print.

Figure 3.19. Goldstein House by modernist architect John Lautner, in Beverly Hills, California. Image taken from rear terrace edge looking towards living room. Image by Arch.james. Date: 24 July 2007. Reproduced with permission from Wikipedia Commons CC BY-SA 3.0.

Figure 3.20. Elrod House by John Lautner, Image by SouthRidgeHouses.com. Reproduced from http://www.architecturendesign.net/elrod-house-by-john-lautner/.

Figure 3.21. The Barcelona Pavilion, Barcelona. Image by Ashley Pomeroy at English Wikipedia. Date: 14 October 2010. Reproduced with permission from Wikipedia Creative Commons Attribution 3.0.

Figure 3.22. Villa Tugendhat exterior. Image by Petr1987 (Own work). Date: 31 October 2014. Reproduced with permission of CC BY-SA 4.0 (http://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons from https://upload.wikimedia.org/wikipedia/commons/c/c2/Vila_Tugendhat_exterior_Dvorak2.JPG.

Figure 3.23. Edith Farnsworth House, Fox River & Milbrook Roads, Plano vicinity, Kendall County, Illinois - north elevation, seen from northeast. Designed by Ludwig Mies van der Rohe. Image by Jack Boucher. Date: 1 February 1971. Reproduced with permission from Library of Congress, Prints and Photographs Division, Historic American Buildings Survey, HABS: ILL, 47-PLAN.V,1-10.

Figure 3.24. Villa Savoye in Poissy. Image by Valueyou (talk). Date: 7 October 2008. Reproduced with permission from Creative Commons Attribution-ShareAlike 3.0 License.

Figure 3.25. Sainte Marie de La Tourette, France. Image by Alexandre Norman. Date: 16 September 2007. Reproduced with permission from French Wikipedia Creative Commons Attribution-ShareAlike 3.0 License.

Figure 3.26. Villa La Roche, Paris. Designed by Le Corbusier. Image by Radomir Cernoch. Date: 16 April 2013. Reproduced with permission under the Creative Commons Attribution-ShareAlike 2.0 License from http://www.flickr.com/photos/30718644@N03/8665435561/.

3.4 Summary

According to the literature presented in the previous Chapter 2, designing an interior environment that fosters a connection to nature will provide positive health benefits, improve learning outcomes and inspire children to become stewards of the environment. The school design precedents presented in this chapter illustrate interior design elements that help improve nature connectedness including:

- Extensive use of windows to blur the boundaries between the interior and the exterior and provide views to the outdoors
- Creating physical settings for socialization, place-identity and self-identity
- Adding operable windows to introduce natural ventilation
- Creating complexity and richness in the space through flexibility of furnishings
- Providing opportunity for exploration, manipulation and innovation
- Use of materials that are sustainable and environmentally friendly
- Interior design practices that provide direct, indirect and symbolic experiences to experiencing nature and its benefits, *i.e.* colour, selection of materials, detailing and décor.

Similarly, Frank Lloyd Wright, John Lautner, Mies van der Rohe and Le Corbusier, also demonstrated a commitment to architecture that connected to nature, thereby increasing the occupants' connection to nature. This was exemplified by using windows to blur the boundaries between interiors and exteriors;

integrating natural materials and natural features (sound, rocks, light); and the use of organic shapes.

The specific application of these elements will obviously vary, depending on several factors, including site climatic and building conditions, client needs, funding and local building regulations. Climatic conditions are a particularly important factor in Winnipeg, which has a continental climate characterized by warm summers and severe winters (Current Results, 2015). Although the folding window walls and direct openings to the exterior in Uto Elementary School would not be feasible in Winnipeg, the concepts can nevertheless be used to formulate design guidelines for Strathcona School. In the next chapter, an analysis of Strathcona School location, the interior space, along with the design program, is provided.

Chapter 4. Site and Building Analysis

4.1 Introduction

The building selected for the investigation of using interior design principles and practices to address nature deficit disorder is Strathcona School. The site of the school was analyzed for several factors that will influence and inform the final design. Programming information that was analyzed included the location of the building, the neighbourhood within the City of Winnipeg, demographics information for the school population, municipal zoning information, transportation access, building architecture, natural ventilation and natural light studies, and finally, a human factors analysis which included client and user profiles and their spatial requirements.

4.2 Criteria for Site Selection

Strathcona School was selected among 12 elementary schools in the Winnipeg School Division for its central location in downtown Winnipeg, with no close proximity to a green space. The school is situated in the inner city of Winnipeg, primarily surrounded by built environment and offers little opportunity for experiencing nature. Strathcona School is located in the William Whyte Neighbourhood, an area characterized by a high prevalence of low income and a high percentage of population "that are, or had been at one time, landed immigrants in Canada" (Winnipeg School Division, n.d., p. 22). The 2015/2016 demographics study reported an enrolment of 309 students at

Strathcona School in September 2015, with 28.9 percent of the population identifying as "landed immigrants in Canada". The prevalence of low income after taxes in the 2014 taxation year was reported to be 53.2 percent. These percentages are important since research by Shultis and More (2011) on visitation of national parks in Canada and the United States has revealed that declines in visitation to parks since the 1980s are due to a number of factors including the lack of minority and immigrant use of parks, as well as the rising costs of user fees that increasingly affect low and middle income families. Since these populations are at 28.9 percent and 53.2 percent respectively in Strathcona School, these values represent many children that have less opportunity to experience nature in park settings.

Strathcona School therefore provides an opportunity to address nature deficit disorder for all students in the school by offering a matrix of experience and exposure to nature - direct, indirect and symbolic - offered through a designed interior that also incorporates environmentally friendly practices such as water and energy conservation and recycling to teach children about the importance of environmental protection. In this way, the designed interior will enrich the children's physical, psychological and spiritual health and inspire children to become stewards of the environment. Teaching children to love nature inspires them to protect nature (Sobel, 2004).

4.3 Analysis

4.3.1 Site Description

Strathcona School is located at 233 McKenzie Street, Winnipeg, Manitoba as shown in Figure 4.1. The school is centrally located in downtown Winnipeg and belongs to the Winnipeg School Division Inner City School District. The school does not have immediate or close proximity to a green space, other than to Taras G. Shevchenko Park, and is surrounded on all sides by built environment, mainly residential, and offers little opportunity for experiencing nature in a park-like setting. However, the residential streets are lined with towering elm trees that constitute an urban forest in the neighbourhood.

Figure 4.1. Map of location of Strathcona School in Winnipeg.

The school is located on a parcel of land bounded by Alfred Avenue to the north, Burrows Avenue to the south, McKenzie Street to the west and McGregor

Street to the east (Figure 4.5). The school lot occupies an area of approximately 300 metres (984 feet) by 100 metres (328 feet). The school building occupies approximately 1/6 of the lot, set back 10 metres (32.8 feet) from property lines, with a square footage of approximately 2066 square metres (22,242 square feet) on the main level and an additional 1051 square metres (11,309 square feet) on the second level, for a total of approximately 3117 square metres (33,551 square feet). Refer to Figures 4.2, 4.3 and 4.4 for floor plans of the basement, first level and second level respectively.

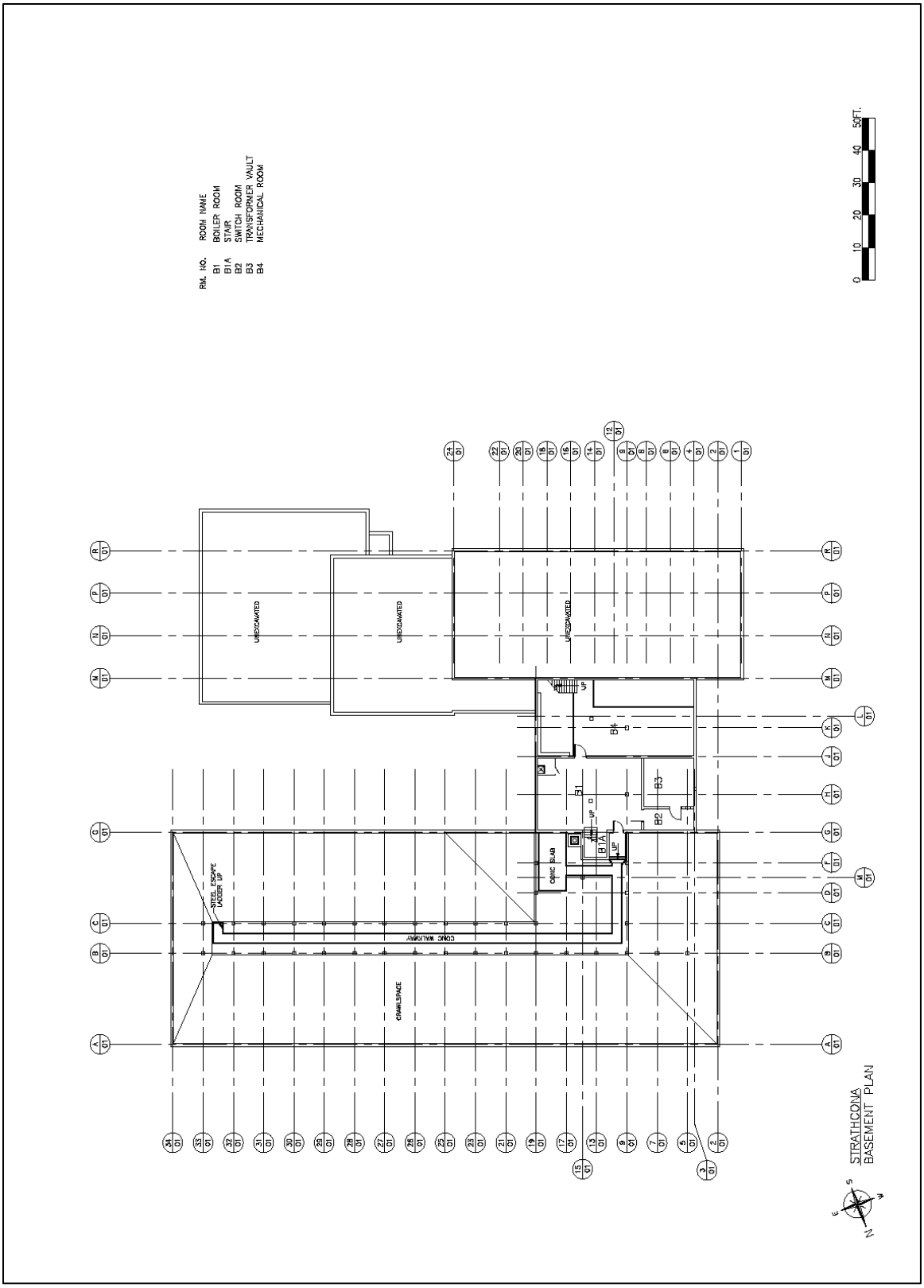


Figure 4.2. Strathcona basement plan.

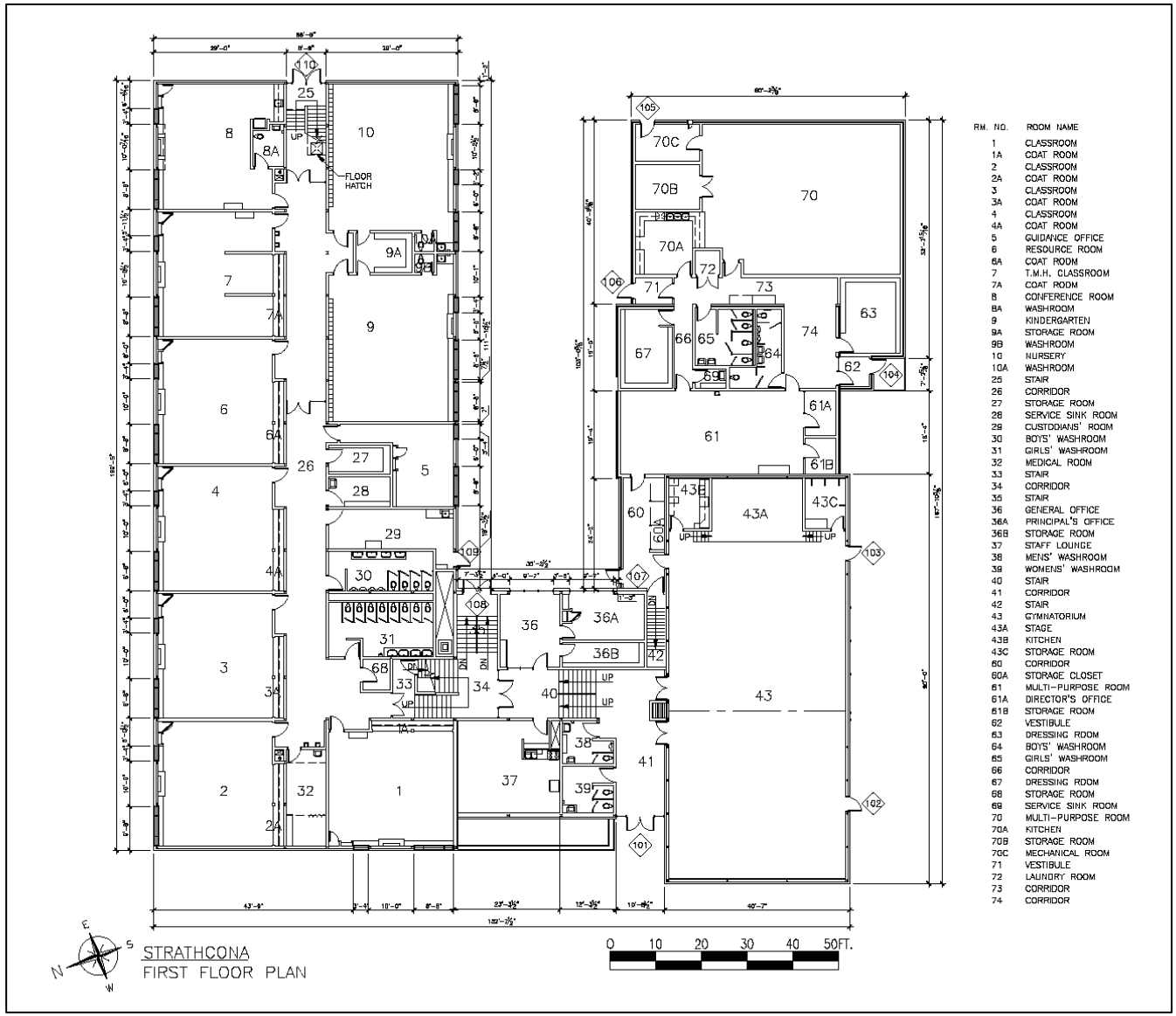


Figure 4.3. Strathcona first floor plan.

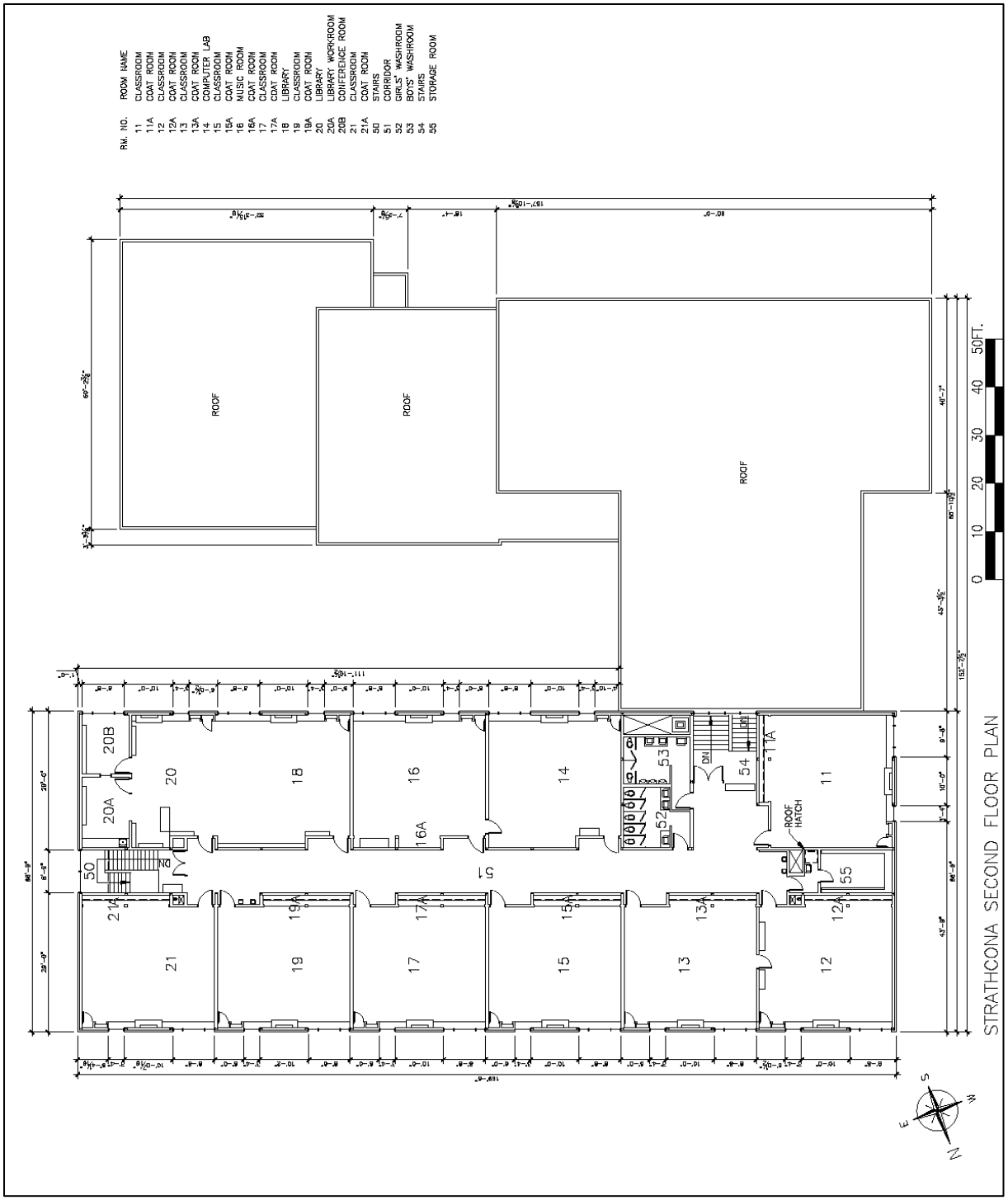


Figure 4.4. Strathcona second floor plan.

The remainder of the lot is playground space, with about 1/3 of the space covered in grass, as can be seen in Figure 4.5. There are trees visible on the school property, some located at the front of the school on McKenzie Street and others in the school yard. There is a row of trees on the city-owned boulevard on all sides of the school, although there are only a few trees on McGregor Street. The courtyard is of interest since it is the site of "Folly Forest", an innovative and imaginative transformation of the asphalt surface into an award winning dynamic play space and garden. In collaboration with the Winnipeg School Division and Strathcona School officials, the landscape architects, Straub Thurmayr CSLA Landschaftsarchitekten and Urban Designers, cut out asymmetrical sections of the asphalt, planted trees and installed benches, follies and an earthen mound (Prairie Design Awards, 2014). A program, "Tree-ty", has been implemented to care for the trees in the school yard; a promise had been made by students and staff to reduce damage to the trees (Winnipeg School Division, 2013). To this end, each classroom has adopted a small group of trees in the Folly Forest that is monitored for growth and observed for damage.

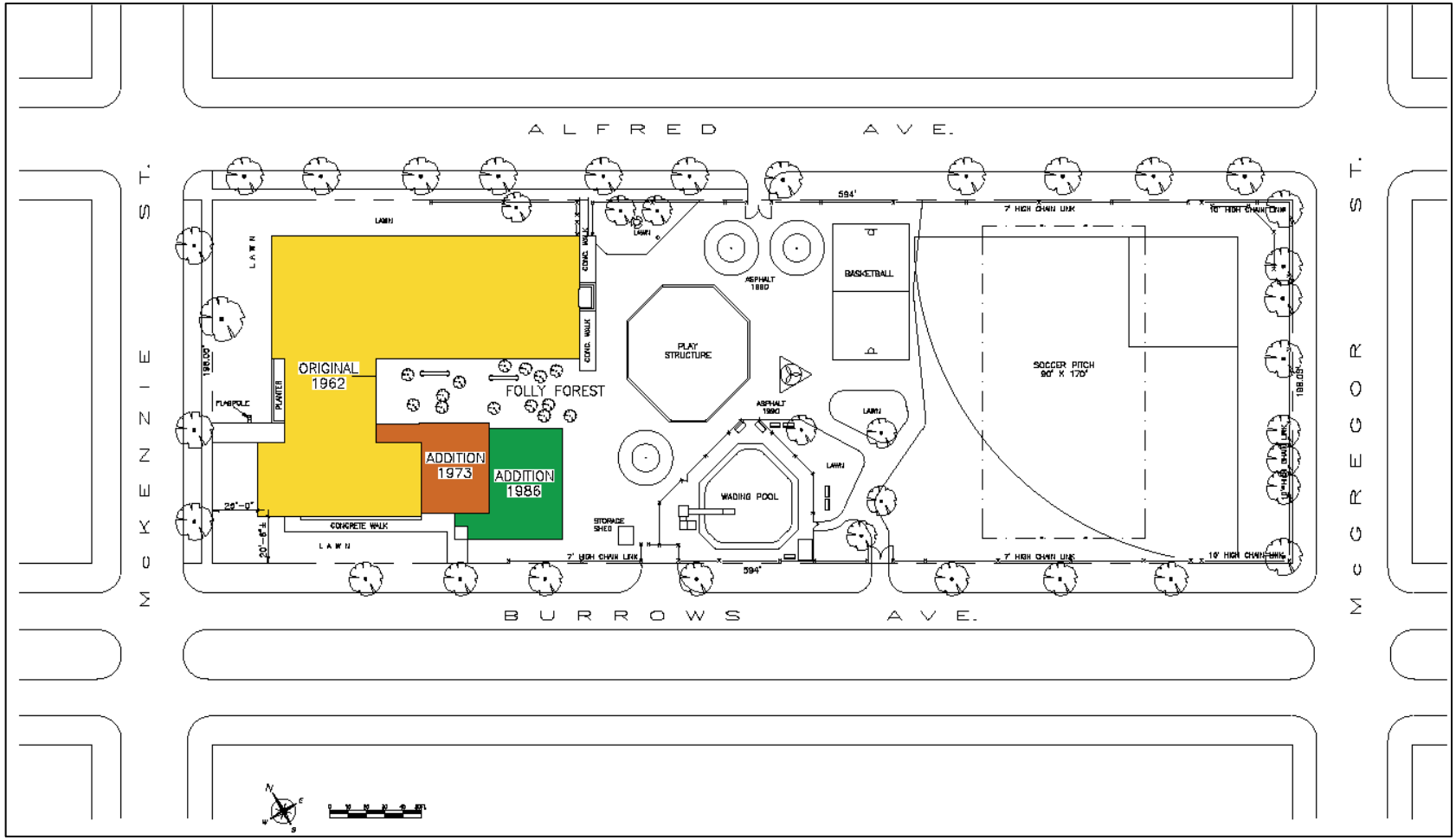


Figure 4.5. Strathcona site plan.

Strathcona School currently has a staff of 41, which includes a principal, a vice-principal, administrative staff, janitorial staff, teachers and educational assistants, providing education to students from Nursery to Grade six (A. Yereniuk, Principal, Strathcona School, personal communication, December 16, 2013). Parents and guardians, as well as volunteers who can include members of the community, are also encouraged to work with staff helping students develop their full potential. The mandate of Strathcona School is to provide an environment that is centered on the child, is challenging yet safe, where meaningful learning experiences are created for the children. Fairness, respect, patience, friendliness and ethical behaviour are paramount in the delivery of services (Winnipeg School Division, 2013).

Strathcona School has demonstrated a commitment to learning about and living the Seven Teachings as part of the Aboriginal Education Policy implemented by the Winnipeg School Division in 1996 and revised in 2005 (Winnipeg School Divison, 2005). Students and staff are committed to living by the Seven Teachings – love, respect, courage, honesty, humility, wisdom, bravery and truth - collectively reviewing values in actions and reflecting on what has been gained by living by the Seven Teaching (Winnipeg School Division, 2013). This commitment to both spiritual law and the connection to the land will be complemented by the project, which will help children reconnect with nature and the land.

The area surrounding the school is a well-established older neighbourhood of the City of Winnipeg, known as William Whyte. The William Whyte Neighbourhood is bounded by Redwood Avenue to the north, Selkirk Avenue to the south, Arlington Street to the west and Main Street to the east. The 2006 census reported an Aboriginal population of 6220, and a population of 1300 immigrants. The median family income for all families in 2006 was reported to be $33,341, and the average family income for the same time period, $36,356. The 2006 census data further reports that 2410 dwellings were occupied in the neighbourhood, 1290 of which were constructed prior to 1946. The predominant form of dwelling is the single detached home (1335 homes), and the remainder of the dwellings split between apartments (620), apartment duplexes, row houses and semi-detached homes. The percentage of participation in the labour force for residents over the age of 25 was reported to be 59.3 percent in 2006, and the labour force unemployment rate for the same demographic group was reported to be 12.3 percent. Nine hundred and thirty families reported second languages as shown in the following table and chart[1], resulting in a neighbourhood rich with an elevated level of cultural diversity.

[1] Tagalog (730), Ukrainian (220), Cree (210), Polish (185), Ojibway (160), Spanish (150), German (105), Lao (90), Vietnamese (75), Russian (60), Oji-Cree (45), Croatian (40), Greek (40), Portuguese (30), Cantonese (25), Ilocano (20), Serbo-Croatian (20), Arabic (15), Hungarian (15), Italian (15), Sioux (15), Slovak (15), Czech (10), Dutch (10), Punjabi (10), Somali (10), Tamil (10), Urdu (10) and other languages (35) (City of Winnipeg, 2013).

Language Group	Language	Reported Number	Total Number
Philippine	Tagalog	730	750
	Ilocano	20	
Slavic	Ukrainian	220	550
	Polish	185	
	Russian	60	
	Croatian	40	
	Serbo-Croatian	20	
	Slovak	15	
	Czech	10	
Indigenous	Cree	210	430
	Ojibway	160	
	Oji-Cree	45	
	Sioux	15	
Italic	Spanish	150	195
	Portuguese	30	
	Italian	15	
Germanic	German	105	115
	Dutch	10	
Other	Lao, Vietnamese, Greek, Cantonese, Arabic, Hungarian, Punjabi, Somali, Tamil, Urdu and Others		355
			2395

Table 4.1. Population reporting second languages in William Whyte Neighbourhood (2006 Census Data).

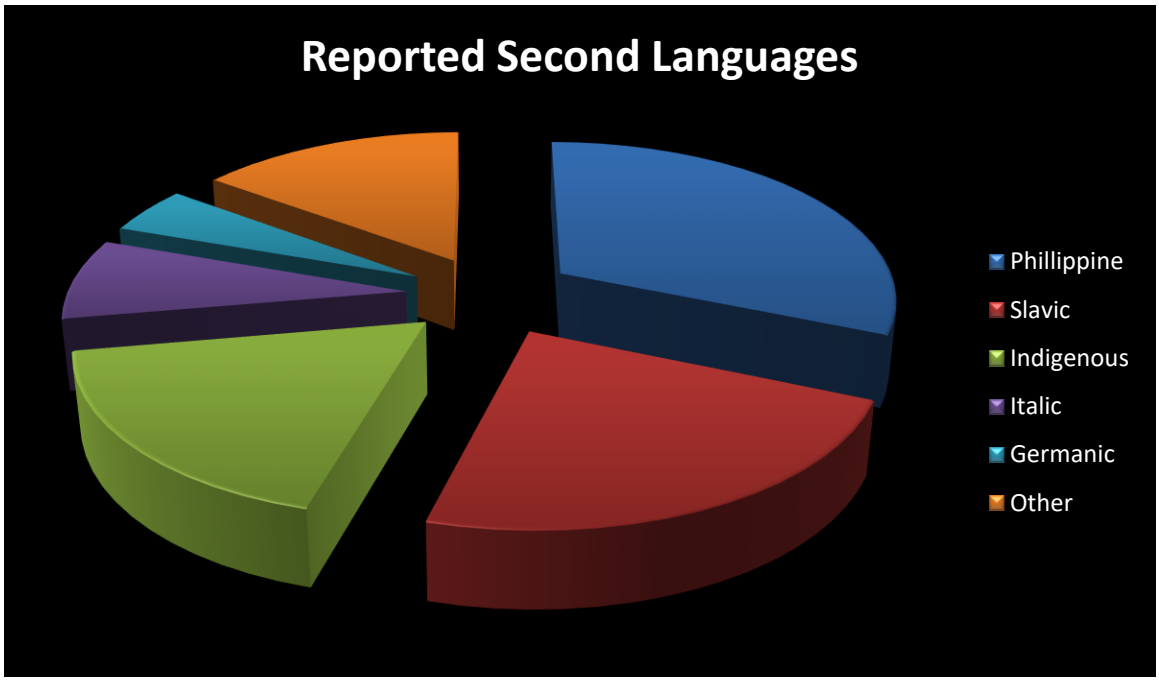


Figure 4.6. Comparative analysis of language groups reported in William Whyte Neighbourhood, Winnipeg (2006 Census Data).

There are no plans for any major changes to the William Whyte Neighbourhood, other than changes in tenancy of the residential and commercial enterprises. New in-fill construction of residential homes has also resulted in an increase of the number of students attending Strathcona School in 2013 - 2014 (A. Yereniuk, personal communication, December 16, 2013).

4.3.2 Site Analysis

As shown in Figure 4.7, the school is the only building on the parcel of land bounded by the four intersecting streets; refer to Appendix A for Strathcona School municipal zoning information. The neighbourhood surrounding the school is predominantly residential with few exceptions. The Springs Church Inner City and the Union of Vietnamese Buddhist Churches of Canada are located south

of the school at the intersection of Burrows Avenue and McKenzie Street; the Ukrainian National Home Association at the intersection of Burrows Avenue and McGregor Street; and a small neighbourhood corner store, Alfred Grocery, at the intersection of Alfred Street and McGregor Avenue. A small green space, Taras G. Shevchenko Park, is also located across Burrows Avenue at the intersection with McGregor Street, and the Alfred Tot Lot is located east of the school at 576 Alfred Avenue.

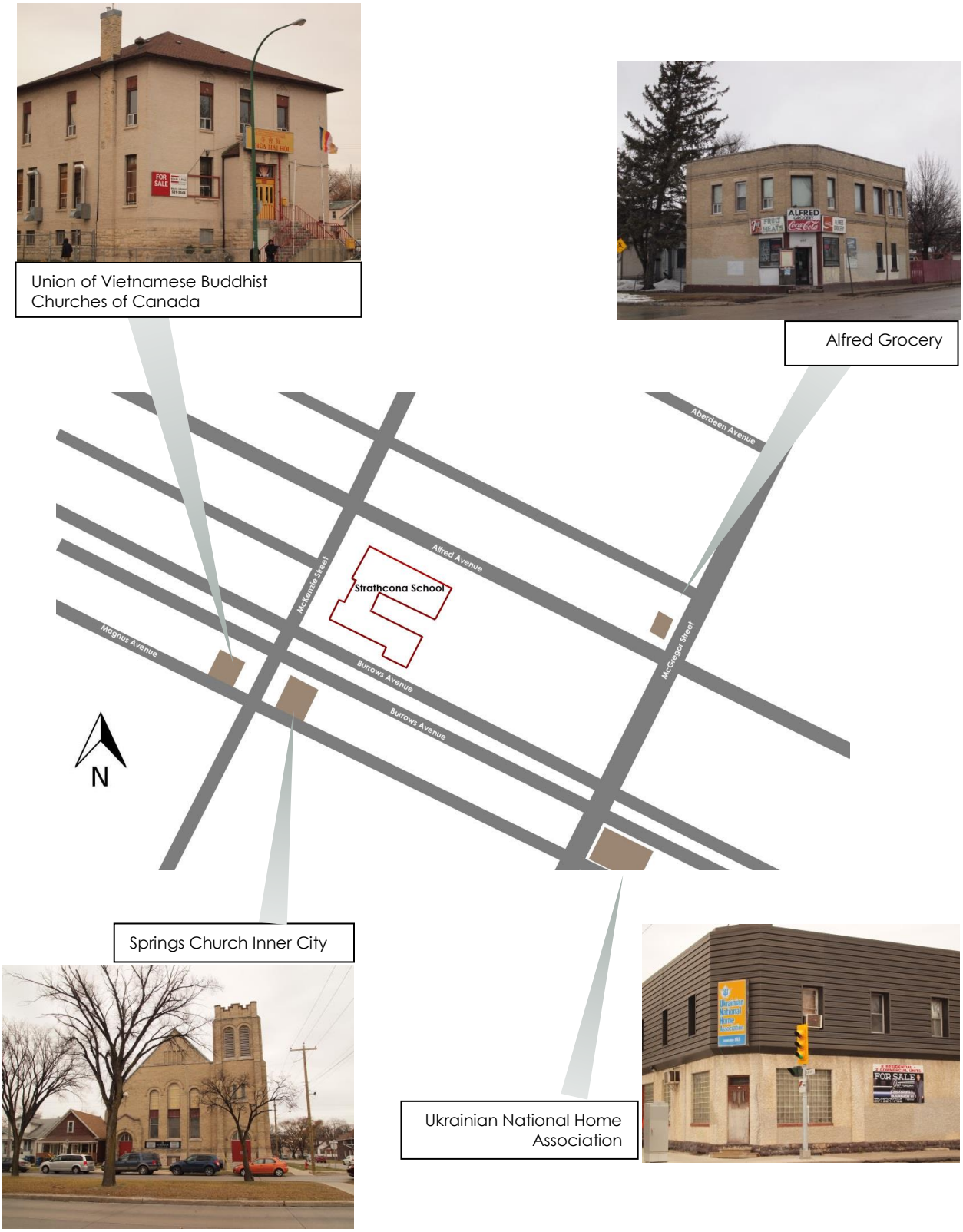


Figure 4.7. Anchor neighbours immediately adjacent to Strathcona School.

