



# ASSESSING SUSTAINABLE BUILDING TECHNOLOGIES FROM A FIRST NATIONS PERSPECTIVE

## *THE COMMUNITY PLAN AS AN ANALYSIS FRAMEWORK*



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PLAN 6000

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### Front Image Credits (counter-clockwise from top)

Cities and Environment Unit. (2015). Wagmatcook HPP Site Plan. (Unpublished). Halifax, NS: Dalhousie University.

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Able Canvas. (n.d.). Heat Pump with Canvas Cover. Retrieved from [http://ablecanvas.ca/ablecanvaswp/wp-content/gallery/heat-pump-shelters/402588\\_241295655947541\\_108200053\\_n.jpg](http://ablecanvas.ca/ablecanvaswp/wp-content/gallery/heat-pump-shelters/402588_241295655947541_108200053_n.jpg)

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To address long-standing housing issues related to over-standardization, many First Nations communities in Canada are experimenting with a pilot-project approach to housing development. Such projects take an innovative approach to design, construction, and community involvement in the development process. Many integrate sustainable building technologies and design strategies (SBTs). SBTs such as energy efficient windows and recycled building materials can reduce energy use or improve indoor air quality. The potential for SBTs to enhance the sustainability of housing in First Nations communities is significant, but there are risks. SBTs can increase project costs and may discourage communities from experimenting with new housing designs in the future if SBTs fail to meet expectations. For First Nations communities to minimize these risks, they must consider how SBTs relate to broader community development objectives. There are few resources available to support communities to identify SBTs that meet community needs and minimize risks.

This project suggests that community plans can provide an analysis framework to examine SBTs in the context of First Nations housing development. The work supports a Housing Pilot-Project (HPP) underway in Wagmatcook First Nation (Cape Breton, Nova Scotia). The HPP emerged from Wagmatcook's 2014 *Community Plan Update*, developed in collaboration with Cities and Environment Unit (CEU) at Dalhousie University. The HPP is to be a locally-focused, community-driven project that advances community Action Areas related to Housing, Health, Culture and Education, Governance, and the Local Economy. To support Wagmatcook First Nation's Chief and Council to identify and select SBTs for the HPP that meet community needs and support community Action Areas, I developed a design guidelines document based on an analysis of an inventory of SBTs compiled for the project. I then analyzed this inventory according to community Action Areas contained in Wagmatcook's *Community Plan Update*. SBTs supportive of community Action Areas appear in the guidelines document (see Appendix).

This report addresses knowledge gaps in First Nations housing development by illustrating how community plans can be used to examine SBTs. Determining how community plans can guide SBT analysis and selection in other communities, and exploring if differences in theme or content in community plans can lead to the selection of different SBTs, requires additional research.

# TABLE OF CONTENTS

## **Introduction**

First Nations Housing Challenges and the Pilot-Project Approach	6
Project Context	8
Project Goal, Objectives, and Methods	9

## **Defining a ‘Sustainable Building Technology’ (SBT)**

Sustainability, Technology, and First Nations Housing Development	10
SBT Definition	11

## **Wagmatcook First Nation Housing Pilot Project (HPP)**

Community Profile and HPP Background	13
HPP and Link to Community Action Areas	14

## **Developing and Analyzing an Inventory of Sustainable Building Technologies (SBTs)**

Identifying and Categorizing SBTs	16
Analyzing the SBT Inventory	17
Connecting the SBT Inventory to the HPP	18

## **Developing a Design Guidelines Document**

Consolidating SBT Categories	19
Applying Wagmatcook’s Action Areas	19

## **Next Steps and Areas for Future Research** 20

## **Conclusion** 21

## **References** 23

<b>Appendix</b> - Wagmatcook First Nation Housing Pilot Project: An Introduction to Sustainable Building Technologies and Design Strategies	26
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**Figures and Maps**

*Figures*

Figure 1. Contrasting Images of On-Reserve Housing in Canada 7

Figure 2. HPP Site Plan and Facade Rendering (2015) 14

Figure 3. HPP Emerges from Wagmatcook’s *Community Plan Update* (2014) 15

Figure 4. Wagmatcook First Nation - Action Areas 15

Figure 5. SBT Inventory Spreadsheet 16

Figure 6. Most Frequent SBTs Appearing in Inventory 17

Figure 7. SBTs Sorted by Project Sequence and Frequency 18

*Maps*

Map 1. Context Map - Wagmatcook First Nation 12

Map 2. Detailed Map - Wagmatcook First Nation 13



## INTRODUCTION

### FIRST NATIONS HOUSING CHALLENGES AND THE PILOT-PROJECT APPROACH

Developing culturally appropriate and high-quality housing is an urgent priority in many First Nations communities in Canada. Media coverage presenting images of housing in disrepair and over-crowded units suggests that housing in First Nations communities is in state of ‘crisis’ (Stastna, 2011; Farber, 2013; CBC News, 2015). The ‘crisis’ is not a recent development. The 1996 Report of the Royal Commission on Aboriginal Peoples acknowledged the long-standing struggles of First Nations communities to secure affordable, safe, and adequate housing. The Commission proposed a twenty-year period of investment to address systemic issues faced by First Nations communities, including the lack of adequate housing (Indigenous and Northern Affairs Canada [INAC], 2010). Despite the pledge, a 2015 interim report published by the Senate Standing Committee on Aboriginal Peoples on housing in First Nations communities recognized that “housing conditions for many communities continues to worsen, and the shortage of housing continues to grow” (p.5).

One major reason for why many First Nations communities have historically faced poor occupant living conditions and high maintenance costs is over-standardization in housing design (MacTavish et al., 2012; Senate Committee on Aboriginal Peoples, 2015). Standardized designs, often the suburban-style bungalow, fail to address community housing needs. The designs do not take into account the cultural values and traditions of communities, or advance community development objectives (Assembly of First Nations [AFN], 2012; Canadian Mortgage and Housing Corporation [CMHC], 2002). Additionally, many homes constructed in First Nations communities are not well-suited to local climatic conditions. Mould is a common housing issue faced in First Nations communities, as housing designs often have inadequate ventilation and do not address high in-home humidity levels common in many First Nations communities (INAC, n.d.).

In response to systemic on-reserve housing issues related to design deficiencies, durability, and building performance, the Assembly of First Nations’ *National Housing Strategy* proposes innovative housing designs and significant community involvement in the design process as strategies for developing culturally appropriate and sustainable on-reserve housing (AFN, 2012). First Nations communities across

Canada are now experimenting with a pilot-project approach to housing development. These pilots are generally one-off projects that take innovative approaches to design, construction, and community involvement in the development process (AFN, 2012). Integrating sustainable building technologies and design strategies (SBTs) including solar panels, energy efficient windows, and low-maintenance landscaping features into housing designs can improve durability, reduce energy consumption, and increase occupant health and comfort. Case study materials and research conducted on successful housing pilot-projects highlight the importance of community involvement in the housing design and construction process, with particular attention focused on SBTs integrated into these projects (CMHC, 2002, 2005, 2009, 2014, 2014b; Dobie & Sienuic, 2003; Dodge & Kinney, 2013; MacTavish et al., 2012).

The success of the pilot-project approach to create innovative and sustainable on-reserve housing has encouraged First Nations communities across Canada to experiment with housing designs that integrate SBTs. *Figure 1* offers contrasting images of housing in First Nations communities. In the image on the left, a tarp covers a leaking roof in Tsartlip First Nation (Vancouver Island). The image on the right, a housing pilot-project constructed in Atikameksheng Anishnawbek First Nation (Ontario), resulted from a partnership between the community and the Mike Holmes Group to construct healthy, durable on-reserve housing. Designed to be energy efficient and incorporate SBTs (mould, fire resistant, and non-toxic building materials; building sensors; insulated slab-on-grade foundation, etc.) the project demonstrates how the pilot-project approach to housing development in First Nations communities has focused on technology to help create innovative and sustainable housing (AFN, 2014; MacDonald, 2014).

**Figure 1. Contrasting Images of On-Reserve Housing in Canada**



Source: Senate Committee on Aboriginal Peoples, 2015, cover

## PROJECT SCOPE, OBJECTIVES, AND METHOD

### PROJECT CONTEXT

As First Nations communities strive to develop more sustainably, technology may play an important role in creating more durable, comfortable, and environmentally-friendly housing. Case study examples, research reports, and media coverage profiling successful housing pilot-projects in First Nations communities focus heavily on how SBTs contribute to project success. Information on the SBTs selection process or challenges encountered by communities is often not provided. Such materials could encourage communities to integrate SBTs appearing to contribute to the sustainability of projects in other communities without examining how they relate to their own development objectives. Yet the financial capacity of communities to experiment with technology and manage potential risks is not equal. Integrating SBTs into housing designs can limit the number of housing units developed because of increased project costs, and can create dependencies on contractors or experts to realize the benefits of SBT integration, particularly with energy generation (CMHC, 2014; Kyser, 2010). The basic need for housing is so significant in many First Nations communities (INAC, 2010; AFN, 2012; Senate Standing Committee on Aboriginal Peoples, 2015) that integrating SBTs may not be the most sustainable choice for every community. If a community must choose between integrating SBTs or developing more units, the more appropriate option may be to develop more units, particularly in communities with severe shortages of housing.

To avoid continued over-standardization in First Nations housing designs, and to maximize benefits and minimize risks associated with SBT integration, First Nations communities require clear, accessible information on SBTs and a straightforward approach for assessing options. Community plans can provide an analysis framework to examine SBTs in the context of First Nations housing development. The purpose of this project is to support Wagmatcook First Nation (Cape Breton, Nova Scotia) Chief and Council to make an informed decision on what SBTs to integrate into a multi-phase Housing Pilot-Project (HPP) underway in the community. Wagmatcook First Nation's *Community Plan Update* (WFN & CEU, 2014) is used to examine an inventory of SBTs developed. A design guideline document has been prepared for Chief and Council based on an analysis of the inventory. The document is presented through the lens of Action Areas (development objectives) contained in the *Community Plan Update*.



## PROJECT GOAL, OBJECTIVES, AND METHODS

**GOAL:** Create a design guideline document in support of Wagmatcook First Nation’s Housing Pilot Project that presents information on sustainable building technologies and design strategies supportive of community Action Areas in Wagmatcook’s *Community Plan Update*

The design guideline document (see Appendix) provides Wagmatcook Chief and Council, community members, and other interested parties with needed information on sustainable building design and development, key design questions to keep in mind during each stage of the HPP, and information on SBTs related to and supportive of the community’s Action Areas. Objectives established and methods used to develop the design guideline document are outlined below.

**OBJECTIVE 1:** Understand the connection between sustainability, technology, and First Nations development. Establish a working definition of SBTs based on the connection. **Method:** literature review.

**OBJECTIVE 2:** Understand context of Wagmatcook HPP. Examine Wagmatcook’s *Community Plan Update* to identify community Action Areas and development objectives. **Method:** literature review.

**OBJECTIVE 3:** Develop and analyze SBT inventory. Examine housing projects to identify SBTs integrated. Categorize inventory by building element. Sort inventory to identify most frequent SBTs. **Method:** case study analysis using spreadsheets to compile data.


**OBJECTIVE 4:** Develop design guidelines document. Provide information on SBTs as they relate to Wagmatcook’s Action Areas. **Method:** spreadsheet data analysis, literature review, document design.

I will now explore the connection between sustainability, technology and First Nations housing development, providing a definition of a ‘sustainable building technology’ used to identify SBTs for this project. I will then profile Wagmatcook First Nation and present background information on the HPP. Next, I will describe the compilation process for an SBT inventory used to develop the design guidelines document. Finally, I will discuss how the inventory was analyzed to connect SBT options to Wagmatcook’s Action Areas. I conclude by discussing next steps for the project and areas for future research.

**SUSTAINABILITY, TECHNOLOGY, AND FIRST NATIONS HOUSING DEVELOPMENT**

In the First Nations context, CMHC (2002) defines sustainability as being “the ability of a community or group of communities to sustain themselves with reasonable independence from outside sources and influences” (p.39). Housing is a key sustaining element for First Nations communities, as it is integral to social stability, health, and individual sense of belonging (National Collaborating Centre for Aboriginal Health, 2010). In building design, technology is often viewed as synonymous with sustainability. That approach is problematic, as not all communities have equal access to the same technologies and not all technologies will suit a community’s world view or values, or actually relate to what a community feels it needs to sustain itself (Fry, 1999). Connecting sustainability to housing development more generally, before considering SBTs, can provide clarity on the proper role of technology in a project. Examining the sustainability of housing, Friedman (2007) suggests the design of homes should reflect the social, economic, and environmental dimensions of development. These dimensions include unit affordability and accessibility, efficient use of financial resources, and environmental impacts of home construction and material choices. The Assembly of First Nations’ *National Housing Strategy* (2012) expands upon this view of sustainability by suggesting that communities focus on how housing development can increase community capacity and improve quality of life.

Housing development in First Nations communities should create new opportunities for community members to learn, and strengthen a community’s ability to sustain itself indefinitely without being dependent on outside sources. Housing should be affordable and accessible, make the most of financial resources, and minimize environmental impacts. Technology can play an important role in this respect, as “green building methods [and technologies] offer superior performance in terms of occupant health and safety, and durability relative to housing in many [First Nations] communities” (Kyser, 2010, p.64). However, Fry (1999) cautions that technology can create new dependencies, particularly with sophisticated technologies that require in-depth knowledge to install, operate, or maintain. While technologies can minimize a building’s energy use, create healthier indoor environments, or extend a building’s lifespan, they should also reflect and support broader community development objectives.



Determining whether technology contributes to sustainability is not straightforward. Rooney (1997) notes that researchers have historically struggled to establish a singular definition of ‘technology’. Components such as machines, gadgets, techniques/skills, hardware/software, and applications of knowledge inform definitions (Rooney, 1997). Layton suggests that technology is an “active and purposive adaptation of means to some human end” (1974, p.40). That is, technology involves applying and adapting human knowledge (means) to achieve a particular objective (end). In re-examining Layton’s work over 30 years later, Johnson (2006) suggests that “[i]t is through technologies that we understand and are able to manipulate the environment and physical world; this interaction with the world requires them to have a physical form and material make-up.” (p.569). There is an element of localness recognizable in applications of technology: “things work differently in different places because of social, cultural, economic, environmental, and other contexts” (ibid.).

Technology, then, is a means to an end. Communities must first define sustainability (end) to determine if and how to use technology (means) to help the community secure what it needs to sustain itself. The needs of communities vary significantly; what one community believes it needs to sustain itself may not be the same for others. In the context of First Nations housing development, sustainability may relate to independence, social stability, affordability and accessibility, community capacity, quality of life, and so forth. For a technology to be sustainable, it must be a means to achieve an end related to the sustaining elements of a community - whatever these might be. A sustainable building technology (SBT) not only has a specific function (e.g. heating, energy production), but supports a community to achieve its development objectives . An SBT is defined as follows:

**A sustainable building technology (SBT) is any technology (the application of human knowledge to achieve a particular end) or design strategy deliberately applied to the design of a building to improve or enhance its environmental, economic, and social performance and function, creating and supporting conditions needed for community learning and development.**

This definition views SBTs as more than just particular systems, materials, or physical components of buildings. For example, solar panels, geothermal heating systems, water collection and recycling systems, recycled building materials, heat recovery systems, double and triple-glazed windows, and high-resistance building insulation are SBTs (Clark, 2010; Mulvaney, 2011). By recognizing the environmental, economic, and social dimensions of SBTs, however, features not conventionally thought of as ‘technologies’ are now within the scope of analysis. Optimizing a building’s solar orientation to capture the sun’s heat, preserving mature trees on site to provide summer shade, creating maintenance and operations handbooks, or even implementing a construction and demolition waste reduction strategy are also SBTs. Having established a working definition of SBTs that allows me to identify a broad range of SBTs, I will now provide a brief community profile of Wagmatcook First Nation and background information on the HPP before discussing the development process for the SBT inventory.

**Map 1. Regional Context Map - Wagmatcook First Nation**



Source: Google Maps, 2015

## COMMUNITY PROFILE AND HPP BACKGROUND

Wagmatcook First Nation is a Mi'kmaq community in Cape Breton, Nova Scotia (*Map 1*). Accessible via the Trans-Canada Highway (NS-105), it is approximately 330 kilometres north east of Halifax. Of 829 registered Band members, almost 750 lived on-reserve in November 2015. The average age in the community is 24 and the community's population grew by over 25% between 2006 and 2011 (AANDC, 2015, 2015b; WFN, 2013). Working with Cities and Environment Unit (CEU) at Dalhousie University, the community has recently updated its 2002 *Community Development Plan*. Wagmatcook's *Community Plan Update (2014)* contains background information on the community, vision and value statements that articulate development objectives, and community structure maps. The *Plan Update* also establishes five key Action Areas to initiate and guide future community development: Housing, Healthy Community, Culture & Education, Open Governance, and Local Economy (*Figure 4*).

Wagmatcook community members have indicated that developing new housing is a key priority. There are approximately 150 homes in the community, most of which are of the single family variety. A housing needs assessment completed in 2014 identified issues such as over-crowding, lack of variety in housing types, few accessible housing units for Elders, and more than 45 Band members in need of housing (WFN, 2013; WFN & CEU, 2014; CEU, 2015). The Housing Pilot Project (HPP) emerges from the *Community Plan Update* as an opportunity to address housing issues in Wagmatcook. The community-driven project strives to advance all five community Action Areas (see *Figure 4*).

**Map 2. Detailed Map - Wagmatcook First Nation**

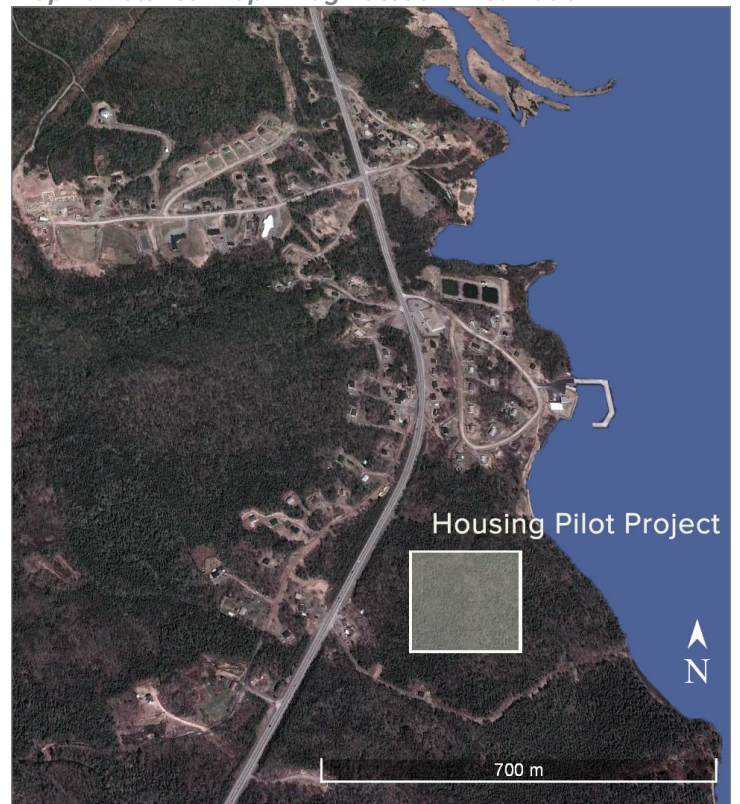


Image Credit: Google Maps, 2015b

Phase 1 of the HPP, conceived of as a multi-phase project, focuses on developing a multi-unit housing complex for Elders in the community. Figure 2 illustrates a conceptual site plan and facade rendering for the project. Two buildings constructed in Phase 1 of the HPP (indicated in red), will provide 8 accessible units, common amenity spaces, and an outdoor landscaped area. Through community engagement workshops conducted for the HPP, and as presented in the *Community Plan Update* (see Figure 3), both Elders and youth in Wagmatcook have expressed interest in seeing SBTs such as recycled building materials solar panels, and ecologically sensitive landscaping features integrated into the design of the HPP (CEU, 2015). Ensuring Elder comfort, minimizing project costs, and decreasing long-term operations and maintenance expenses related to the HPP are priorities for Wagmatcook Chief and Council (CEU, personal communications, November 2015).

### HPP AND LINK TO COMMUNITY ACTION AREAS

The HPP is to advance all five of Wagmatcook's community Action Areas. There is significant community interest in exploring eco-friendly housing and SBTs through the design of the HPP. Eighty percent of Wagmatcook youth are interested in sustainable building design (Figure 3). Elders would like the HPP to respect and preserve natural areas, use energy efficient heating and lighting systems, and to have high indoor air quality (CEU, 2015). Integrating SBTs is likely to increase the building cost of the HPP (CMHC, 2014; Kyser, 2010). Wagmatcook must determine if and what SBTs are feasible for the project.

**Figure 2:** HPP Site Plan and Facade Rendering (2015)

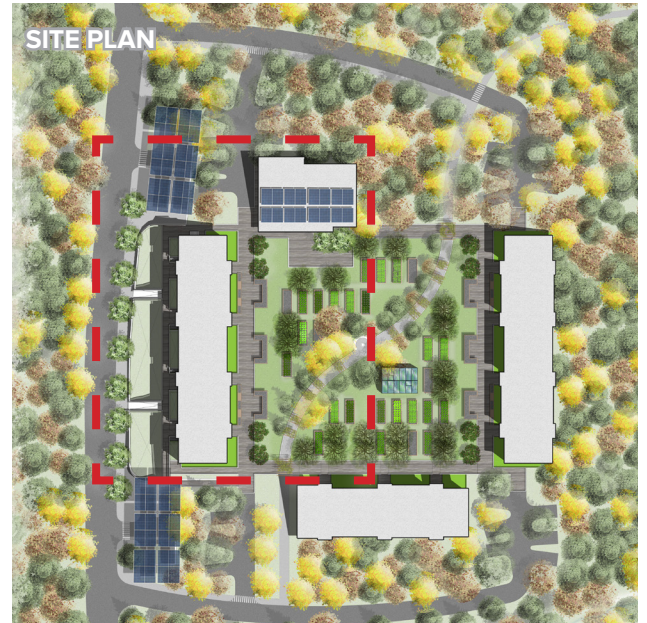
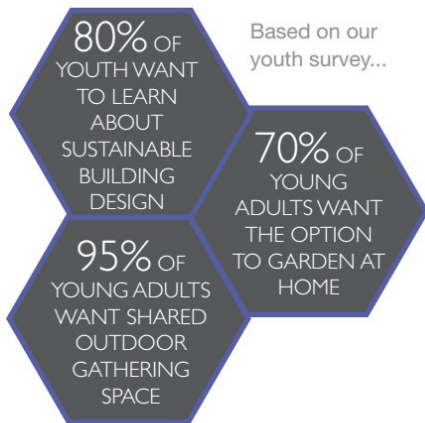


Image Credit: CEU, 2015b (Unpublished)

Figure 3. HPP Emerges from Wagmatcook's Community Plan Update (2014)

## WAGMATCOOK FIRST NATION COMMUNITY PLAN UPDATE | HOUSING

A HOUSE SHOULD MEET THE NEEDS OF ITS RESIDENTS. THAT MEANS HOUSING CAN TAKE MANY DIFFERENT FORMS. DEVELOPING SUITABLE HOUSING FOR ALL STAGES OF LIFE IS ESSENTIAL



### HOUSING

#### Project Ideas

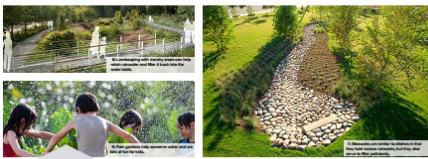
During the first community workshop held in May, people shared the following ideas with us:

- Gardening - home landscaping
- Privacy
- Landscaping improvements
- Drainage Management
- Home Infrastructure
- Alternative service options (to be able to choose where to live)
- Energy alternatives could increase choice
- Eco-friendly housing



#### Eco-friendly Housing

Eco-friendly housing refers to homes that have less of an impact on the environment because they use less energy and are made with environmentally friendly materials. The design of a house can help achieve this with features such as passive solar or solar panels. Passive solar energy refers to making minor changes to homes to help them take and store energy efficiently. These small changes, such as being mindful of shade on the windows, can offset energy costs leading to a more ecologically and financially sustainable high environment.



#### Landscaping & Drainage Management

Landscaping can serve to dual purpose of beautifying a space and providing more effective drainage management. Trees with deep, fibrous and a large volume of roots, will break the soil as the roots expand to hold the excess stormwater. Using artificial drainage systems, such as French drains, can also be used to manage runoff, and rainwater, and their pollutants. Landscaping such as more trees and shrubs can naturally manage stormwater. The water in the surrounding area serves to maintain the trees and plants. Beyond simply managing the stormwater, trees are also popular for uses such as soil conservation and harvesting rainwater. Landscaping can also improve privacy and add to the feeling of "being in the woods".



Image Credit: WFN & CEU, 2014, p. 85

Figure 4. Wagmatcook First Nation - Action Areas

### HOUSING

Think creatively about housing design and lot development by including community members in housing discussions, decision making, building and training opportunities.

Action Area 1

### HEALTHY COMMUNITY

Protecting and celebrating the land and waters while creating new outdoor community spaces to support healthy lifestyles.

Action Area 2

### CULTURE & EDUCATION

Enhancing Wagmatcook's cultural awakening through building new projects and education programs rooted in traditional Mi'kmaq values.

Action Area 3

### OPEN GOVERNANCE

Building a culture of open communication and trust enables community members to be informed and provide valuable feedback to leadership.

Action Area 4

### LOCAL ECONOMY

Investing in our own people by supporting practical business ideas and keeping community dollars local by reducing economic leakage.

Action Area 5

Image Credit: WFN & CEU, 2014, p. 70

Advancing community Action Areas is key to the sustainability of Wagmatcook, as they are connected to key 'sustaining' elements identified by the community. Selecting SBTs supportive of Wagmatcook's community Action Areas can maximize the benefits realized from integrating specific design strategies or technologies into the HPP. SBTs may play an integral role in the success of the HPP, but they should be linked to Action Areas as directly as possible. I will now outline the compilation process of an SBT inventory used to the earlier definition of SBTs provided and how this inventory was analyzed through the lens of Wagmatcook's *Community Plan Update* Action Areas to produce a design guidelines document for the HPP.

**IDENTIFYING AND CATEGORIZING SBTS**

To identify SBTs related to and supportive of Wagmatcook’s Action Areas, I compiled an inventory of SBTs integrated into housing development projects across North America. I examined case study materials and building industry publications to identify SBTs. As there is a significant volume of material available on sustainable building design and development, I narrowed the scope of materials and publications examined by focusing only on those sources published after the year 2000 (to ensure information reflects current industry practices). I preferred sources available freely online (to ensure information is accessible to Wagmatcook community members and other interested parties), that examine residential development projects or examine SBT integration in First Nations housing development projects. I compiled data into a spreadsheet organized by case study/project, SBT feature, and building element. I classified SBT according to building elements found in architectural graphic design standards manuals (American Institute of Architects et al., 2010). I examined a total of 76 projects (10 focused specifically on First Nations housing development projects) and four general guides across 21 sources. I initially identified 1043 individual SBT features (including those found in multiple projects) (see *Figure 5*).