Public access to the school from the north or the south of Winnipeg is provided by several City of Winnipeg Transit bus routes – Numbers 15, 16, 17. Transportation by bus to Strathcona School from the corner of Portage and Main takes on average 20 minutes (Winnipeg Transit, 2013). Pedestrian access to the school is facilitated by City of Winnipeg managed sidewalks on all sides of the school. The school is easily accessible to vehicular traffic; Burrows Avenue is a major thoroughfare linking the Burrows-Keewatin Neighbourhood in northwest Winnipeg to Main Street, and McGregor Street parallels Main Street, providing a convenient and alternate north/south access route from the inner city Canadian Pacific rail yards to the Templeton-Sinclair Neighbourhood to the north.

4.3.3 Building Analysis

4.3.3.1 Main Features of Strathcona School

Although Strathcona School initially opened as a ten-room school in March 1905 and expanded in 1911, the current two-storey building was built in 1962 (Winnipeg School Division, 2013). The two-storey school building occupies approximately 1,858 square metres (20,000 square feet), housing 21 classrooms, a gymnasium, an office area, a general purpose area, a community recreational space and a multipurpose room. The general purpose area and community recreational space were added in 1973, and the multi-purpose room in 1986 (Winnipeg School Division, 2013).

The following series of photographs provides additional visual information about the building's rectilinear exterior façade. Figure 4.8 is an image of the front façade of the school, facing McKenzie Street. This section of the school is part of the original construction dating to 1962. The solid brick façade laid in a running bond pattern is punctuated with windows on the west side on both the first and second storeys. Figure 4.9 shows the main entrance to the school from McKenzie Street, also part of the 1962 construction, as is the gymnasium. As can be seen in the image, the metal doors are fitted with windows, but are also flanked by glazing on both sides and above, up to the top of the second level, providing an abundance of natural lighting in the entrance foyer of the school.

Figure 4.8. Strathcona School, 1962 construction, McKenzie Street.
Image by S. Therrien-Richards.

Figure 4.9. Strathcona School, main entrance, McKenzie Street.
Image by S. Therrien-Richards.

In addition to the main entrance on McKenzie Street, there are two entrances at the rear of the school, an entrance in the two-storey section of the school accessible from a set of stairs on the exterior (Figure 4.13) and a smaller entrance tucked behind the trees in the courtyard at ground level and seen in Figure 4.10.

Figure 4.10. Ground level access on east side. Image by S. Therrien-Richards.

Access to the gymnasium is direct from the main McKenzie Street entrance, but access to the classrooms on the first floor requires going up a set of stairs at the south end of a hallway and descending a set of stairs at the north end of the hallway. Similarly, access to the classrooms on the second floor from the McKenzie Street entrance requires going up the set of stairs at the south end of the hallway (Figure 4.11) and ascending a second set of stairs at the north end of the hallway (Figure 4.12).

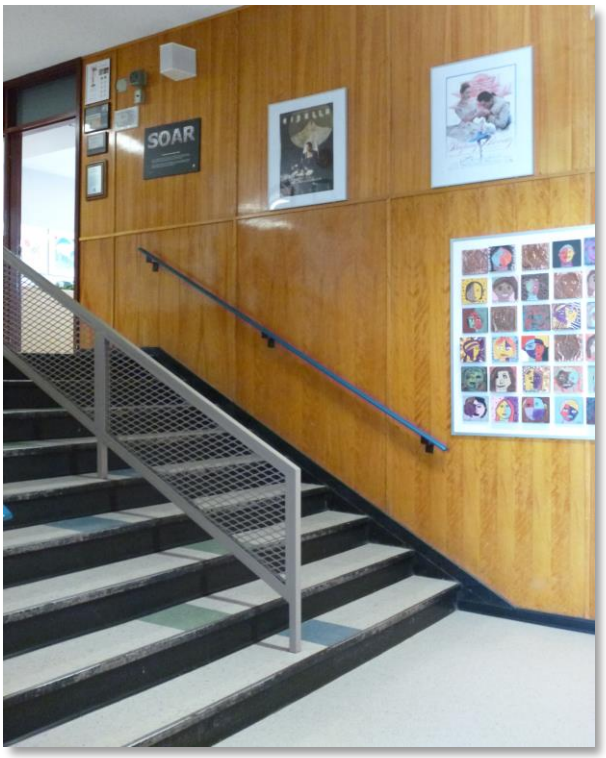


Figure 4.11. Staircase at south end of hallway. Image by S. Therrien-Richards.

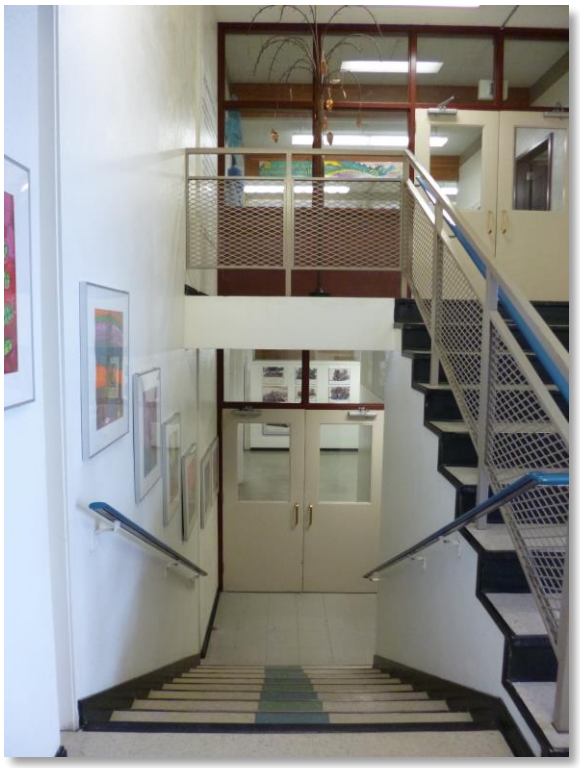


Figure 4.12. Staircases at north end of hallway. Image by S. Therrien-Richards.

Egress from the classrooms on the first floor from the exit on the east side of the school requires ascending 5 steps in the inside of the school to a double set of doors, as can be seen in Figure 4.13 and descending 4 steps in the exterior of the school to ground level, as can be seen in Figure 4.18. The school is not equipped with elevator access to lower or upper levels.

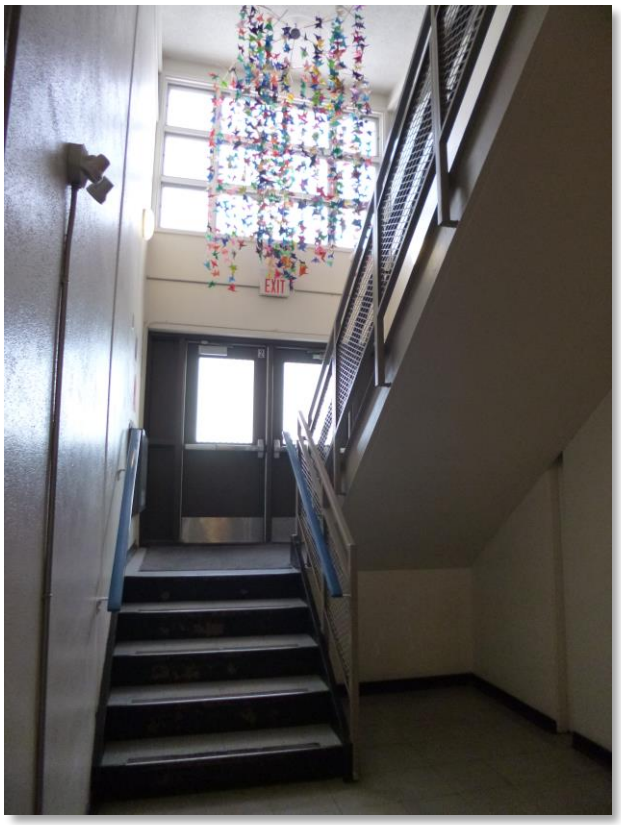


Figure 4.13. East exit from Strathcona School. Image by S. Therrien-Richards.

Figure 4.14 and Figure 4.15 are both perspectives of the school's gymnasium from Burrows Avenue, with Figure 4.15 showing garden plots planted by the classrooms during 2013.

Figure 4.14. Gymnasium, Burrows Avenue. Image by S. Therrien-Richards.

Figure 4.15. View of garden plots along Burrows Avenue. Image by S. Therrien-Richards.

Figures 4.16 to 4.18 are images of the rear of the school, adjacent to the playground that borders on McGregor Avenue. The images also show the extensive fenestration in the classrooms on the first and second storeys of the original 1962 construction. The courtyard between the classrooms and the gymnasium can be clearly seen in Figures 4.17 and 4.18.

Figure 4.16. Strathcona School, view from Burrows Avenue. Image by S. Therrien-Richards.

Figure 4.17. Strathcona School, view from McGregor Avenue. Image by S. Therrien-Richards.

Figure 4.18. Strathcona School, entrance from the playground. Image by S. Therrien-Richards.

As mentioned earlier, the courtyard is the site of "Folly Forest", an innovative and imaginative transformation of the asphalt surface into an award winning dynamic play space and forest. Asymmetrical sections of the asphalt were cut out, trees were planted and benches, follies and an earthen mound were installed. The use of recycled material was an integral part of the design. The new play space fosters engagement through play with nature (Prairie Design Awards, 2014).

The property is posted by the Winnipeg School Division, restricting hours of access, and signs on the school indicate that closed circuit television provides security 24 hours a day, as can be seen in Figure 4.19. Several of the windows are equipped with a heavy gauge screen, visible in the upper level windows.

Figure 4.19. Security features. Image by S. Therrien-Richards.

The interior of the school displays a lack of natural attributes, such as water features, flora or fauna, although one classroom has a pet fish. However, there are many windows bringing in lots of natural light in the classrooms. The structural wood beams on the ceiling in the classrooms clad in red birch plywood (Figure 4.34) are reminiscent of tree branches and should be incorporated into the design of the classroom. This same red birch plywood is used in the front entrance of the school and in the administrative area (Figure 4.11), displaying the use of natural materials as promoted by the International Style architects. Finally, the school has few architectural characteristics representative of sustainable design or construction.

4.3.3.2. Natural Ventilation Studies

As can be seen in Figure 4.20, the prevailing winds in Winnipeg, based on Environment Canada quarterly data averaged over a period of five years, flow predominately from the south.

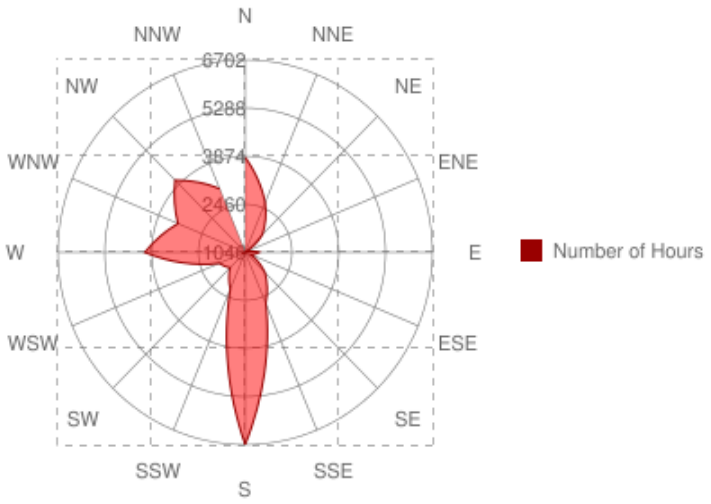


Figure 4.20 Wind direction for the City of Winnipeg over 5-year period, based on quarterly data (Weatherstats, 2015).

The impact of the prevailing winds against Strathcona School façade can be seen (Figures 4.21 and 4.22). At present, Strathcona School experiences no benefit from natural ventilation due to the prevailing winds. There is only one row of clerestory windows in the Green Commons area, located in the southeast section of the school, and these windows are not operable. The breeze rises over the school and provides no natural ventilation or cooling (Figure 4.22) (van Lengen, 2008).

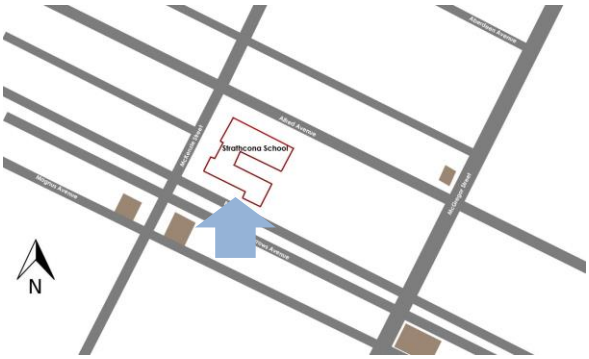


Figure 4.21. Direction of prevailing winds in Winnipeg against Strathcona School façade.

Figure 4.22. Sketch of wind effect on south façade of Strathcona School.

To optimize natural ventilation, operable windows need to be located on the façade perpendicular to air flow patterns from the prevailing winds and on the opposite façade to allow for cross-ventilation airflow (Figure 4.24).

Large elm trees planted along Burrows Avenue on the south side of Strathcona School provide shelter from the dominant south winds, decreasing the air

velocity at the canopy level (Figure 4.23). The airflow will pass and accelerate near the ground, entering the building with a reduced heat content and increased humidity, providing a cooling effect (van Legen, 2008). This is particularly effective if cross-ventilation is created by using upper windows to move the cool air from one side of the building to the other (Figure 4. 24).

Figure 4.23. Elm trees lining Burrows Avenue on south façade. Image by S. Therrien-Richards.

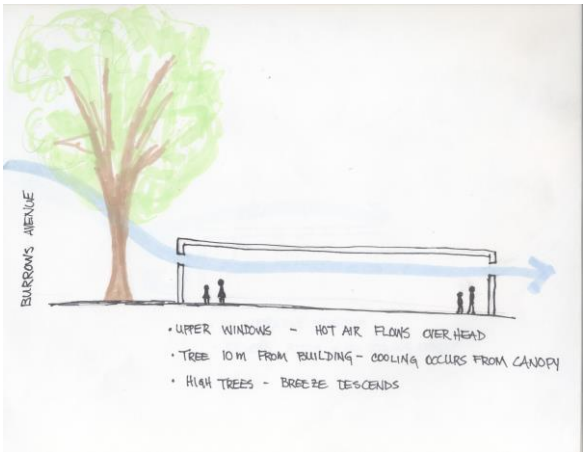


Figure 4.24. Sketch of cooling breeze descending from tall trees.

The final consideration is that interior spaces need to be configured to optimize cross ventilation. Maldonado (1998) recommends placing bathrooms and kitchens on the leeward side or downwind side of a building, with large windows in as direct a line as possible from rooms on the windward side of the building. This configuration provides good ventilation and evacuates odours to the exterior. The space in the Green Commons has been reconfigured with the placement of kitchens and bathrooms based on optimal cross-ventilation. Maldonado further recommends that partitions perpendicular to the path of airflow be kept to a minimum to limit obstructions to the airflow. Short vertical

walls allow air flow but full floor-to-ceiling partitions block air flow (Figure 4.24). Furniture placement should also be carefully considered to maximize air movement within and through the space.

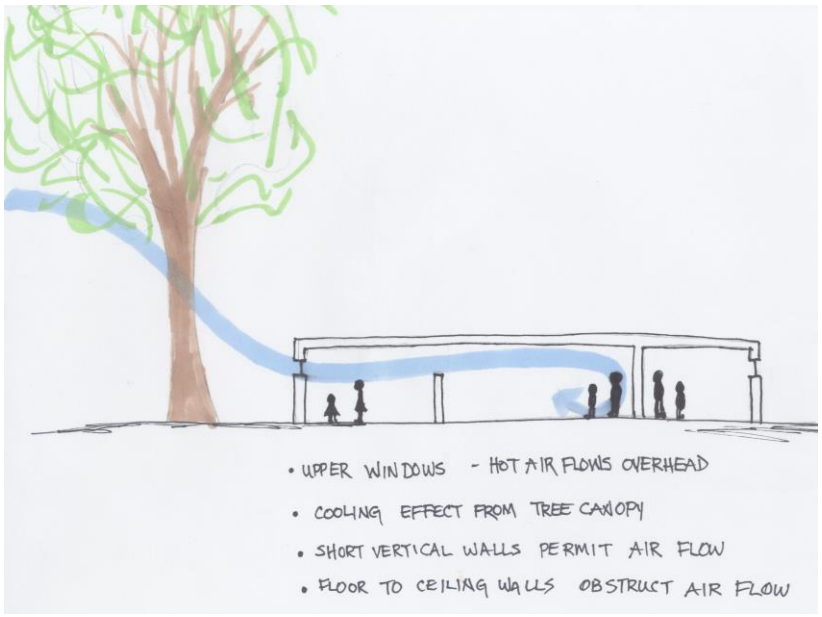


Figure 4.25. Sketch of impact of vertical walls in Green Commons on cooling breeze descending from tall trees.

4.3.3.3. Natural Light Studies

The importance of natural light has been clearly documented. In the space projected for the Green Commons, the windows are limited to a row of clerestory windows on the north and south façades, with no windows on the east façade. Natural light entering the space is very limited. Refer to Figures 4.26 to 4.28.

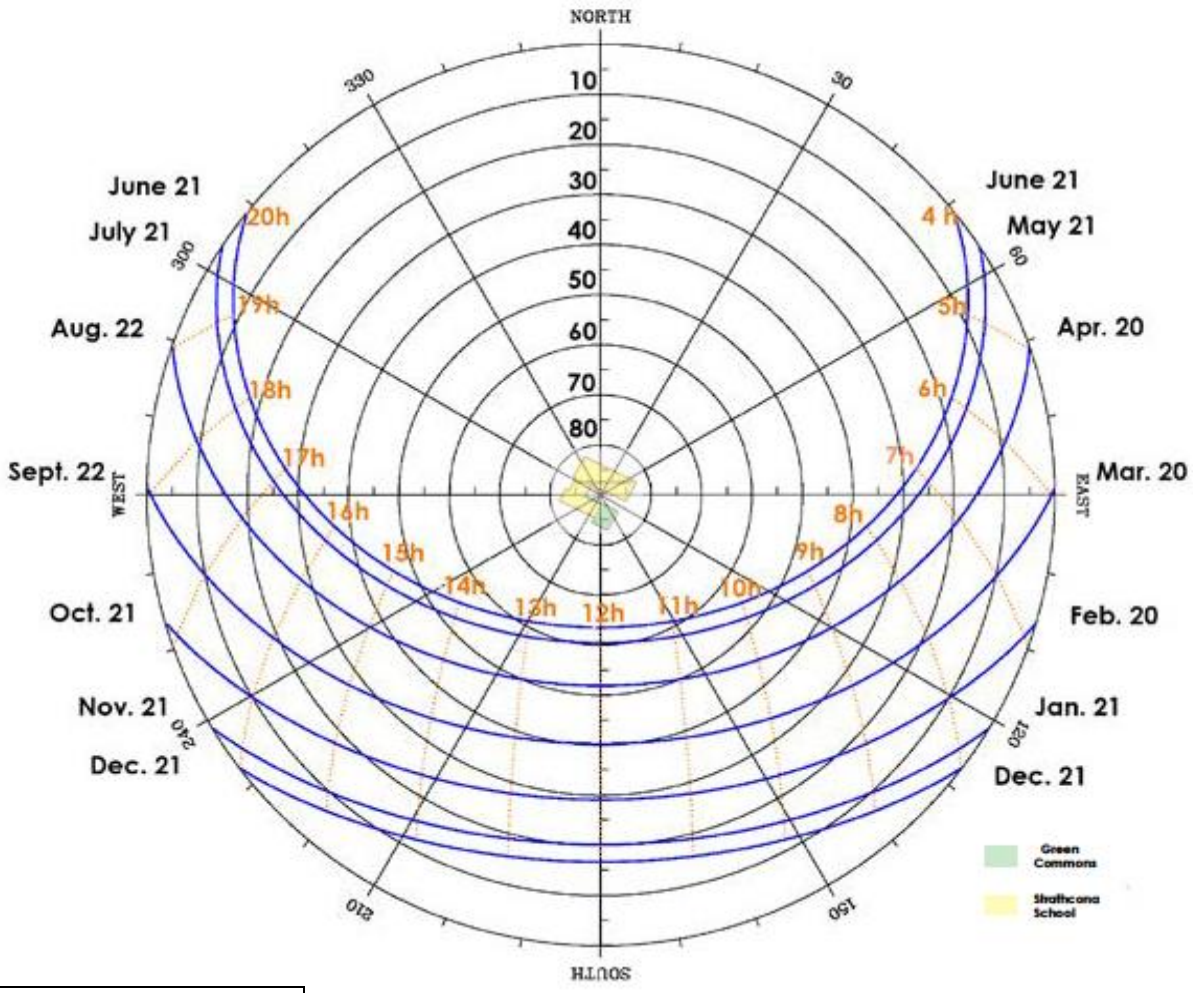
Figure 4.26. North façade of Green Commons. Image by S. Therrien-Richards.

Figure 4.27. South façade of Green Commons. Image by S. Therrien-Richards.

Figure 4.28. East façade of Green Commons. Image by S. Therrien-Richards.

A sun path diagram also provides information on how the sun will impact Strathcona School, based on its latitude (49.92°) and longitude (-97.15°), as can be seen in Figure 4.29. The sun path chart has been provided in Polar coordinates, plotted in Central Standard Time (-6 hours). Based on this diagram, the position on the sun, indicated by both the solar azimuth and the solar angle, on any given day and time can be determined. As seen in Figure 4.30, the longest day of sunlight occurs on June 21, when the sun rises at approximately 5h and sets at 20h, with azimuths of 50° and 310° respectively. At this time of the year, the sun will penetrate into the east sections of the school, including the

Green Commons, until mid-day, and then into the south and west portions of the school for the afternoon and into the evening. The north façade of the Green Commons will experience direct sun exposure for only for a brief period in the morning between 10h and 11h. The shortest day of the year occurs on December 21 when the sun rises at approximately 8h and sets at 16h, with azimuths of 128° and 230° respectively. At this time of the year, the north façade of the Green Commons will not receive direct sunlight, but the east and south façades of the school will receive direct sunlight from the sun throughout the day as the sun moves across the sky. Based on this data, an acoustical analysis (Appendix B) and a light study of the Green Commons (Appendix C) were conducted to determine the number and positioning of windows to both minimize and maximize solar penetration into the spaces, while minimizing adverse noise transmission to the interior. This will be further discussed in the next chapter.



Strathcona School
233 McKenzie St.
Winnipeg
Latitude: 49.92°
Longitude: -97.15°
Time Zone: -6

Figure 4.29. Sun path chart for Strathcona School. Retrieved from http://solardat.uoregon.edu/SunChartProgram.html on October 27, 2015.

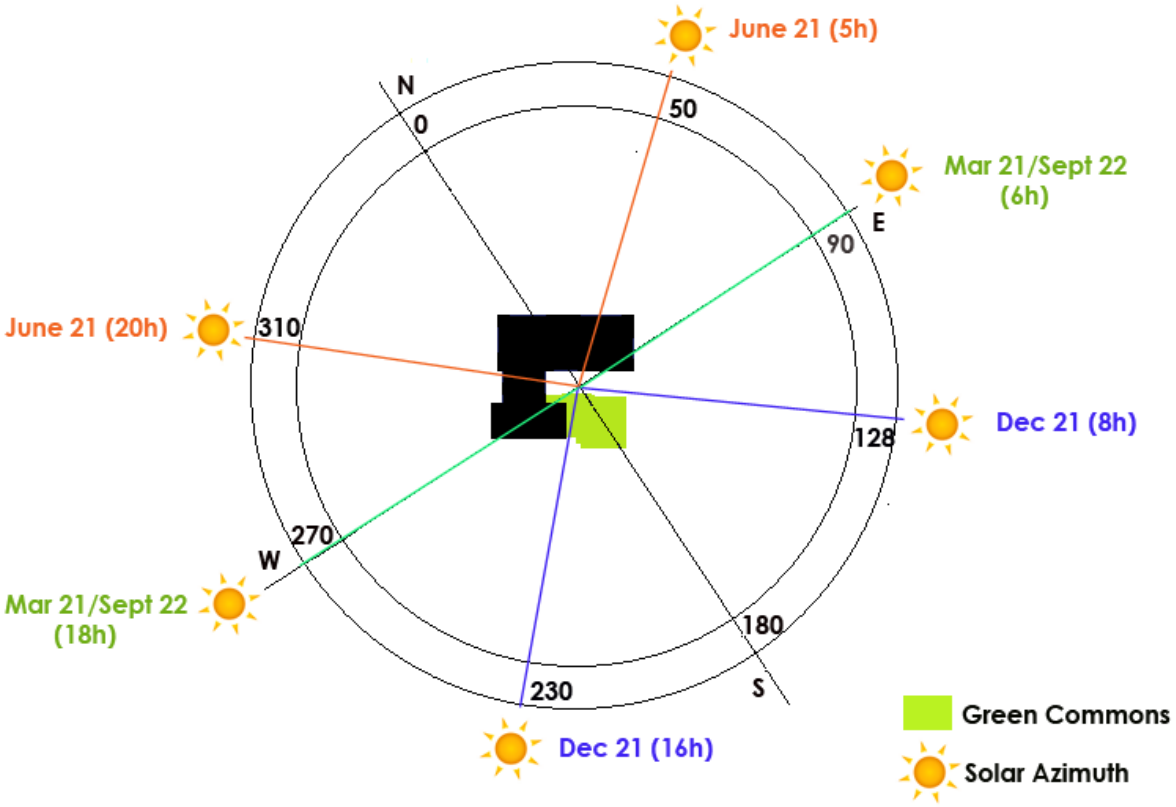


Figure 4.30. Solar azimuths for Strathcona School and the Green Commons.

4.3.3.5. Opportunities and Constraints

Based on the site and building analysis, a summary of the opportunities and constraints identified has been provided in the following table:

List of Opportunities
Site ❖ Landscaping with mature trees on Burrows and Albert Avenues and McKenzie Street, providing opportunities for natural cooling ❖ McKenzie Street and Albert Avenue - quiet residential streets ❖ Burrows Avenue - heavy with traffic but lower speeds reduce traffic noise ❖ School lot generous size ❖ Landscaping with mature trees on Burrows and Albert Avenues and McKenzie Street, providing opportunities for natural cooling ❖ Prevailing winds from South for cooling ❖ Folly Forest
Strathcona School ❖ Elements of International design ▪ Rectilinear form ▪ Red birch plywood panelling in the hallway ❖ Windows on all facades in single, double and triple rows of three or four ❖ Opportunity to meet school building space standards not met for multipurpose space, library and kitchenette
Classrooms ❖ Large windows in classrooms on both north and south facades ❖ Clerestory windows in the hallways allow light to penetrate into the classroom ❖ Elements of International design ▪ Support beams on second floor clad in red birch plywood ❖ Direct view to Folly Forest from classroom on south façade ❖ Generous size ❖ Recessed doors with small open area ❖ Indirect natural lighting on north façade ❖ Direct natural lighting on south façade ❖ All classrooms facing quiet residential streets or Folly Forest
Green Commons ❖ Possible direct and unobstructed view to Folly Forest from north façade ❖ Possible direct and unobstructed view of playground and field from east façade ❖ Free façade of Green Commons ❖ Open floor plan for Green Commons ❖ Based on acoustical analysis, option to add 136 square feet of windows to south façade for ventilation (less than 15% of surface area) ❖ Opportunity to create access to Green Commons directly from school ❖ Integration of International language into Green Commons – communication between 1962, 1973 and 1986 phases

Hallways ❖ Elements of International Style ▪ Red birch plywood panelling in the hallway ❖ Large window on east façade allows light to penetrate into the hallways ❖ Clerestory windows on hallway walls of classrooms allow light to penetrate into the hallways
List of Constraints
Site ❖ Burrows Avenue - heavy with traffic
Strathcona School ❖ Multi-level school not universally accessible – only stairway access ❖ Upgrading for code compliance with major renovations
Classrooms ❖ Indirect natural lighting on north façade insufficient during fall/winter ❖ Heating caused by direct natural lighting on south façade
Green Commons ❖ No access to Green Commons from school ❖ Access to Green Commons only from Burrows Avenue ❖ Cluster of small rooms in Green Commons not conducive to group activities

Table 4.2 List of opportunities and constraints for Strathcona School.

4.3.4 Human Factors Analysis

4.3.4.1 Client Profile

The Winnipeg School Division is the largest school division in the City of Winnipeg, with 77 schools located in four distinct districts: Central, Inner City, North and South. The Winnipeg School Division offers educational programs and services to approximately 33,000 students from Nursery to Grade 12. Different programming is offered including elementary and secondary classes, as well as alternative, advanced and language programs. Programming is also offered for students with special education and behavioural needs. Life-long learning and adolescent parents are supported, as well as new Canadians and students, and families from a variety of diverse cultures. School therapy and counselling services are also offered in support of student wellness and development (Winnipeg School Division, 2013).

The Mission of the Winnipeg School Division …

is to provide a learning environment that promotes and fosters the growth of each student's potential and provides an opportunity for the individual student to develop the knowledge, skills, and values necessary for meaningful participation in a global and pluralistic society. (Winnipeg School Division, 2013)

4.3.4.2 Guiding Principles of Winnipeg School Division

The Winnipeg School Division…

- Believes in the equality, worth, potential and dignity of all individuals.
- Believes that the public school is an essential component of society and culture. By working co-operatively with the home and the community the Division can ensure that its programs reflect the

changing needs of society and the values, beliefs, and traditions of the local school community.

- Believes that in addition to basic literacy and communication skills all students must be challenged to develop the ability to interpret and evaluate information.
- Believes each student must be given the opportunity to develop the values, attitudes, and moral principles that enable them to become responsible citizens who relate to others in an empathetic and moral manner.
- Believes its greatest resource is the staff. The Division is committed to providing professional development for all employees and an opportunity to participate in the decision-making process of the Division.
- Will advocate on behalf of students to ensure appropriate care and support services are provided for all children.
- Believes in the dignity of the individual and supports the staff in the maintenance of proper student conduct to ensure a safe nurturing learning environment within the schools. (Winnipeg School Division, 2013)

These guiding principles support the project goals of fostering a greater connection to nature and inspiring children to become stewards of their environment. The improved intellectual, emotional and spiritual well-being of the

children resulting from a closer connection to nature will help the children to better understand and integrate environmental ethics into their lifestyle in the short term and beyond as they mature into adulthood.

4.3.4.3 User Profiles

Strathcona School currently has a complement of approximately 40 staff, which includes a principal, a vice-principal, administrative staff, janitorial staff, 21 - 26 teachers, and teacher assistants, providing education to students from Nursery to Grade six. Parents and guardians, as well as volunteers who can include members of the community, are also encouraged to work with staff helping students develop their full potential. The mandate of Strathcona School is to provide an environment that is centered on the child, is challenging yet safe, where meaningful learning experiences are created for the children. Fairness, respect, patience, friendliness and ethical behaviour are paramount in the delivery of services (Winnipeg School Division, 2013).

Strathcona School has demonstrated a commitment to learning about and living the Seven Teachings as part of the Aboriginal Education Policy implemented by the Winnipeg School Division in 1996 and revised in 2005 (Winnipeg School Divison, 2005). Students and staff are committed to living by the Seven Teachings – love, respect, courage, honesty, humility, wisdom, bravery and truth - collectively reviewing values in actions and reflecting on

what has been gained by living by the Seven Teaching (Winnipeg School Division, 2013). This commitment to both spiritual law and the connection to the land will be complemented by the project, which will help children reconnect with nature and the land.

4.3.4.3.1 Primary Users

Primary users are defined as those who occupy the site for most of the time and include students and staff at Strathcona School. The school children are students between the ages of 5 and 12 attending a public school program in the City of Winnipeg's catchment area for Strathcona School. The total student population between Kindergarten and Grade 6 at Strathcona School in September 2015 was reported to be 309 students (Winnipeg School Division, n.d.). In addition to the students, a total of 41 teachers, administrative staff including a principal, vice-principal and office support; and maintenance staff constitute the primary users. One full-time police officer is also assigned to Strathcona School. A demographic profile follows in Table 4.3.

User (No.)	Gender	Behavioural Needs	Physiological Needs	Spatial Needs
Students aged 5 to 12 (309)	Female and male	Learning – 9 a.m. to 4 p.m. After school activities – 4 p.m. to 8 p.m. Transitioning Recess	Washroom facilities Lunch/food services	Storage for backpacks, school supplies, coats, boots Desk/chair
Teachers (21-26) and Teacher Assistants (Varied)	Female and male	Teaching – 8:30 a.m. to 4:00 p.m. Meeting space for students After school activities – 4 p.m. to 8 p.m. Internet Telephone	Washroom facilities Lunch/food services	Desk/chair Classroom space Staff area / lounge / lunchroom Meeting space Secure storage for personal effects Parking
Administrative Staff (4)	Female and male	Office area Internet Telephone	Washroom Facilities Lunch/food services	Both private and open office spaces Storage Desk/chair Parking Staff area / lounge / lunchroom Meeting space for staff
Maintenance Staff (2)	Female and male	Cleaning Minor repairs Maintenance Landscaping	Washroom facilities Lunch/food services Need to be able to multi-task as maintenance will require both building and grounds work	Access to all interior and exterior spaces Staff area/lounge Parking Supply/cleaning room
Police Officer (1)	Female and male	Office area Internet Telephone	Washroom facilities Lunch/food services	Staff area / lounge / lunchroom Meeting space Secure storage for personal effects Parking

Table 4.3. Demographic profile of primary users.