**Figure 5. Initial SBT Inventory Spreadsheet**

CASE STUDY	SBT FEATURE	CATEGORY
Elsternwick, Australia ( <i>Koones, 22</i> )	Dual-flush toilets	Plumbing
<u>Description:</u> modular in-fill home on a narrow lot, small building footprint allowed on-site trees to be preserved; home took 3 weeks from demo to assembly; all modules of the home were completed prior to being taken to the site (including plaster, paint, tiling, cabinets, etc.). Steel frame construction and panels used. FirstRate5 thermal performance assessing tool used.	Low-VOC paints	Finishes
	Small footprint	Design
	Structural plywood cladding	Envelope
	Water-efficient fixtures and appliances	Plumbing
	Ceiling fans	HVAC
	High-efficiency windows	Windows
	Open floorplan	Design
Northern Sustainable House, Inuvik, NWT (CMHC, 2014)	High-efficiency building envelope (R53)	Envelope
<u>Description:</u> CMHC Research Highlight: Design and Construction of the Northern Sustainable Home - Inuvik, Northwest Territories. Describes the design and construction process of a super-insulated home with sustainable building technologies such as solar photovoltaic and hot water panels.	High-efficiency condensing boiler (natural gas)	HVAC
	Heat recovery ventilator (HRV)	HVAC
	Solar hot water panels	Energy
	Photo voltaic panels (3.6w, grid-connected)	Energy

SBT Categories: plumbing, finishes, design, envelope, cooling, windows, lighting, energy, HVAC, landscaping, appliances, building materials, construction, water, site design

Inventory Sources: BuildingGreen Inc., 2006, 2009; CMHC, n.d., 2002, 2009, 2011, 2012, 2014, 2014b; Dobie & Sienuic, 2003; Dodge & Kinney, 2013; Friedman, 2012; Graham, 2014; Koones, 2014; Kyser, 2010; Maclay, 2014; MacTavish et al., 2012; McGraw-Hill Construction, 2014; Perzel, 2004; Snyder, 2014; T’Sou-ke First Nation, n.d.



## ANALYZING THE SBT INVENTORY

With SBTs compiled and categorized, I then began analyzing the inventory. I sorted SBTs alphabetically to identify features common to multiple projects and to group similar features together (e.g. water efficient bathroom fixtures, low flow kitchen faucets, etc.). With duplicates removed and similar features grouped, 254 individual features remained from the initial 1043. Of these 254 features, 117 appear in at least two projects; the other 137 appear in a single project or are not easily grouped with other SBTs. The 254 features were then sorted by frequency (out of 80 case studies, projects, and guides examined). *Figure 6* illustrates the SBTs appearing most frequently in the inventory. I sorted features by frequency to identify SBTs most commonly integrated into housing development projects, as more innovative or untested SBTs have higher risk of failure (Kyser, 2010).

**Figure 6. Most Frequent SBTs in Inventory**

<b>SBT</b>	<b>Number/80</b>	<b>%</b>
Water efficient/low flow water fixtures (fixtures, toilets)	50	62.50
Low VOC paints (offgassing of volatile organic compounds)	42	52.50
LED lighting	40	50.00
Optimal solar orientation	39	48.75
Dual flush toilets	39	48.75
Photovoltaic panels (1 on car port, 1 on shading - various capacities)	35	43.75
Energy Efficient Appliances	32	40.00
Solar hot water panels	26	32.50
Triple-glazed windows (some argon filled, low E coating, fiberglass framed)	23	28.75
Heat recovery ventilator (HRV)	22	27.50
Natural cross-ventilation (site plan/window placement, etc.)	21	26.25
Rain barrels/rainwater harvesting	21	26.25
Super insulation/highly insulated (R-31,R-32, R-38,R-40, R-46 in walls; R38,R50, R54,R60)	20	25.00
Hydronic/radiant in floor heating system	20	25.00
Drought-tolerant, native planting	18	22.50
Recycled content in building materials (fly ash in concrete, within products, etc.)	17	21.25
Large overhangs (minimize solar gain in summer)	17	21.25
High-efficient/energy efficient windows	14	17.50
Low VOC (offgassing of volatile organic compounds)	13	16.25
Permeable paving materials	13	16.25

## CONNECTING THE SBT INVENTORY TO THE HPP

With the most frequent SBTs identified, I then began connecting the SBT inventory to Wagmatcook’s HPP. I refined initial SBT categories to more accurately reflect the development/construction sequence of the HPP, allowing for SBTs to be identified by both project stage and frequency. The categories that an SBT could be classified under was expanded to 17 (from the initial 15). SBT features were re-classified under these new categories based on when an SBT should be selected in the development/construction sequence, and were again sorted by frequency (see *Figure 7*).

*Figure 7. SBTs Sorted by Project Sequence and Frequency*

<b>CULTURAL/PHILOSOPHICAL ASPECTS</b>	Count (out of 80)	%
Integrated Design Process (collaborative design)/ knowledge sharing	5	6.25
Life-cycle design and material selection approach	2	2.5
Training program/opportunities for locals	2	2.5
Vernacular architecture (indigenous, tipi)	2	2.5
Wooden poles carved by locals integrated into design	1	1.25
Colour choices linked to seasons	1	1.25
Comprehensive community planning process	1	1.25
Documentary film to preserve the process	1	1.25
Elder/community ceremony to open building	1	1.25
Eco-tourism program (bring visitors to see sustainable features)	1	1.25
Focus on cultural compatibility (art integrated, materials)	1	1.25
Opportunities for cultural expression	1	1.25
Culturally-oriented landscaping (cultural herbs, plants)	1	1.25
<b>GENERAL BUILDING &amp; SITE DESIGN</b>	Count (out of 80)	%
Optimal solar orientation	39	48.75
Natural cross-ventilation (site plan/window placement, etc.)	21	26.25
Minimized building footprint	11	13.75
Daylighting (high sunlight penetration)	10	12.5

SBT Categories (based on project sequence): philosophical/cultural aspects, general building & site design, floorplan, construction strategy, building materials - general, foundation, framing/structure, roof, building envelope, facade, building systems, lighting & plumbing, interiors, flooring, appliances, landscaping, operations & maintenance

## CONSOLIDATING SBT CATEGORIES

Once the SBT inventory was finalized and the preliminary analysis complete, I consolidated the 17 SBT categories into four broad HPP stages to simplify the development of the design guideline document: **Planning & Design** (cultural and philosophical aspects, general building & site design, floorplan) **Construction** (construction strategy, building materials - general, foundation, framing/structure, roof, building envelope, facade), **Building Systems & Interiors** (building systems, lighting & plumbing, interiors, flooring, appliances), and **Landscaping, Operations & Maintenance**. SBTs fitting within each of these categories were then examined according to how they may relate to and support Wagmatcook's Action Areas.

## APPLYING WAGMATCOOK'S ACTION AREAS

For each broad HPP stage, I then examined SBTs according to Wagmatcook's five Action Areas: Housing, Healthy Community, Culture & Education, Open Governance, and Local Economy. Of the 254 SBTs identified, I selected 46 for the design guideline document. I selected these SBTs based on how frequently they appear in the SBT inventory and the likelihood that they may relate to and support Wagmatcook's Action Areas. Active solar energy technologies (e.g. photovoltaics, solar thermal panels) were not selected for the design guideline document, as these technologies have high upfront costs and greatly increase the complexity of the HPP site and building design due to increased infrastructure costs and maintenance requirements (NRC, 2013; Nova Scotia Power, 2015). However, as community members expressed interest in seeing solar panels integrated into the HPP (CEU, 2015), I have provided information on designing the HPP to be 'solar ready'. I conducted an extensive literature review on the 46 SBTs selected. Information on how SBTs function, when/why to select SBTs, and how they may enhance the sustainability of the HPP is provided for each SBT. There are 16 SBTs presented in Planning & Design, 16 in Construction, 7 in Building Systems & Interiors, and 7 in Landscaping, Operations & Maintenance. Community Action Areas that supported by each SBT are indicated using coloured circles, to maintain thematic consistency with Wagmatcook's *Community Plan Update* (WFN & CEU, 2014).

## NEXT STEPS AND AREAS FOR FUTURE RESEARCH

I then formatted the 46 SBTs into an appendix, complete with illustrations and diagrams. I used this appendix to develop the main body content of the design guideline document. In the main body section, I present basic principles of sustainable building design, discuss the connection between sustainability and the HPP, and suggest that Wagmatcook Chief and Council and community members question how SBTs relate to or support the community's Action Areas. For each of the four broad HPP stages, design priorities, key questions, and presents SBTs that may relate to Wagmatcook's Action Areas are presented. The design guidelines document concludes by discussing partnership ideas to explore to support of the HPP and reiterates that the community should attempt to link SBTs back to its Action Areas.

### NEXT STEPS

My immediate next step is to present the design guideline document to Wagmatcook Chief and Council. I will refine this document based on feedback received from Chief and Council, my project supervisor and technical advisor, and CEU staff. I will examine the feasibility of developing an abbreviated version of the design guidelines document (2-4 pages) to make it more accessible to a wider audience. Finally, once I have finished refining the design guidelines document, I will investigate how to make this document available online through Wagmatcook's website.

### AREAS FOR FUTURE RESEARCH

Opportunities for future research in support of Wagmatcook's HPP include:

- Identifying training and partnership opportunities related to SBTs selected
- Developing a 'homeowner handbook' that provides residents of the HPP with information on how SBTs function, how they can assist with maintenance and upkeep, etc.
- Creating a film or website to document the development of the HPP

Exploring how community plans can guide SBT analysis and selection in other communities, and examining if differences in theme or content in community plans may lead to the selection of different SBTs may support a broader research program.

**CONCLUSION**

This project illustrates how Wagmatcook's *Community Plan Update* and Action Areas was used to assess SBTs in support of the community's HPP. The design guideline document developed provides Wagmatcook Chief and Council with accessible information on SBTs that may relate to and support the community's Action Areas. The document illustrates only a few possibilities for the HPP, however, and more detailed analysis of SBTs presented is required (e.g. cost, local availability). It is critical that Band members be directly involved in the design of the HPP, including determining if and what SBTs should be selected. Due to ethical considerations, Wagmatcook Band members were not consulted during the course of this work. Creating opportunities for Band members to learn more about SBT options and to express which SBTs they believe to be most supportive of community development objectives could add additional depth to the analysis, as well as influence the content and format of the design guideline document. Future research should seek to engage community members directly to ensure that findings are informed by community desires and development objectives as they evolve in real time, as opposed to static content articulated in community plans alone. While information contained in the design guideline document may inform the design decision-making process for the HPP, Chief and Council and the people of Wagmatcook First Nation will ultimately decide what technologies and design strategies best support the community's Action Areas and ambitions for the future.

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## **APPENDIX**

### Wagmatcook First Nation Housing Pilot Project An Introduction to Sustainable Building Technologies and Design Strategies



# WAGMATCOOK FIRST NATION HOUSING PILOT PROJECT

*AN INTRODUCTION TO SUSTAINABLE BUILDING  
TECHNOLOGIES AND DESIGN STRATEGIES*



Prepared for:  
Wagmatcook First Nation &  
Cities and Environment Unit  
(Dalhousie University)

**Jake Papineau**  
Master of Planning - Candidate (2016)  
School of Planning - Dalhousie University  
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December 9, 2015



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# WAGMATCOOK FIRST NATION HOUSING PILOT PROJECT

*AN INTRODUCTION TO SUSTAINABLE BUILDING  
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To the Chief and Council and people of Wagmatcook First Nation: it has been an honour to conduct this research in support of the community's Housing Pilot Project. I truly hope that this work contributes to the success of the project.

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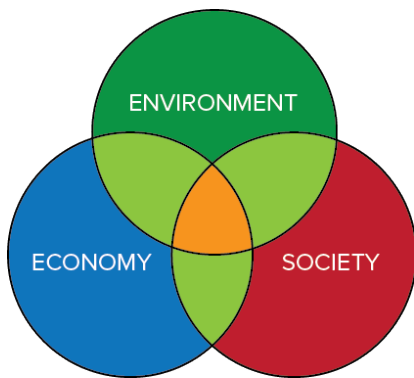
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<b>Sustainability and The Housing Pilot Project</b>	4
<b>Sustainable Building Technologies &amp; Design Strategies</b>	6
1. Planning & Design	6
2. Construction	8
3. Building Systems & Interiors	10
4. Landscaping, Operations & Maintenance	12
<b>Building Momentum</b>	14
<b>References</b>	16
<b>Appendix - Sustainable Technology &amp; Design Strategy List</b>	18

# SUSTAINABILITY AND THE HOUSING PILOT PROJECT



*What is sustainability?*

Sustainability is about recognizing that what we choose to do today impacts what we leave behind for future generations. We must respect and protect what we rely on for our survival - our environment, our culture and society, and our economy. Consuming fewer natural resources, reducing energy and water use, protecting the environment, and creating new economic opportunities will allow future generations to lead healthy, happy lives.

*How Can Technology Contribute to Sustainability?*

Technologies and design strategies can improve a building's performance (e.g. energy use) and better connect a building to community values. Some technologies and strategies are expensive. Selecting the best options for the HPP requires careful consideration.

## INTRODUCTION

Focused on the sustainability of Wagmatcook First Nation's Housing Pilot Project (HPP), this document introduces sustainable building technologies and design strategies and provides information on potential options for the HPP. Information presented can support Chief and Council to identify technologies and design features that best meet the needs of the community and support community Action Areas. The information is meant to inspire Wagmatcook First Nation to be ambitious and thoughtful during every step of the HPP - from design and construction to maintenance.

## WHAT MAKES A BUILDING SUSTAINABLE?

Sustainable buildings meet the needs of the community now and into the future. They integrate sustainable building technologies and design strategies to reduce energy use or to create more comfortable living spaces. There is no single approach communities can follow to create a sustainable building. However, sustainable buildings generally share a number of basic design principles:

- 1. Designed for the future** - is accessible to community members of all ages and physical abilities and is easily adaptable to accommodate future community needs
- 2. Minimizes environmental impacts** - has a building and site design that protects mature trees, soil, water, and wildlife habitats
- 3. Uses the sun for heating and lighting** - south facing windows let in heat and light in the winter, and breezes and shade from trees provide cooling in the summer
- 4. Is locally-focused** - is constructed using local labour wherever possible, uses building materials produced locally, recycled or reclaimed materials, or materials made from renewable sources
- 5. Minimizes heat losses** - is highly insulated, uses energy efficient windows, and loses little heat energy
- 6. Maximizes energy and water efficiency** - uses small, efficient heating, cooling, and ventilation (HVAC) systems, heat recovery ventilators, energy efficient appliances, and water-efficient plumbing
- 7. Creates healthy spaces** - has excellent air circulation, uses materials that are good for indoor air quality, and is well connected to the outdoors and surrounding community



## SUSTAINABILITY AND THE HOUSING PILOT PROJECT

Community members, including Elders and youth, have indicated interest in seeing eco-friendly, sustainable housing developed in Wagmatcook. Sustainable building technologies and design strategies can support the sustainability of the HPP and may create new opportunities for community members to learn about sustainable building design and construction. Many possible benefits can be realized by integrating sustainable technologies and design strategies into the HPP, but there are limitations, as well.

### *Benefits*

- Reduces energy and water consumption, decreases utility bills and creates significant long-term cost savings
- Creates new training opportunities for community members on how to install and maintain selected technologies and design features
- Increases the durability and lifespan of the building (if properly maintained)
- Creates more comfortable and healthy indoor environments

### *Limitations*

- Increases the complexity of the design and construction process
- Increases upfront building costs (insulation, windows, HVAC)
- Requires proper maintenance, upkeep, and inspections

## IMPORTANCE OF THE COMMUNITY PLAN

The Community Plan should guide the assessment and selection of sustainable building technologies and design strategies for the HPP. Hundreds of sustainable building technologies and design strategies can enhance the sustainability of the HPP. Determining which of these many options is best for the HPP will not be straightforward. No matter the technology or design strategy encountered, Chief and Council and community members should ask how particular technologies or design features meet community needs or relate to community Action Areas (WFN & CEU, 2014).

## DOCUMENT FORMAT

The following sections present sustainable building technologies and design strategies to consider for the HPP. Key questions to keep in mind during each stage of the HPP are also included. Finally, coloured circles show the Action Areas supported by each technology or design strategy. For a more complete list of technologies and design features that may be appropriate for the HPP, please see the Appendix.

*What are sustainable building technologies and design strategies?*

**Sustainable building technologies** are integrated into a building's structure or interior and have a specific function. They use fewer resources than typical options (foundation and framing, heating systems, plumbing fixtures, lighting, etc.).

**Sustainable design strategies** are general strategies that contribute to the sustainability of a project. They are often simple and cost-effective, and focus on how a project relates to the community and its environment (accessible design, using local labour, etc.).

### KEY GUIDING QUESTION

*How does a sustainable building technology or design strategy support our community's Action Areas contained in the Community Plan Update?*

### Secondary Questions

- Does the technology or design strategy require a lot of maintenance?
- Does the technology or design strategy create new training opportunities for the community?
- Is the technology or design strategy complicated? Is it easily fixed if it breaks?

# SUSTAINABLE BUILDING TECHNOLOGIES & DESIGN STRATEGIES

## Elements of Planning & Design

- 1.1. Community and Cultural Considerations
- 1.2. Site & Building Design
- 1.3. Floorplan



Image Credit: WFN & CEU, 2014, p.2

### *Planning & Design - Technologies & Design Strategies*

- Integrated design process
- Training opportunities
- Colour choices linked to seasons
- Document the process
- Groundbreaking & opening ceremonies
- Eco-tourism program
- Cultural landscaping
- Optimal solar orientation
- Daylighting
- Natural cross ventilation
- Solar-ready design
- Preserve mature trees
- Universal design
- Flexible floorplan

### **DESIGN PRIORITIES**

1. *Involve the Community*
2. *Support Cultural Values*
3. *Protect Natural Features*
4. *Design for Everyone*

## 1. PLANNING & DESIGN

The sustainability of all projects begins at the planning and design stage. During the stage key decisions are made that will affect the rest of the HPP. Design strategies selected at this stage of the HPP should focus on connecting community members to the project and meeting community needs.

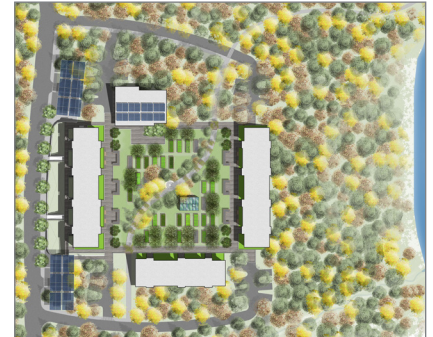


Image Credit: CEU, 2015 (unpublished)

### 1.1. Community & Cultural Considerations

- **Bring Many Voices to the Table** - the more people involved in the design of the HPP, the better. Expand the conversation by bringing in engineers, architects, contractors, and tradespeople.
- **Document the Process** - documenting as much of the design and construction of the HPP as possible can help to tell the story of the project. Photos and film capture the hard work and efforts of the community, and celebrate successes and can be shared with others.
- **Create Training Opportunities** - working with contractors, suppliers, and educators can help create opportunities for community members to gain hands-on experience with technologies and design strategies.

### 1.2. Site & Building Design

- **Be 'Solar Ready'** - to make the most of available funding, the HPP should not integrate solar panels right away. However, the HPP's site plan and building design can be 'solar ready'. This means identifying areas where solar panels will receive the most sunlight, determining how these panels will work with building systems and connect to the rest of the community, and creating a long-term energy strategy for Wagmatcook.
- **Focus on Important Features for the Community** - the site plan for the HPP should connect the project to the rest of the community. Placing priority on site features like outdoor gathering spaces and a common community building can create an attractive place for residents to live.

### 1.3. Floorplan

- **Design for Everyone & Be Flexible** - the floorplan for the HPP should accommodate community members of all ages and mobilities. The floorplan should be flexible, with features like movable walls allowing for units to be reconfigured in the future to be larger or smaller.

See pages 16 - 19 of the Appendix for more ideas!

## Technologies & Design Feature Suggestions - Planning & Design



### GROUNDBREAKING CEREMONY ●●●

Inviting Elders, youth, community members, and key contributors to a groundbreaking ceremony for the HPP can bring people together to celebrate work accomplished to date, and create a spirit of collaboration and cooperation for the rest of the project.

Image Credit: <http://nanaimobusinessnews.ca/wp-content/uploads/2015/06/dig.jpg>



Image Credit: CEU, 2015 (unpublished)

### OPTIMAL SOLAR ORIENTATION ●●

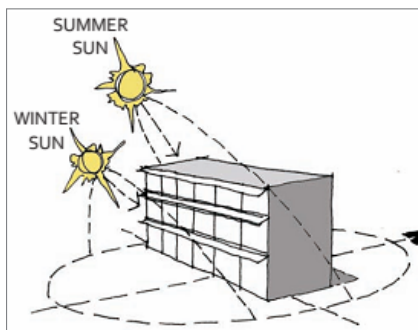


Image Credit: City of Vancouver, 2009, p.18

By using the sun for heating and lighting as much as possible, the HPP can reduce energy use by up to 25%. This requires orienting buildings towards the sun's path in the south. Carefully placed south facing windows let in light in the winter and warm interior spaces. Window overhangs can block too much sun from entering indoor spaces in the summer (Reynolds, n.d.).

### WORK WITH NATURE & PROTECT SENSITIVE AREAS ●●

The HPP's site plan and building design should work with nature to reduce energy use. Planting coniferous trees can protect the building from cold winter winds, saving energy for heating. The site plan and building design should protect sensitive areas such as streams and animal habitats, and areas with mature trees.

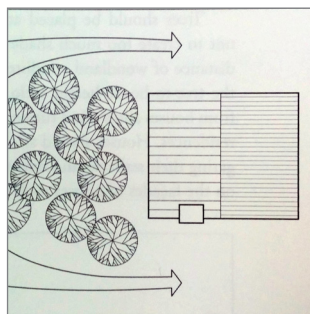


Image Credit: Friedman, 2007, p.57

### UNIVERSAL DESIGN & FLEXIBLE FLOORPLAN ●●

The HPP's site plan and building design should follow universal design standards. These standards ensure that residents of all ages and mobilities are safe and comfortable in their homes. Hallway widths and doorways should accommodate wheelchairs. Site plans should avoid very steep slopes. Finally, the HPP should have a floorplan that is flexible and can be reconfigured as the needs of the community change over time (movable partition walls, expandability of units).



Image Credit: CMHC, 2014, cover

### Planning & Design - Key Questions

- Does a particular technology or design strategy respect and strengthen our culture and values?
- Are new training opportunities created for community members?
- Does the site plan and building design work with and protect natural features?
- Will community members of all ages and mobilities be comfortable in inside and outside of the HPP?
- Will the HPP eventually have solar panels? Where should they be located?

# SUSTAINABLE BUILDING TECHNOLOGIES & DESIGN STRATEGIES

## Elements of Construction

- 2.1. Construction Strategy
- 2.2. Building Materials
- 2.3. Foundation, Framing & Insulation

### *Construction - Technologies & Design Strategies*

- Local labour/self-build construction model
- On-site construction and demolition waste sorting & recycling
- Bulk purchase materials
- Locally source building materials
- Recycled/recyclable, compostable, or biodegradable building materials
- Products that do not contain Volatile Organic Chemicals (VOCs) that are harmful to human health
- Sustainably harvested wood products
- Insulated slab on grade foundation
- Minimal thermal bridges
- Advanced framing
- Highly insulated and airtight building envelope (R60 in roof, R40 in walls)
- High efficiency windows
- Exterior rainscreen

### **DESIGN PRIORITIES**

1. *Use Local Labour*
2. *Spend More on Insulation*
3. *Prevent Air/Water Leaks*

## 2. CONSTRUCTION

During the construction stage the HPP will begin to take shape on the ground. The stage involves developing construction strategies (how to build the HPP), and determining what building materials to use.

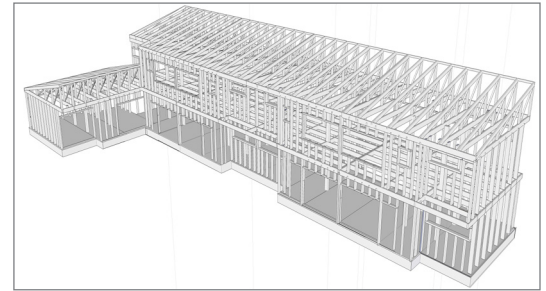


Image Credit: CEU, 2015 (unpublished)

Technologies and design features selected at this stage of the HPP should create a well-insulated, durable, and air/water tight building. Spending more on insulation and ensuring the building is air/water tight will reduce money spent on utilities and create more comfortable spaces for residents.

### 2.1. Construction Strategy

- **Build it Yourself** - utilizing local skills and labour to construct the HPP can create new training and job opportunities, reduce project costs, and create community pride and attachment to the project. Technology and design decisions should build on existing community skills.
- **Have a Soil & Erosion Control Plan** - soil and other materials excavated during construction can erode in rain storms and wash away into nearby watercourses. The HPP should minimize excavation, store soil for reuse, and protect soil from contamination.

### 2.2. Building Materials

- **Think Local** - purchasing building materials in bulk from local suppliers can save money on material costs and support the local and regional economy. Storing bulk purchased materials for later use can reduce maintenance costs for the HPP, as materials needed will be on hand.
- **Use 'Healthy' Materials** - some building materials emit odours that are harmful to human health. These materials should not be used in the HPP. Avoid materials containing volatile organic compounds (VOCs).

### 2.3. Foundation, Framing & Insulation

- **Spend More on Insulation** - having better insulation means spending less to heat and cool the HPP over its lifespan. A well-insulated building is more comfortable and does not have drafty areas. Heating and cooling systems can be much smaller and work more efficiently.
- **Use High Efficiency Windows** - using double- or triple-glazed windows reduces heat losses, prevents condensation from forming, creates well-lit interior spaces, and saves money on heating/cooling.

See pages 20- 23 of the Appendix for more ideas!

## Technologies & Design Feature Suggestions - Construction

### LOCAL LABOUR/SELF-BUILD MODEL ●●●●●

Linked to creating training opportunities for community members, using a 'self-build' approach to construct the HPP can create new job and training opportunities, reduce total project costs, and support the local economy. Determining how to use local labour most effectively during construction can allow many community members to help.