4.3.4.3.2 Secondary Users

Secondary users are defined as those who frequent the environment on a regular basis but less frequently than the primary users. This group includes department resource staff and family members of students. Refer to Table 4.4.

User (No.)	Gender	Behavioural Needs	Physiological Needs	Special Needs
Resource Staff (Psychologists, Sociologists, etc.) (1-2)	Female and male	Office area Internet Telephone	Washroom facilities	Staff area / lounge / lunchroom Private office space Parking
Parents, Grandparents and Guardians of Children (Varied)	Female and male	Short 2-4-hour visits to site	Washroom facilities	Parking

Table 4.4. Demographic profiles of secondary users.

4.3.4.3.3 Tertiary Users

Tertiary users are defined as those who frequent the site infrequently or for short periods of time. Refer to Table 4.5 for the demographic profiles of tertiary users.

User (No.)	Gender	Behavioural Needs	Psychological Needs	Special Needs
Delivery Personnel Suppliers (1)	Female and male	Access into building quickly Ability to deliver products without delays	Washroom facilities	Easy access to site and office Parking
Volunteers (Varied)	Female and male		Washroom facilities	Secure storage for personal effects Access to staff area / lounge/ lunchroom
Equipment Repair Personnel (1)	Female and male	Access into building	Washroom facilities	Easy access to site and office Parking

Table 4.5. Demographic profiles of tertiary users.

4.3.5 Spatial Requirements and Analysis

An analysis of user requirements and proposed spaces, based on the Public School Finance Board *School Building Space Standards*(SBSS) (November, 2012) and the National Building Code of Canada (NBCC) (2010), is summarized in Table 4.6 and shown graphically in Figure 4.29. The calculations are based on a school population of 309 students equally divided between males and females. The NBCC (2010) and the National Fire Code of Canada (2010) were also reviewed to determine applicable requirements for Strathcona School. Refer to Appendices D and E respectively.

Space	Area (m^2)	Description of Requirements	Special Requirements	Meets SBSS & NBCC YES	NO
Common Areas (Entrances - 3 / Vestibules and Circulation	Not specified	Lockers/cubicles for coat, footwear and backpack storage Secure storage Easy maintenance Durable Efficient lighting	Durable, easily maintained flooring Ability to withstand heavy cleaning and student abuse Vandal resistant Water and humidity resistant materials Moisture resistant wall surfaces Noise reduction	✖	
Water Closets Students Staff Health Services Sick Bay Grooming Room	 9 26	Gym change rooms 1 WC and 2 Basins /30 boys and 1 WC and 2 Basins/25 girls (NBCC) Barrier-free WCs - 1.5 m by 1.5 m in size (NBCC)	5 WC for boys 6WC for girls based on population of 300 students Easy to clean and disinfect Water and humidity resistant Moisture resistant wall surfaces Hard non-porous flooring	✖	
Classrooms 1 Kindergarten 20 Grades 1 - 6 (80 m^2 per classroom) Storage (Kindergarten only)	 93 1600 14	Seating for up to 30 students Vertical surfaces (Tables – circular – 4) Flexibility for enclosing spaces Sound control Projection ability Display boards/areas Easy maintenance Durable	Durable, easily maintained flooring Non-allergenic surfaces Natural daylighting Moisture resistant wall surfaces Durable storage areas and furnishings	✖	
Gymnasium (251- 400 enrolment) Ancillary Space Office Change/Shower Storage WC	 372 11 93 38 11	Flexibility for enclosing spaces Flexible seating	Hardwood flooring Noise reduction Easy to clean and disinfect Water and humidity resistant Moisture resistant wall surfaces Hard non-porous flooring in ancillary spaces	✖	
Multi-purpose Room (0.37 m^2/student = 111 m^2 for population of 300 students)	0	Seating should accommodate larger groups Easy to maintain Durable	Natural materials Noise reduction Durable, easily maintained flooring Non-allergenic surfaces		✖
Staff Areas Administration Reception/ Secretarial Staffroom (1.4 m^2 x no. of staff, based	 11-14 70 58	Offices are filled with natural light Meeting room Engaging spaces for work	Soft flooring for comfort and acoustics Appropriate lighting – task and overhead	✖	

Space	Area (m^2)	Description of Requirements	Special Requirements	Meets SBSS & NBCC YES	NO
on 41 staff) Support Services (Resource Teaching, Guidance & Special Services)	37-139				
Library/Resource Centre	114	SSBS requires a resource centre of 149 m^2, based on SSBC of minimum of 149 m^2	Soft flooring for comfort and acoustics Appropriate lighting – task and overhead Easy to clean and disinfect		✖
Kitchenette	0	SSBC requires 19 m^2	Easy to clean and disinfect Water and humidity resistant Moisture resistant wall surfaces Hard non-porous flooring		✖

Table 4.6. Functional/aesthetic requirements and spatial requirements.

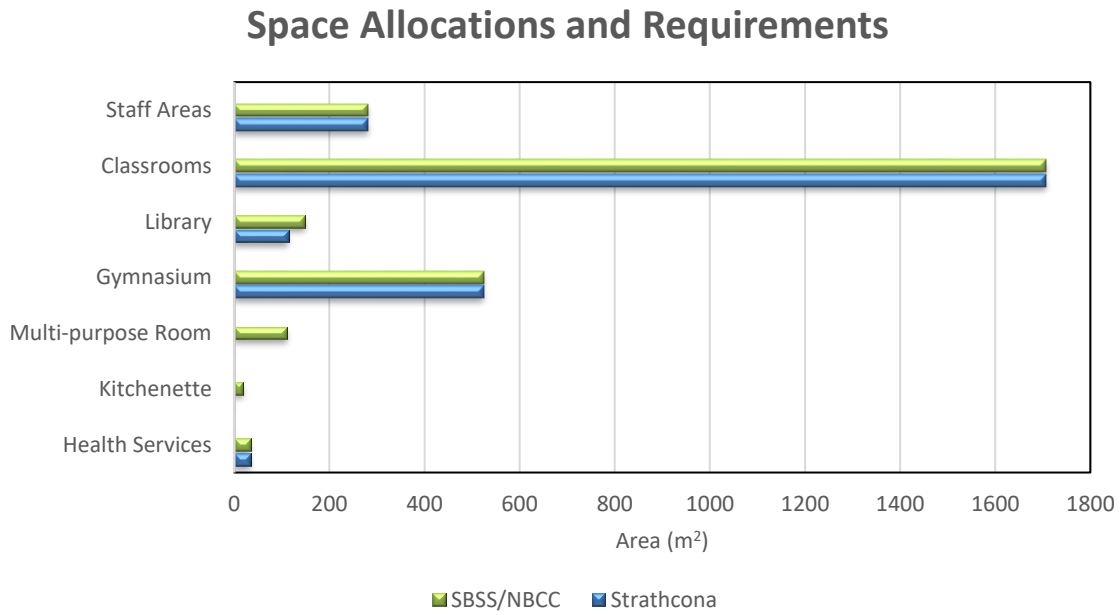


Figure 4.31. Spatial area requirements compared to actual space allocations at Strathcona School.

As can be seen in Table 4.6 and Figure 4.31, there are three areas in which there are deficiencies in space allocation at Strathcona School, based on the NBCC

(2010) and SBSS (2012). Strathcona School requires a multi-purpose room and a kitchenette, which are currently non-existent. In addition, the library space is undersized and requires expansion. The creation of the Green Commons in a new space will allow Strathcona School to meet the requirements of the SBSS for these spaces, as well as provide an opportunity to meet NBCC requirements for barrier-free access. The areas that will be modified to create the Green Commons are shaded in the demolition drawing (Figure 4.32). This is also an opportunity to strategically improve wayfinding in Strathcona School – these areas have been highlighted in Figures 4.33 and 4.34. The hallways are generously sized at 2667 mm (8.75 feet) wide, with nooks of 762 mm (2.5 feet) by1587 mm (5 feet) at each classroom doorway. As can be seen in Figures 4.35 and 4.36, the current environment provides few clues to indicate location and direction. Finally, since the existing library will be relocated to the Green Commons, this provides another opportunity, that is, to design a classroom in the space currently occupied by the library. This area has been shaded in Figure 4.34 in the southeast section of the school on the second floor and is 8331 mm (27.3 feet) in length and 7760 mm (25.5 feet) in width. The library has existing features that can be incorporated into the new design for the classroom. The existing fenestration brings in lots of natural light as can be seen in Figure 4.37. The structural wood beams on the ceiling are reminiscent of tree branches and should be incorporated into the design of the classroom.

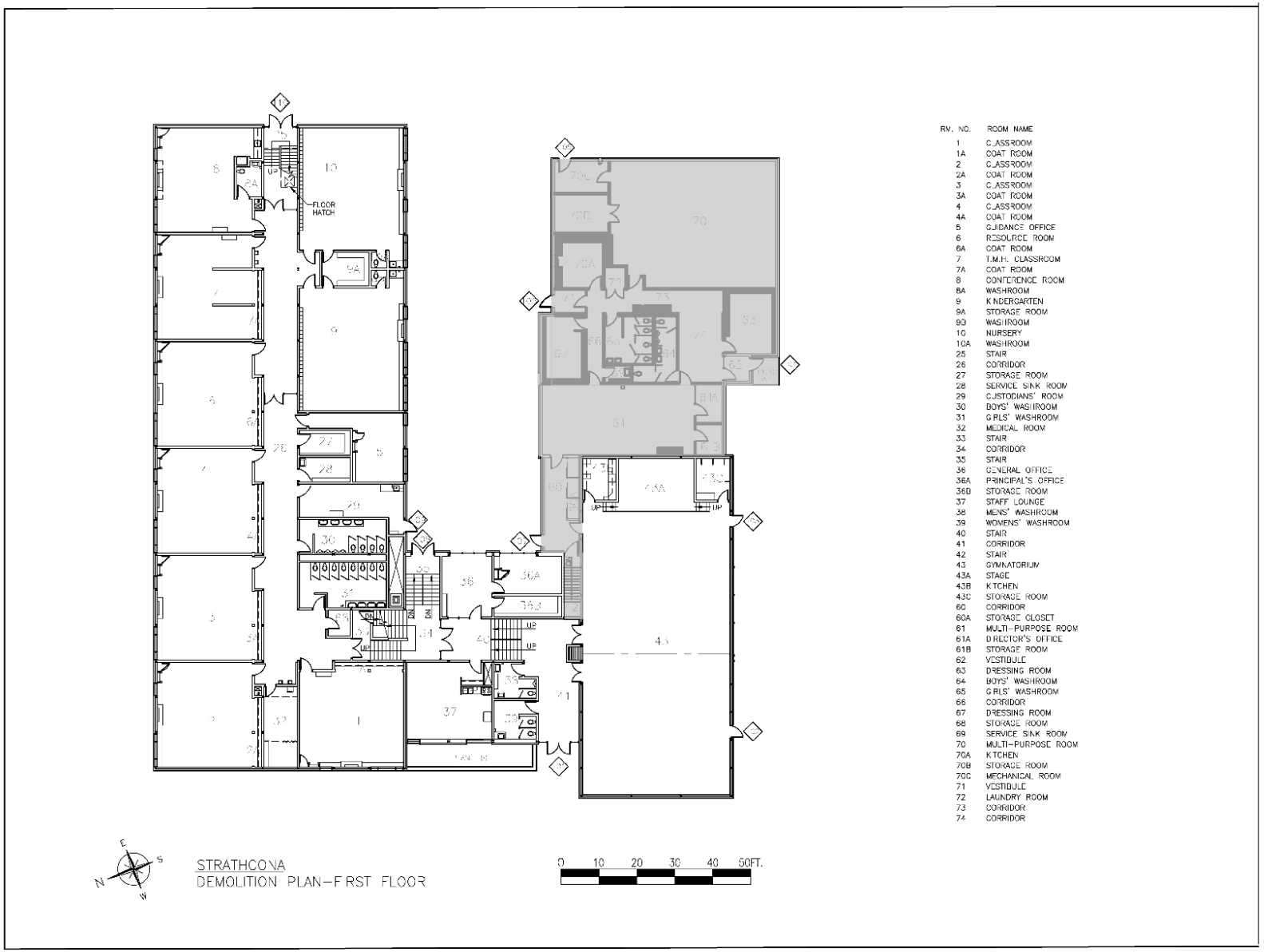


Figure 4.32. Demolition drawing of existing spaces in Strathcona School to create Green Commons.

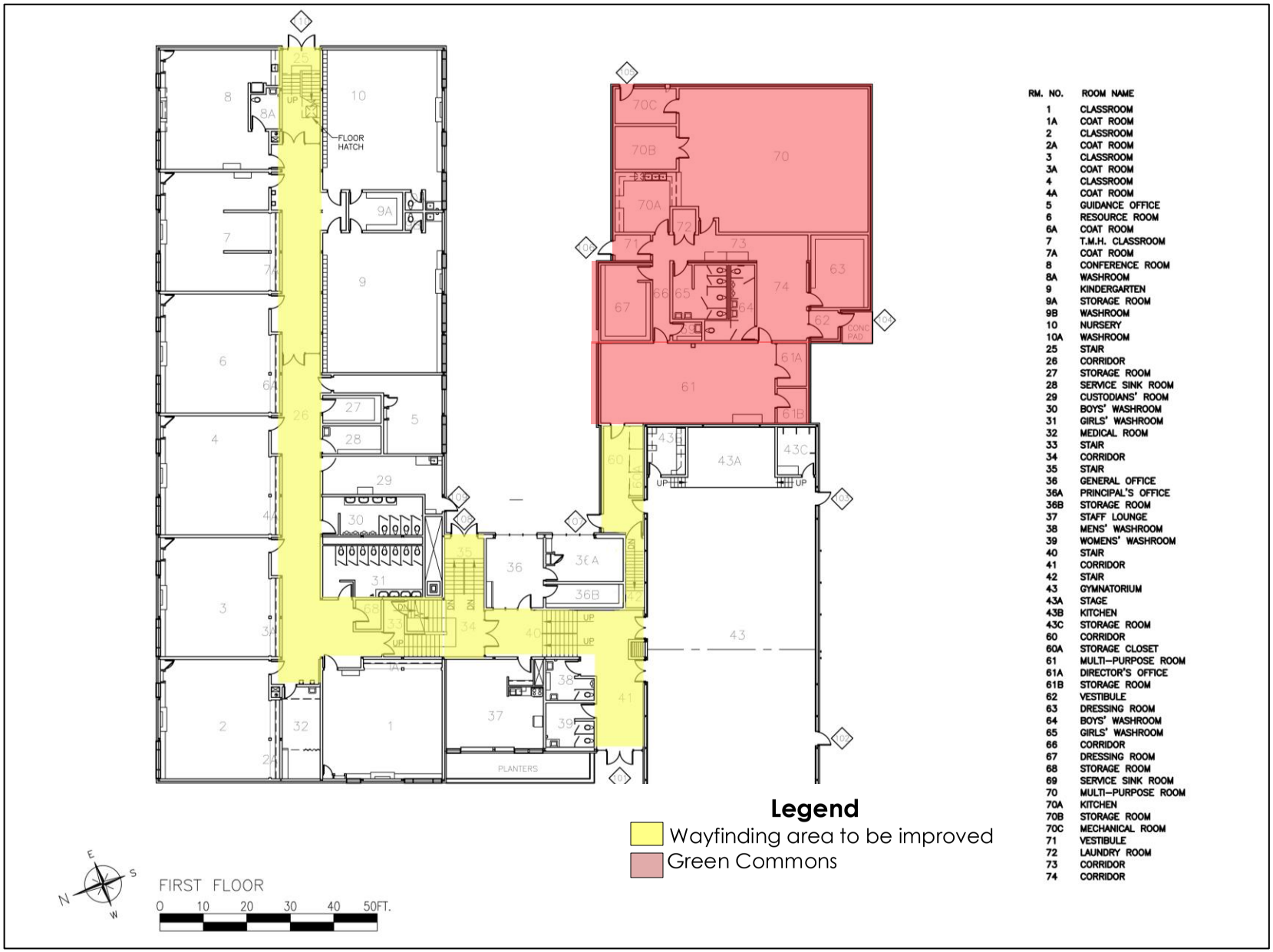


Figure 4.33. Areas on first floor to be designed for Green Commons and to improve wayfinding.

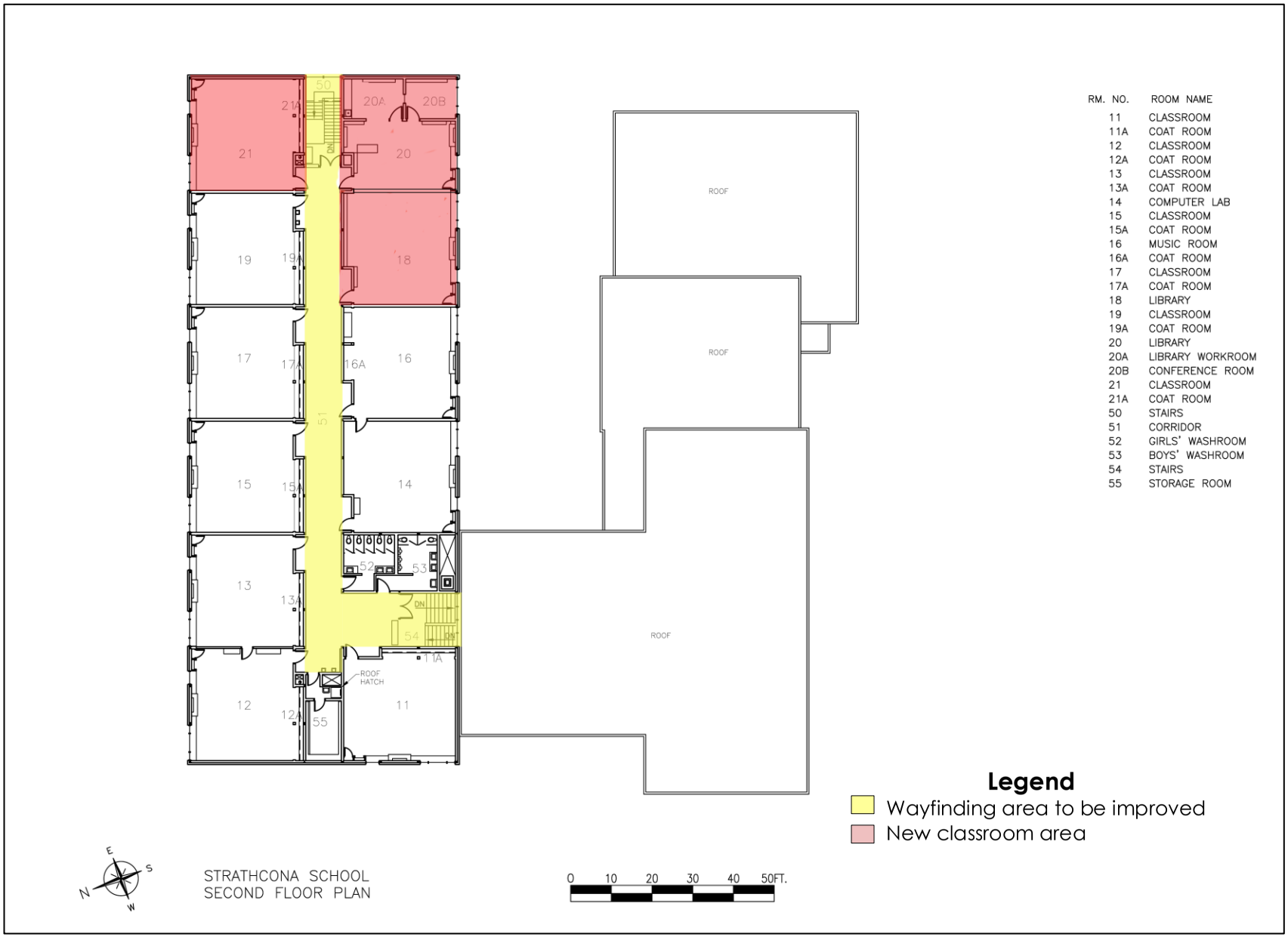


Figure 4.34. Areas on second floor to be designed for improved wayfinding and for new classrooms.

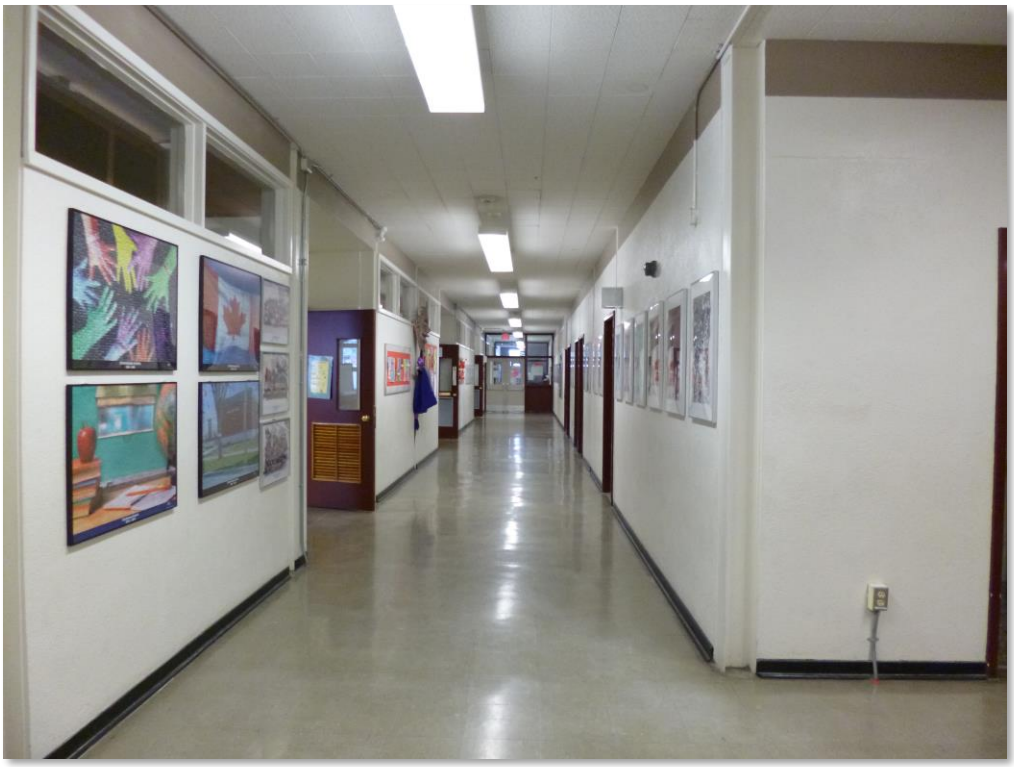


Figure 4.35. First level hallway in Strathcona School. Image by S. Therrien-Richards.

Figure 4.36. Second level hallway in Strathcona School. Image by S. Therrien-Richards.

Figure 4.37. Strathcona School library seating for students with south facing windows. Image by S. Therrien-Richards.

Adjacency Matrix

The following matrix describes the adjacency requirements for the various areas in Strathcona School. The orange dots describe areas which need to be adjacent and the green dots describe areas which can be nearby, but are not required to be immediately adjacent.

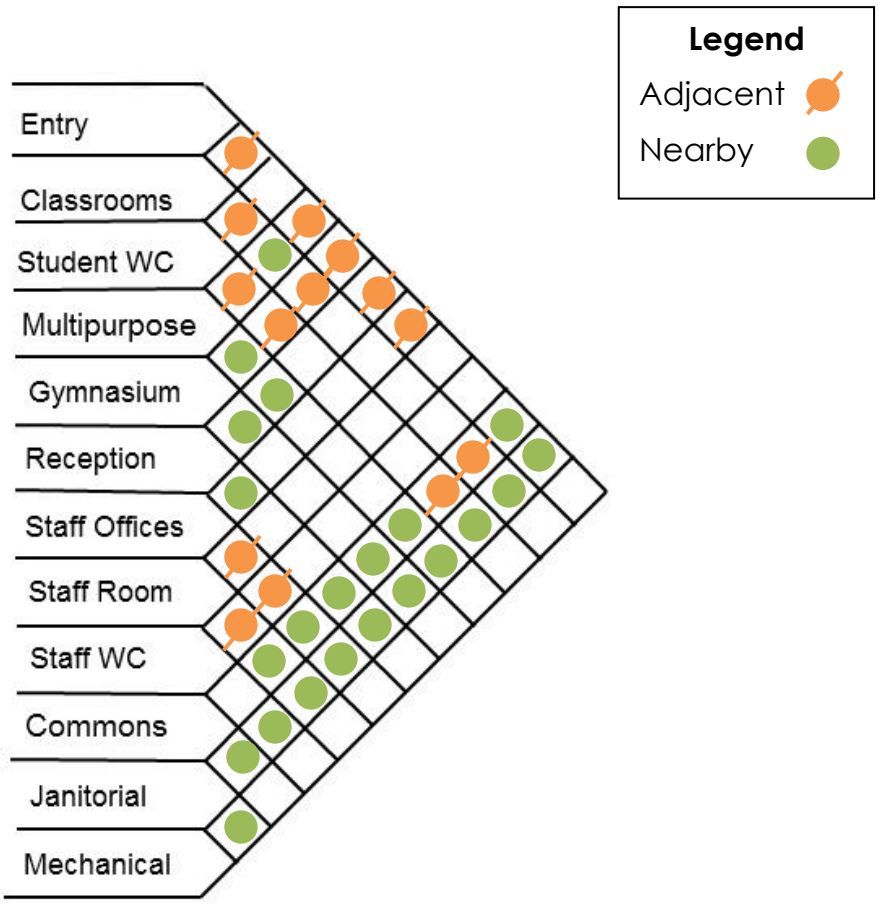


Figure 4.38. Adjacency matrix for Strathcona School.

The following diagram further shows the adjacency matrix for Strathcona School in a bubble diagram format, indicating both major and convenient adjacencies in a further analysis of spatial needs. The areas enclosed within the solid line were designed to meet the project objectives.

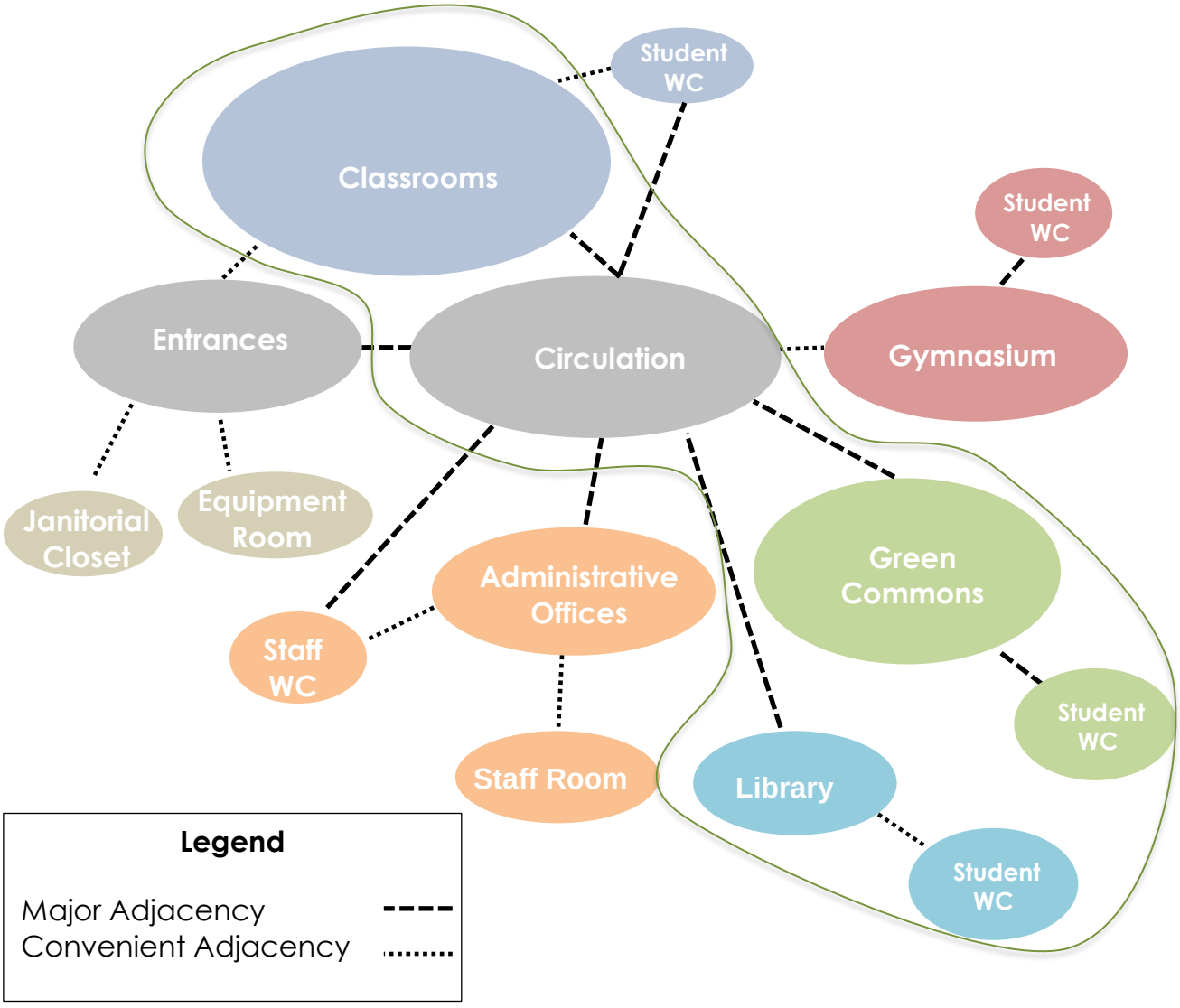


Figure 4.39. Bubble diagram showing required adjacencies for Strathcona School.

Chapter 5. Concept Proposal and Program Design

5.1 Introduction

The proposal for the project, "Fostering the Connection to Nature Through Urban Elementary School Design", was inspired by place - specifically the geography in southern Manitoba. The elements of nature found in the boreal forest and the prairie grassland guide and inform the features of the design of the Green Commons, the classrooms and the circulation pathways in Strathcona School. These are the areas where the children spend the greater part of the day and where the greatest impact of a design to restore nature deficit will be felt. The things that surround us in nature will be introduced into these spaces to foster the human/nature connection – light, fresh air, natural shapes and forms, and colours. Materials will be selected that are environmentally friendly and locally sourced when possible.

5.2 Concept Proposal

My inspiration for the design is derived from the very elements of nature that surround us in the southern Manitoba context, where two dominant ecosystems are separated and yet connected by the Manitoba escarpment (Figure 5.1). The lay-out of the school lends itself to mimicking the level changes of the southern Manitoba geography. The lower level is connected to the upper level by a section of offices with staircases going up and down. The upper level is representative of the boreal forest; the lower level, of the prairie grassland; and

the office area of the Manitoba escarpment. When you "unfold" the section of the school as seen in Figure 5. 2, it becomes even more evident that the school layout mirrors the lines of the southern Manitoba geography.

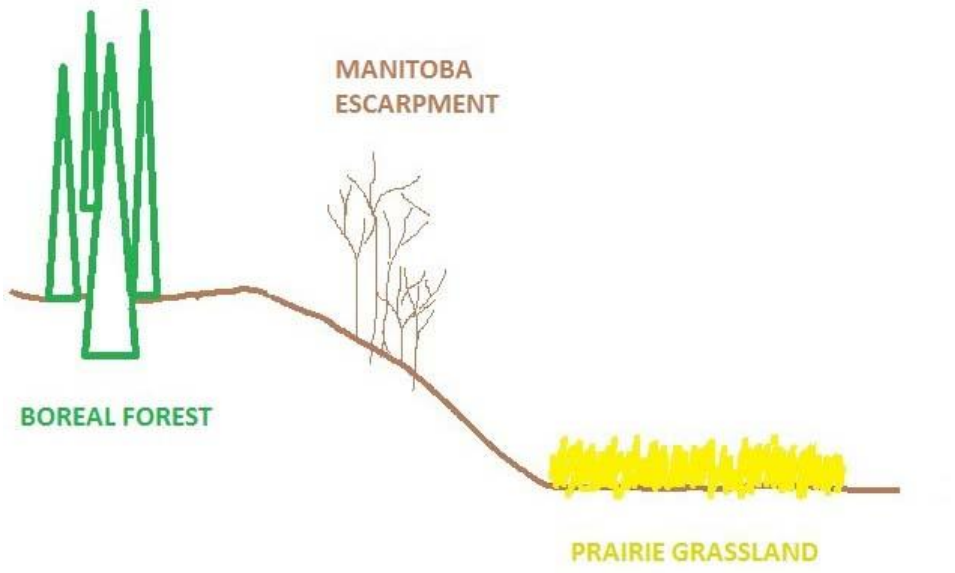


Figure 5.1. Southern Manitoba geography.