Image Credit: <http://www.yukon-news.com/news/takhini-river-triplex-first-of-its-kind-in-canada/>

### Construction - Key Questions

- How can local skills and labour be used to construct the HPP?
- Will the building be air and water tight? Will it be very well insulated?
- Are indoor building materials good for air quality?

### SUSTAINABLY HARVESTED WOOD ●

Sustainably harvested wood products come from well-managed forestry operations that do not over harvest trees, protect wildlife habitats, and respect landholder rights. The Forest Stewardship Council (FSC) certifies lumber from sustainably harvested sources. Although these products can cost more, use certified lumber whenever possible.



Image Credit: <http://www.coastaltreated.com/web/index.php?id=11>



Image Credit: <http://www.architectureanddesign.com.au/features/features-articles/7-quiet-achievers-lesser-known-construction-materials>

### ADVANCED FRAMING ●●●

Advanced framing means to carefully place framing studs to reduce construction waste and to minimize thermal bridges (areas in a building where heat more easily escapes). Double-stud framing is one approach that offsets stud placement along wide walls allowing for thick, continuous insulation. Improving framing and insulation for the HPP will greatly reduce heat losses, decrease the size of heating/cooling systems needed, and create more comfortable spaces.

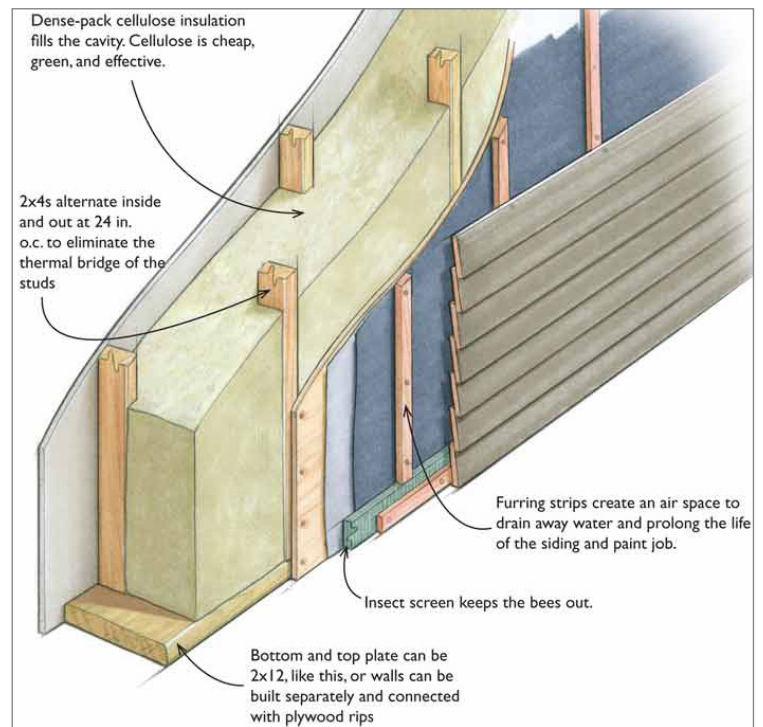


Image Credit: <http://www.greenbuildingadvisor.com/green-basics/double-stud-walls>

### EXTERIOR RAINSCREEN ●●●

A rainscreen is a space created between a building's exterior and siding to allow air to flow between. Rainscreens are particularly important in rainy or humid climates, as they can prevent mould from forming on walls due to excessive moisture build up. They increase a building's durability.

# SUSTAINABLE BUILDING TECHNOLOGIES & DESIGN STRATEGIES

## Elements of Building Systems & Interiors

- 3.1. Heating, Cooling & Ventilation
- 3.2. Plumbing & Hot Water
- 3.3. Lighting & Appliances

*Space and water heating alone account for 80% of a residential building's yearly energy use!*

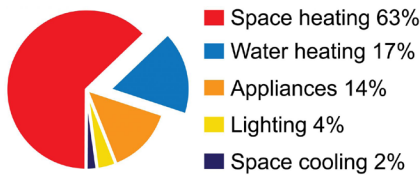


Image Credit: <http://www.nrcan.gc.ca/energy/products/categories/water-heaters/13735>

### Building Systems & Interiors - Technologies & Design Strategies

- Ductless mini-split heat pumps
- Heat/energy recovery ventilator
- Energy efficient lighting
- High efficiency hot water system
- Water efficient/ low flow plumbing fixtures
- Durable, easy to clean, healthy indoor materials
- Energy and water efficient appliances

### DESIGN PRIORITIES

1. Use Small, Efficient HVAC Systems (with Heat / Energy Recovery)
2. Use Energy Efficient Lighting and Appliances
3. Use Water Saving Fixtures & Plumbing

## 3. BUILDING SYSTEMS & INTERIORS

The installation of building systems and interior finishings will overlap with the construction stage. In Canada, space and water heating accounts for over 80% of a home's energy use. By choosing efficient heating, cooling, and ventilation systems (HVAC), hot water heaters, lighting, and water efficient fixtures, the HPP can consume little energy and water, greatly decreasing utility bills.



Image Credit: <https://spartanandhannah.files.wordpress.com/2011/08/ductwork-for-hrv-2.jpg>

### 3.1. Heating, Cooling & Ventilation (HVAC)

- **Save Energy with Heat Pumps** - with a well-insulated building envelope, small ductless mini-split heat pumps in each unit can heat and cool the HPP throughout the year. Heat pumps are energy efficient and can save a significant amount on heating and cooling costs.
- **Have Mechanical Ventilation with Heat Recovery** - air tight buildings need mechanical air ventilation to provide fresh air to all interior spaces, which improves air quality. Select a ventilation system that has a heat or energy recovery ventilator to pre-heat incoming air/remove humidity.

### 3.2. Plumbing & Hot Water

- **Use Efficient Hot Water Systems** - minimizing the distance hot water must travel to reach fixtures and wrapping hot heater tanks with extra insulation can reduce energy consumption for water heating. Tankless hot water systems save space and are more efficient, but cost more.
- **Minimize Water Use** - using low flow faucets and showerheads and dual flush toilets can greatly reduce water use, preserving valuable groundwater and reducing water treatment costs.

### 3.3. Lighting & Appliances

- **Use Compact Fluorescent or LED Lights** - compact fluorescent (CFL) or LED lights consume less energy and have longer lifespans than incandescent bulbs. Select lighting solutions based on room function (kitchen v. bedroom) and look for rebates that may be available.
- **Choose Energy Efficient Appliances** - EnerGuide or EnergyStar rated appliances can cost more upfront than other appliances, but consume less energy over their lifespan, saving more money over the long term.

See pages 24 - 25 of the Appendix for more ideas!

## Technologies & Design Feature Suggestions - Construction

### DUCTLESS MINI-SPLIT HEAT PUMP

Ductless mini-split heat pumps are efficient heating and cooling systems. They work by extracting ambient heat from the air, even in very cold temperatures. They can provide nearly all of a unit's heating and cooling requirements throughout the year. Small electric baseboard heaters in bedrooms and bathrooms may be needed to provide extra warmth on only the coldest days. Heat pumps can reduce heating and cooling costs for the HPP by up to 60% (Nova Scotia Power, 2014).

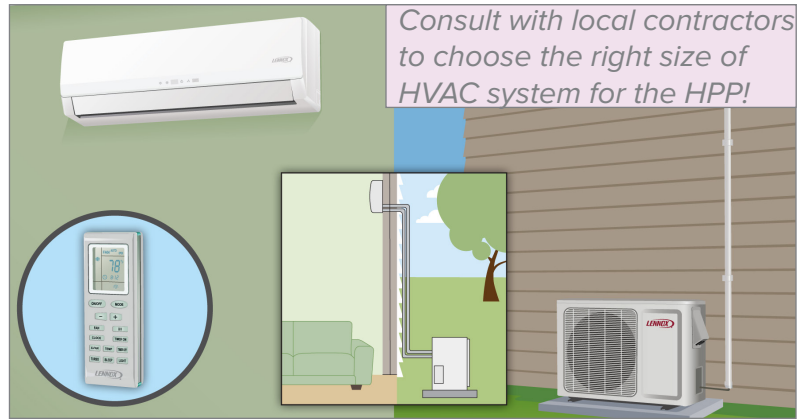


Image Credit: <http://cdn.shopify.com/s/files/1/0720/5269/files/minisplit.png?13702160605309217940>

### MECHANICAL AIR VENTILATION

Heat recovery ventilators (HRVs) provide constant air circulation. Fresh air is brought in from outside and stale air from indoors is exhausted outside. HRVs use heat energy from exhausted air to warm fresh air coming into the building, reducing energy use. Energy recovery ventilators function the same, but also remove excess humidity from the air. Both HRVs and ERVs improve indoor air quality.



Image Credit: [passivehouse.com.au/cms/works/hrv-installed.jpg](http://passivehouse.com.au/cms/works/hrv-installed.jpg)

### Building Systems & Interiors - Key Questions

- How much will the HVAC system cost to operate and maintain?
- Will contractors test building systems to make sure they work properly?
- Are interior finishes easy to clean and durable?

### WATER EFFICIENT FIXTURES & PLUMBING

Toilets, showers, and clothes washers can use a lot of water over the course of a year. Choose water efficient taps, shower heads, appliances, and other fixtures to reduce consumption. By selecting low-flow or dual-flush toilets, over 15,000L of water can be saved per year, per user. Using less water reduces wastewater treatment costs, as well (CMHC, 2014b).



Image Credits: <https://foeme.files.wordpress.com/2012/01/blog-emily-double-flush222.png> (L) & CMHC, 2014, p.16 (R)

### ENERGY EFFICIENT LIGHTING & APPLIANCES

Using energy efficient lighting and appliances can save money over the lifespan of the HPP. Compact fluorescent (CFL) or LED lighting fixtures consume 75% less energy than older incandescent bulbs. There may also be rebates available for bulbs. Look for EnerGuide or EnergyStar rated appliances to find the best performing models (NRC, 2010).

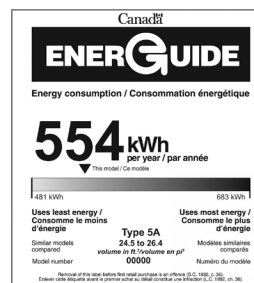


Image Credits: [http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/images/energystar/eg\\_labels\\_refrigerator-2012\\_whit.jpg](http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/images/energystar/eg_labels_refrigerator-2012_whit.jpg) (L) & <http://i.huffpost.com/gen/1779677/original.jpg> (R)

## Elements of Landscaping, Operations & Maintenance

- 4.1. Landscaping
- 4.2. Operations & Maintenance



Image Credit: <http://www.gulfcoastpavers.com/new/wp-content/uploads/2012/08/Permeable-Paver-5.jpg1>

### *Landscaping, Operations & Maintenance - Technologies & Design Strategies*

- Community gardens and edible planting
- Rainwater collection
- Native, drought-tolerant vegetation
- Permeable paving materials
- Stormwater management landscape features
- Resident handbook / user manual
- Long-term maintenance strategy

### **DESIGN PRIORITIES**

1. *Select low-maintenance landscaping features*
2. *Use permeable paving surfaces and stormwater management features*
3. *Consider impact of technology decisions on residents and long-term building maintenance*

## 4. LANDSCAPING, OPERATIONS & MAINTENANCE

With construction complete and building systems and interiors finished, the focus for the HPP will shift to creating an attractive outdoor space for residents and visitors. At the same time, a long-term maintenance strategy for the HPP should be developed to preserve investments made in the project.



Image Credit: <http://livinggreenandsavingenergy.com/wp-content/uploads/2013/01/Rain-Garden-Design.jpg>

### 4.1. Landscaping

- **Outdoor Spaces for the Entire Community** - features like gardens, playgrounds, fire pits, and places to sit help to create attractive outdoor spaces for the entire community to enjoy. Integrating these types of features into the landscape plan for the HPP will encourage residents to be outside and will attract visitors from other areas of the community.
- **Opt for Low Maintenance** - selecting plants and other vegetation that do not require much maintenance (watering, fertilizing, tending) can save time and money spent on up-keeping landscaped features. Plants that are culturally important or native to the region are good choices.
- **Manage Stormwater** - landscaping features like rain gardens and bioswales can help manage stormwater on site, prevent localized flooding, and slow the flow of runoff into lakes and other water bodies.

### 4.2. Operations & Maintenance

- **Create a Handbook / User Manual for Residents** - developing a handbook or user manual for HPP residents can provide valuable information on how selected technologies and design strategies work, what to do if something breaks or needs maintenance, provide information on other Band resources or programs, and other information.
- **Develop a Long-Term Maintenance Strategy** - creating a long-term maintenance strategy for the HPP can provide a predictable schedule for what building components require maintenance and when. This predictability can reduce the amount the Band has to spend on repairs, as regular maintenance will extend the lifespan of the HPP and its more expensive components, including sustainable building technologies.

See pages 26 - 27 of the Appendix for more ideas!



## Technologies & Design Feature Suggestions - Landscaping, Operations, & Maintenance

### COMMUNITY GARDENS & EDIBLE PLANTING ●●●

Having spaces for gardening can encourage residents to learn more about growing healthy food. Outdoor cooking and eating areas complement community gardens by providing spaces for gathering and sharing meals. Planting fruit-producing trees and bushes, herbs, and other edible plants across the HPP site area can attract wildlife and provide community members with berries, fruits, or herbs to eat, without requiring significant maintenance. Collecting rainwater in barrels or using other storage systems can lower water bills by reducing the amount of fresh water needed for landscaping.



Image Credit: <http://www.wagmatcook.ca/education/elementary-secondary.php>

### STORMWATER MANAGEMENT FEATURES ●

Landscaping features can be used to manage stormwater, preventing localized flooding and slow the flow of stormwater runoff into lakes, streams, and other nearby water bodies. Features like rain gardens (collect water from building downspouts), bioswales (long, depressed features that collect water along roadways), and permeable paving materials (hard surfaces that permit water to seep into the ground) can help prevent localized flooding and create new habitat spaces for animals.



Image Credit: [http://madeinjakarta.org/wp-content/uploads/2014/07/IMG\\_2454.jpg](http://madeinjakarta.org/wp-content/uploads/2014/07/IMG_2454.jpg)

### LONG-TERM MAINTENANCE STRATEGY ●●●●

Having a long-term maintenance strategy for the HPP based on technologies and design strategies selected can protect investments made in the project. Some technologies and design strategies will require particular maintenance during different times of the season. For example, qualified professionals should inspect heat pumps once a year. However, the Band can perform other maintenance duties, such as keeping heat pumps clear of snow and ice during the winter and changing indoor air filters. Training community members to assist with building maintenance can help to decrease long-term maintenance costs.



Image Credit: <http://www.heatpumpsussex.co.uk/library/img/heat-pump-sussex-600-350-installation-3.jpg> (T) & [https://www.affirmfinancial.ca/wp-content/uploads/2016/02/home\\_maintenance.jpg](https://www.affirmfinancial.ca/wp-content/uploads/2016/02/home_maintenance.jpg) (B)

### Landscaping, Operations & Maintenance - Key Questions

- What landscaping features are most important to the community?
- What type of maintenance is required for landscaping features?
- What information will residents need to know about key HPP features?
- What maintenance does the HPP require? When does it need to be performed?

### *Partnership Ideas*

- **Canada Mortgage and Housing Corporation**  
(design expertise, capacity-building, best practices)
- **Dalhousie University**  
(architecture, engineering)
- **Efficiency Nova Scotia**  
(energy efficiency, rebates)
- **Nova Scotia Community College** (training, student labour)
- **Nova Scotia Power**  
(financing, energy efficiency)
- **Other First Nations in Cape Breton:** We'koqma'q, Membertou, Eskatoni, Potlotek, Chapel Island (knowledge sharing)

### **KEY GUIDING QUESTION**

*How does a sustainable building technology or design strategy support our community's Action Areas contained in the Community Plan Update?*

## CONCLUSION

The information presented in this document can support Chief and Council to identify sustainable building technologies and design features that support the sustainability of the HPP. Chief and Council and community members in Wagmatcook should think creatively about the HPP and be ambitious. Regardless of technologies or design strategies selected, keeping the following three principles in mind can help maintain the focus needed to realize the full potential of the HPP as a driver of positive change in the community.

- **Focus on Partnerships.** Every decision made and every stage of HPP is opportunity to create new partnerships. From local building material suppliers to educational institutions to government departments, the HPP provides a solid foundation to form new partnerships and to collaborate on other projects in Wagmatcook. The list to the left illustrates just a few partners that may be interested in working with Wagmatcook moving forward. These partners can provide design expertise, technical knowledge, or training, in support of the HPP.
- **Build Housing, Create Opportunities.** The HPP is an opportunity for Wagmatcook First Nation to show leadership in sustainable housing design. The skills and knowledge gained by community members through the HPP on how to develop sustainable, efficient housing will be in high demand as communities across Canada shift to developing more sustainable housing.
- **Housing is Not Just Shelter.** Housing is a key component of the lives and futures of the people of Wagmatcook. Investing in the HPP to ensure comfort, energy efficiency, and durability will provide community members with not only places to live, but opportunities to become more engaged and to contribute to a successful future for the community.

The HPP represents an exciting new approach for developing housing in Wagmatcook. In many ways, it will be an experiment in building eco-friendly and sustainable housing in the community. While there are risks involved, integrating sustainable building technologies and design strategies into the HPP can help to create more energy efficient, adaptable, healthy, and comfortable homes for community members - now, and into the future.

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**FOR A COMPLETE LIST OF REFERENCES CONSULTED IN PREPARATION OF THIS DOCUMENT, PLEASE SEE PAGES 28 - 31 IN THE APPENDIX**



Image Credit: <http://wagmatcook.ca/services/housing.php>

## APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

This Appendix provides a comprehensive list of sustainable building technologies and design strategies to integrate into the Housing Pilot Project (HPP). It illustrates what is possible for the HPP and should inspire meaningful, community-focused discussions.

Technologies and design strategies in this Appendix come from an inventory of over 1200 features identified in housing projects across North America. Coloured circles show the community Action Areas supported by each technology or design strategy.

Not all technologies and design strategies listed will be appropriate for the HPP. Chief and Council and the people of Wagmatcook First Nation will decide what technologies and design strategies best support the community's Action Areas and ambitions for the future.

To read more about the technologies and design strategies listed, please consult the References and Bibliography section. There are many online links!

### Legend

#### Community Action Areas

- Housing
- Healthy Community
- Culture & Education
- Open Governance
- Local Economy

### CULTURALLY SUPPORTIVE TECHNOLOGIES & DESIGN FEATURES

- **Integrated Design Process:** adopt a collaborative, knowledge-sharing approach to building design. Residents, architects, engineers, planners, trades people, and landscapers should work together to create a building design that supports as many community values and priorities as possible. Having many voices at the table during the design process can prevent design and construction complications (CMHC, 2014; MacTavish et al., 2012).
- **Life-Cycle Design Approach:** select building materials that consider environmental, social, cultural and economic impacts across the entire lifespan of the building, and require little energy and raw materials to produce (Friedman, 2012).
- **Community Training Program:** work with contractors, building material suppliers, and other educational partners to create training opportunities for community members to learn how to work with, install, and maintain innovative building materials and technologies. Such training can increase local knowledge and capacity, reduce dependencies on outside contractors for ongoing maintenance, and inspire community members to take part in future projects (Perzel, 2004; INAC, 2010).
- **Colour Choices Linked to Seasons:** use colours associated with the changing of the seasons to better connect the building to natural cycles (Kyser, 2010; Perzel, 2004).
- **Vernacular Architecture:** building design can reflect and respect cultural values by using traditional building forms and materials. For example, integrating the wikuom (wigwam) form and materials such as spruce, pine or fir into building designs can connect a community's past, present, and future (CMHC, 2005b).



*A modern building constructed in Alberta, Canada illustrates how the wikuom (left) form can be integrated into the design of new buildings*

*Image Credits: (L) <http://www.muiniskw.org/pgCulture1d.htm> & (R) <http://www.blackfootcrossing.ca/architecture.html#design>*

**Document the Process:** document the design and construction process through photographs and film as much as possible. Images and film can later be used to create a documentary of the project to be shared with community members and others interested in the success of the project. Documenting the process can help to preserve memories of the project and inspire future projects in Wagmatcook (Perzel, 2004).



*Documenting the design and construction of the housing pilot project offers an opportunity to capture great memories and to share project success with others*



Image Credit: <http://www.afn.ca/uploads/images/h4h-nc2.jpg>

**Groundbreaking & Opening Ceremonies:** project groundbreaking and opening ceremonies can bring community members together to celebrate the start of construction and project completion, supporting and encouraging a spirit of collaboration and cooperation (Dobie & Sieniuc, 2003).



*Incorporating opportunities for personal and cultural expression into the design of the housing pilot project can help create a greater sense of home for residents*

**Eco-Tourism / Innovation-Tourism:** environmentally-friendly and innovative projects can attract visitors from outside the community, including researchers, government officials, other First Nation bands, residents from other communities, and even tourists. Inviting visitors and having tours of successful community projects may create new project and partnership opportunities (T'Sou-ke First Nation, n.d.).



Image Credits: T'Sou-ke First Nation. (n.d.).



*T'Sou-ke First Nation in British Columbia has attracted many visitors to see the community's solar energy projects (L) and electric car charging stations (R), raising the community's profile across Canada.*



Image Credit: CEU, 2015 (Unpublished)

**Cultural Compatibility & Cultural Expression:** select building materials and designs that are compatible with and support cultural values. Create opportunities for personalization and cultural expression in unit design (MacTavish et al., 2012).



*Plants like kljikmanasqi (bayberry) can be incorporated into the site and landscape plan for the housing pilot project*

**Cultural Landscaping:** include traditional herbs and plants in landscaping features, helping to connect newly designed and planted features with traditional cultural values (Perzel, 2004).

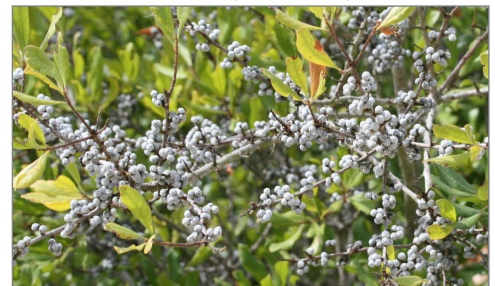


Image Credit: <https://eyeonnature.files.wordpress.com/2012/03/bayberry.jpg>

# APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

## SITE & BUILDING DESIGN

*Optimal solar orientation involves identifying the sun's path throughout the year and creating a building design that uses the sun for heating and lighting*

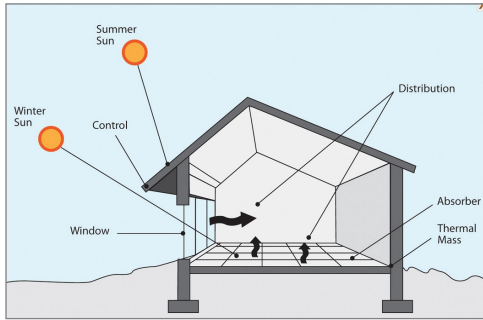


Image Credit: Holladay, 2015

*Shading from trees and shrubs can prevent overheating in the summer*



Image Credit: <http://energy.gov/energysaver/landscaping-shade>

*Daylighting focuses on allowing as much natural light to enter inside as possible*

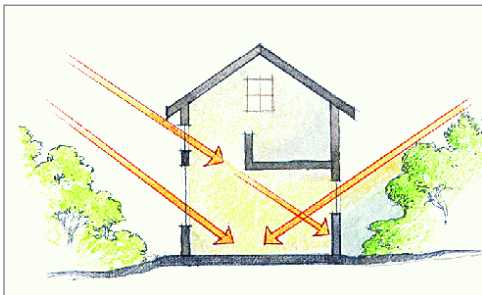


Image Credit: Green Building Advisor, n.d.

- **Optimal Solar Orientation:** optimal solar orientation involves analyzing the building site to determine the sun's path throughout the year (highest in summer, lowest in winter) and orienting a building to take advantage of solar energy for heating and lighting. Optimal solar orientation on some sites requires rotating a building to face south and can reduce energy used for heating by up to 25%. Windows and overhangs on the building's south side can let in light and warmth in the winter and prevent overheating in the summer. On the floorplan, place frequently occupied spaces on the south side of a building to maximize occupant comfort and access to daylight. If there are too many windows or inadequate shading, well-insulated buildings will overheat in the summer. Optimal solar orientation is less important for well-insulated, airtight buildings. (Holladay, 2015; v, n.d.; Reynolds, n.d.).

- **Daylighting:** windows and skylights can be strategically placed to allow more daylight into a building's occupied spaces. Increasing the amount of daylight in a building creates more comfortable spaces for occupants, better connects buildings with natural sun cycles, and reduces the need for artificial lighting. Daylighting is closely related to optimal solar orientation and can reduce energy consumption for lighting (Green Building Advisor, n.d.; Ander, G.D., 2014).

- **Natural Cross Ventilation:** involves carefully orienting a building to take advantage of prevailing wind patterns on site, with natural breezes entering occupied spaces. Determine wind patterns and place windows on both sides of the building to allow for breezes to 'cross' through. Reduces energy consumption for ventilation (Autodesk Sustainability Workshop, 2011; City of Vancouver, 2009)

*Natural breezes can provide fresh air and ventilate indoor spaces*

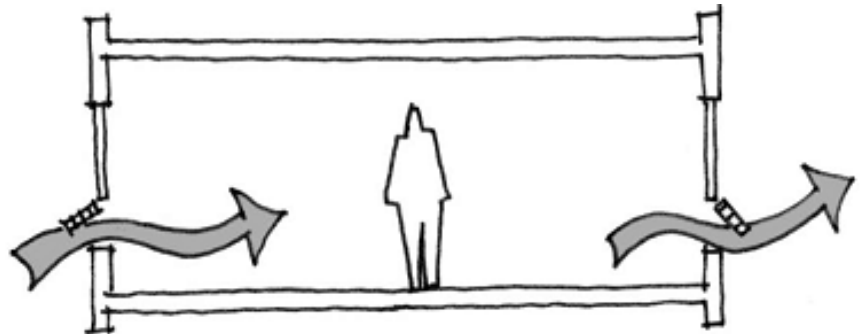


Image Credit: City of Vancouver, 2009

**Solar Ready Design:** a solar-ready building design allows for solar energy features like photovoltaic (electricity) or solar thermal panels (hot water) to be easily integrated in the future. Designing a building to be solar-ready requires architects, designers and tradespeople to examine the site plan and building design to identify areas on the building's roof where there is little shade and where solar panels will receive the most energy, in addition to other factors. Designing a building to be solar-ready increases the complexity of the site and building design, but can make it much easier and cheaper to install solar energy features (NRC, 2013; Lisell, Tetreault, & Watson, 2009).