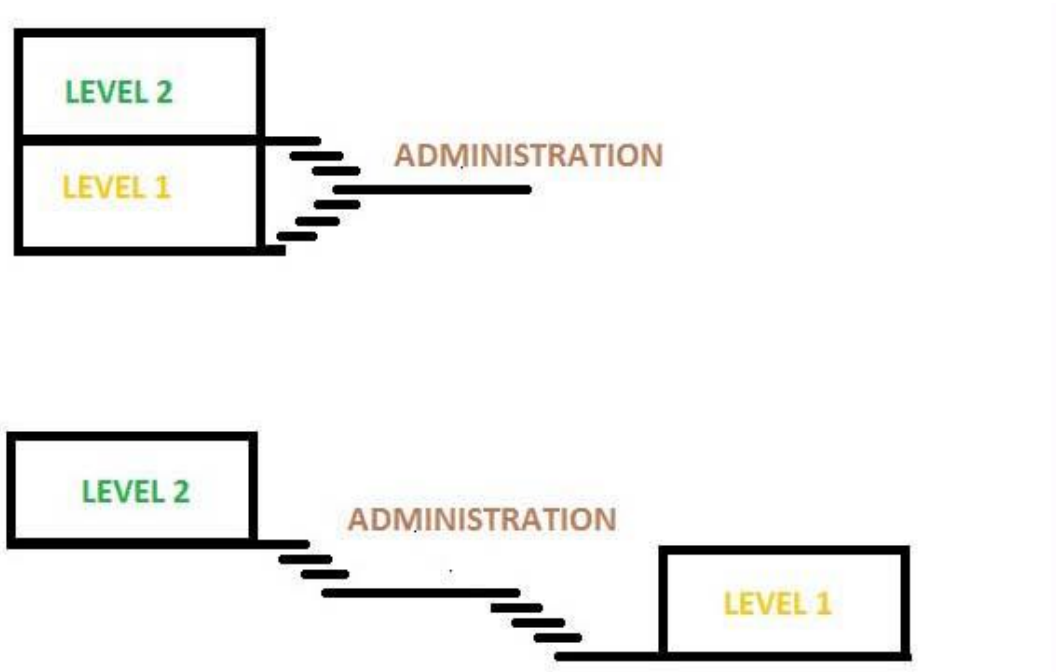


Figure 5.2. Schematic of Strathcona School "unfolded".

The ecozones, the boreal forest, the prairie grassland and the Manitoba escarpment, influence the design of the spaces and the wayfinding system in Strathcona School. These ecozones also provide guidance as to colours and material selection in the design. The boreal forest colours are dominated by various shades of green associated with the coniferous species. The accents are provided by lichens and mosses, with bright splashes of oranges, greys and lime green as can be seen in Figure 5.3.

Figure 5.3. Colours of the boreal forest. Images by S. Therrien-Richards.

The escarpment area is associated with the more neutral colours of aspen, poplar and burr oak - off white, greys and browns - during the late fall, winter and early spring. However, the fall adds a riot of yellows, oranges and reds as deciduous leaves change colour. This colour scheme is shown in figure 5.4.

Figure 5.4. Colours of the Manitoba escarpment. Images by S. Therrien-Richards.

The prairie grassland is dominated by the colours of the prairie sky and the grasses, blues, greens and golden yellows, and the rich browns of the soil.

Figure 5.5. Colours of the prairie grassland. Images by S. Therrien-Richards

These colour schemes form the basis of colour selection for each of the areas in Strathcona School as follows: Level 1 areas, which include the Green Commons and the hallways on the first storey – the colours of the prairie grassland; Level 2 areas, which includes the classroom and the hallways on the second storey – the colours of the boreal ecosystem; and the Administration area - the colours of the Manitoba escarpment.

5.3 Proposed Zoning and Circulation

The following images (Figures 5.6, 5.7 and 5.8) show the proposed spatial organization, flow and circulation for Strathcona School, based on the information presented in Chapter 4.3.4, Human Factors Analysis. Spatial requirements based on the occupancy profile, the adjacency matrix and space allocation requirements set by the Public School Finance Board (2012) informed the proposed zoning and circulation. Figure 5.6 illustrates how the Green Commons provides the necessary area to address the deficiencies at Strathcona School for a multi-purpose space, a kitchenette and a library. Cut-outs of the required areas for each of the spaces were used to determine the most optimal organization of the spaces. The organization of the school, the flow and circulation are shown in Figures 5.7 and 5.8.

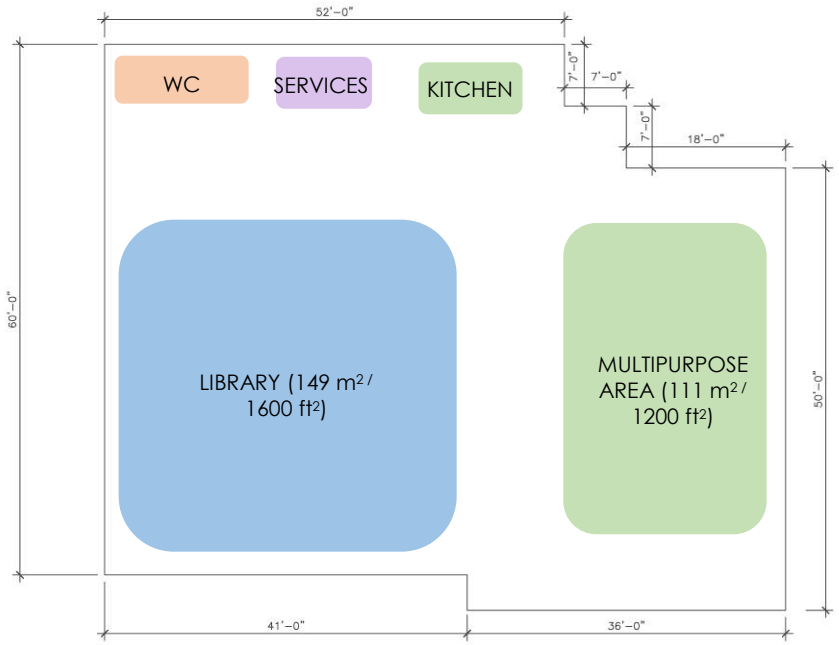


Figure 5.6. Meeting the space allocation requirements set by the Public School Finance Board.

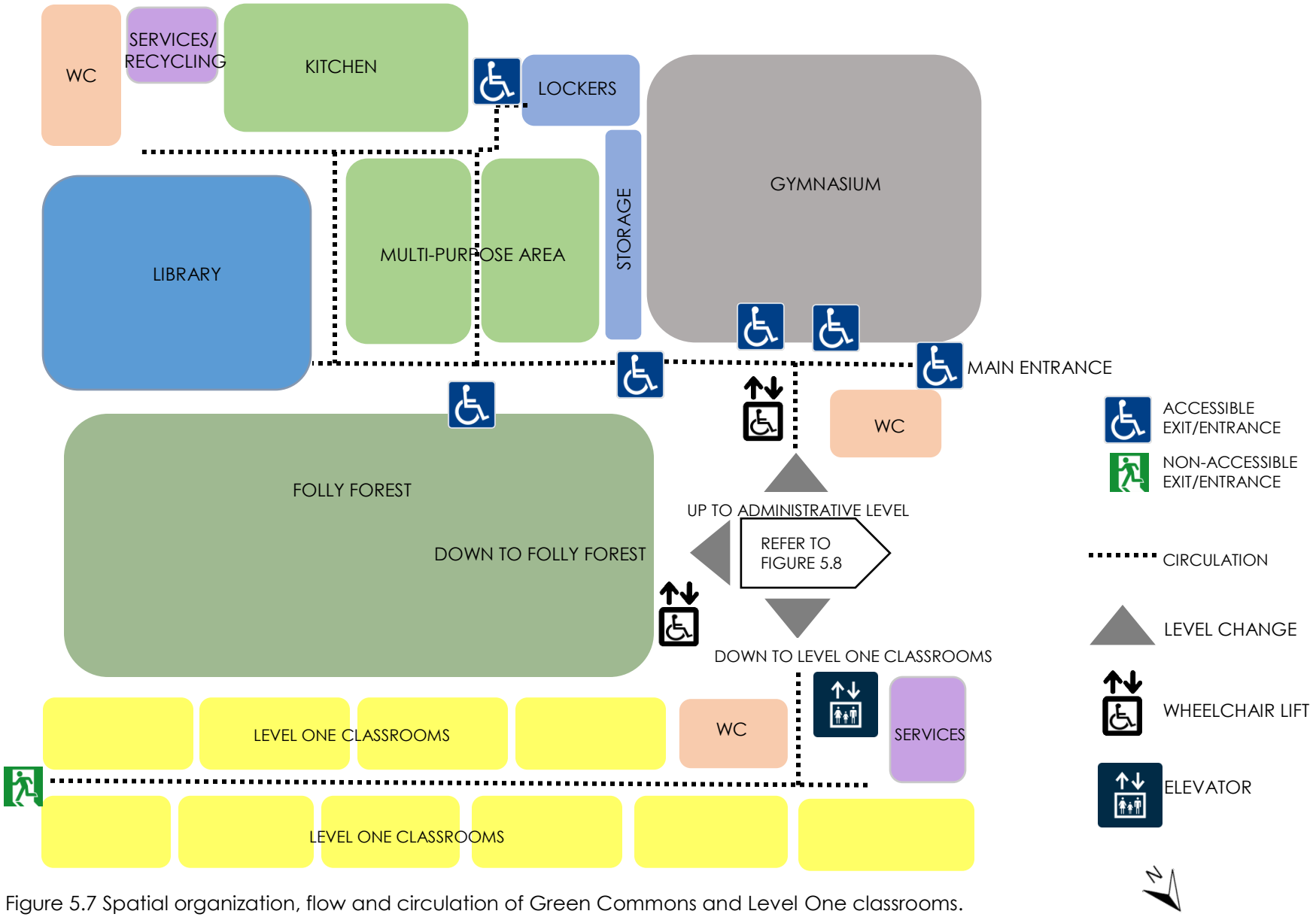


Figure 5.7 Spatial organization, flow and circulation of Green Commons and Level One classrooms.

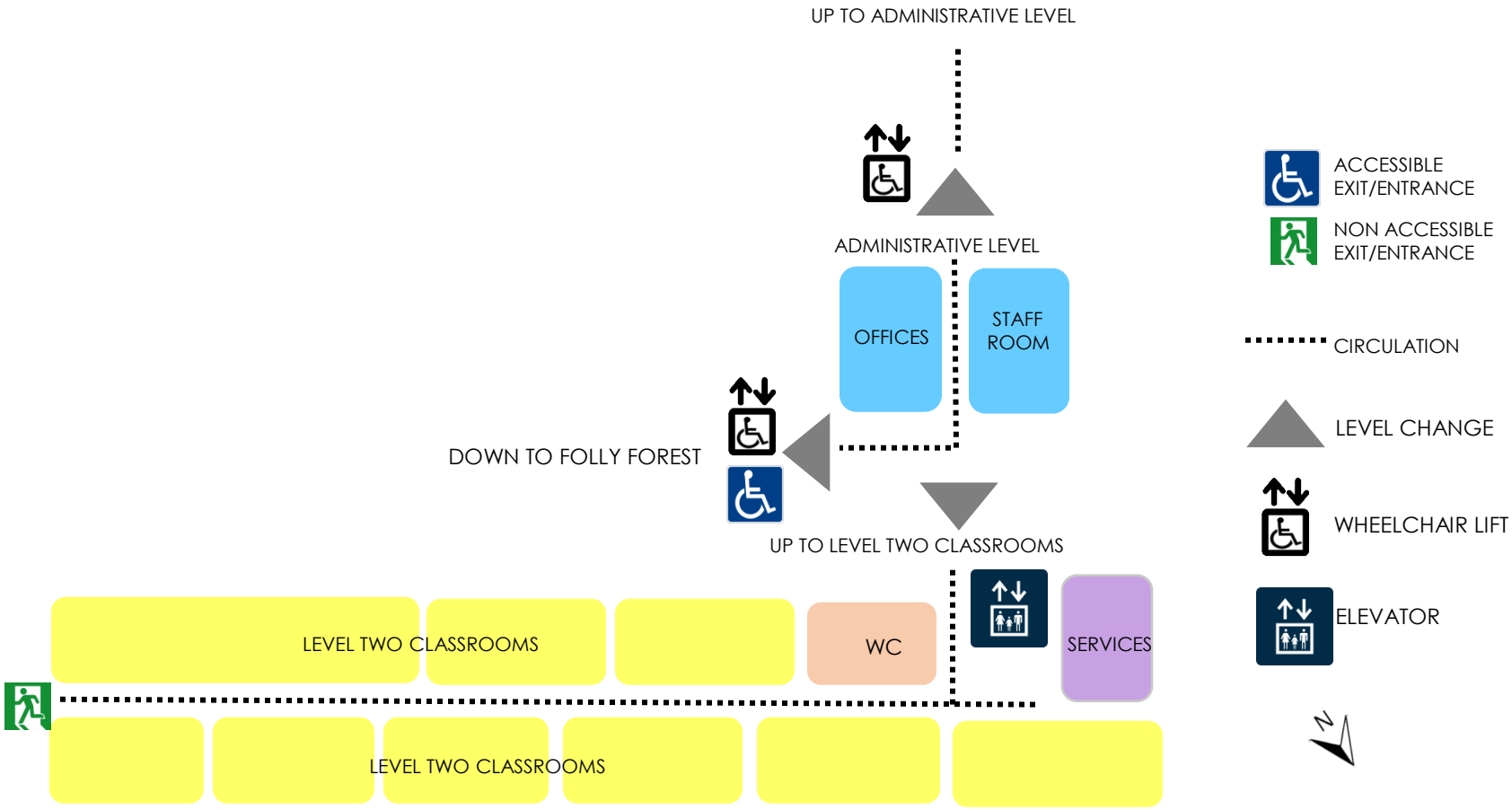


Figure 5.8 Spatial organization, flow and circulation of Administrative Level and Level Two classrooms.

5.4 Program Design

The program design at Strathcona School addresses nature deficit through bio-inspired and sustainable design theories, and is based on development and place-based education theories discussed in Chapter 2. This includes incorporating more contemporary teaching practices of small, medium and large group structures within the classroom (Dudek, 2007), a reversal of the past practice to have children sit in classrooms facing teachers or in clusters of desks. As stated by Heerwagen and Orians (2002), preferences exhibited naturally by children for play have not been considered in the design of schools and playgrounds, which have essentially remained the same for the past fifty years.

The design was also influenced by the precedents and the International Style architects in Chapter 3. The recommended space allocations set out by the Public School Finance Board (2012) are met and design changes make all levels of the school fully accessible as required by the National Building Code of Canada (2010) and the National Fire Code of Canada (2010). Furthermore, the original 1962 building, with its modern geometry and features, was used to create a cohesive design language with the more contemporary additions in 1973 and 1986. The design concepts for each of the spaces are summarized below in Table 5.1 and Figures 5.9 and 5.10:

Space	Bio-inspired Design – Bringing the Outside In	Sustainable Design – Environmental Stewardship	Design based on Development/Place-based Education Theories	International Style Design
Green Commons And Classrooms	- Photographs and posters of nature - Gardens/plants/trees - Sounds of nature - Views to the outside - Viewing nature/weather - Natural materials and decorations - Films/movies/books/ magazines on nature - Organic shapes - Natural forms - Complexity	- Natural ventilation - Natural lighting - Operable windows - Acoustical performance - Environmentally friendly materials	- Clear open spaces - Well delineated paths - Variety, complexity - Adaptability - Spaces for refuge - Small to large group spaces - Properly dimensioned furniture - Settings for socializing, place identity and self-identity - Places to explore and climb - Non-hierarchical spaces accessible to adults and children	- Allowing materials to do their work - Simplicity of form and materials - Rectilinear patterns - Organic forms
Green Commons	- Access to outside - Heraclitean movement	- Water conservation - Energy conservation - Recycling - Composting		- Ribbon windows - Connecting indoors to outdoors - Open floor plan
K-Grade 3 Classrooms		- Recycling - Composting	- Refuge with ceiling effect - Visual connections to surrounding spaces - Multiple access points to refuges	- Retaining Red Birch plywood wood beams
Grade 4-6 Classroom		- Recycling - Composting	- Large group spaces - Refuge building - Landscape modification	- Retaining Red Birch plywood wood beams

Space	Bio-inspired Design – Bringing the Outside In	Sustainable Design – Environmental Stewardship	Design based on Development/Place-based Education Theories	International Style Design
Circulation Pathways	- Views to the outside - Natural materials and decorations - Organic shapes - Natural forms - Complexity - Access to outside	- Natural lighting - Natural ventilation - Acoustical performance - Environmentally friendly materials	- Transformation of hallways to socializing/meeting space - Transition space - Nooks/activity pockets	- Retaining existing Red Birch plywood wall panelling

Table 5.1 Design concepts for each of the spaces in Strathcona School based on the theoretical underpinnings, the precedents and International Style architecture.

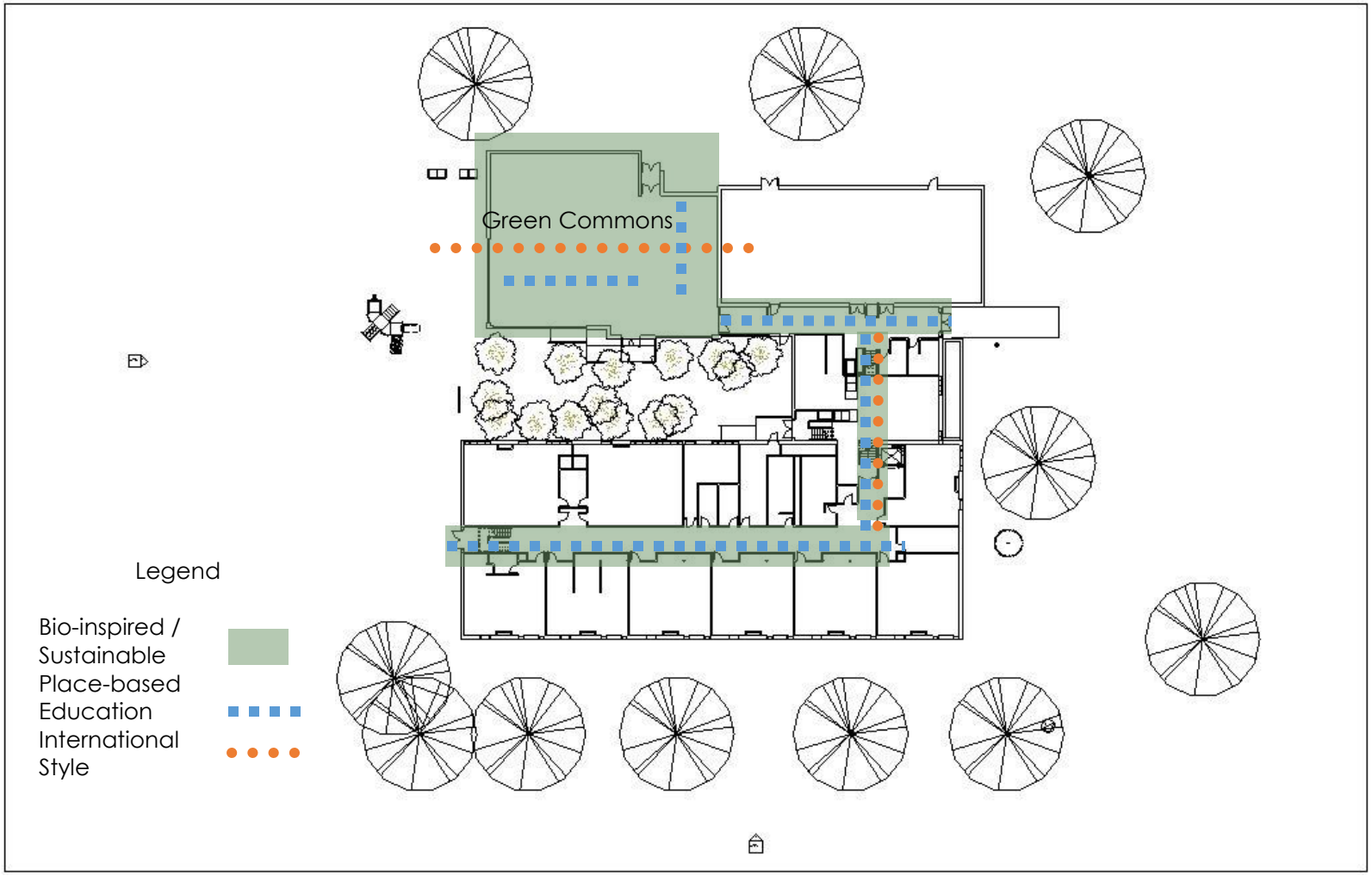


Figure 5.9. Strathcona School Level 1 and Administrative Level, showing the application of theoretical underpinnings, the precedents and International Style architecture to the design.

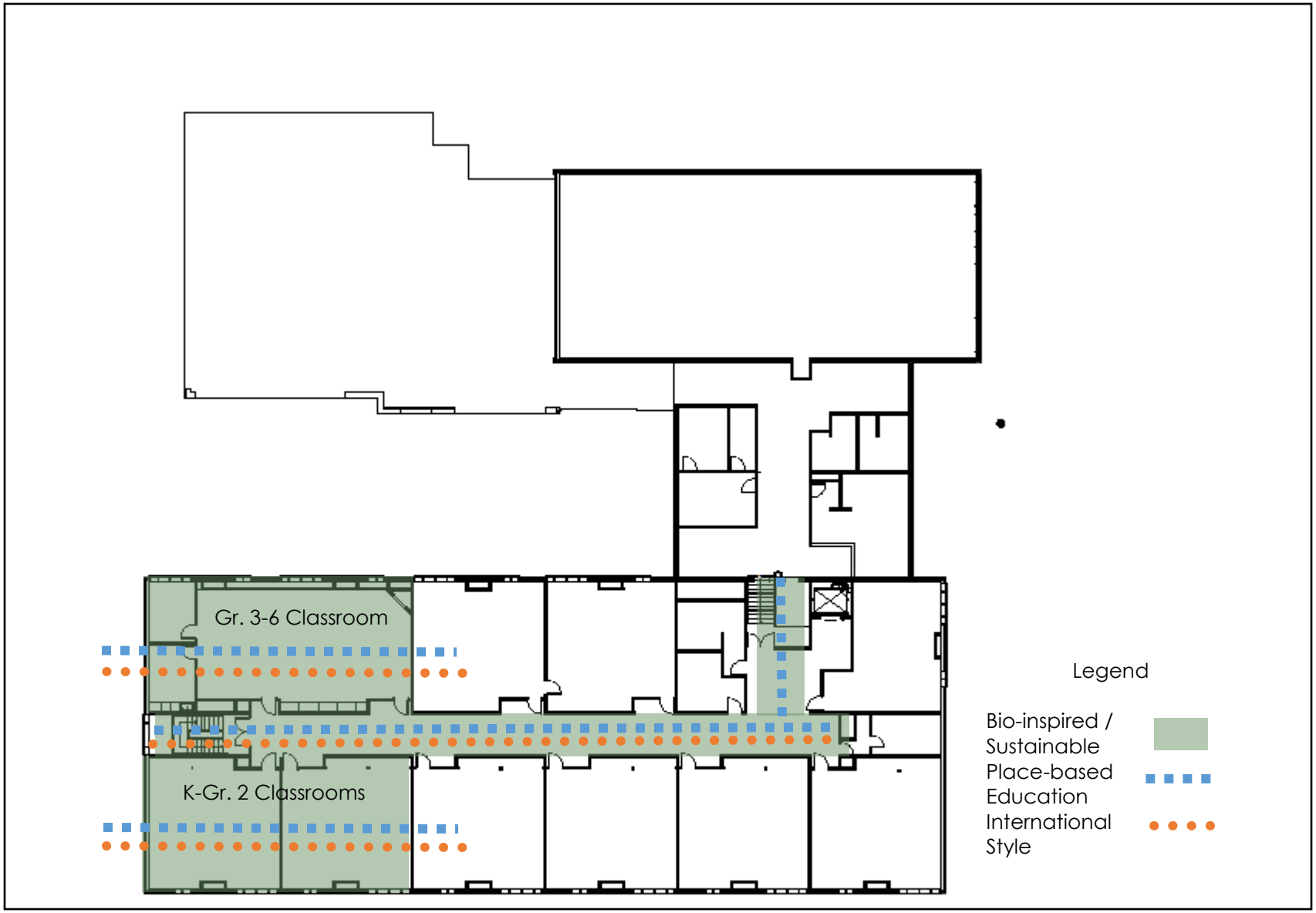


Figure 5.10. Strathcona School Level 2, showing the application of theoretical underpinnings, the precedents and International Style architecture to the design.

5.4.1. Major Theories and Design

The proposed design contributes to addressing nature deficit disorder for the students of Strathcona School. The design for the Green Commons, which features a library, a multi-purpose area and support spaces (WC, janitorial), and a kitchen, as well as the classrooms, is bio-inspired and sustainable. The design incorporates the concept of "bringing the outside in", a concept that is promoted in the literature and shown in the precedents as a tool to address nature deficit disorder in an interior. Environmental stewardship is achieved using sustainable design in the interior including natural ventilation and lighting, water and energy conservation fixtures, recycling and composting spaces. Environmentally friendly materials are natural and remind children of nature.

The proposed design creates interior spaces in the Green Commons, the circulation pathways and the classrooms to foster development and place-based education. Spaces allow various levels of social interaction, from small to large group meeting spaces. The result is an environment that allows children at Strathcona School to access the type of space that they need in a moment. It may be a refuge for one or a small group, a small meeting space for a few students to socialize and mingle, or a large group space. The spaces are adaptable, complex and offer variety.

The design makes use of the original construction in 1962 and its character, and creates a cohesive design language with the more contemporary additions in 1973 and 1986. The architectural principles applied to the renovated spaces that are found in the 1962 construction include the installation of ribbon windows in the Green Commons; retaining red birch plywood veneers in the Administration Area and red birch wood beams on the second floor of the classroom area; selecting materials and forms that are organic and simple; using rectilinear patterns; allowing materials to do their work (*i.e.* brick wall in Green Commons); and an open floor plan. In so doing, the design also creates connections between the 1962, 1973 and 1986 phases of construction, and the Folly Forest. The windows introduced in the Green Commons create views to the exterior, but also create a visual connection to Folly Forest. The modifications to traffic flow in the Green Commons further reinforce this connection by creating a direct physical connection to the Folly Forest, as well as a direct physical connection to the 1973 and 1986 phases of construction.

The redesigned space also meets the Public School Finance Board (2012) space standards that are currently deficient. This includes adding a multi-purpose area, a larger library and a kitchenette, all of which are housed in the Green Commons. Finally, the design makes the school fully accessible, by providing wheelchair lifts and an elevator, and eliminating physical barriers to access of the 1973 and 1986 phases from the 1962 phase of construction, as required by

the National Building Code of Canada (2010) and the National Fire Code of Canada (2010).

5.4.1.1. Bio-inspired Design

In the literature review, bio-inspired design referred to settings that allowed interaction and an experience of feeling as being in nature. Elements and attributes of nature that can be incorporated into bio-inspired design include heraclitean movement; complexity; repetition of natural forms; organic shapes and multi-sensory experiences. An interior that incorporates heraclitean movement, motion that is constant but predictable and therefore calming, could feature an aquarium, or views of clouds. Complexity could be achieved by providing sub-spaces or zones that encourage sensory exploration and multi-sensory experiences (sight, touch, odor, sound and taste).

> *"the schoolhouse should not fight the forces of nature; it should work with nature to provide comfort"*
>
> *"the schoolhouse should not be divorced from nature; it should harmonize with and take advantage of all that nature has to offer"*
>
> *(Caudill, 1954, p. 54)*

For Strathcona School, the key elements of bio-inspired design that were incorporated include natural lighting; the creation of refuges which are complex and encourage movement; the repetition of natural patterns and organic shapes; features that provide viewing of heraclitean movement; and

colours and shapes inspired by the southern Manitoba geography, including the boreal ecosystem and the prairie grassland. In the Green Commons, clouds replicating the sky and the tree canopy contribute to the biophilic design and the incorporation of attributes of nature. In addition to providing opportunities for environmental education, the aquarium and the reading nook with a skylight introduce heraclitean movement as recommended by Heerwagen (2003), and introduce complexity into the design by creating zones that encourages multi-sensory experiences (sight, touch, odour and sound). This supports Reggio design principles, by creating an environment that both encourages interaction between the user and the space and becomes a workshop for experimentation and learning. The Green Commons, the classroom and the hallways are also designed to consider biophilic design as recommended by the International Future Living Institute (2014). Nature is deliberately incorporated through "Environmental Features, Light and Space, and Natural Shapes and Forms" (p. 40). Nature's patterns and colours are used to connect the users to nature. Furthermore, natural elements are featured in the design to make a direct connection to nature within the space, and the fenestration further blurs the separation between the exterior and the interior.

5.4.1.2. Sustainable Design

The development of pro-environmental attitudes is supported by designing Interventions to Strathcona School that are sustainable and environmentally

based to teach and develop a lifelong conservation ethic and consider energy conservation, water conservation, waste minimization and recycling. To this end, the Green Commons is designed to serve as a teaching opportunity on sustainability. Recycling is encouraged by placing containers adjacent to the kitchen and in the classrooms. Waste minimization is promoted by introducing vermicomposting in the recycling area in the Green Commons. Children can learn about natural composting principles by "feeding" their organic lunch waste to the vermicomposting containers. Water conservation is achieved with dual-flush toilets, waterless urinals and low-flow automated faucets. A self-sustaining ecosystem and aquarium in the Green Commons also provides the opportunity for children to participate in the care of the organisms in the aquarium, but also to learn about the natural processes that occur in a freshwater ecosystem.

Sustainable design is also achieved through the increase in natural ventilation as discussed in Chapter 2. Based on the site analysis in Chapter 4, the prevailing winds in Winnipeg were found to flow predominately from the South. For the Green Commons area, located in the southeast section of Strathcona School, there were three possible façades onto which operable windows could be introduced – the north, the east and the south façades. Through modeling and site analysis, including sound analysis (Appendix B) and sun path analyses (Appendix C), it was determined that operable windows on the south façade

result in the greatest opportunity for airflow to enter the space, and operable windows on the north façade for airflow to exit the space. As recommended by Maldonado (1998), outlet openings for the operable window are the same size or larger than inlet openings; these openings are placed at occupant height for occupant cooling. The effect of shading and cooling is further enhanced by the row of elm trees along the south façade of Strathcona School on Burrows Avenue. Natural ventilation is enhanced in the Green Commons by the distribution of the interior spaces. The interior spaces are configured to optimize cross ventilation. The Green Commons features large open spaces. Partitions perpendicular to the path of airflow have been minimized to limit obstructions to the airflow. Furniture placement has been considered to maximize air movement within and through the space.

Improving daylight and views is another important feature of sustainable design. The analysis of daylighting (Appendix C) justified the addition of clerestory windows along the south side of the Green Commons (Figure 5.11) to introduce daylight into the room, without compromising sound quality (Appendix B), as well as the addition of a curtain

Figure 5.11. Operable clerestory windows on south façade of Green Commons offering views of tree canopy, with smaller lower windows offering views to the street. Not to scale.

wall along the north and east façades (Figures 5.12 and 5.13). Low-e glazing triple paned windows reflect infrared energy to minimize solar gain. These modifications in the Green Commons enable students and staff to experience views to the exterior from all points in comfort. The addition of windows in the Green Commons also creates a clear communication between the interior, Folly Forest and the Grades 4-6 classroom.

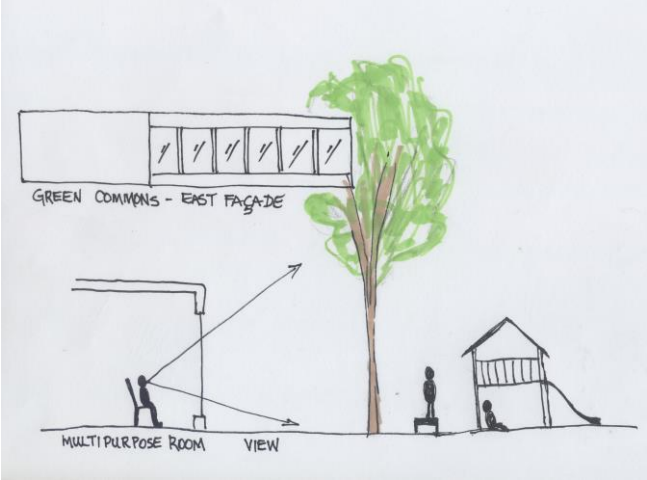


Figure 5.12. Curtain wall with operable windows on east façade of Green Commons offering views of playground and trees. Not to scale.

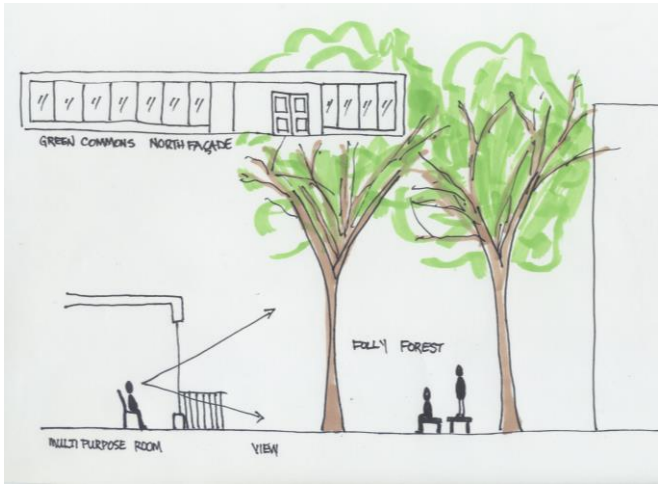


Figure 5.13. Curtain wall with operable windows on north façade of Green Commons offering views of Folly Forest. Not to scale.

A ribbon of windows was also placed under the windows in the kitchenette at a lower level to give children direct views to the outside (Figure 5.11). Careful placement of various feeders and bird houses both along Burrows Avenue and in the Folly Forest would give children direct views of birds, squirrels and other urban wildlife. Furthermore, the operable clerestory windows would introduce their songs and sounds into the Green Commons.

When needed, an electric lighting system enhances daylighting. Since a multitude of tasks take place in the Green Commons, layered lighting provides the required illumination to supplement daylighting and minimizes lighting energy use. Occupant controls, such as dimming, help to provide flexibility in the use of electric lighting. The lighting scheme for the Green Commons and the classrooms can be seen in the Reflective Ceiling Plans (Appendix G). A combination of direct-indirect fluorescent luminaires specifically designed for classrooms provide 40 to 50 foot-candles (431 to 538 lux) evenly throughout the open/main area. This ensures adequate illumination of ceilings and wall surfaces. In addition, dimmable task lighting provides higher lighting levels when required. The modifications also meet the recommendations set out by the International Future Living Institute (2014) to create an environment that "optimizes physical and psychological well-being" (p. 37), with operable windows and access to fresh air and daylight.

Another important of feature of sustainable design is good acoustical control. Since the length and width of the Green Commons is greater than the height of the ceiling, acoustic control was placed on the ceiling as recommended by Perkins (2001). Acoustical panels were also placed on the large wall adjacent to the multi-purpose area. Since different acoustic zones were required for different activities, such as quiet zones, play zones and task specific zones, the ceiling, the walls, the floors and the furniture all became part of the acoustic landscape

through material selection. This meant using soft absorptive surfaces on seating, using flooring with sound control underlayment and avoiding circular spaces and curved walls.

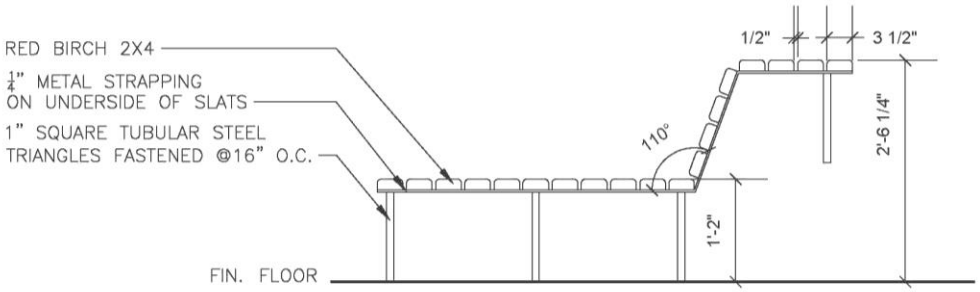
The final consideration of sustainable design was material selection. As set out in Chapter 2, all materials selected are durable, easy to maintain, yet provide a beautiful aesthetic. Sustainable products integrating recycled content, low or non-volatile organic content, and the use of natural products were selected. Existing installations of red birch plywood on the walls and ceiling beams were retained. All new wood products selected are certified by the Forest Stewardship Council and locally sourced when possible. The furniture, fixtures and equipment are described in greater detail in Section 5.6 and Appendix F.

5.4.1.3. Design for Place-based Education

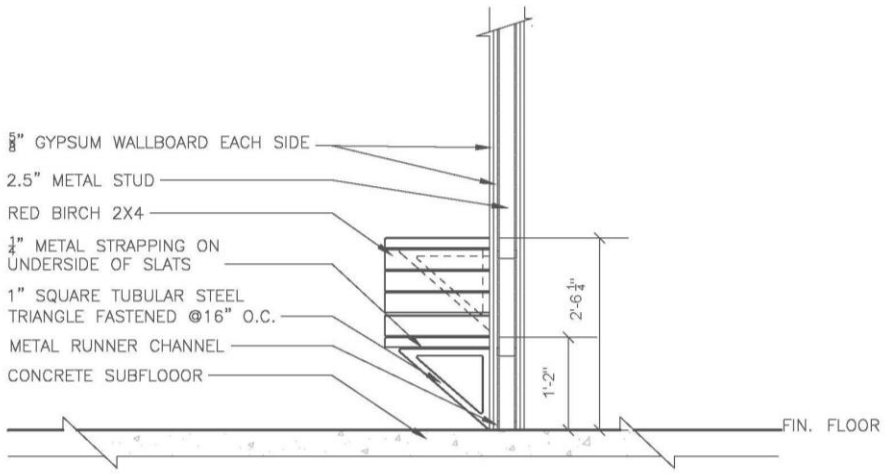
The concept of place–based education requires changes to the typical classroom. The proponents of place-based education recommend several design features to facilitate learning including open spaces for flexibility and adaptability. The Green Commons and the classrooms are designed as open spaces, with furnishings that are flexible and adaptable. All furniture was sized appropriately to accommodate the full range of children's sizes. The smaller chairs have seat heights of 350 mm, and the larger chairs, 430 mm. Similarly, two table heights have been used in the Green Commons, 610 mm and 710 mm.

All the spaces can be organized for small to large groups and there are places to climb and explore.

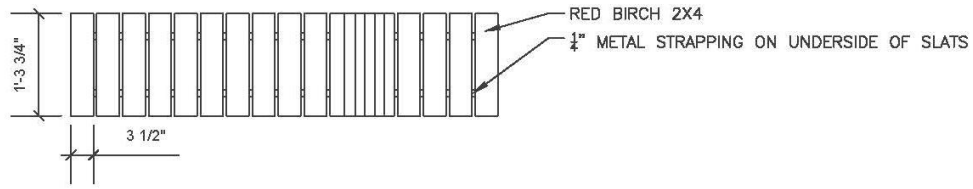
Since the hallways of Strathcona School are generously sized at 2667 mm (8.75 feet) wide, with nooks of 762 mm (2.5 feet) by1587 mm (5 feet) at each classroom doorway, this provided an opportunity to create small spaces or "activity pockets" to unwind, relax and socialize. Seating has been incorporated into the hallways and nooks to create a setting for socialization and place-identity development (Figure 5.14). By redefining the purpose of the corridor, this creates an opportunity to integrate elements of bio-inspired design to achieve the benefits of exposure to nature.



D1 FRONT ELEVATION OF HALLWAY BENCH SEATING OUTSIDE OF CLASSROOMS
NOT TO SCALE



D2 SIDE ELEVATION OF HALLWAY BENCH SEATING OUTSIDE OF CLASSROOMS
NOT TO SCALE



D3 PLAN VIEW OF HALLWAY BENCH SEATING OUTSIDE OF CLASSROOMS
NOT TO SCALE

Figure 5.14. Details of hallway seating.

5.5 Interior Development

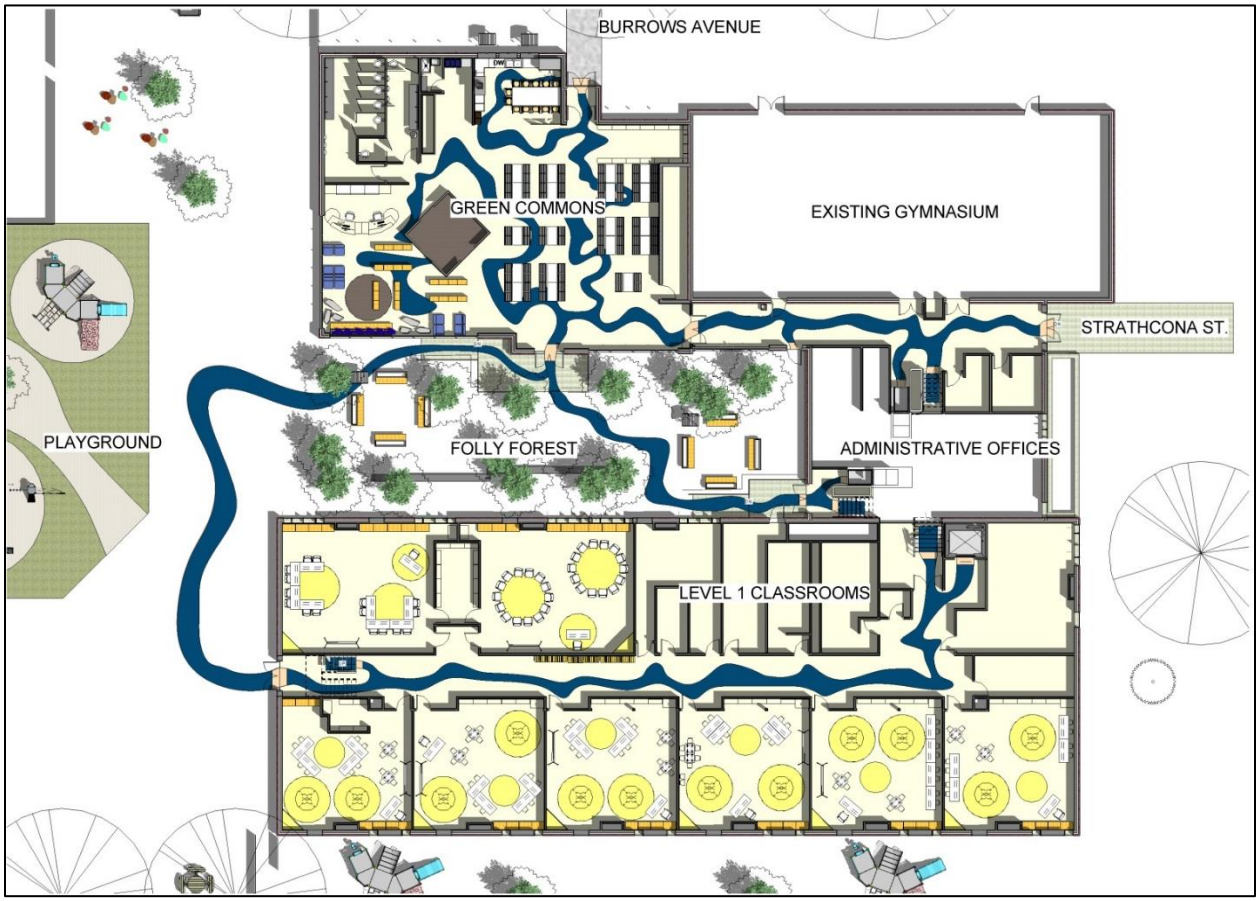


Figure 5.15. Strathcona School – Level 1.

Design changes were made to the Green Commons, the Administrative Level, the classrooms and the hallways. The changes made to each of these areas are discussed in more detail in the following sections.

5.5.1 Green Commons

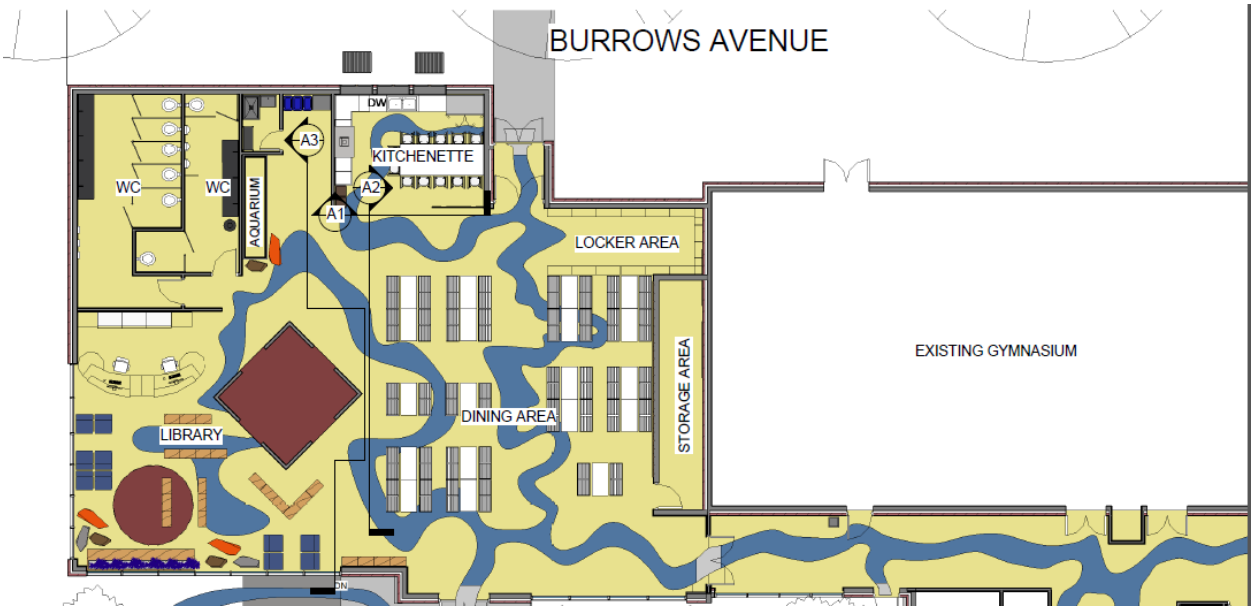


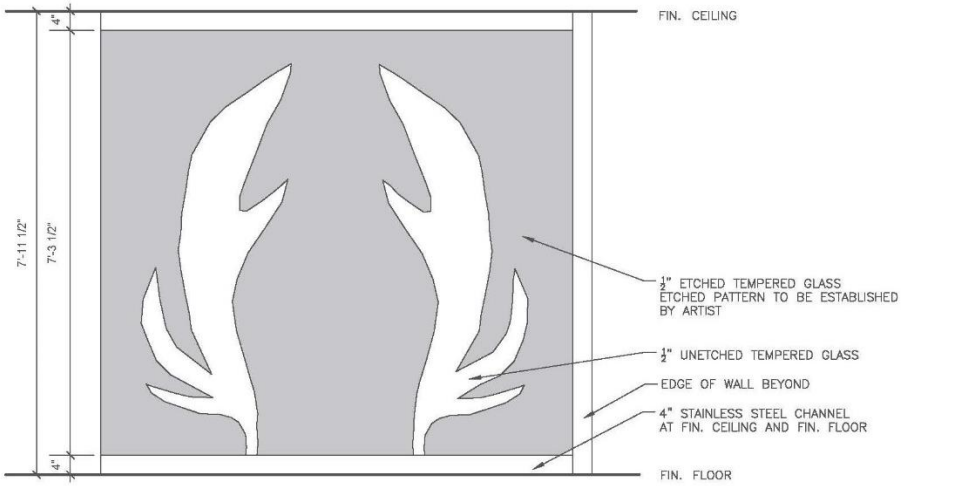
Figure 5.16. Strathcona School – Green Commons

Adjacent to the entrance to the Green Commons on Burrows Avenue is the kitchenette area, which can be used for school meal programs. The kitchenette is equipped with an adjustable sink lift system to raise and lower the kitchen sink and adjacent counter to make the workspace accessible to all ages of children and to someone in a seated position. This system allows the sink and counter to be adjusted to heights between 71 and 91 cm (28 and 36 inches) (Accessibility Professionals Inc., 2017). The kitchenette is equipped with appliances for food preparation and can be used by staff and volunteers to teach children about

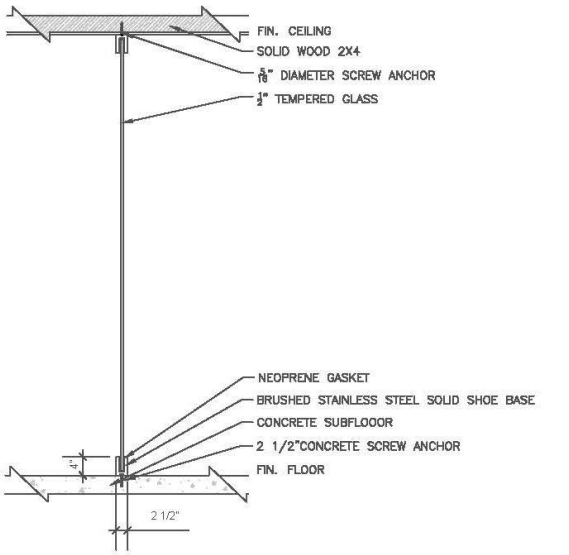
gardens and food preparation using natural foods and herbs harvested from indoor plants in the kitchen. The small indoor gardens/plants create direct experiences to nature. The antler glass wall (Figure 5.17, 5.18 and 5.19) is a symbolic experience as are the images of wildlife from the prairie grasslands throughout the Green Commons.

Figure 5.17. Section A1 - Kitchenette.

Figure 5.18. Strathcona kitchenette.



D4 FRONT ELEVATION OF ART GLASS WALL
NOT TO SCALE



D5 SIDE ELEVATION OF ART GLASS WALL
NOT TO SCALE

Figure 5.19. Details of antler wall in kitchenette.

At the main entrance is a locker area for children and storage area above. The lockers and storage cabinets are all constructed of red birch plywood. The intent of using red birch plywood is to repeat the use of red birch from the original 1962 construction phase of the school. From here the wayfinding path (Figure 5.19) leads to a dining area, where again, red birch has been selected on the acoustical wall on the east side of the Green Commons. The furniture in the dining area has been selected to be easily folded and stored in the storage room behind the acoustical wall. This provides flexibility for use of the dining area, which can then be used for large group gatherings, such as meetings or performances. The ceiling in the Green Commons features clouds and Armstrong Infusions Shapes installed below the clouds backlit with recessed lighting to replicate the feeling of a blue sky with clouds.

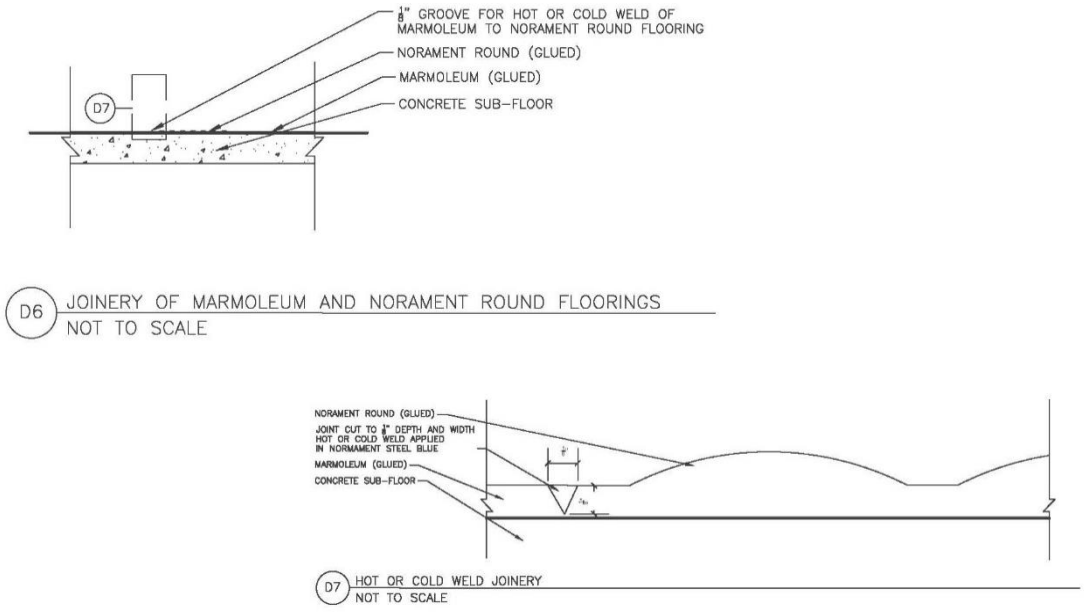


Figure 5.20. Details of wayfinding path joinery.

Figure 5.21. Section A2 - Dining area in Green Commons.

Figure 5.22. Locker, storage and dining area.

The area adjacent to the kitchenette on the east side has containers for recycling and vermicomposting to encourage children to be environmentally responsible. The compost can be used in containers for plants indoors and outdoors. A small janitorial room is adjacent to the recycling/composting area.

The path continues to an ecosystem aquarium (Figure 5.24), which provides heraclitean movement and sounds for students. Soft lightweight benches shaped as rocks can be moved for students to sit and gaze at the fish and other wildlife in the aquarium.

Figure 5.23. Section A3 - Library, aquarium and reading nook under skylight.

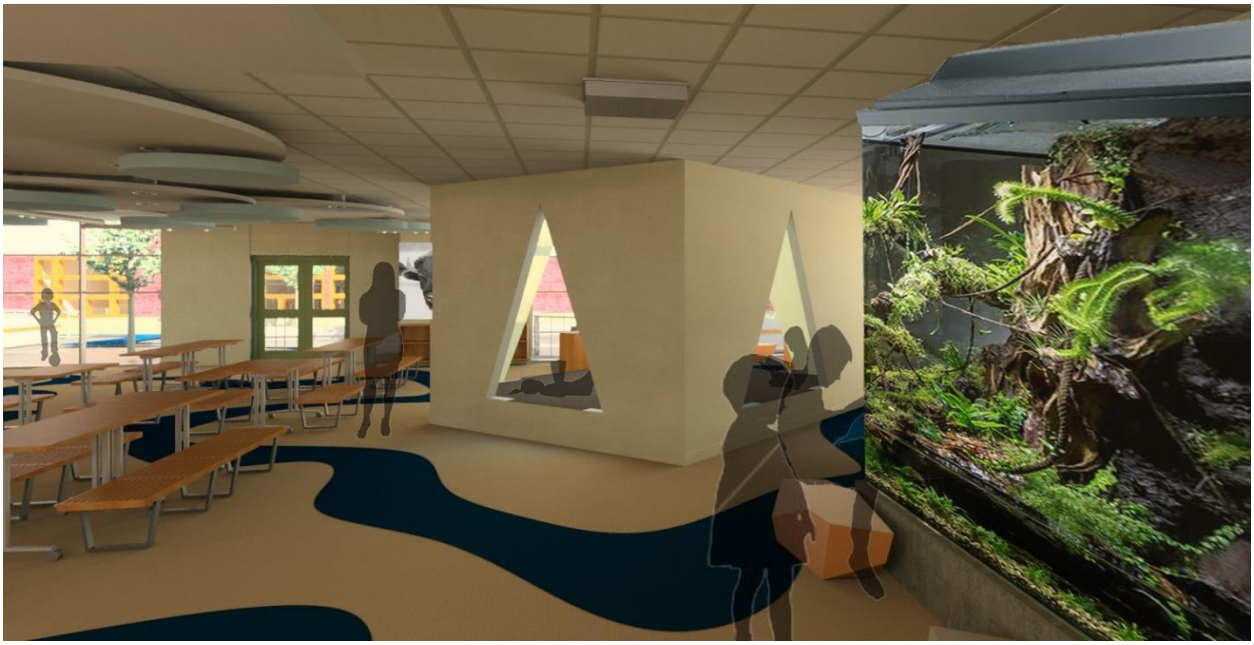


Figure 5.24. Aquarium adjacent to reading nook. Image of bison by S. Therrien-Richards.

Adjacent to the aquarium is the library area of the Green Commons. The library has many options for seating for private, small group or large group settings. The furniture is designed to be easily moved and reconfigured as required by staff or students (Figure 5.25). Small area rugs also allow students to sit on the floor if desired. The skylight and seating area below provides a space for quiet reading or for looking up and watching the clouds and the sky, introducing another example of heraclitean movement in the space (Figure 5.26). The library is surrounded on two sides by curtain walls that allow direct views to the outside and direct experiences to nature, as well as creating a communication with the outdoors, and bringing in lots of natural light. The curtain walls are designed with

a dual insulating glass system and a solar shield feature to protect occupants from visible light. Operable windows allow for cross-ventilation and introduce the sights and sounds of nature. Small gardens and plants are found throughout the space to introduce more direct experiences to nature. Symbolic experiences are introduced through the images of wildlife and nature-based books and documentaries available from the library.

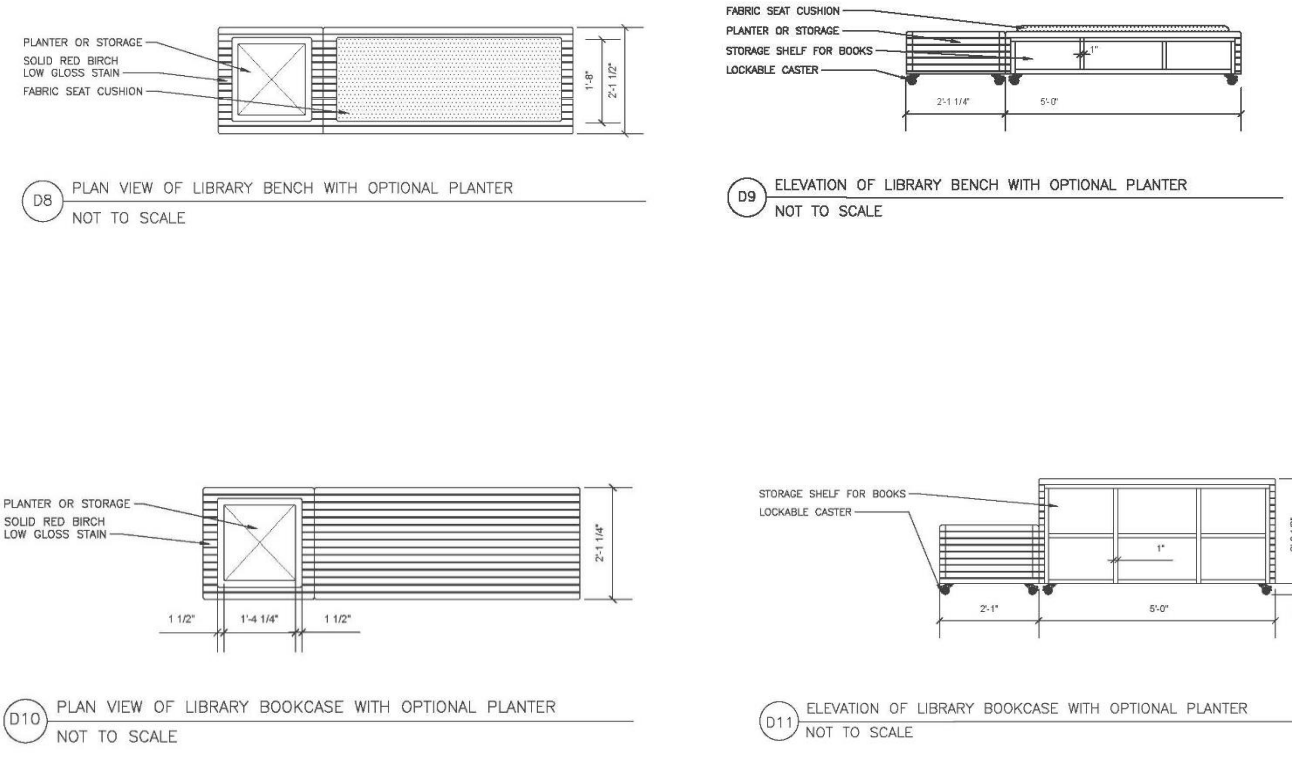


Figure 5.25. Details of library seating / shelving.

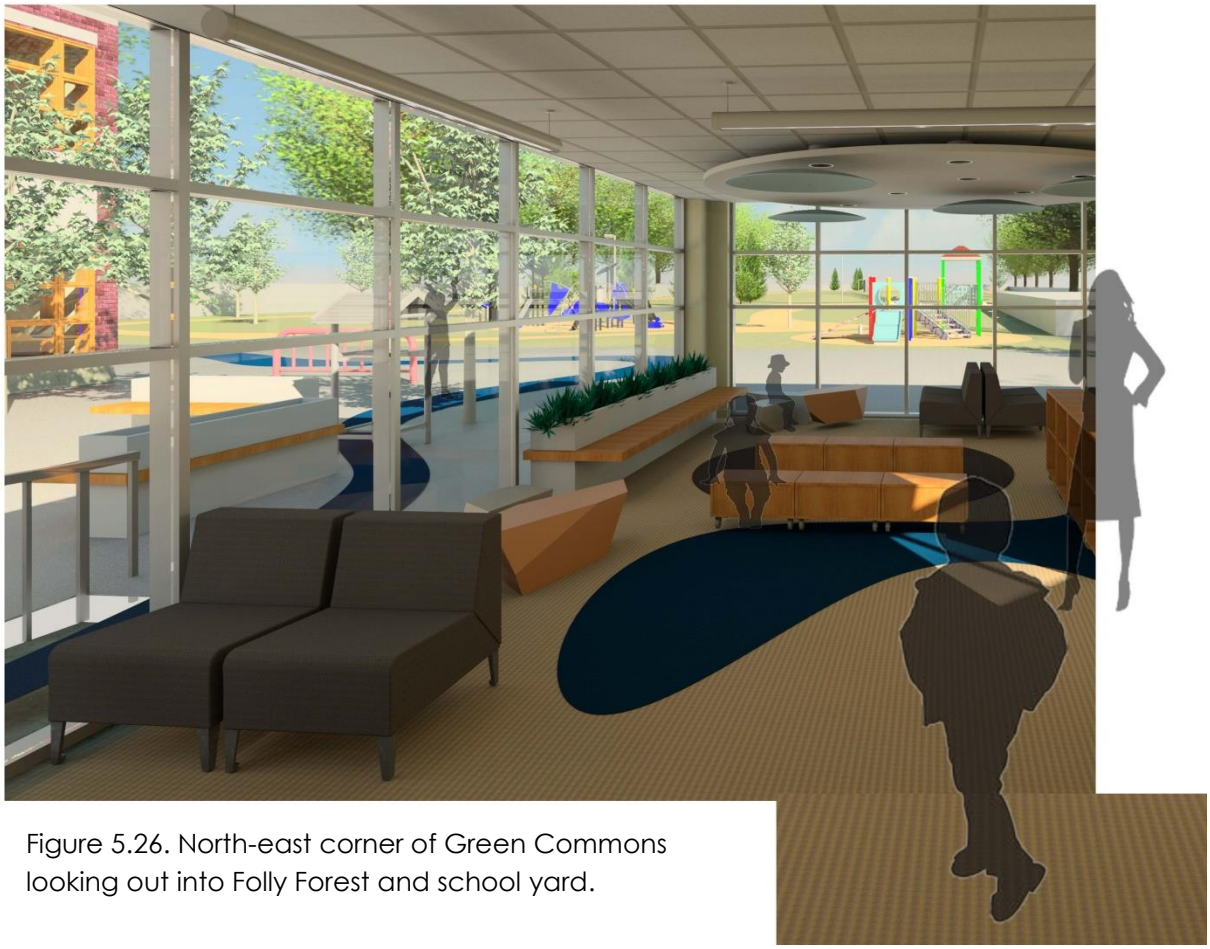


Figure 5.26. North-east corner of Green Commons looking out into Folly Forest and school yard.

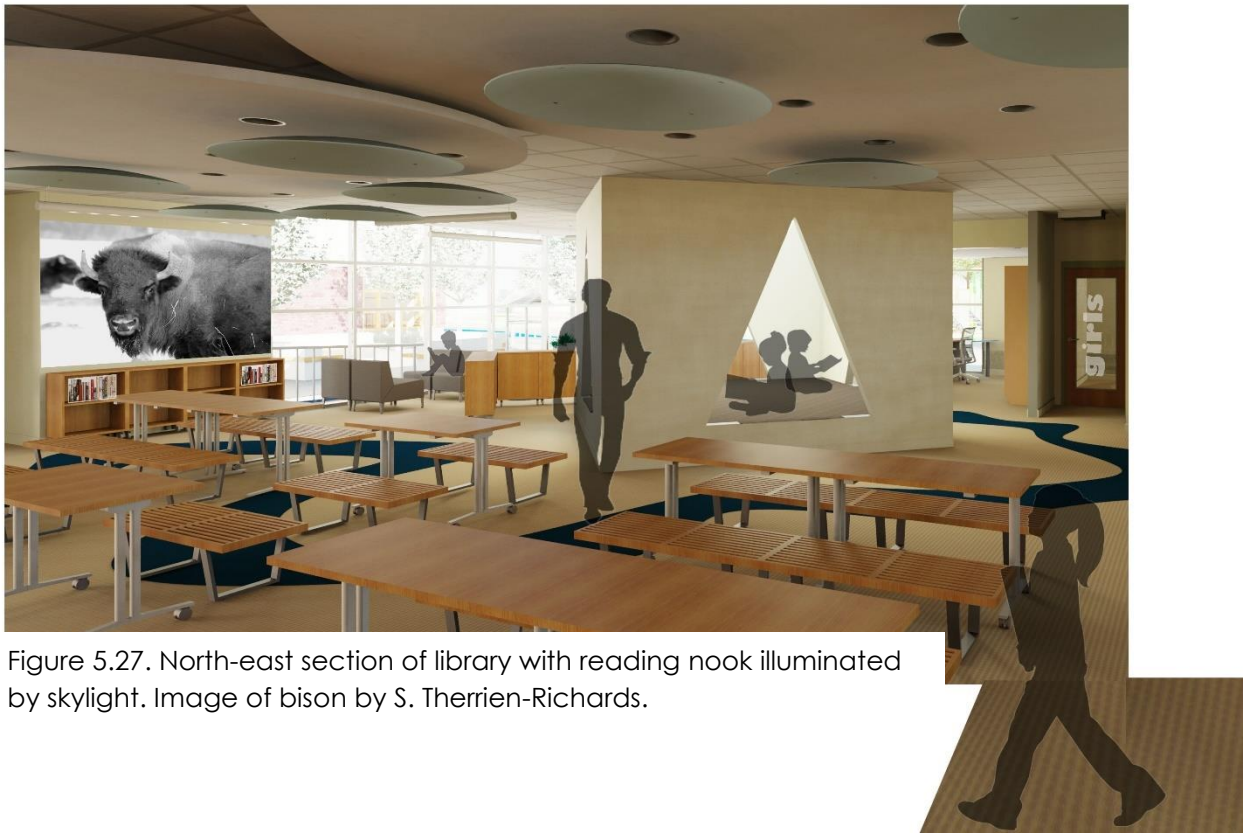


Figure 5.27. North-east section of library with reading nook illuminated by skylight. Image of bison by S. Therrien-Richards.

From the library, the path leads to a fork with one path going to the exterior and the Folly Forest, and the other path going towards the main entrance on Strathcona Street.