**Preserve Mature Trees and Vegetation & Protect Animal Habitats:** once removed from a site, mature trees and vegetation are gone forever. Newly planted trees or vegetation take years or decades to reach maturity, and animal species that called the area home may never return. Mature trees and vegetation provide shade, privacy, protect air and water quality, and create beautiful and serene environments. A building's site design should protect mature trees and vegetation and animal habitats. Building site designs should avoid sensitive natural areas such as wetlands, streams, and other areas that are home to a variety of species (Elmendorf, Gerhold, & Kuhns, 2005; Notice Nature, n.d.).

**Universal Design & Flexible Floorplan:** is the design buildings and floorplans to accommodate occupants of all ages and physical abilities, and to be adaptable in the future. Flexible floorplans make buildings more adaptable to community needs as they change over time. CMHC's FlexHousing Checklist offers a good starting point for designing universally-accessible and flexible buildings. Movable indoor walls, gentle slopes, and wheelchair accessible doorways are just a few design strategies to integrate into the HPP (CMHC, 2014b).

*The proposed floorplan for the HPP incorporates many universal and flexible design strategies. Indoor spaces are wheelchair accessible and it is possible to expand or reconfigure units in the future*



Image Credit: CEU, 2015 (Unpublished)

*Designing a solar-ready building adds complexity to site and building design, but can make it easier and cheaper to integrate solar panels in the future*

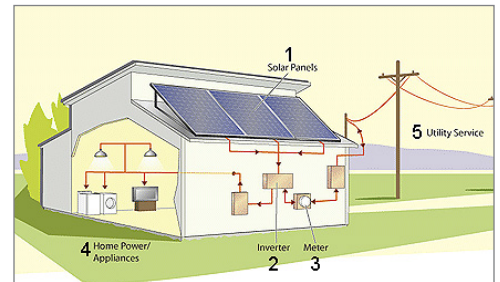


Image Credit: [http://sroeco.com/solar/wp-content/uploads/2009/05/how\\_solar\\_works\\_en.png](http://sroeco.com/solar/wp-content/uploads/2009/05/how_solar_works_en.png)

*Building and site designs should protect mature trees and vegetation and respect animal habitats*



Image Credit: <http://3.lushome.com/wp-content/uploads/2012/11/canadian-house-design-glass-enclosure-bromont-1.jpg>

*Walk-in bathtubs and wheelchair friendly counter heights are just a few of the universal and accessible design features to incorporate early on in the site and building design of the HPP*



Image Credit: CMHC, 2014b, cover

## APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

*Skilled local labourers and tradespeople can help train and coordinate community volunteers, reducing labour costs and creating new opportunities for learning*



Image Credit: Gillmore & Stewart, 2013

*Bulk purchasing materials can have significant cost savings and materials like nails, screws, and lumber are reusable in many other projects*



Image Credit: <http://afcan.net/images/construction-materials.jpg>

*Excavated soil can wash into watercourses during rain storms, possibly harming fish and other wildlife.*



Image Credit: Province of Nova Scotia, n.d.

### CONSTRUCTION STRATEGY

- **Local Labour/Self-Build Model:** using local and volunteer labour can provide community members with new job and training opportunities, can reduce total project costs, can create community pride and attachment to the project, and can support the local economy. Having a strategy for utilizing local skills and labour in the construction process can be key to project success. The more involved the community is in the construction process, the better. (CMHC, 2002; Gillmore & Stewart, 2013; Kyser, 2010; Perzel, 2004).
- **On-Site Construction & Demolition Waste Sorting/Recycling:** sorting and re-using waste materials generated during the construction of the HPP can reduce the volume of material disposed of in the landfill. In residential construction, wood, gypsum, and brick account for approximately 85% of all waste material generated. As some construction materials contain hazardous chemicals or substances, not all materials will be reusable or recyclable. Evaluate materials on a case-by-case basis. Storing scrap or reusable materials in a dry location can make it easy to use these materials in other projects (Jeffrey, 2011; BuildGreen, 2009).
- **Bulk Purchased Materials:** buying construction materials in bulk from local or regional suppliers can result in significant cost savings. Suppliers may be willing to offer better prices for purchasing in bulk. Try to negotiate long-term supply contracts for better prices. Some construction materials, like nails, screws, flooring materials, and so on, are used in all building projects. Storing bulk purchased materials can make maintenance of the HPP easier (e.g. extra flooring material), but storage can be difficult if there are few secure spaces for storage in the community (Behm, et al., n.d.).
- **Soil and Erosion Control Plan:** construction excavation can disturb a significant volume of soil. Excavated material can erode in rain storms and wash into nearby watercourses. This material may harm fish, wildlife, and drinking water quality. Creating a soil and erosion control plan involves limiting excavation activity, storing soil in designated areas, and diverting water flows on site. Properly storing excavated soil and protecting it from contamination can reduce the volume of new soil needed for landscaping (Province of Nova Scotia, n.d.; Government of New South Wales, 2004).



## BUILDING MATERIAL CHOICES

**Products Containing Recycled Content:** building materials containing recycled content require low amounts of materials and energy to produce, reducing greenhouse gas emissions. Materials containing recycled content can also be more affordable. Recycled landscaping features, cement and sidewalks, concrete foundations, and building materials may contain tires, asphalt, salvaged lumber, and fly ash. When possible, select products labeled as 'environmentally-friendly' (US EPA, 2008).

**Products that Do Not Contain Harmful Compounds:** Volatile Organic Compounds (VOCs) like formaldehyde, alcohols, or other hydrocarbons are harmful to human health and emit odours that make breathing more difficult. Long-term exposure to VOCs has been linked to lung cancer and heart disease. Whenever possible, avoid products that contain VOCs. Look for products with labels indicating that they contain no/low VOCs or other irritants (Friedman, 2005; Environment Canada, 2015).

**Locally Sourced Building Materials:** locally produced, manufactured, or sourced building materials can minimize the total distance that products must travel from factories and stores to the construction site. Selecting locally produced, manufactured, or sourced materials can also benefit the local and regional economy. Consider price, availability, and durability when selecting building materials (CMHC, 2005; Morton, 2013).

**Sustainably Harvested Wood Products:** using sustainably-harvested wood products supports well-managed forestry operations and sustainable harvesting practices. In Canada, the Forest Stewardship Council (FSC) certifies lumber products from forests that harvest wood sustainably, protect wildlife habitats, and respect Aboriginal and First Nations land rights. FSC-certified lumber is often more expensive than non-certified lumber. Retailers may be able to provide non-FSC-certified lumber that is still harvested and produced sustainably, if FSC-certified lumber is too costly (FSC, n.d.; Coastal Treated Products Company, n.d.; Gentleman, 2012; NRDC, 2008).

**Recyclable, Compostable, or Biodegradable Materials:** select building materials that are recyclable, compostable, or biodegradable. These materials minimize environmental impacts and reduce waste that reaches the landfill, allow new products to be created from old products, and can even return nutrients to the soil when disposed of properly (McDonough & Braungart, 2002; McLaren, 2013).

*Recycled content is in many building materials, such as rubber roofing shingles and flooring*



Image Credit: <http://rethinktires.ca/around-the-home/recycled-rubber-products/roofing-shakes/>

*FSC certified wood is inspected and verified to come from sustainably managed forestry operations*



Image Credit: Coastal Treated Products Company, n.d.

*Cork is a biodegradable building material used in flooring and other applications*



Image Credit: McLaren, 2013

# APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

Insulated slab-on-grade foundations have rigid foam insulation beneath the slab to prevent heat loss through the foundation. Plumbing and other services must be carefully planned

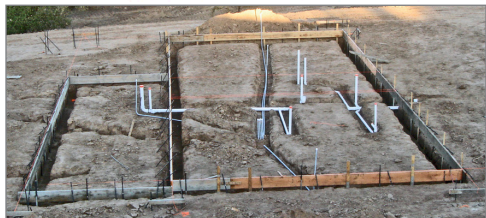
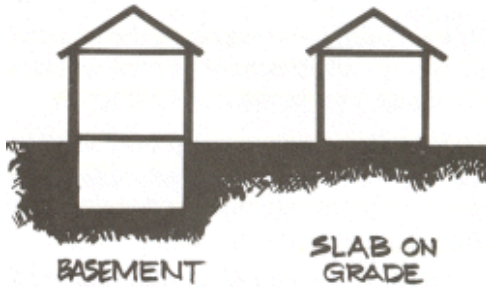


Image Credit: <http://radonreductionspecialists.com/images/examples.gif> (T) & <http://static1.squarespace.com/static/541c856ee4b03f1e8811aee3/t/54c035e3e4b0a1a744d75f87/1421882882052/?format=1000w> (B)

A double-stud wall is an advanced framing technique that increases the width of the wall cavity by using off-set studs, allowing for thick insulation

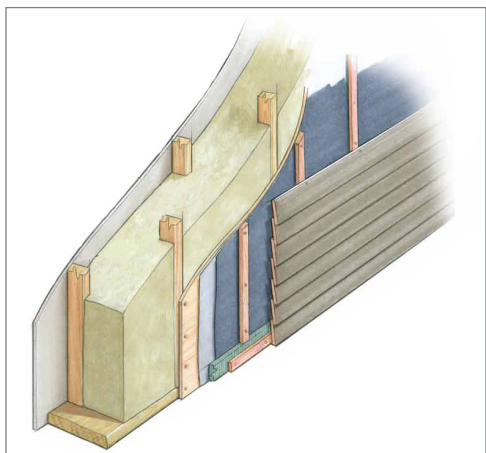


Image Credit: Green Building Advisor, 2013

## FOUNDATION, FRAME & ROOF

- **Insulated Slab-on-Grade Foundation:** insulated slab-on-grade foundations are at-grade concrete slabs built on top of rigid foam insulation panels. Insulation minimizes heat loss and prevents floors from feeling cold. These types of foundations require minimal excavation, are quick and affordable to construct, and are energy efficient. They should be well-drained and constructed on top of a porous material like gravel, with a strong moisture barrier to prevent cracks. Plumbing systems need to be carefully planned, as pipes must be cast into the concrete slab and are not easily changed (Bolkaders & Block, 2010; CMHC, n.d.; Cosgrove & Reynolds, n.d.).
- **Minimal Thermal Bridging:** thermal bridges are the ‘paths of least resistance’ in a building where heat escapes most easily. These occur in areas where there are gaps in insulation, including window frames and wall framing studs. Architects, contractors, and tradespeople must pay close attention to building details such as corners and framing to minimize heat loss. Adding exterior insulation to a building can minimize thermal bridging and increase air tightness (Dryvit, n.d.; Autodesk Sustainability Workshop, n.d.).

The image on the left illustrates a home with significant thermal bridging, where heat is escaping through the framing and roof. The image on the right illustrates the same building with exterior rigid foam insulation.

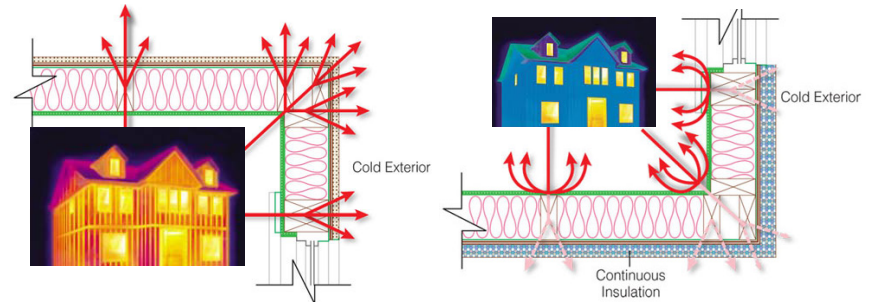


Image Credits: Dryvit, n.d.

- **Advanced Framing & Optimal Stud Placement:** optimally placing framing studs (every 24 inches) and using advanced framing techniques such as double-stud walls can reduce construction waste and increase energy efficiency of the building envelope. Double-stud framing reduces heat loss by offsetting studs to reduce the number of thermal bridges (framed wall area where heat can escape) and create more space for insulation. Achieving R-40 insulation values is possible with thick, well-insulated walls (US Department of Energy, 2000; Green Building Advisor, 2013).

## BUILDING ENVELOPE & FACADE

**Highly Insulated & Airtight Building Envelope:** approximately 25% of a typical home's energy losses result from warm air escaping from inside to outside through leaks, with an additional 10% of energy lost through thermal bridging. A highly insulated and air-tight building envelope (what separates a building's inside and outside) is critical for reducing heat losses, minimizing thermal bridges, and creating warm, comfortable, draft-free interior spaces for occupants (Friedman, 2007; Passivedia, n.d.).

**High Efficiency Windows & Frames:** double- or triple-paned, gas-filled windows with added coatings that permit light, but not heat (Low-E coating) can greatly reduce heat loss from windows, prevent condensation from forming on windows, and permit light to enter rooms without overheating them. Triple-paned, gas-filled windows can cost 10-25% more than double-paned windows, but have significantly better performance. Fiberglass or composite material window frames reduce thermal bridging, have minimal maintenance requirements, and long life-spans (Autodesk Sustainability Workshop, n.d.(B); Taylor, 2011).

**Environmentally-Friendly Insulation:** cellulose insulation, made from recycled newspapers, can be blown in to attics and walls, creating an airtight envelope. Other environmentally-friendly insulation materials include wood fiber or wood shaving insulation, soy-based spray-foam insulation, or glass or mineral wool. Some insulation materials contain recycled materials, reducing the environmental impact associated with their production. Spray foam insulations are extremely air tight, but may use gases that are harmful to the environment. Consult with building material suppliers and contractors to determine the healthiest and most cost effective solution (Green Building Advisor, 2012).

**Exterior Rainscreen:** wooden strips (furring) or other materials can be applied to a building's exterior to create space between the outside wall and siding. Air flows into the space from the bottom of the screen, venting from spaces at the top of the building, which are protected by roof overhangs and insect-proof meshing. Rainscreens are particularly effective in humid or moist climates, or in areas prone to excessive rains, helping to increase building durability and protecting against mould (Building Green, 2011).

*Thick, continuous insulation (yellow) and an air-tight barrier (red) can act as a 'warm coat' and greatly reduce heat losses and air leakages, increasing energy efficiency*

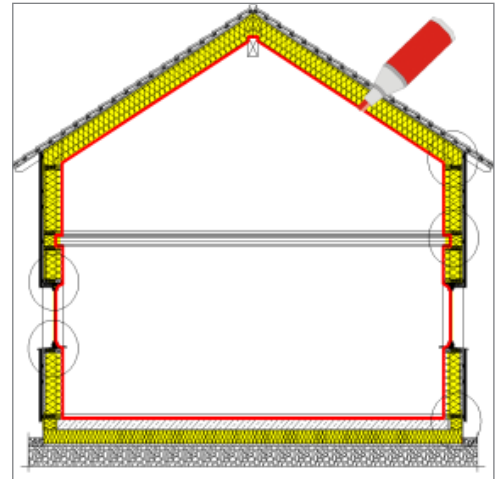


Image Credit: Passivedia, n.d.

*Argon gas can be pumped into spaces between window panes to increase the energy efficiency of windows*

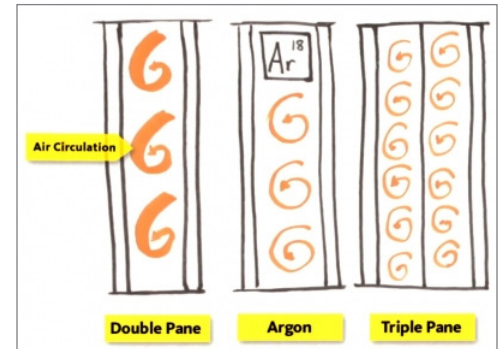


Image Credit: Autodesk Sustainability Workshop, n.d.(b)

*Rainscreens allow air to flow behind a building's exterior wall and siding, protecting against moisture build-up*



Image Credit: <http://www.allfinishconstruction.com/wp-content/uploads/2009/01/rainscreen.jpg>

## APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

A ductless mini-split heat pump is an energy-efficient choice for heating and cooling in Nova Scotia. Small electric baseboard heaters used with heat pumps can ensure indoor spaces are comfortable on very cold days

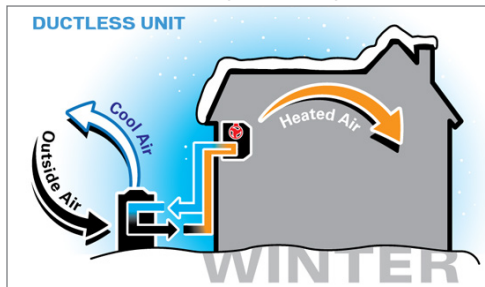


Image Credit: Nova Scotia Power, 2014

Keep outdoor heat pumps free from snow and ice to make sure they work efficiently. Protective covers can help



Image Credits: [http://ablecanvas.ca/ablecanvaswp/wp-content/gallery/heat-pump-shelters/402588\\_241295655947541\\_108200053\\_n.jpg](http://ablecanvas.ca/ablecanvaswp/wp-content/gallery/heat-pump-shelters/402588_241295655947541_108200053_n.jpg)

Use heat/energy recovery ventilators in well-insulated, air-tight buildings to provide abundant fresh air



Image Credit: Boyer, n.d.

### BUILDING SYSTEMS

- **Ductless Mini-Split Heat Pump:** a ductless mini-split heat pump uses a compressor, refrigerant fluids, and a fan to extract heat from outdoor air, with indoor air exchanger units blowing warm air inside. Air exchangers have filters to remove dust and pollen from the air, improving indoor air quality. Heat pumps can operate in temperatures as low as -27 degrees Celsius, with only small back up heat sources (e.g. electric baseboards) needed for any extra heating. Heat pumps also provide cooling by removing heat and humidity from indoor spaces in the summer. Units range in price from \$3000 - \$5000, but can reduce heating and cooling costs by up to 60% compared to standard electric or oil/gas systems. Heat pumps must be regularly maintained, with annual inspections and air filter changes. Contractors can provide advice on what units are most appropriate and may offer long-term maintenance packages (NRC, 2014; Nova Scotia Power, 2014)
- **Heat Recovery Ventilator (HRV) / Energy Recovery Ventilator (ERV):** ensuring that there is adequate fresh air in indoor spaces is important in well-insulated and air-tight buildings. Heat recovery ventilators are mechanical ventilation systems that circulate fresh air and exhaust stale air, recovering up to 80% of the heat contained in exhausted air to preheat incoming air. Energy recovery ventilators function the same, but remove excess humidity from the air as well. HRV/ERVs improve indoor air quality and can reduce heating and cooling costs. They require ductwork and must run constantly to be efficient. Contractors selling ductless mini-split heat pumps may also be able to help with HRV/ERVs systems (Boyer, n.d.; NRC, 2014b).
- **Energy Efficient Lighting:** high-efficiency compact fluorescent (CFL) or LED lighting consumes 75% less energy (75%+ with LEDs) than standard incandescent lighting. Fixture cost and bulb cost are the two factors that affect lighting cost beyond just energy consumption. CFL lighting is becoming increasingly popular in homes, with fixture and bulb costs declining in recent years. LED lighting fixtures are more expensive, but are becoming more common over time, and consume very little energy. The lifespan of CFL bulbs and LED bulbs is between 10,000 and 50,000 hours. Base lighting choices on room function (e.g. kitchens need more lighting than bedrooms). Rebates may be available to offset higher CFL and LED fixture and bulb costs (NRC, 2010; US Department of Energy, n.d.).

**High Efficiency Hot Water System:** standard electric hot water tanks are the most affordable hot water heating option, but can consume over seven times their purchase price in energy over their lifespan. Hot water storage tanks can be ‘wrapped’ to reduce heat losses. Installing a drainwater heat recovery system can recover heat from drained water, pre-heating water going into the hot water tank. Tankless hot water systems provide ‘on-demand’ hot water, do not need as much space, and are more energy-efficient, but have much higher upfront costs. Plumbing for hot water systems should minimize the distance that hot water has to travel to reach faucets (reduces heat loss). (NRC, 2012).

**Water Efficient/Low Flow Plumbing Fixtures:** toilets, showers, and clothes washers account for over 50% of a home’s yearly water use. Low-flow faucets, showerheads, dual-flush toilets, and water-efficient clothes and dishwashers can save a significant volume of water over the course of year. For example, a low-flow toilet (6L per flush) can save over 15,000L of water over the course of the year (compared to a 13L per flush toilet). Minimizing water consumption also reduces wastewater treatment costs (CMHC, 2014c; City of Toronto, n.d.).

## INTERIOR & FINISHES

**Durable, Easy to Clean, and Healthy Indoor Materials:** select indoor building materials based on affordability, durability, occupant comfort, ease of cleaning, and impact on indoor air quality. Materials such as bamboo, cork, or other hardwoods are good choices if sustainably harvested. For flooring, use carpet sparingly, as it is difficult to clean and reduces air quality. Look for carpets made of natural fibers (wool). Linoleum (natural) and tile/stone are good choices for kitchen and bathroom flooring. Avoid materials and sealers that contain VOCs, as these have a negative impact on air quality (Maas, 2009; Friedman, 2012).

**Energy and Water Efficient Appliances:** energy efficient and water efficient appliances have higher-up front costs, but save money over their lifetime by using less energy and water. Look for EnerGuide or Energy Star label to identify the most energy and water efficient appliances (Green Building Advisor, 2014).

*Tankless hot water heaters with drainwater heat recovery can save space and energy, but cost much more than tank systems*



Image Credits: [gotankless.ca/achieving-the-best-water-heater-efficiency/2013](http://gotankless.ca/achieving-the-best-water-heater-efficiency/2013)

*Low-flow showerheads can reduce water consumption without negatively affecting water pressure*



Image Credit: CMHC, 2014c, p.16

*Look for the Energy Star or EnerGuide label when selecting appliances*



Image Credit: [http://www.energy.gov.yk.ca/images/estar\\_eguide.jpg](http://www.energy.gov.yk.ca/images/estar_eguide.jpg)

## APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

*Integrating raised planters into community garden designs allows those in wheelchairs, Elders, and young children to safely take part in community gardening activities*



Image Credit: <https://rvlrclimatechange.files.wordpress.com/2011/06/planting-4-cropped.jpg>

*Sized based on annual rainfall, and with overflow pipes to prevent flooding, rainwater collection systems can provide water for gardening and landscaping*



Image Credit: CMHC, 2013, p.31

*Permeable pavers can provide stable walking and parking spaces, while slowing water runoff*



Image Credit: <http://www.gulfcoastpavers.com/new/wp-content/uploads/2012/08/Permeable-Paver-5.jpg1>

### LANDSCAPING

- **Community Gardens & Edible Planting:** community gardens can be important gathering places for community members. They provide opportunities to socialize, exercise, and grow healthy food. Community gardens should have amenities such as tool-sheds, watering spigots, and abundant outdoor seating. Outdoor features like communal kitchens and greenhouses can encourage interaction and knowledge-sharing between community members of all ages. Distributing food grown in community gardens throughout the community or selling to local businesses or restaurants can create new economic opportunities. Edible planting involves planting fruit-producing trees and bushes, herbs, and other edible plants across a building's outdoor area to create visually-pleasing features that residents and visitors can eat (Friedman, 2007; Friedman, 2012).
- **Rainwater Collection:** rainwater collection systems, including rain barrels, reduce the amount of ground or surface water needed for watering plants or other landscaped features. They can minimize environmental impacts related to water use and lower water bills. Rainwater is collected from a building's gutters using barrels, cisterns, or other collection tanks. The size of storage tank needed depends on annual rainfall amounts and anticipated water usage, with overflow pipes installed to prevent flooding. Preventing debris, insects, and other animals from entering collection tanks is important, as contamination can be an issue. Locate tanks close to gardens, or have a convenient system for pumping water from the tank to where it is needed (CMHC, 2013; Mobbs, 2010).
- **Native, Drought-Tolerant Vegetation:** selecting plants and other vegetation native to the area can lower water consumption and maintenance requirements, as these species are better adapted to the local environment. Planting culturally important species can create a more natural, spiritual landscape. Xeriscaping is a commonly-used term in landscaping that refers to designing water- and fertilizer-efficient landscapes (CMHC, 2013; Friedman, 2012).
- **Permeable Paving Materials:** using permeable paving materials, such as interlocking bricks, in parking areas and for walkways can reduce water runoff and allow water to seep into the soil. Look for materials that do not reduce accessibility (CMHC, 2013b).

**Stormwater Management Landscape Features:** landscaping features can help manage stormwater and slow the flow of stormwater runoff into lakes and other bodies of water. Rain gardens collect and absorb water from building downspouts and feature water-loving plants and porous soil materials. They can help to prevent localized flooding if located at a proper distance from buildings and may create new habitats for animals. Bioswales are long, depressed areas that collect large volumes of stormwater. They are often located alongside roadways and help to slow the flow of water runoff and filter water that reaches storm drains or water bodies (CMHC, 2013b; Danko, 2006; Natural Resources Conservation Service, 2005)

*Bioswales, such as ditches running alongside roadways, can help to collect stormwater and filter pollutants from stormwater before it reaches lakes, streams, and groundwater sources*



Image Credit: CMHC, 2013b, p.5

## OPERATIONS & MAINTENANCE

**Resident Handbook / User Manual:** a resident handbook or user manual developed to ‘tell the story’ of the HPP can provide valuable information and guidance on how selected technologies or design features work, and what maintenance requirements are. A handbook should contain important contact information for residents to report maintenance issues, links to other Band programs and services, resident responsibilities, and general Band housing policies. Organizing orientation sessions to familiarize residents with unique features of units can help with upkeep and maintenance. Examples of resident handbooks / user manuals are available online and may provide templates for developing a handbook / manual for HPP. Translating this document into Mi’kmaq may also help to protect and strengthen the use of the language in the community (BuildingGreen, 2009; Canadian Forces Housing Agency, n.d.).

*Resident handbooks or manuals can help to tell the story of the Housing Pilot Project and explain technologies and design features*



Image Credit: [http://thumbnails-visually.netdna-ssl.com/a-guide-for-budgeting-indoor-home-maintenance\\_53a0891a58b11\\_w1500.png](http://thumbnails-visually.netdna-ssl.com/a-guide-for-budgeting-indoor-home-maintenance_53a0891a58b11_w1500.png)

**Long-Term Maintenance Strategy:** a long-term, seasonal maintenance strategy for the HPP can increase the building’s lifespan, address small maintenance issues before they become large issues (cost savings), protect the health and safety of building residents, and allow for more predictable maintenance budgets for the Band. A home maintenance checklist developed by CMHC can form the basis of a strategy for the HPP, with additions made based on technologies and design features selected. Creating training opportunities for residents and other community members to gain home maintenance skills is also possible (CMHC, 2010; National Home Warranty, n.d.).

*Develop a long-term maintenance strategy based on technologies and design strategies selected. For example, heat pumps require yearly maintenance.*



Image Credit: <http://www.heatpumpsussex.co.uk/library/img/heat-pump-sussex-600-350-installation-3.jpg>

## APPENDIX: SUSTAINABLE TECHNOLOGIES & DESIGN STRATEGIES

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