The colour scheme of the Prairie Grasslands continues to the main entrance and along the wayfinding path that leads to an emergency exit across from the school gymnasium, and then to paths going up to the Administrative Level. This level can be accessed by either a set of stairs or a wheelchair lift.

5.5.2 The Administrative Level

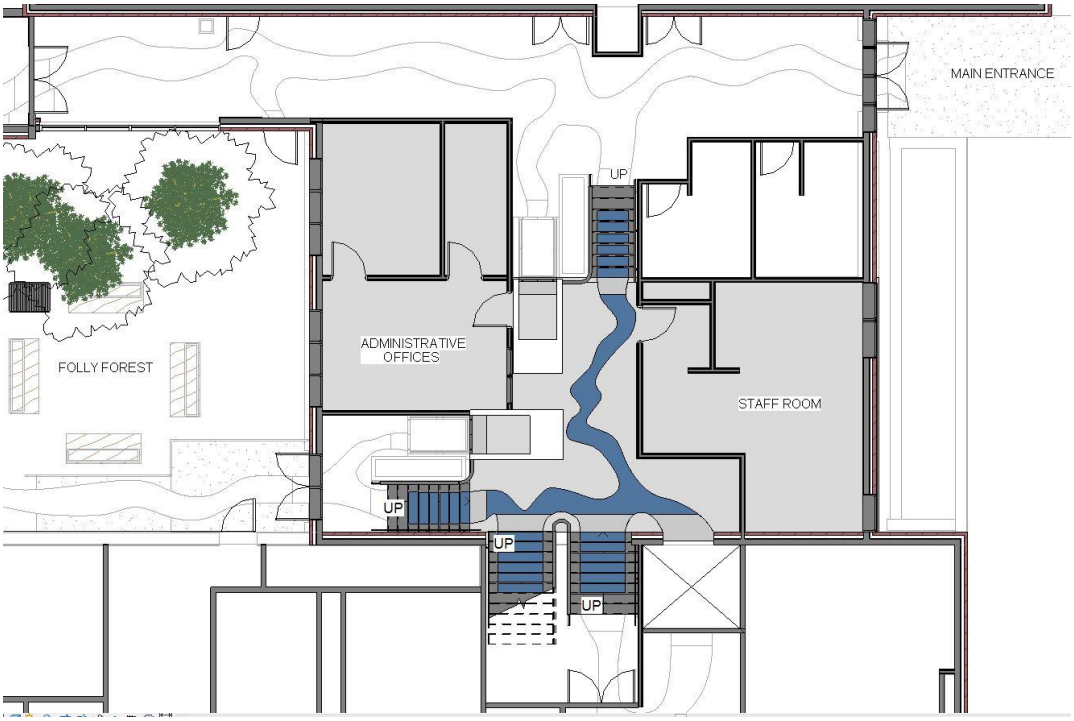


Figure 5.28. Strathcona School – Administrative Level.

Figure 5.29. Section A4 - Strathcona School – Administrative Level leading to classrooms.

The colour scheme announces the change from the prairie grassland to the escarpment at the Administrative Level, as does a Tyndall stone planter with birch trunks. The yellows and blues of the grassland are replaced with the muted creams and greys of the escarpment on the Administrative Level. Following the

wayfinding path up the stairs goes past the two administration offices, a storage room and the staff room. The original red birch plywood walls on the east side of the Administration Level have been retained.

Past the administration offices, the wayfinding path branches off in four streams. One stream leads to an elevator, which provides direct access between all levels of the school. The second stream leads to a staircase going down to Level 1 classrooms and the prairie grassland theme, and the third stream to a staircase going up to Level 2 classrooms and the boreal forest theme. The final stream leads to a second wheelchair lift which has been added to the Administration Level to make it fully accessible from this level to Level 1, and leads to the Folly Forest. The Tyndall stone planter with birch trunks has been repeated at the wheelchair lift to announce the change from Level 1 to the Administration Level, that is, the change from grassland to escarpment, as does the wallcovering of a stylized aspen forest along the staircase.

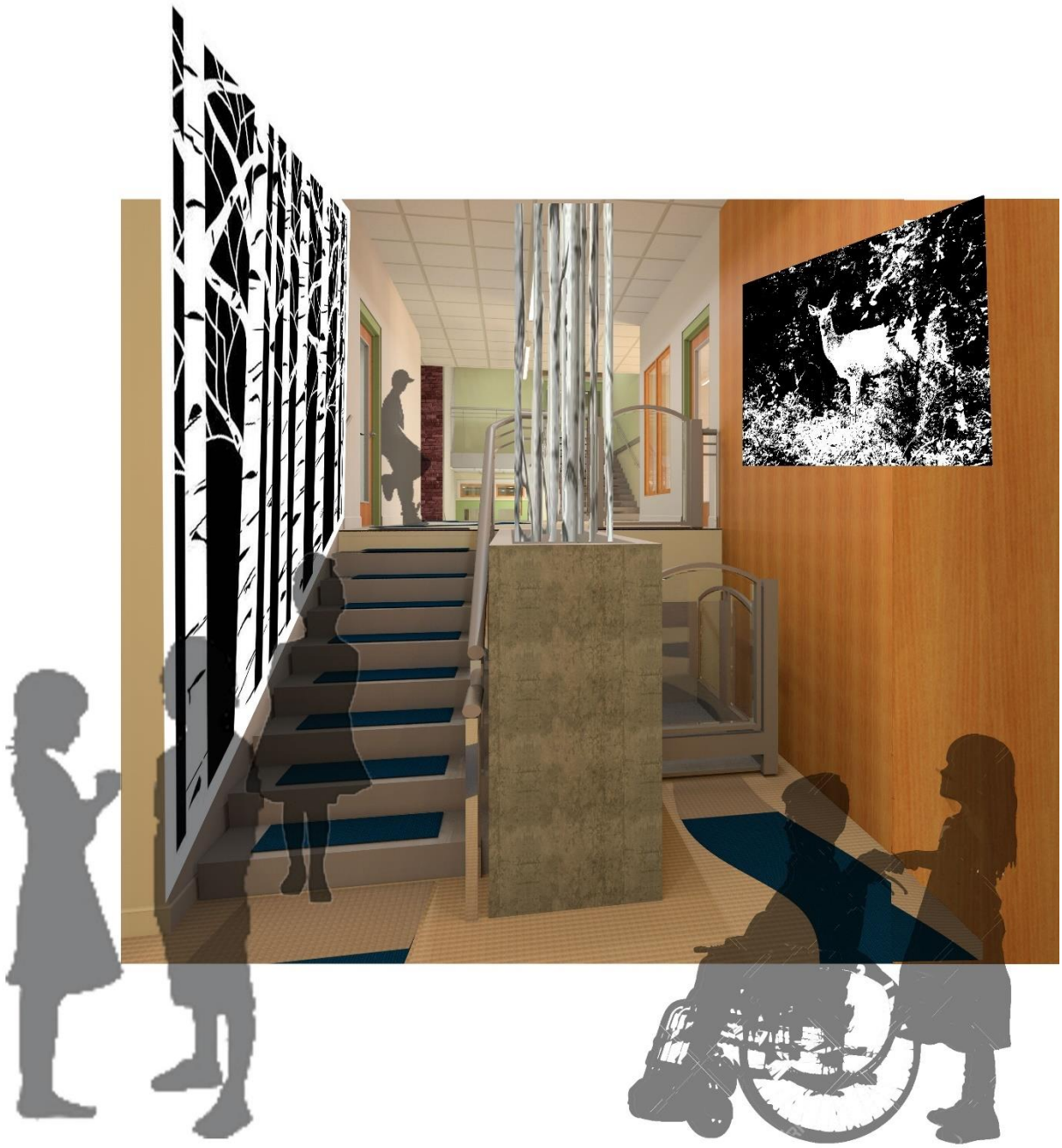


Figure 5.30. Strathcona School – Wheel chair lift to the Administrative Level and classrooms. Image of deer by S. Therrien-Richards.

5.5.3 Classrooms

Figure 5.31. Strathcona School – Level 2 classrooms.

The wayfinding path continues down the hallway meandering past the classrooms on Level 2. The Grades K-3 classrooms are located on the north side of the hallway and the Grades 4-6 classrooms on the south side. In Section A5, once again the colour schemes of the prairie grassland and boreal forest are evident.

Figure 5.32. Section A5 - Strathcona School – Level 1 and Level 2 classrooms.

An important feature of the K-3 classroom is to offer appropriately dimensioned furnishings for young children. Other important design features to facilitate learning in a place-based education scenario include adaptable and flexible furniture that can be moved aside to create open spaces. There are several seating options which allow flexibility for both the teacher and the students. All of the furniture in the classroom can be arranged as required for small and large group settings. Small area rugs on the floor can be used for floor seating. A small nook has also been created in the corner of the classroom for one or two students. The front of the nook is a resin product that is impregnated with small branches and leaves. This creates a sense of refuge with a solid boundary at the back and sides, and a permeable boundary at the front. Seating has also been created along the window wall to allow students to either connect with the exterior as needed throughout the day. The classrooms on Level 2 are at the height of the tree canopy, allowing the students to view the trees and urban wildlife directly. Plants and small gardens in the classroom further add to the direct experience. Symbolic experience is provided through images of wildlife and children's artwork and projects posted on the feature wall.

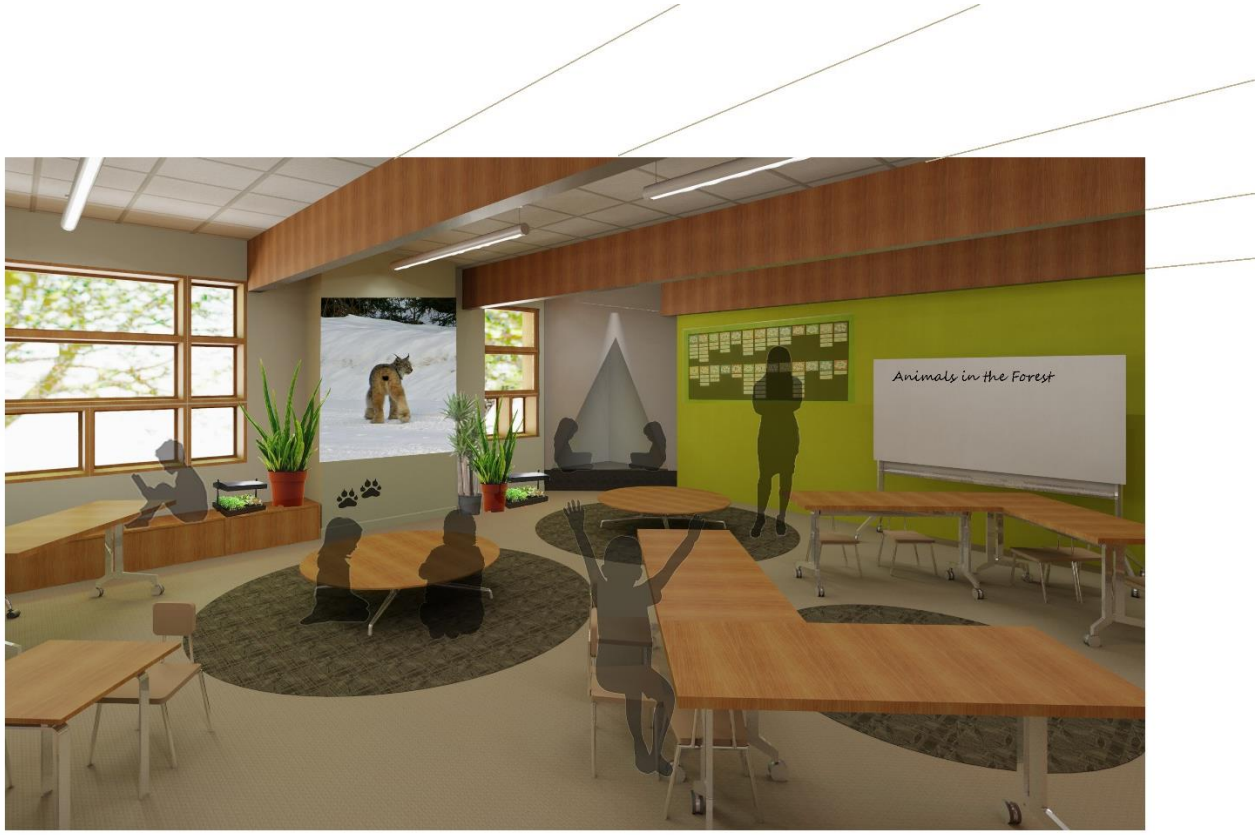


Figure 5.33. Level 2 - Kindergarten to Grade 3 classroom. Image of lynx by France Richards.

Similarly, to achieve the greatest possible learning outcomes, the Grades 4–6 classroom was also designed to optimize flexibility. The furniture selection allows for reconfiguration for private, small and large group settings. The desks can be folded and moved out of the way to create open spaces for small and large groups. The small meeting rooms to the east also provide spaces for small group meetings. Large windows have been installed towards the classroom and between the two rooms to allow natural light to enter both spaces and to create a connection between the rooms and the larger classroom. Two small nooks, as well as the window seats along the window wall, allow students to do work alone or reflect through the views to the exterior. The front wall of the nooks

is a resin product that creates a sense of refuge with a solid boundary at the back and sides, and a permeable boundary at the front. These classrooms are also at the height of the tree canopy, allowing the students to view the trees and urban wildlife directly, and to look into the Folly Forest. Plants and small gardens in the classroom further add to the direct experience. Symbolic experience is provided through images of wildlife and children's artwork and projects posted on the feature wall.

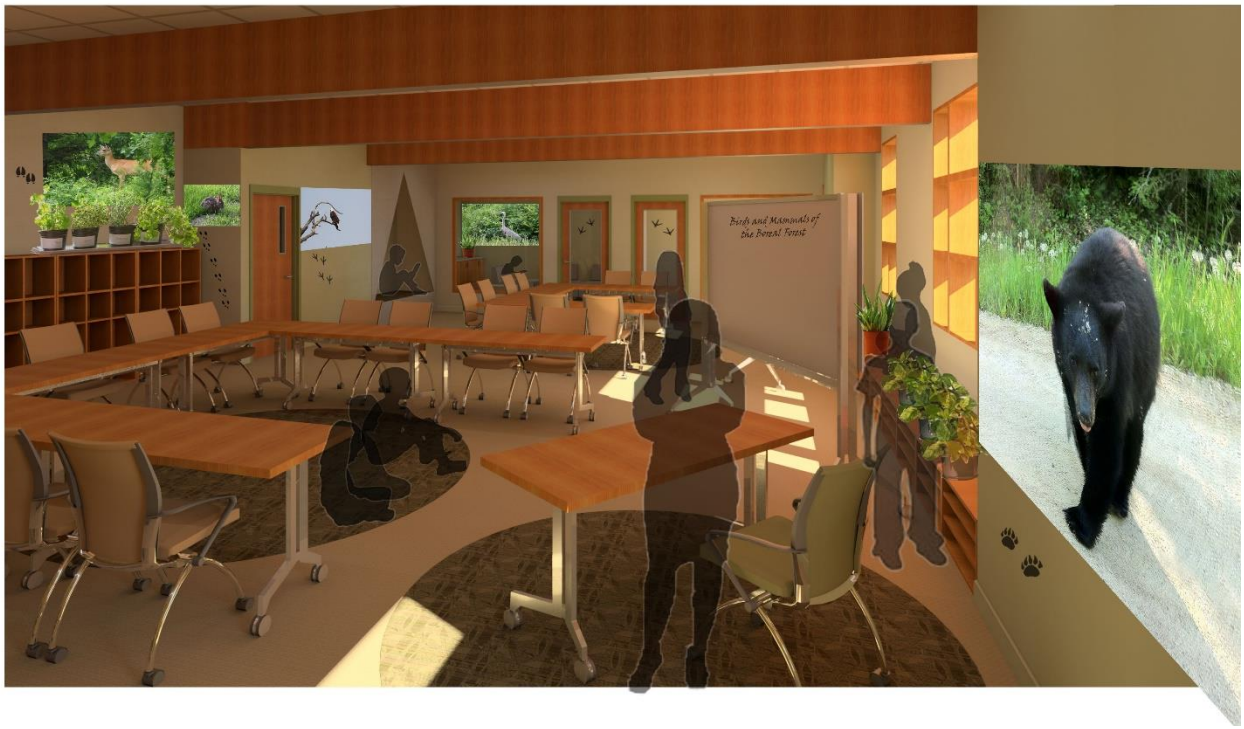


Figure 5.34. Level 2 - Grades 4 to 6 classroom on Level 2. Image credits as follows: bear – Frank Richards; eagle, cottontail rabbit and heron – Pat and Brent Miller; deer – S. Therrien-Richards.

5.5.4 Hallways

The hallways to the classrooms on Level 2 continue to carry the boreal forest theme. The colour scheme is continued, and in addition, boreal wildlife silhouettes are used to identify classrooms. Seating has been incorporated into the hallways in the shape of the Manitoba geography. This meeting space encourages students to unwind, relax and socialize, and creates a transition to learning areas. The structure of the seating gives children the flexibility to choose, whether to sit, recline or lay down. The wayfinding path continues to the end of the hallway, down the stairs and leads to the exterior.

Figure 5.35. Classroom nooks and hallway seating on Level 2.

5.6 Furniture, Flooring and Other Finishes

5.6.1 Furniture Selection

The furniture selected is minimal in character to focus on the natural elements in the spaces. Furniture has been appropriately scaled and dimensioned to ensure both comfort and concentration for children from 5 to 13 years of age, and for staff. The furniture offers flexibility and adaptability, allowing students and staff to easily rearrange or reconfigure the arrangements for intimate and small or large group settings. Organic forms and natural materials were selected to reinforce the connection to nature and sustainability. A variety of textures was selected to stimulate the senses. Comfort, durability and ease of maintenance were also considered during the selection of furniture and fabrics.

A

B

C

D

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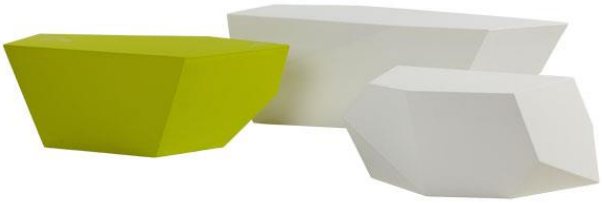


G

H

I

J

K

L

M

N

A Titan Ultimate Stool T90 - Seat Height 445 mm

B Herman Miller Nelson Platform Bench

C Herman Miller Everywhere Flip-Top Table – Height 724 mm

D Herman Miller Everywhere Flip-Top Tables Nested for Storage

E Haworth Very Task Chair - Height Adjustable Arms

F Coalesse Circa Straight Chair

G Six Inch Rock Elements

H Haworth Planes Easel

I Haworth Planes Training Table

J Haworth Planes Training Tables Nested for Storage

K Haworth X99 Seminar Chair

L Teknion dna Modular Seating

M Steelcase Coalesse Bob Table

N Virco Parison Chair

5.6.2 Flooring and Other Finishes

In addition to sustainability, flooring and other finishes were selected to introduce natural materials and a variety of textures, a beautiful aesthetic combined with durability (Figure 5.36).

Figure 5.36. Flooring and other finishes.

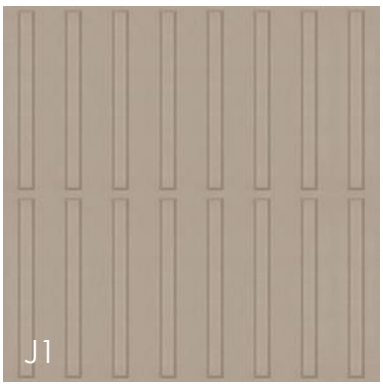
Most of the flooring throughout the school is Marmoleum sheet flooring. This material was selected because of its sustainability; Marmoleum is natural and environmentally friendly, manufactured from 97% natural raw materials (linseed oil and wood flour), and a recycled content of 43%. In addition to these features, Marmoleum is easy to maintain and durable, is anti-static, keeping it dust-free, and has bacteriostatic properties that inhibit micro-organisms, which is beneficial for human health (Forbo Flooring Systems, n.d.).

The colours selected for the various levels are representative of the Manitoba geography, with Level 1 spaces clad in Real 3173 (M1), introducing varying shades of yellow representative of the Prairie Grassland. The Administrative Level

is covered in Modular T3405 (M2), associated with the neutral colours of the Manitoba Escarpment, dominated by greys, browns and off-whites, with bright accents of yellows and oranges. Level 2 areas are covered in Modular T3234 (M3), with various shades of green representative of the Boreal Forest.

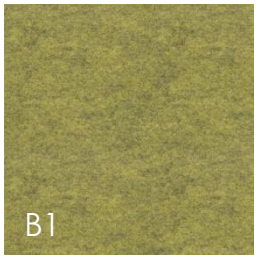
The path that helps with wayfinding and navigation of the spaces throughout the school is covered in Norament Round rubber flooring (N1). This flooring is excellent in high traffic areas as it absorbs noise and is slip resistant. Maintenance is simple since the flooring is dense, non-porous and repels dirt, therefore requiring no finishing, waxing or sealing. The raised round pattern helps visually impaired people in wayfinding (Nora Systems, 2015).

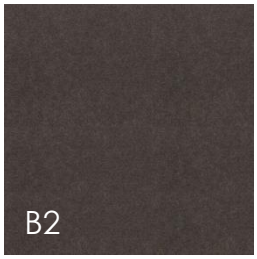
In addition, Johnsonite Tactile Warning Tiles (J1) were installed at changes in level and at entrances and exits to alert visually impaired people. These tactile



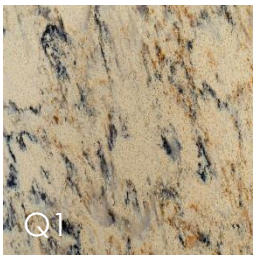
strips of solid rubber, manufactured by Johnsonite Flooring, serve as a warning to blind people using a cane. The visual contrast of the tactile strips to the surrounding floor also alerts people with residual vision to a change, and the strips can be felt through the soles of shoes (Johnsonite, n.d.).

Small area carpets have also been incorporated into the design. This provides an area for students to sit in comfort on the floor as an additional option. The carpets in the staff offices and lounge also provide additional comfort for the occupants. Carpets with natural vegetation patterns introduce nature indirectly into the space, in addition to providing comfort and improving sound absorption. The carpets selected are Interface products from the Biodiversity Collection; Prairie Grass in 9311 Prairie (C1) on Level 1; Broadleaf in 9271 Delta (C2) on the Administrative Level; and Broadleaf in 9280 Meadow (C3) on Level 2. The Biodiversity Collection is manufactured from 32% post-consumer recycled content and a minimum total recycled content of 66%. The nylon carpet fibres and back are both 100% recyclable. Interface products have low VOC emissions and use a tactile installation process instead of glue, also eliminating VOCs (Interface, 2017). The carpeted areas provide soft areas for students to sit on and the Biodiversity line brings in vegetation patterns onto the floor. Damaged tiles can easily be replaced and Interface has a cradle to grave systems for all of their products.





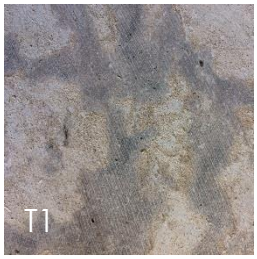
Bōlyü Svelte products were also selected in the classrooms and the Green Commons. Bōlyü Svelte, a polyester yarn with 40% minimum post-consumer recycled content with anti-soil and commercial stain protection, and lifetime warranties, was applied in the seating areas in the privacy nooks in the classrooms on the Second Level in SLV25 (B1) and to the seating areas under the skylight in the Green Commons in SLV78 (B2) (Bōlyü, n.d.).



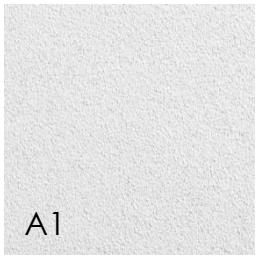
A quartz product by Dupont, Zodiaq (Q1), was installed in the kitchenette and Green Commons bathroom for all the countertops. Although quartz is a manufactured product, it was selected for its durability and ease of maintenance. The Zodiaq product is 97% quartz. The remaining 3% is a combination of adhesives and sealants, which meet or exceed emissions guidelines for volatile organic compounds, are low-emitting, nontoxic and non-allergenic for humans. The non-porous surface requires no sealants, resists staining and does not harbour

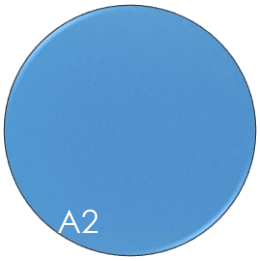
bacteria or viruses (Dupont, 2017). The Mocha Latte pattern replicates the yellows and golds of the prairie landscape.

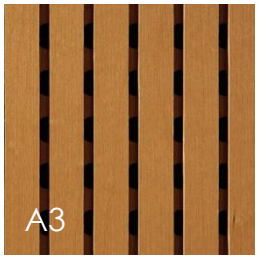
Tyndall stone (T1) was selected for the planters in the school and in Folly Forest. One advantage of using Tyndall stone is that it is locally sourced with Canada being the only source worldwide. The preserved organisms including corals, sponges, gastropods, trilobites and algae can be seen in the patterns within the stone, introducing another symbolic experience for the children (Gillis Quarries Ltd., 2017).



Armstrong Ultima ceiling tiles (A1) were selected for ceilings and clouds. These offer excellent durability, light reflectance of 90%, humidity resistance and certified acoustical performance with an NRC of up to 0.75. The tiles are soil, impact and scratch resistant, washable and can be scrubbed, all of which are important maintenance requirements in a school setting (Armstrong Ceiling Solutions, 2017). Blue translucent Infusions Shapes by Armstrong (A2) were also installed below the clouds to replicate the feeling of a cloudy blue sky in the Green Commons. An Armstrong Woodworks Channeled Vector wall (A3) with a 13-mm profile with 3 mm grooves was selected for the west wall in the Green Commons. This product

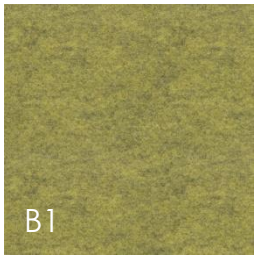


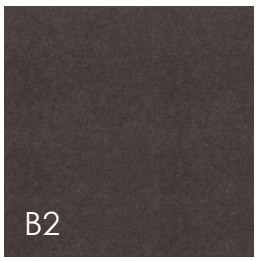




features real wood veneer in a Red Birch finish on a fire-retardant fiberboard with 100% biobased content, 92% recycled content and acoustical backing to improve sound quality (Armstrong Ceiling Solutions, 2017).

Bōlyü Svelte Unbacked SLV25 (B1) was applied to a feature wall in each classroom on Level 2 and SLV78 (B2) on Level 1. This product provides acoustical performance and fire ratings, contains 95% post-consumer recycled content and is 100% recyclable (Bōlyü, n.d.). This wall can also be used to display students' artwork and projects as recommended in the Emilia Reggio system (Dudeck, 2007).



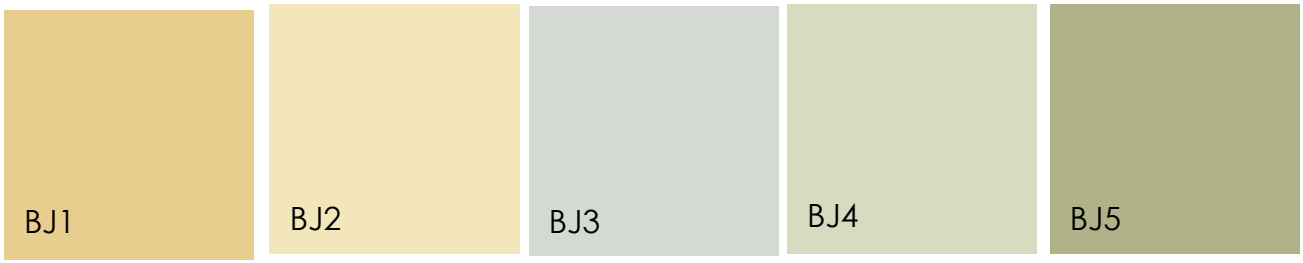


A varia ecoresin by 3Form provides a separation between the privacy nooks in the classrooms and the remainder of the classroom. The ecoresin product is manufactured from 40% pre-consumer recycled material. The translucent product allows the person in the nook to see out, yet feel protected by the design in the ecoresin, while the teacher can also see in. A natural pattern was selected (Whisper) as a symbolic experience of nature (F1).

To minimize the solar gain in the expanse of windows in the Green Commons, ACG Solarshield Green (AG1) was selected in a dual insulating glass configuration. With argon, the U-

value is 0.29, providing some insulation in cold weather. This product also absorbs energy from the visible light spectrum, thereby increasing interior comfort and reducing visual glare (AGC Glass Company, 2016).

Benjamin Moore paints were applied to the wall surfaces; the paints selected meet stringent requirements for material health with zero VOC and low odour. In addition, the paints are certified by the Master Painters Institute (Benjamin Moore, 2017). The walls in the Green Commons and other Level 1 spaces are painted in Concord Ivory HC-12 (BJ1) and Weston Flax HC-5 (BJ2); Administrative Level walls are painted in Wickham Gray HC-171 (BJ3); and Level 2 walls are painted in Glazed Green CC-580 (BJ4) and Grasslands CC-590 (BJ5).

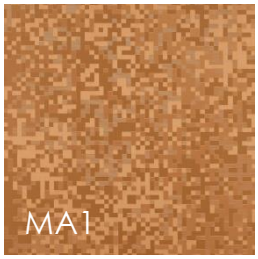


Fabrics were selected for their durability (100,000 double rubs) and ease of maintenance and cleaning. It was also important to introduce fabrics that had recycled content and could be cleaned with water-based solutions.

In the Green Commons, the soft seating next to the curtain wall and the librarian chairs are upholstered in Momentum Domain in Pristine, a geometric pattern reminiscent of an aerial view of prairie crops (MD1). The fabric contains 70%

post-consumer recycled polyester and 30% polyester (Momentum Textiles, n.d.). The Six Inch Rock Elements are done in find an Arc Com fabric, Intaglio 2, from the eco-tex Collection in three colours – sunflower #30 (AC1), tangerine #31 (AC2) and iron #41 (AC3). This product features stain protection and is mildew and abrasion resistant. According to Arc Com (n.d.), it is produced with a reduced environmental Impact and 99% of all water and raw materials used are recycled.

On Level 1, the fabric selected for the student chairs is Maharam Bitmap in Copper 011 (MA1), a durable 100% vinyl in a geometric design with an anti-microbial finish (Maharam, 2017). The fabric selected for the student chairs on Level 2 is Maharam Bitmap, in Aloe 010 (MA1). The fabric for the teachers' chairs is Momentum Juncture in Annatto(MJ1); it is manufactured with rapidly renewable fibre content (66% cotton, 29% nylon and 5% polyester), and can be cleaned with water-based products (Momentum Textiles, n.d.).



5.7 Exterior Development

The wayfinding path in steel blue Norament Round continues from the hallways, through the exits, and out into the school yard. At the exit from the classrooms, the meandering path separates into two streams, one leading to the Green Commons and the other to school entrance off the Green Commons, linking up to the existing wayfinding paths in the interior of the school. In this way, the communication between the interior and the exterior is created, linking the inside and the outside. The exterior wayfinding path also invites the students to walk down the path that circles around the school yard and further exposes the children to the pockets of nature that are in the yard as can be seen in the site plan (Figure 5.37).

The original rectilinear form of Strathcona School was retained. The major exterior changes were made to the Green Commons, in which the addition of windows, curtain walls and a large skylight were introduced to improve daylighting and direct views to the exterior. These changes can be seen in the elevations (Figure 5.38 to 5.41).

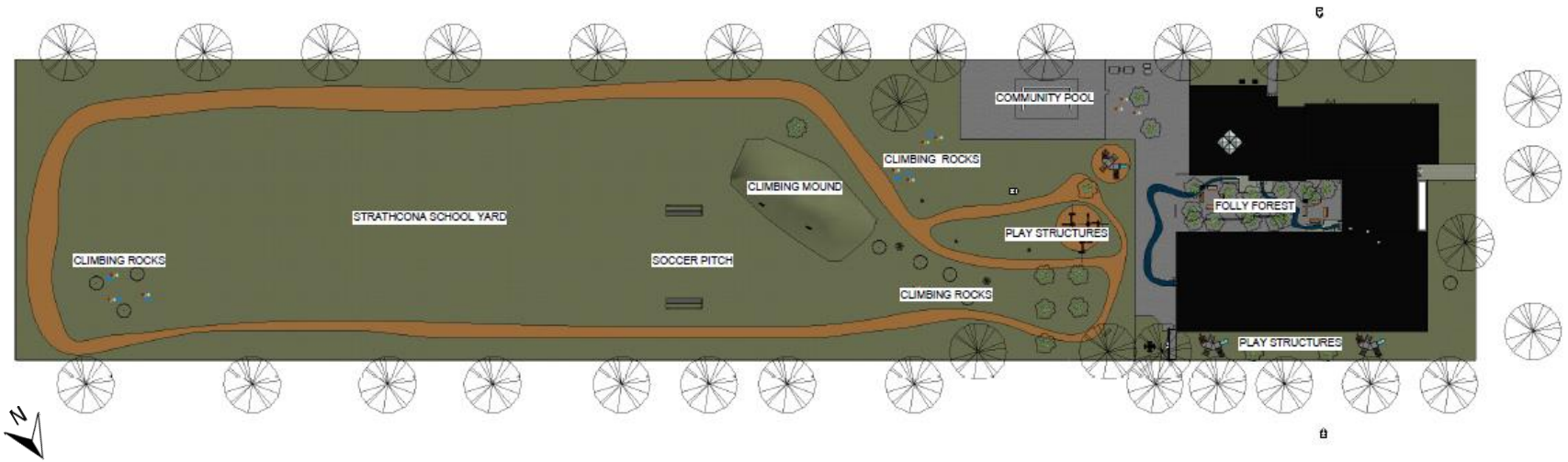


Figure 5.37. Site plan of Strathcona school yard.

Figure 5.38. East elevation.

Figure 5.39. North elevation.

Figure 5.40. West elevation.

Figure 5.41. South elevation.

5.8 Summary

The design of Strathcona School was inspired by place - the geography in southern Manitoba. The elements of nature found in the boreal forest, the escarpment and the prairie grassland guided and informed the elements of the design of the Green Commons, the classrooms and the circulation pathways. These are the areas where the children spend the greater part of the day and where the greatest impact of bio-inspired design to restore nature deficit would be felt. To foster the human/nature connection through direct experiences, light, fresh air and direct views to the exterior were introduced into the spaces with curtain walls and operable windows. Opportunities to experience heraclitean movement and sound were introduced with a skylight and an aquarium. Indirect experiences were created by selecting natural shapes and forms, images of wildlife and colours taken from the Manitoba landscape. Furnishings that were age appropriate and provided flexibility were selected to optimize the possible structuring of the spaces for place-based education. The Green Commons and the classrooms were designed to allow teachers and students to work/play individually, in small groups or in large group settings. Materials were selected that are environmentally friendly and locally sourced when possible to introduce the concepts of sustainable design. Elements of the International design of the original construction were introduced to create a connection between all sections of the school. The rectilinear forms were respected and the Red Birch plywood was introduced into the Green Commons on the acoustical wall and in casework. Collectively, these design features provide educational opportunities about nature and can contribute to the development of pro-environmental understanding. This understanding can further lead to a life-long appreciation and passion to protect nature.

Chapter 6. Conclusions

6.1 Lessons Learned

Through this practicum, I have learned how to apply the concepts of design that were taught in the program to take a project from start to completion. A concept was developed that was researched, based on design questions, and developed into a completed design. I was able to apply a lifelong interest in the natural environment and sustainability to a design that would benefit and help children learn about nature and its restorative powers, while simultaneously developing a love for nature that would translate into a commitment to its protection for the long term. I discovered that there are many small design elements that can be incorporated to instill that love of nature, and it is the collection of these elements that combine to create the experience. It may be beneficial in a small way to install a view to the exterior, but if that view is to a solid wall, the benefits will be greatly reduced. It is the combination of windows and views of nature that create the benefit, by creating the direct experiences. However, the contribution of indirect and symbolic experiences cannot be underestimated. These serve as reminders of nature, which when enhanced with direct experiences, will foster the connection to nature that is so needed to address nature deficit disorder in children.

However it is not sufficient to incorporate direct, indirect and symbolic experiences unless these are presented in a form that fosters learning for

children of all ages. Age-appropriate learning experiences and place-based education must be provided to optimize conditions for learning. For this project, this included promoting learning about nature through bio-inspired and sustainable design. This was intended to develop pro-environmental attitudes and create a life-long appreciation and passion for nature.

6.2 Challenges and Opportunities

The completion of this Master of Interior Design has not been without its challenges. My career in the environmental field, firstly with analysis of environmental pollution, followed by environmental protection and assessment, and lastly, resource management, has nurtured a lifelong interest in nature and its restorative properties. Translating my interest in nature into design concepts that would address nature deficit disorder in urban children and create a sense of environmental stewardship beyond the classroom has been challenging. My research clearly indicated that the greatest benefits were associated with immersion in nature or direct experiences; however, this project was intended to create an interior environment that also provided indirect and symbolic experiences that would contribute towards the project goals. These have been incorporated into all of the spaces to ensure that the collective influence of direct, indirect and symbolic experiences helps to address nature deficit disorder.

Some of the limitations of the project included working with an existing building. When the project was initially proposed, the intent was to create a design that was economically feasible, to respect the School Building Space Standards (Public School Finance Board, 2012), and to make the school fully accessible. I have attempted to remain within these limitations but there would have been many more design options had these limitations not been followed.

One of the opportunities with using Strathcona School for this practicum was the design of the original construction in 1962 including the rectilinear form, the red birch plywood paneling and support beams and the extensive use of windows. These design elements were retained and integrated into the project to create a common design language between the 1962 construction and the 1973 and 1986 additions.

The site also presented a number of opportunities which included the size of the lot, the mature trees on the property, the Folly Forest, and the orientation of the school. These features allowed for the design to incorporate natural ventilation and cooling, and introduce windows and curtain walls with direct views to nature and to the Folly Forest. These design features also helped to create a communication between the interior and the exterior. This connection is an essential feature towards creating a direct experience to nature from the interior

of the school. The students and staff can see nature throughout all the seasons, hear the sounds of nature and feel the breezes from the open windows.

6.3 Future Directions

For the purposes of my project, I decided to limit the scope of the project to "nature" as defined in the Oxford Dictionary (2017) and not include humans or human creations. In my view, the issue with nature deficit disorder is with the absence or limited access to natural phenomena as defined by plants, animals and the natural landscape. The influence of humans and human creations in an urban environment is excessive and unavoidable. I therefore elected to exclude humans and urban nature created or altered by humans from the scope of my project. This would however be an interesting area to study further and to contribute to a limited amount of research on the impact of humans and urban nature in addressing nature deficit disorder.

A second area of research that would be worthwhile to pursue is the effectiveness of indirect and symbolic experiences, with and without the benefit of direct experiences, in addressing nature deficit disorder. One way to achieve this would be to conduct post-occupancy studies of both adults and children to determine whether the restorative benefits are achieved in these environments. It would also be interesting to determine whether or not the interior environment

can play a substantial role in teaching about environmental stewardship and creating a long-term commitment to protecting nature.

6.4 Reflections on the Design

This practicum project has taught me the importance of working through all the steps in the design process, from concept to research to design. It was interesting and rewarding to build a physical model to test theories on lighting. I also thought that using an acoustical analysis was an excellent approach to determining the amount of noise that would be transmitted through the windows, and based on this information, to determine the maximum amount of window area to introduce on the south façade of the Green Commons. Finally, I enjoyed the challenge of introducing experiences that were place-based and age appropriate. This was easily more easily achievable in a school where spaces are allocated to specific age groups, but I can appreciate that it would be challenging to offer the range of experiences to multiple age groups if space was limited.

It was also very challenging to retrofit a school to make it fully accessible. This was complicated by the fact that Strathcona School in built on three levels, which are presently reached by staircases only. Fortunately, the wide hallways enabled the addition of wheel chair lifts in the west and east entrances of the school and the addition of an elevator in the centre of the school. The

introduction of tactile strips at changes of level and at the entrances to the school, also help people who are visually impaired to navigate the school more safely.

This practicum has helped me to expand my understanding and the appreciation of design theory through an investigation to address the three questions of inquiry that I proposed with respect to addressing nature deficit disorder that I wanted to address in the design:

What conditions foster interaction and experiences that become embedded in the learning processes of children?

In what ways can the interior design of a school help children to learn about nature and help resolve the problem of nature deficit for children in urban environments?

How can learning in a classroom environment foster environmental stewardship beyond the classroom?

Based on my project, I found that learning and development must be age appropriate. This included creating experiences for children that target cognitive learning for children from ages 5 to 7, affective learning for children from ages 8 to 10 and evaluative learning for children from ages 11 to 12 and older. These experiences could be direct, such as views or excursions to gardens, parks, forests or yards; indirect such as trips to managed places such as zoos, museums or aquariums; or symbolic such as representations in movies, books, images and computers.

To provide the range of learning experiences required and to help children learn about nature, I incorporated many elements of bio-inspired design in Strathcona School. Views to the outdoors; sounds and photos of nature; gardens, plants and trees; the use of natural materials; organic shapes and natural forms; films and books on nature; and heraclitean movement were introduced throughout the school.

Place-based education was an important concept in creating the optimal space for learning for all age groups. Clear open spaces, well delineated paths, variety, complexity, adaptability, spaces for refuge and socializing, and properly dimensioned furnishings were elements of place-based education that benefited learning for all age groups.

Developing pro-environmental attitudes was also made possible through sustainable design which included natural ventilation and lighting, installing operable windows, enhancing acoustical performance, selecting environmentally friendly materials, recycling and composting, and using water and energy conservation fixtures.

I hope that the combination of bio-inspired and sustainable design elements, providing a range of direct, indirect and symbolic experiences throughout the

school, will provide opportunities for cognitive, affective and evaluative learning to both address nature deficit disorder in the short term, and create environmental stewards in the long term. I also hope that these design elements will help to nurture and grow the appreciation of nature that exists in every child, but most importantly, in the child who is experiencing an alienation from nature.

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Appendix A. Municipal Zoning Information.

Strathcona School Zoning Information (City of Winnipeg, 2013) **233 McKenzie Street** **Roll Number: 14030257000** **Neighbourhood: William Whyte**		
2014 Assessment Roll (Market value as at April 01, 2012)		
Property Class	**Status**	**Assessed Value**
Institutional	Exempt	$1,013,000
Property Information		
Property Use Code	PIISC - School	
Assessed Land Area	2.7 Acres	
Zoning	PR2 – Parks and Recreation –Active Neighbourhood/Community	
	This district is intended for sites that include community recreation facilities and parks that are accessed by a mix of pedestrian and vehicular traffic. These sites may provide active programs and activities, including community centres, hockey pens, arenas, indoor soccer, wading pools, spray parks, skateboard parks and athletic fields. Parking facilities ranging from 10 to 100 stalls may be associated with these uses. These parks and facilities typically occur along collector streets. Facility Type: Wading Pool Official Name: Strathcona Recreation Centre Wading Pool Facility Type: Recreation Centre Official Name: Strathcona Recreation Centre Facility Type: Day Care Official Name: Splash Day Care	
Water Frontage Measurement	1,188.06 ft.	
Sewer Frontage Measurement	1,188.00 ft.	
Property Influences	External Corner Bus Route Bus Stop Medium Traffic	
Street Priority	P3S - Residential Street treated as a P2 (Collector/Bus Route)	
Snow Zone	C Note: Snow Zone related residential parking ban and snow clearing schedule do not apply to P1 and P2 priority streets. However, if an address is on a service road adjacent to a P1 or P2 street, the residential parking ban will apply to the service road as per the snow zone.	
Parking Zone	North Main	
Electoral Ward	Mynarski	
Insect Management Area	45 (Burrows Central, Robertson, William Whyte)	

Table A.1. Municipal zoning information for Strathcona School.

Appendix B. Acoustical Analysis.

An Acoustical Guide developed by Saflex Architectural (n.d.) was used to conduct a simplified analysis of the noise transmitted to the interior from the outside. Since noise transmission occurs through the weakest element, the windows, it was important to determine the acceptable window noise reduction (NR) that would provide an acceptable quality of sound in the Green Commons. The process is a three-step calculation as follows:

Step 1 - Calculate the noise exposure

Step 2 - Calculate the noise reduction

Step 3 – Calculate the window noise reduction

STEP 1 AND 2: NOISE EXPOSURE AND NOISE REDUCTION

The Acoustical Guide states that road traffic is of a strong low frequency and is generally in the range of 76 dBA for a single lane of highway traffic. Several adjustments can be made to this Base Sound Level depending on a number of factors such as the number of lanes, the distance of the building to the road, traffic speed and vegetation. These adjustments for the Green Commons south façade are listed in the table below:

Factor	Condition at the Green Commons South Facade	Adjustment (dBA)
Number of lanes	4 lanes on Burrows Avenue	+6
Distance to road	15 metres	0
Traffic volume	Light truck traffic with speeds of 30 kph	-7
Traffic speed	30 kph	-6
Shielding by foliage	Foliage 15 m or less from road	-1
TOTAL ADJUSTMENT		-8
SOUND LEVEL AT SOUTH FAÇADE OF GREEN COMMONS = Base Sound Level + Adjustments = 76 dBA – 8 dBA = 68 dBA		

Table B.1. Adjustments to noise exposure and reduction for south façade of the Green Commons.

As calculated above, based on the total adjustment, the noise exposure or traffic sound level for the Green Commons south façade on Burrows Avenue would be in the range of 68 dBA. This figure is referred to as the Traffic Equivalent Sound Level.

According to the Acoustical Guide, the brick wall assembly at Strathcona School would typically have a Sound Transmission Class (STC) rating of 60 to 65, which provides good sound proofing. Windows typically have STC ratings of 27-29, with double and triple glazing improving the STC. Since there are few

windows on the south façade of Strathcona School, the acoustical analysis was done based on a STC of 60 for the brick wall. For the interior of the Green Commons, a Noise Criteria (NC) of 35 to 40 was the recommended level for an open class classroom and library (Saflex Architectural, n.d.).

STEP 3: WINDOW NOISE REDUCTION

Applying the Traffic Equivalent Sound Level of 68 dBA and NC of 35 to the chart in Figure 1.7 of the Acoustical Guide (p. 11), the Minimum Required Composite Noise Reduction (NRc) is 31 dB. The wall assembly in the Green Commons South Façade provides an estimated Exterior Wall Noise Reduction (NR) for traffic noise of 49 dBA (Figure 1.15d, p. 24). The minimum required NR is calculated using the following equation: NR – NRc = window noise reduction. For the Green Commons South Façade, the minimum NR = 49 – 31 = 18 dB.

Using Figure 1.8, a minimum NR of 18 dB, with 10% total exterior wall occupied by windows, yields an adjustment of 28 dB to be subtracted from the wall NR to obtain the window traffic NR. For the Green Commons South Façade, this works out to 49 db – 28 db = 19 dB. According to Figure 1.9, the required window sound transmission class to provide an interior Noise Criteria in the range of 35 to 40 dB with a window traffic NR of 19 dB would be within the range of double glazing windows.

Using Figure 1.8, a minimum NR of 18 dB, with 20% total exterior wall occupied by windows, yields an adjustment of 24 dB to be subtracted from the wall NR. For the Green Commons South Façade, this works out to 49 dB – 24 dB= 25 dB. According to Figure 1.9, the required window sound transmission class to provide an interior Noise Criteria in the range of 35 to 40 dB with a window traffic NR of 25 dB would require a window STC of 32 dB, which exceeds the STC of double glazed windows. This would allow traffic noise to impact on the Noise Criteria in the Green Commons. Based on this information and an analysis of Figure 1.8, the maximum total exterior wall occupied by windows in the south façade of the Green Commons must remain at 15% or less.

In conclusion, since double glazed windows typically have STC ratings of 27 to 29 (Saflex Architectural, n.d.), the total exterior wall area occupied by windows on the south façade of the Green Commons would have to be 15% or less. This value would ensure that the Noise Criteria (NC) in the interior of the Green Commons would remain at or below an NC of 35 to 40, the recommended level for an open class classroom and library. The south façade of the Green Commons measures 23.8 metres by 3.6 metres, resulting in a total surface area of 85.7 square metres. Therefore, to ensure that the NC remains below 35 to 40, the total exterior wall occupied by windows should remain below 15%; applying this percentage to the total area of the south façade results in an area of windows of 12.9 square metres.

The existing windows each measure 1220 mm by 457 mm, or 0.55 square metres, for a total of 3.3 square metres of area for 6 windows. A set of double doors with two windows on each door would add an additional 2 metres x 0.9 metres x 2 = 3.6 square metres. To remain within 12.9 square metres, the south façade of the Green Commons could accommodate an additional 6 square metres of windows (12.9 – 3.3 – 3.6 = 6.0). This would allow for an additional 2 banks of windows for a total 3.3 square metres, plus a row of windows at a lower level to give children a view to the outdoors on Burrows Avenue not to exceed 2.7 square metres. This configuration would be within the recommended 15% area for windows to maintain the NC below 35 to 40.

Appendix C. Light Studies of Current and Proposed Construction.

C.1. Analysis of Light for Dates and Times during School Year

The sun path chart for Strathcona School (Figure 4.29) was used to calculate the solar azimuths and solar angles for three school days during the year, and for three times on those dates. The results are summarized below:

Date		9:00 a.m.	Noon	3:00 p.m.
September 22	Solar Azimuth	35°	45°	32°
	Solar Angle	125°	180°	235°
December 21	Solar Azimuth	14°	20°	14°
	Solar Angle	140°	180°	210°
June 21	Solar Azimuth	58°	64°	55°
	Solar Angle	115°	180°	250°

Table C.1. Summary of solar azimuths and solar angles for Strathcona School.

C.2. Light Study of South Façade

Following is an image to scale of the south façade of the Green Commons area of Strathcona School, showing few windows on the south façade.

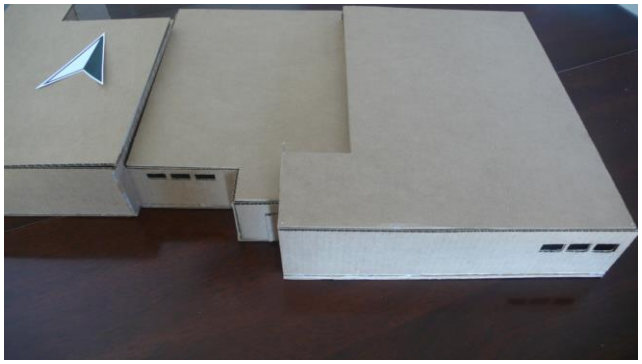


Figure C.1. Model of existing south façade of proposed Green Commons. Image by S. Therrien-Richards.

Based on the sound analysis conducted (refer to Appendix B), it was determined that the maximum square footage of windows on the south façade that would also provide good sound control would be limited to 15% of the façade, or 138 square feet. This would permit adding two additional banks of windows to the south façade. The comparative analysis of light for various dates and times during the school year was done using the existing construction and a proposed renovation with windows totaling 15% of the façade. To meet the 15%

target and to reinforce the International Style architecture of the earlier phases of the school, the clerestory windows were organized in a linear pattern of 3 banks of 3 windows, suggesting a ribbon pattern as seen in the architectural images of Frank Lloyd Wright and Le Corbusier (Figures 3.16, 3.24 and 3.25).

Based on this data, a photographic comparison of light as it penetrates the south façade of the Green Commons was conducted, comparing the light from the existing construction and the light that would enter with an increase in the number of windows on three dates, September 22, December 21 and June 21. The results are presented in the following tables.

Date		9:00 a.m.	Noon	3:00 p.m.
September 22	Solar Azimuth	35°	45°	32°
	Solar Angle	125°	180°	235°

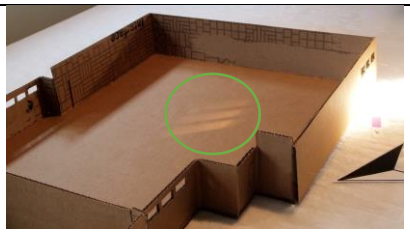
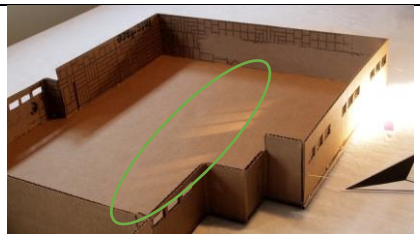
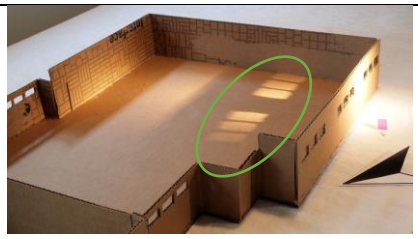
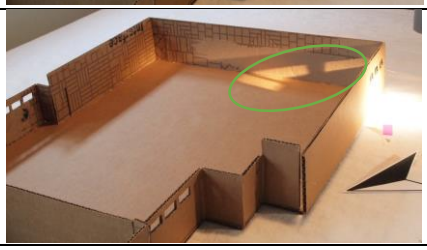
Time	Existing Construction	Proposed Construction
9:00 a.m		
Noon		
3:00 p.m.		

Table C.2. Comparison of lighting on September 22 between existing and proposed construction. Images by S. Therrien-Richards.

It is clear that by adding additional windows, the natural light moves right across the entire space on September 22, although it does not penetrate further into the space (Table C.2).

Date		9:00 a.m.	Noon	3:00 p.m.
December 21	Solar Azimuth	14°	20°	14°
	Solar Angle	140°	180°	210°

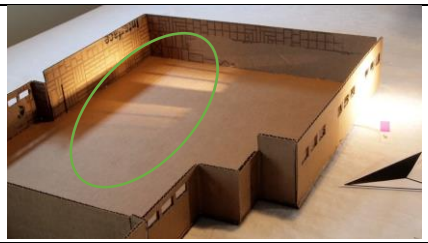
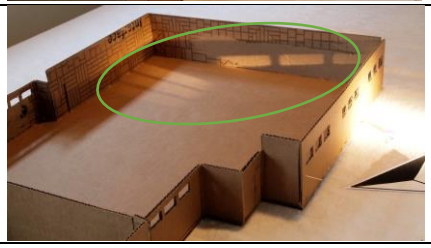
Time	Existing Construction	Proposed Construction
9:00 a.m		
Noon		
3:00 p.m.		

Table C.3. Comparison of lighting on December 21 between existing and proposed construction. Images by S. Therrien-Richards.

The additional banks of clerestory windows allow the natural light again to move right across the entire space, but in December, the low angle of the sun also allows the light to penetrate further into the space (Table C.3).

Date		9:00 a.m.	Noon	3:00 p.m.
June 21	Solar Azimuth	58°	64°	55°
	Solar Angle	115°	180°	250°

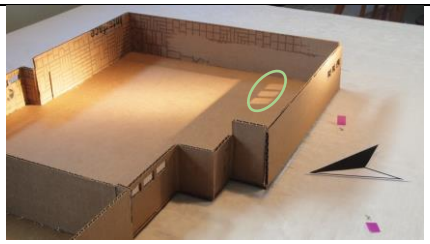
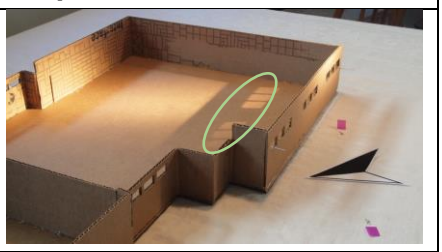
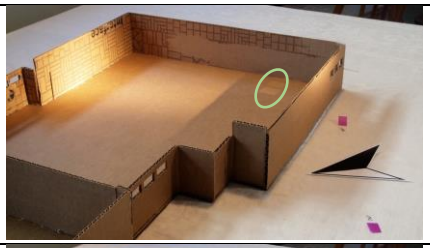
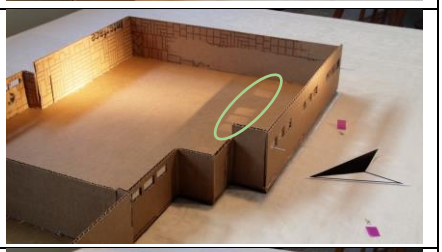
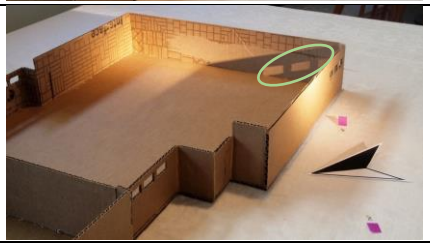
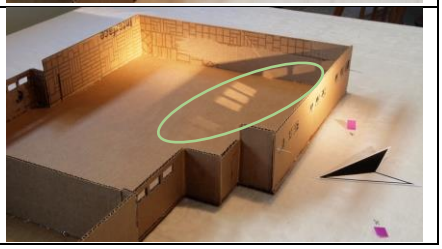
Time	Existing Construction	Proposed Construction
9:00 a.m		
Noon		
3:00 p.m.		

Table C.4. Comparison of lighting on June 22 between existing and proposed construction. Images by S. Therrien-Richards.

Again, the addition of the additional windows increases the amount of natural light introduced into the space. However, with a higher solar angle, the light does not penetrate further into the space but rather spreads across the space as seen on September 22.

C.3. Light Study of North Façade

Following are images to scale of the north façade of the Green Commons area of Strathcona School, showing few windows.

Figure C.2. Model of existing site of proposed Green Commons – North Façade. Image by S. Therrien-Richards.

The north and east façades face the Folly Forest and the school playground. Since there are no noise issues, there are no limitations to the area of windows for sound control. Therefore, to more closely link the indoors and the outdoors and to improve connectedness to nature, these façades will be changed to incorporate the maximum area of windows possible.

Appendix D. Applicable Requirements for Compliance with the National Building Code of Canada (NBCC) for Strathcona Elementary School.

The National Building Code of Canada (National Research Council of Canada, 2010) was reviewed to determine applicable requirements for Strathcona Elementary School with respect to general fire safety, fire safety within the floor areas, fire exits, health requirements and barrier-free design for both access and health requirements. The sections, articles, sub-articles and clauses that apply to Strathcona Elementary School have been listed below.

As determined in *Section 3.1*, *General*, *Article 3.1.2.1* of the NBCC, Strathcona Elementary School qualifies for an occupancy classification of Group A Division 2 – an assembly occupancy not classified elsewhere in Group A. *Article 3.17.1.* sets out the occupant load for Group A, based on the use of the space and the type of furnishings. Based on this requirement, the allowable number of persons for the areas that will be designed, which include the Green Commons, the classroom and the library, has been calculated in Table A.1. With a reported population of 242 students in 2011 (Winnipeg School Division, 2012) and a staff of approximately 40, the total number of persons in the school falls between 280 and 300 persons. To account for volunteers and others who may be in the school, the occupancy load will be based on 300 persons. This value will be applied to calculate the number of water closets, urinals and lavatories required by the NBCC to meet the health requirements as set out in *NBCC Section 3.7 Health Requirements* and *NBCC Section 3.8 Barrier Free Design*. This data is summarized in Tables A.2.

At this time, Strathcona Elementary School is not a barrier-free building. The requirements to render the building accessible are listed in *NBCC Section 3.8 Barrier-Free Design*. Barrier-free paths of travel are required for not less than 50% of the pedestrian entrances to and from the exterior (Article 3.8.1.2. Entrances),

and within the school from the first storey to the mezzanine and from the mezzanine to the second storey (Article 3.8.2.1. Areas Requiring a Barrier-Free Path of Travel).

Section 3.1 General

3.1.2.1. Occupancy Classification – Group A Division 2 – Assembly occupancies not elsewhere classified in Group A.

3.1.17.1. Occupant Load for Group A:

Assembly use of space with non-fixed seats - 0.75 m^2 per person

Assembly use of space with non-fixed seats and tables – 0.95 m^2 per person

Assembly use of classroom – 1.85 m^2 per person

Assembly use of reading room – 1.85 m^2 per person

Description of Space	NBCC Space Requirement	Strathcona School Space
Assembly use of space with non-fixed seats	0.75 m^2 per person	Green Commons
Assembly use of space with non-fixed seats and tables	0.95 m^2 per person	Green Commons
Assembly use of classroom	1.85 m^2 per person	Classroom
Assembly use of reading room	1.85 m^2 per person	Library

Table D.1. Occupancy load table for Strathcona Elementary School Green Commons, classroom and library.

Section 3.2 Building Fire Safety

3.2.2.23. Group A, Division 2, Any Height, Any Area, Sprinklered

2 a) building shall be of noncombustible construction and sprinklered throughout,

b) floor assemblies shall be fire separations with a fire-resistance rating of not less than 2 h,

c) mezzanines shall have a fire-resistance rating not less than 1 h,

d) loadbearing walls, columns and arches shall have a fire-resistance rating not less than that required for the supported assembly

Section 3.3 Safety within Floor Areas

3.3.1.1. Separation of Suites

1) Each suite shall be separated from adjoining suites by a fire separation having a fire-resistance rating not less than 1 h.

3.3.1.3 Means of Egress

3) Means of egress shall be provided from every roof intended for occupancy, and from every podium, terrace, platform or contained open space

4) At least 2 separate means of egress shall be provided from every roof intended for an occupant load of more than 60, to stairs in conformance with 3.4.

5) A rooftop enclosure shall be provided with an access to exit that leads to an exit at roof level or on the storey immediately below the roof.

6) A rooftop enclosure more than 200 m^2 in area shall have at least 2 means of egress.

3.3.1.5. Egress Doorways

1) b) A minimum of 2 egress doorways shall be provided intended for occupant load greater than 60.

d) in a floor area that is sprinklered throughout and i) the travel distance is more than 25 m, or ii) the area of the room or suite is more than 200 m^2 (as per Table 3.3.1.5.B.)

3.3.1.9. Corridors

1) The minimum width of a public corridor shall be 1100 mm.

2) The minimum unobstructed width of a corridor serving classrooms shall be 1100 mm.

3.3.1.11. Door Swing

1) The door providing access to exit shall swing on a vertical axis.

2) A door than opens into a corridor or other facility provided access to exit from a room intended for an occupant load of more than 60 shall swing in the direction of travel to exit.

3.3.1.13 Doors and Door Hardware

1) A door that opens into or is located in a public corridor that provides access to exit shall

a) provide a clear opening of at least 800 mm and

c) not open onto a step.

2) A door in an access to exit shall be readily openable without keys, special devices or special knowledge of the door opening mechanism.

3) Door release hardware shall be operable with one hand and openable with not more than one releasing operation.

4) Door release hardware shall be installed not more than 1200 mm above the finished floor.

3.3.1.18. Guards

1) A guard not less than 1070 mm high will be provided

a) around any roof to which access is provided and

c) at each raised floor, mezzanine, balcony, gallery, interior ramp where the difference in level is more than 600 mm.

Section 3.4 Exits

3.4.2.1 Minimum Number of Exits

1) Every floor area intended for occupancy shall have at least 2 exits.

3.4.2.3. Distance between Exits

1) The least distance between 2 exits of a floor area shall be

a) one half the maximum diagonal dimension of the floor area, but can be less than 9 m for a floor area having a public corridor.

3.4.3.2. Exit Width

1) The minimum aggregate required width of exits shall be determined by multiplying the occupant load by

a) 6.1 mm per person for ramps with a slope of not more than 1 in 8, doorways and passageways,

b) 8 mm per person for a stair with risers not more than 180 mm and run not less than 280 mm, or

c) 9.2 mm per person for i) ramp with slope of more than 1 in 8, or ii) stairs other than those described in b).

3.4.5. Exit Signs

1) Every exit door shall have an exit sign if the exit serves

b) a building with an occupancy load of more than 150, or

c) a floor area that has a fire escape as part of the means of egress.

2) Every exit sign shall

a) be visible on approach to the exit, and

c) conform to design specifications.

3.4.6.4. Dimensions of a Landing

1) The length and width of a landing shall be at least the width of the stairway in which it occurs, except in a straight run, the length need not be more than 1100 mm.

2) Where a doorway or stairway empties onto a ramp through a side wall, there shall be a level area across the full width of the ramp, and for a distance of 300 mm on either side of the opening, except one side if it abuts on an end wall.

3.4.6.5. Handrails

1) A stairway shall have a handrail on at least one side, and on both if it is 1100 mm or more wide.

2) If the width of a ramp or flight of stairs is more than 2200 mm, one or more intermediate handrails continuous between landings will be provided, and located so that there will not be more than 1650 mm between handrails.

3) a) The circular cross-section with an outside diameter will be not less than 30 mm and not more than 43 mm.

b) A non-circular cross section with a graspable portion will have a perimeter not less than 100 mm and not more than 125 mm, and the largest cross-sectional dimension will be no more than 45 mm.

5) The height of the handrail on stairs and ramps will be between 865 mm and 965 mm.

10) At least one handrail at the side of a stairway or ramp shall extend horizontally not less than 300 mm beyond the top and bottom of the stairway or ramp.

11) The clearance between a handrail and any surface behind it shall be not less than 50 mm, or 60 mm is the surface is rough or abrasive.
13) A ramp shall have handrails on both sides.

3.4.6.6. Guards
1) Every exit hall have a guard on each side.
2) The height of guards shall be not less than 920 mm measured vertically to the top of the guard from a line drawn through the outside edge of the stair nosing and 1070 mm around landings.
3) The height of guards for exit ramps and their landings shall be not less than 1070 mm measured vertically to the top of the guard from the ramp surface.

3.4.6.7. Ramp Slope
1) The maximum slope of a ramp shall be
    a) 1 in 10 in any assembly occupancy and
    d) 1 in 10 for an exterior ramp.

3.4.6.10. Horizontal Exits
3) In a horizontal exit where there is a difference between the connected floor areas, slopes as set out in 3.4.6.7. shall be used.
4) No stairs or steps will be used in a horizontal exit.

3.4.6.11. Doors
1) The distance between a stair riser and the leading edge of the door during its swing shall be not less than 300 mm.
2) No exit door shall open directly onto a step, except that is there is danger of blockage from snow or ice, an exit door can open onto not more than one step that is no more than 150 mm high.

3.4.6.12. Door Swing

1) The door will open in the direction of exit travel.

Section 3.7 Health Requirements

3.7.2.2. Water Closets (WCs)

1) WCs shall be provided for each sex assuming that the occupant load is equally divided between males and females.

5) Urinals are permitted to be substituted for two thirds of the number of WCs required for males.

6) The number of WCs required for assembly occupancies is set out in Table 3.7.2.2.A. For a population of approximately 300 occupants, assuming an equal division of males and females, a minimum of 3 WCs is required for males and 6 WCs for females. For 151-175 persons of each sex (population of 302 to 350), a minimum of 4 WCs is required for males and 7 WCs for females.

7) The number of WCs required for primary schools shall be at least one for each 30 males and one for each 25 females.

3.7.2.3. Lavatories

1) At least one lavatory shall be provided in a room containing 1 or 2 WCs or urinals, and at least one additional lavatory for each additional 2 WCs or urinals.

4) Lavatories shall be equipped with faucets that

a) operate automatically, or

b) have lever-type handles that do not close under spring action.

3.7.2.6. Surface Protection

1) Wall and floor surfaces below the top of the urinal shall be impervious and durable for a distance from the urinal to a point not less than 900 mm from the projected outline of the urinal on the wall or floor.

2) Floor surfaces around a WC shall be impervious and durable for a distance not less than 900 mm from the projected outline of the WC on the floor.

3.7.2.7. Floor Drain

1) A floor drain shall be installed in a washroom containing a urinal equipped with an automatic flushing device.

Population	No. of Males	No. of Females	Requirements for Males		Requirements for Females		Barrier-Free Design
			WC	**Lavatories**	**WC**	**Lavatories**	**WC/Universal**
1-30	15	15	1	1	1	1	1[1]
1-60	30	30	1	1	2	1	1[1]
251 - 300	150	150	5	3	6	3	3[1]
301 - 350	175	175	6	3	7	4	3[2]

Table D.2. NBCC primary school requirements for WCs and lavatories for males and females.

Section 3.8 Barrier-Free Design

3.8.1.2. Entrances

1) Not less than 50% of the pedestrian entrances of a building shall be barrier-free and shall lead from

a) the outdoors at sidewalk level, or

b) a ramp that conforms to 3.8.3.4 and leads from a sidewalk.

[1] This value is based on the space being used by a small population and located on one floor of the school.

[2] This value is based on the Strathcona Elementary School in its entirety, which is distributed over three storeys. Provided that a barrier-free path of travel could be provided to each of the storeys, each storey would be required to have a barrier-free access WC or Universal Toilet Room.

3.8.1.3. Barrier-Free Path of Travel

1) The unobstructed width of a barrier-free path of travel shall be not less than 920 mm.

4) The width of a barrier-free path of travel that is more than 30 m long will be increased to not less than 1500 mm for a length of 1500 mm at intervals not exceeding 30 m.

3.8.2.1. Areas Requiring a Barrier-Free Path of Travel

1) Except for certain areas (e.g. service rooms, janitor's rooms) a barrier-free path of travel will be provided from the entrance storey and within all normally occupied floor areas served by a passenger elevator or escalator.

2) A barrier-free path of travel for persons in wheelchairs is **not** required within those parts of a floor area that are not at the same level as the entry level, **provided** that the uses on any raised level are accessible on the entry level by means of a barrier-free path of travel.

3) In an assembly occupancy, the number of spaces designated for use within rooms or areas with fixed seats shall conform to Table 3.8.2.1. For an occupancy of 201 to 300 persons, 4 spaces would be required for wheelchairs, and for 301 to 400 persons, 5 spaces would be required.

3.8.2.3. Washrooms Required to be Barrier-Free

1) A washroom in a storey to which barrier-free path of travel is required shall be barrier-free.

3) In a building in which WCs are required according to Subsection 3.7.2, at least one barrier-free WC shall be provided in the entrance storey, unless

a) a barrier-free path of travel is provided to barrier-free WCs elsewhere in the building.

4) If alterations are made to an existing building, universal toilet rooms conforming to Article 3.8.3.12 are permitted.

3.8.3.1. Accessibility Signs

1) Signs with the international symbol for accessibility will indicate the location of a barrier-free entrance.

2) A washroom that is barrier-free shall be identified with appropriate signage.

3.8.3.2. Exterior Walks

1) Exterior walks that form part of a barrier-free path of travel shall

a) have a slip-resistant, continuous and even surface,

b) be not less than 1100 mm wide, and

c) have a level area adjacent to an entrance way (Article 3.8.3.4).

3.8.3.3. Doorways and Doors

1) Every doorway that is located in a barrier-free path of travel shall have a clear width of no less than 800 mm when the door is open.

3) Door opening mechanisms will not require tight grasping and twisting of the wrist as the only means of operation.

4) The threshold for a doorway will not be more than 13 mm higher than the finished floor and shall be beveled.

5) Every door that provides a barrier-free path of travel shall be equipped with a power door operator if the entrance serves

d) a building of Group A major occupancy greater than 500 m^2 in building area.

9) A closer for an interior door in a barrier-free path of travel shall have a closing period of not less than 3 s.

10) A door without a closer in a barrier-free path of travel shall have a clear space on the latch side extending the height of the doorway and not less than

a) 600 mm beyond the edge of the door opening if the door swings toward the approach side, and

b) 300 mm beyond the edge of the door opening if the door swings away from the approach side.

3.8.3.4. Ramps

1) A ramp located in a barrier-free path of travel shall

a) have a width of not less than 870 mm,

b) have a slope not more than 1 in 12,

c) have a level area not less than 1500 mm by 1500 mm at the top and bottom of the ramp, and at intermediate levels leading to a door,

d) have a level area not less than 1200 mm long and at least the same width as the ramp at intervals not more than 9 m in length or where there is an abrupt change in the direction of the ramp.

3.8.3.8. Water Closet Stalls

1) At least one WC stall or enclosure required by Article 3.8.2.3. shall be barrier free and

a) be not less than 1500 mm wide by 1500 mm deep,

b) be equipped with a door that can be

i) latched from the inside with a closed fist,

ii) provides a clear opening of at least 800 mm wide,

iii) swings outward, unless sufficient space can be provided within the enclosure to permit the door to be close without interfering with a wheelchair,

iv) is provided with a door pull not less than 140 mm long located with a midpoint between 200 and 300 mm from the hinged side of the door and between 900 mm and 1000 mm above the floor, and

v) is provided with a door pull on the outside, near the latch side of the door,

c) have a WC located with a clearance between the fixture and the wall of one side between 285 mm and 305 mm,

d) be equipped with grab bars that

i) are mounted horizontally on the side wall closest to the WC and extend not less than 450 mm in both directions from the most forward point of the WC

ii) if the WC does not have an attached water tank, are at least 600 mm in length, mounted horizontally on the wall behind the WC and centered on the toilet bowl,

iii) are mounted between 840 mm and 920 mm above the floor,

iv) are installed for a load of 1.3 kN or more

v) are between 30 mm and 40 mm in diameter

vi) have a clearance of between 35 mm and 45 mm from the wall.

e) be equipped with a coat hook mounted not more than 1200 mm above the floor on a side wall, and projecting no more than 50 mm from the wall, and

f) have a clearance of not less than 1700 mm between the outside of the stall face and the face of an in-swinging washroom door and 1400 mm between the outside of the stall face and any wall-mounted fixture.

3.8.3.9. Water Closets

1) A WC shall

a) be equipped with a seat located between 400 mm and 460 mm above the floor,

b) be equipped with hand-operating flushing controls that are easily accessible or automatically operable,

c) be equipped with a seat lid or other back support, and

d) not have a spring-activated seat.

3.8.3.10. Urinals

1) If a urinal is provided in a barrier-free washroom, the urinal shall

a) be wall mounted, with the rim between 488 mm and 512 mm above the floor, or

b) be floor mounted, with the rim level with the finished floor.

2) The urinal shall have

a) a clear width of approach of 800 mm centered on the urinal,

b) no step in front and

c) installed on each side a vertically mounted grab bar that is not less than 300 mm long, with its centre line 1000 mm above the floor, located not more than 380 mm from the centre line of the urinal.

3.8.3.11. Lavatories

1) The lavatory will

a) be located so that the distance from the centre line of the lavatory and the side wall is not less than 460 mm,

b) have a rim height not more than 865 mm above the floor,

c) have a clearance below the lavatory not less than

i) 760 mm wide

ii) 735 mm at the front edge

iii) 685 mm high at a point 205 mm back from the front edge, and

iv) 230 mm high over the distance from a point 280 mm to a point 430 mm back from the front edge,

d) have insulated pipes where they could present a burn hazard,

e) have a soap dispenser located nearby, not more than 1200 mm above the floor,

f) have a towel dispenser or hand-drying equipment located nearby, not more than 1200 mm above the floor.

2) Mirrors shall be located

a) with the bottom edge not more than 1000 mm above the floor, and

b) be inclined to the vertical.

3.8.3.12. Universal Toilet Rooms

1) A universal toilet room shall

a) be served by a barrier-free path of access,

b) have a door capable of being locked from the inside and released from the outside in case of emergency, and

i) a latch mechanism operable with a closed fist located between 900 mm and 1000 mm above the floor,

ii) have a door pull not less than 140 mm long located on the inside, with its mid-point located between 200 mm and 300 mm from the hinged side of the door and between 900 mm and 1000 mm above the floor,

c) have a lavatory in compliance with Article 3.8.3.11.

d) have one WC conforming to Article 3.8.3.9, and that has a clearance to the walls of

i) between 285 mm and 305 mm on one side, and

ii) not less than 875 mm on the other side,

e) have grab bars conforming to Article 3.8.3.8.,

f) have no internal dimensions between the walls less than 1700 mm,

g) have a coat hook as set out in Article 3.8.3.8, and a shelf located not more than 1200 mm above the floor

h) be designed to allow a wheelchair to back into the space described in d) ii above, and

i) be designed to allow a wheelchair to turn in a space not less than 1500 mm in diameter.

3.8.3.16. Drinking Fountains

1) a) At least one drinking fountain shall be barrier-free and have a spout located near the front of the unit not more than 915 mm above the floor, and

b) be equipped with controls that are easily operable with one hand from a wheelchair or automatically operable.

Appendix E. Applicable Requirements for Compliance with the National Fire Code of Canada 2010 (NFC) for Strathcona School.

The National Fire Code of Canada 2010 (National Research Council of Canada, 2010) was reviewed for requirements with respect to existing buildings, specifically Strathcona Elementary School. In addition to the fire safety requirements of the National Building Code of Canada (NBC), the following sections, articles, sub-articles and clauses from the National Fire Code of Canada that apply to Strathcona Elementary School have been listed below:

Section 2.1. General

2.1.5. Portable Extinguishers

2.1.5.1. 1) Portable extinguishers shall be installed in all *buildings* except *dwelling units.*

Section 2.2. Fire Separations

2.2.1.1. 3) Rooms, corridors, shafts and other spaces shall be separated where practicable by *fire separations* conforming to the NBC.

2.2.2.1. Openings in Fire Separations

1) Openings in *fire separations* shall be protected with *closures* in conformance with the NBC.

Section 2.3. Interior Finishing, Furnishing and Decorative Material

2.3.1.1. Interior Finish

1) The interior finish material that forms part of the interior surface of a floor, wall, *partition* or ceiling shall conform to the NBC.

2.3.1.2. Movable Partitions and Screens

1) Movable *partitions* or screens, including acoustical screens, shall have a *flame-spread rating* not greater than the interior finish of the area in which they are located.

2.3.1.3. Decorative Materials

1) Decorative materials on walls or ceilings shall have a *flame-spread rating* not greater than the interior finish of the area in which they are located.

2.3.1.4. Interconnected Floor Spaces

1) Combustible contents in *interconnected floor spaces* in which the ceiling is more than 8 m above the floor, shall not exceed the limit specified in Subsection 3.2.8. of Division B of the NBC.

2.3.2. Flame Resistance

2.3.2.1. Drapes, Curtains and Decorative Materials

1) Drapes, curtains and other decorative materials including textiles and films used in *buildings* shall conform to CAN/ULC-S109, "Flame Tests of Flame-Resistant Fabrics and Films," when such drapes, curtains and other decorative materials are used in

a) any *assembly occupancy*

b) any lobby or *exit*

Section 2.7

Section 2.7.1.1. Means of Egress

1) *Means of egress* shall be provided in *buildings* in conformance with the NBC.

Section 2.7.1.2. Open Floor Areas

1) Aisles in conformance with Sentences (2) to (4) shall be provided in every *floor area* that

a) is not subdivided into rooms or *suites* served by corridors giving *access to exits,* and
b) is required by the NBC to have more than one egress doorway.
2) Every required egress doorway shall be served by an aisle that
a) has a clear width not less than 1 100 mm (3.6 feet),
b) has access to at least one additional egress doorway, and
c) at every point on the aisle, provides a choice of 2 opposite directions by which to reach an egress doorway.

2.7.1.3. Occupant Load
1) The maximum permissible *occupant load* for any room shall be calculated on the basis of the lesser of
a) 0.4 m^2 (4.3 ft^2) of net floor space per occupant, or
b) the *occupant load* for which *means of egress* are provided.
2) The number of occupants permitted to enter a room shall not exceed the maximum *occupant load* calculated in conformance with Sentence (1).

2.7.1.4. Signs
1) In *assembly occupancies* with *occupant loads* exceeding 60 persons, the *occupant load* shall be posted in conspicuous locations near the principal entrances to the room or *floor area.*
2) Signs required by the NBC to indicate the *occupant load* for a *floor area* shall be posted in conspicuous locations near the principal entrances to the *floor area.*
3) Signs required in Sentences (1) and (2) shall have lettering not less than 50 mm (2 in.) high with a 12 mm (0.5 in.) stroke.

2.7.1.6. Maintenance
1) *Means of egress* shall be maintained in good repair and free of obstructions.

2.7.3. Exit Lighting, Exit Signs and Emergency Lighting

2.7.3.1. Installation and Maintenance

1) *Exit* lighting, *exit* signs and emergency lighting shall be provided in *buildings* in conformance with the NBC.

2) *Exit* lighting and *exit* signs shall be illuminated during times when the *building* is occupied.

3) Emergency lighting shall be maintained in operation condition, in conformance with Section 6.5.

Appendix F. Materials and Finishes.

MATERIAL	CODE	MANUFACTURER	CODE2	DESCRIPTION	COLOUR
WALL					
PAINT	BJ1	BENJAMIN MOORE	HC-12	CONCORD IVORY	LIGHT YELLOW
PAINT	BJ2	BENJAMIN MOORE	HC-5	WESTON FLAX	MEDIUM YELLOW
PAINT	BJ3	BENJAMIN MOORE	HC-171	WICKHAM GREY	LIGHT GREY
PAINT	BJ4	BENJAMIN MOORE	CC-580	GLAZED GREEN	LIGHTSAGE GREEN
PAINT	BJ5	BENJAMIN MOORE	CC-590	GRASSLANDS	MEDIUM GREEN
FLOORING					
MARMOLEUM	M1	FORBO	REAL 3173	VAN GOGH	GOLDS/YELLOWS
MARMOLEUM	M2	FORBO	MODULAR T3405	GRANADA	GREYS/ORANGES
MARMOLEUM	M3	FORBO	MODULAR T3234	FOREST GROUND	GREENS
RUBBER	N1	NORAMENT SYSTEMS	733	NORAMENT ROUND	STEEL BLUE
WARNING TILE	J1	JOHNSONITE	TG1-XX	38 PEWTER	LIGHT GREY
CARPET TILE	C1	INTERFACE	9311	PRAIRIE GRASS	YELLOWS
CARPET TILE	C2	INTERFACE	9271	DELTA	BLUES/GREYS
CARPET TILE	C3	INTERFACE	9280	BROADLEAF	GREENS
CARPET TILE	B1	BOLYU SVELTE	SLV25	SHINING MOMENT	BRIGHT GREEN
CARPET TILE	B2	BOLYU SVELTE	SLV78	FUZZY WUZZY BROWN	DARK BROWN
FABRIC					
UPHOLSTERY	MD1	MOMENTUM	DOMAIN	PRISTINE	BLUE/GREY/ORANGE
UPHOLSTERY	AC1	ARC COM	INTAGLIO 2	SUNFLOWER #30	YELLOW
UPHOLSTERY	AC2	ARC COM	INTAGLIO 2	TANGERINE #31	ORANGE
UPHOLSTERY	AC3	ARC COM	INTAGLIO 2	IRON #41	GREY BROWN
UPHOLSTERY	MA1	MAHARAM	BITMAP	COPPER 011	ORANGE
UPHOLSTERY	MA2	MAHARAM	BITMAP	ALOE 010	BRIGHT GREEN

MATERIAL	CODE	MANUFACTURER	CODE2	DESCRIPTION	COLOUR
UPHOLSTERY	MJ1	MOMENTUM	JUNCTURE	ANNATTO	ORANGE/GOLD/GREY
OTHER FINISHES					
KITCHEN COUNTERTOP	Q1	DUPONT ZODIAQ		MOCHA LATTE	CREAM/GOLD/GREY
PLANTERS	T1	GILLIS QUARRIES		TYNDALL STONE	GREY RUBBED FINISH
CEILING TILES	A1	ARMSTRONG		ULTIMA	WHITE
CLOUDS	A2	ARMSTRONG INFUSIONS	BPSM59TPB	PEACE BLUE	PALE BLUE
ACOUSTIC WALL	A3	ARMSTRONG WOODWORKS	W7	MAPLE 13MM PROFILE	REDDISH GOLD
FEATURE WALL	F1	3FORM		WHISPER	TRANSLUCENT/TWIGS
CURTAIN WALL GLASS	AG1	ACG	SOLARSHIELD	GREEN	LIGHT GREEN

Table F.1. Schedule of materials and finishes applied in Strathcona School.

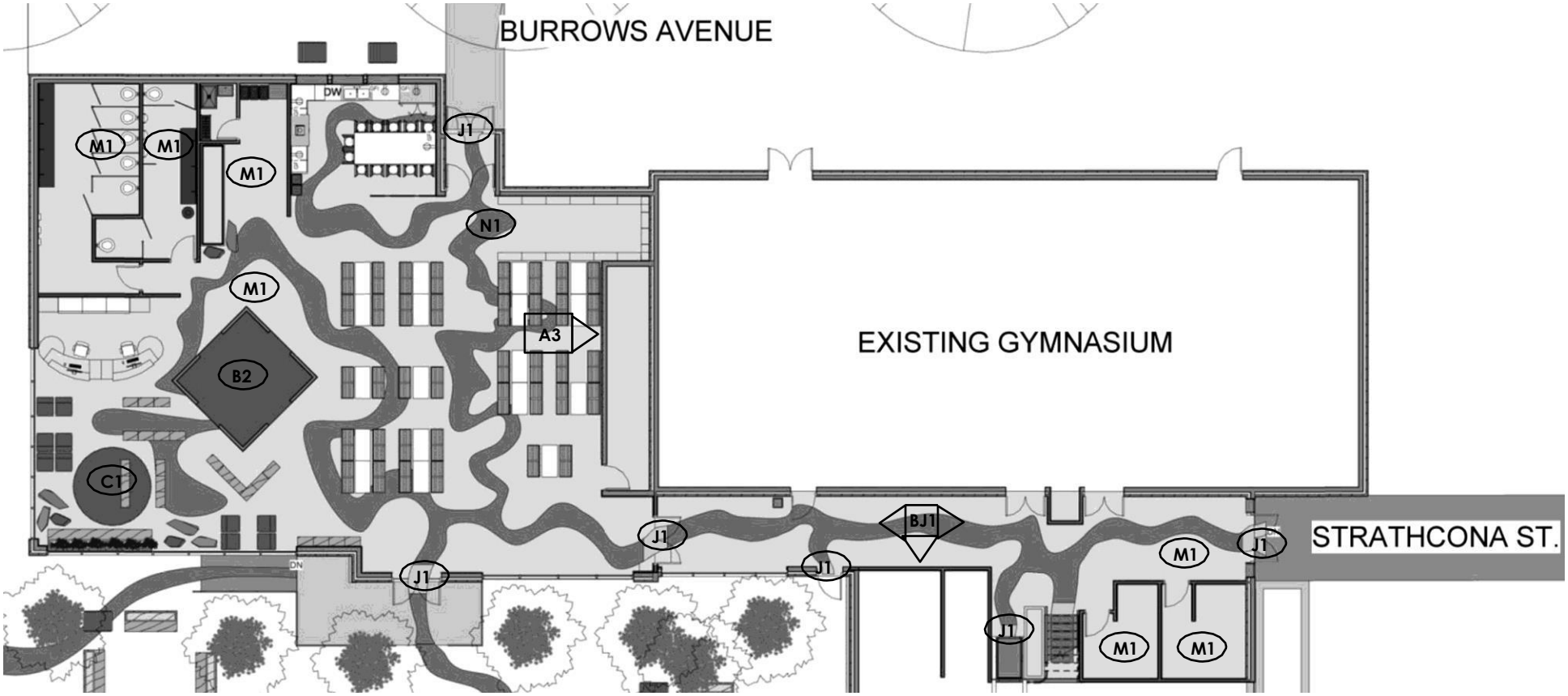


Figure F.1. Green Commons and entrance ways - materials and finishes.

Figure F.2. Administrative Level - materials and finishes.

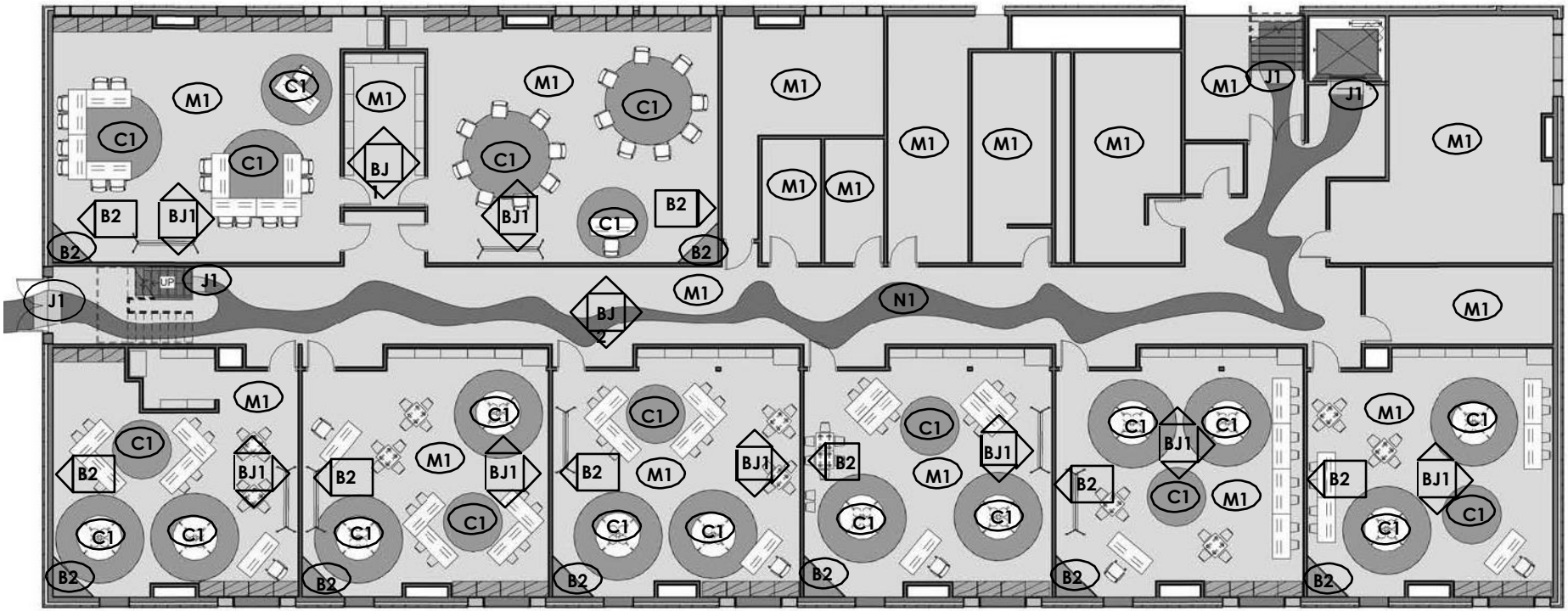


Figure F.3. Level 1 classrooms - materials and finishes.

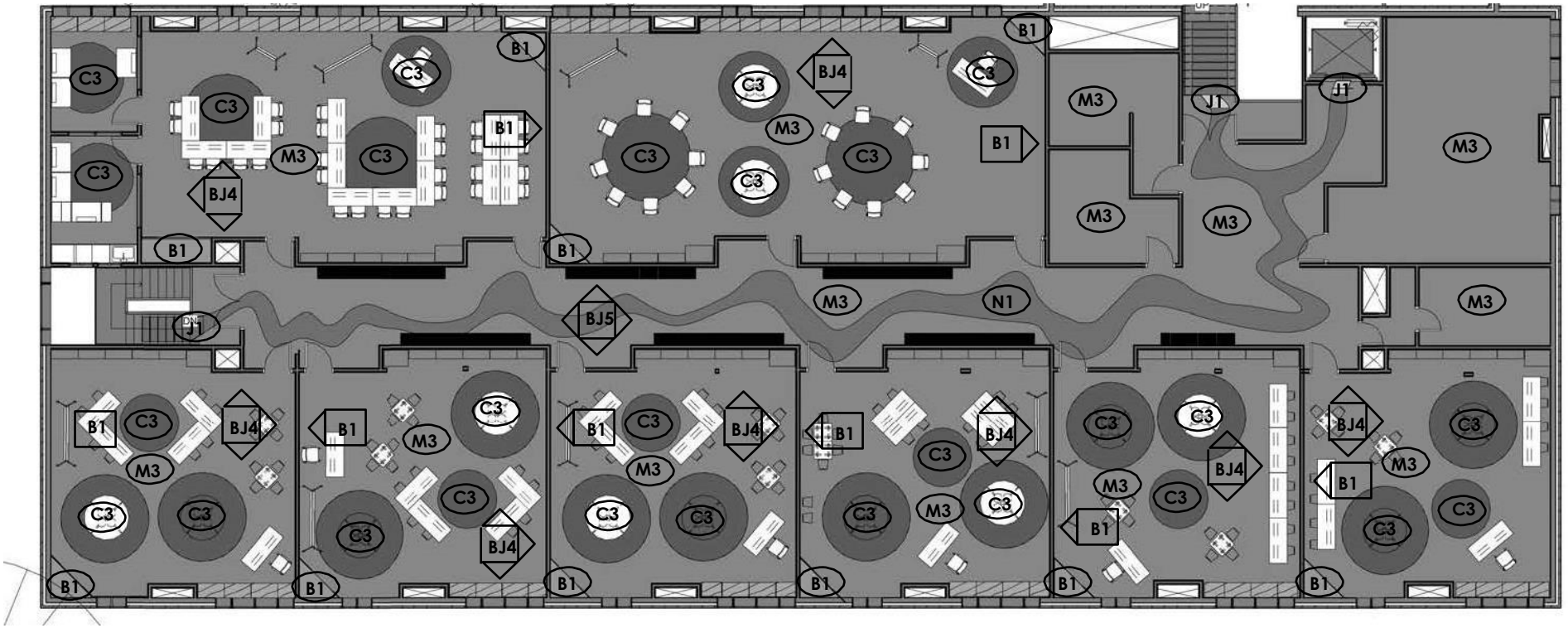


Figure F.4. Level 2 classrooms - materials and finishes.

Appendix G. Reflected Ceiling Plans.

Figure G.1. Reflective Ceiling Plan Level 1

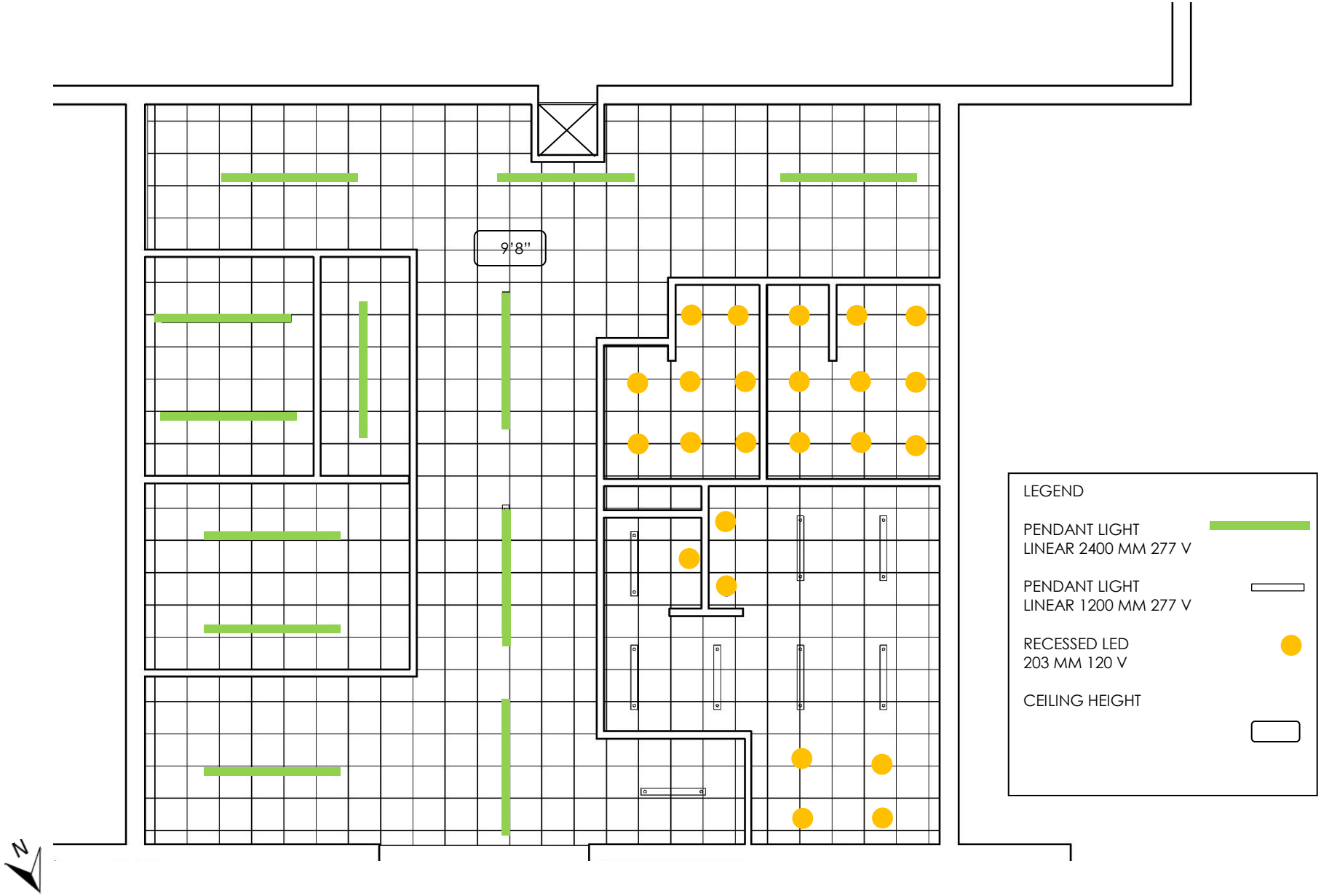


Figure G.2. Reflected ceiling plan Administrative Level

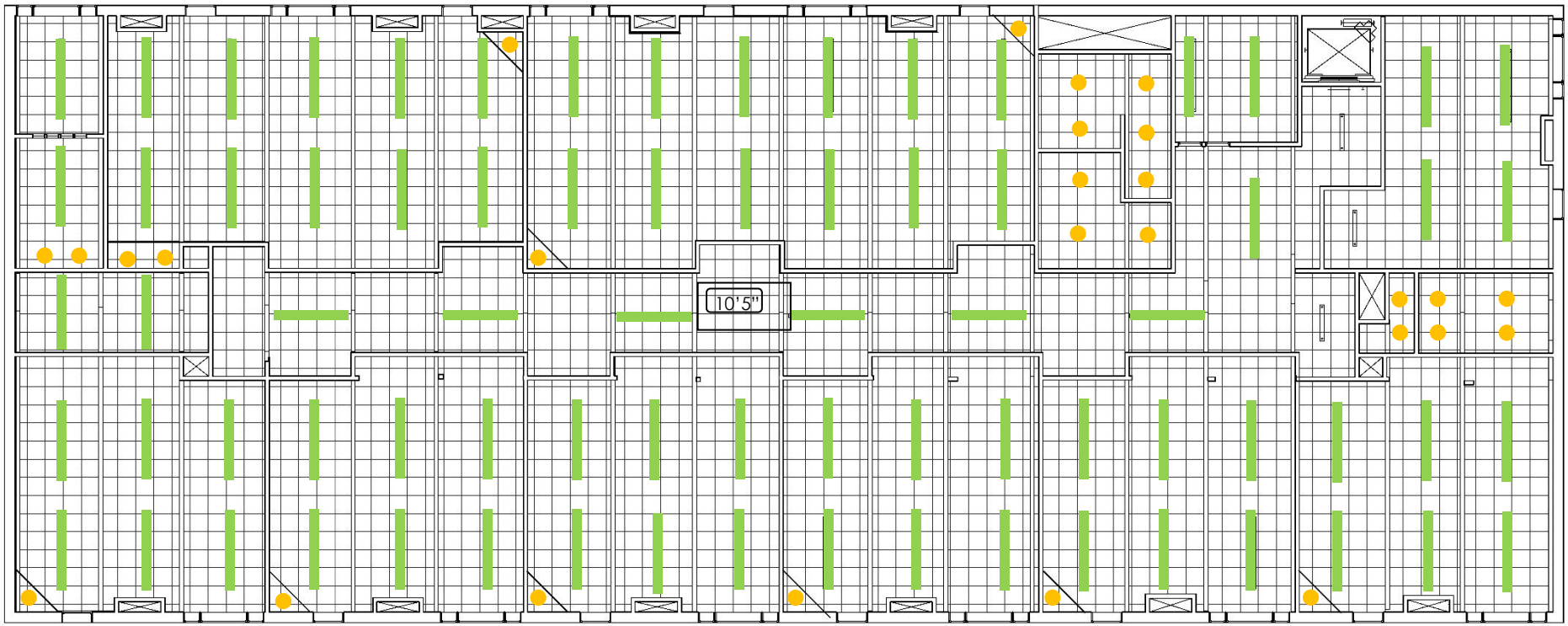


Figure G.3. Reflected ceiling plan Level 2