ONTARIO'S PUBLIC INFRASTRUCTURE: ADAPTING TO CLIMATE CHANGE

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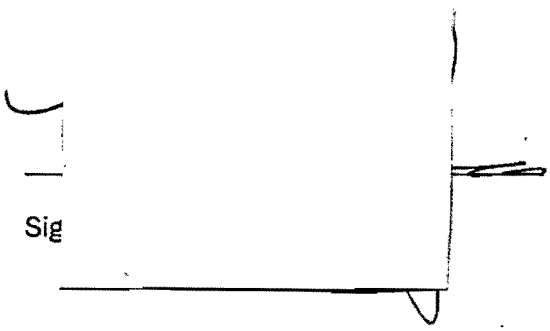

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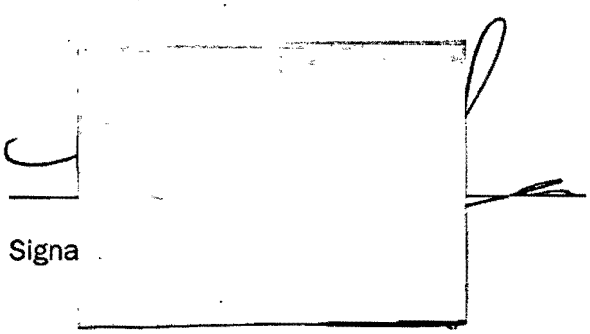

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ABSTRACT

The rapid pace at which the climate is changing has forced governments globally to focus on adaptation techniques for their built environment. This paper will define and explain Ontario's current management framework over its building portfolio and identify gaps in planned adaptation strategies and recommend solutions to fill these gaps. This research will be informed by current literature that details the most appropriate and successful approaches to managing a building portfolio in the face of climate change. Recommendations will be made as to how Ontario's public infrastructure frameworks and strategic approaches can be modified to embody a more holistic, realistic and result-based approach to built form adaptation.

Key words: Climate Change, Resiliency, Adaptation, Vulnerability, Public Infrastructure

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1.0 Introduction

Public infrastructure is critical to Ontario's global competitiveness and the quality of life Ontarians enjoy. Well-functioning infrastructure promotes productivity and supports the local economy through lower business and operating costs. Since the 1980s, Ontario's public infrastructure has been under constant stress and constraint (www.fin.gov.on.ca, 2010). Underinvestment, aging infrastructure, deferred maintenance and continual expansion of services required for Ontarians have led to a significant gap between actual and needed infrastructure. The result has produced widespread infrastructure failures and an ongoing battle against infrastructure backlogs (www.fin.gov.on.ca, 2010).

Climate change issues are continually being seen at the top of government agendas and will shape the way in which governments operate and manage infrastructure in the years to come. Climate can be defined as the average temperature, precipitation and wind over a specific period of time (Bizikova et al., 2008). Statistically significant changes in this average state of climate over an extended length of time is referred to as climate change (Bizikova et al., 2008). These changes can be attributed to natural or human induced changes in the composition of the atmosphere or changes in land use (Bizikova et al., 2008). There have been two primary responses to climate change: mitigation and adaptation. In the climate change context, mitigation is defined as "implementing policies to reduce greenhouse gas emissions..." (Olmos, 2001, p.3) and adaptation refers to "[an] adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Olmos, 2001, p.3). The Ontario government has recognized that both mitigation and adaptation are necessary components of an overall climate change strategy for the province. Mitigation, in the context of buildings, includes the reduction of electricity use and greenhouse gas (GHG) emissions from current operations (which inherently will reduce or slow the rate

in which climate changes) while adaptation refers to implementing policies and making capital investments that will prepare and protect Ontario's building infrastructure against changing climates.

In summer 2008, a government portfolio restructuring exercise saw two ministries, Ministry of Energy and Ministry of Public Infrastructure and Renewal, merge together to form the Ministry of Energy and Infrastructure (MEI). The formation of this new 'super-ministry' signaled the government's intent to push greening initiatives across the province further, both internal to government and externally to the public. According to the Ministry of Energy and Infrastructure "combining the resources and strategic objectives of the two ministries brings added strength and focus as the province works to achieve its vision of a new green economy" (www.mei.gov.on.ca, 2009). This new 'green' direction includes a focus on the issues of climate change and the potential impacts they pose on Ontario's infrastructure. Furthermore, mitigation strategies must be realized in order to properly manage and provide stewardship over the governments building portfolio to decelerate and reverse climate change impacts. In order to reduce greenhouse gas emissions, produce more efficient buildings and ensure a cleaner electricity grid for the province, merging these two ministries made perfect sense. Ontario government buildings are a key source of the total amount of greenhouse gases accounting for approximately 75% of the Ontario government's entire carbon footprint (www.ontariorealty.ca, 2010). Merging these ministries would allow for a focused oversight and increased connectedness between energy consumption and the infrastructure government manages.

A key agency for MEI in managing the government's portfolio is the Ontario Realty Corporation (ORC). The ORC provides real estate services to the Ontario government, including strategic portfolio management, asset management, property and land management and capital project oversight (www.ontariorealty.ca, 2010). In addition, the ORC supports the government's greening agenda by managing the portfolio in an environmentally responsible way, whether it be energy conservation

initiatives or supporting the principles of the provincial Growth Plan. The ORC is, in most basic terms, the agency responsible for managing the province's diverse asset portfolio on a day-to-day basis and is responsible for delivering on sustainability and Growth Plan performance measures.

Recently, reports from the Environmental Commissioner of Ontario (ECO) and the Province of Ontario's Expert Panel on Climate Change Adaptation recommend how the Ontario government can incorporate resilient building practices into planning for critical infrastructure. In 2009, the ECO released his annual report entitled 'Building Resilience' which focuses on many aspects of sound planning practices within the Ontario Government and recommends changes for the future. In the same year, The Expert Panel on Climate Change Adaptation prepared and submitted a comprehensive report entitled *'Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan'* to the Minister of the Environment detailing 59 recommendations for the Ontario government by which to further adapt to changing climates in the province. Many of the recommendations were directed at MEI due to the fact that MEI is responsible for managing the building portfolio in Ontario. These two documents, along with future annual reports, will form the foundation for change for Ontario in moving toward a sustainable built environment.

The Ontario government manages a wide range of buildings and structures across the province and has a mandate to provide safe and convenient services to the public through these assets. The government's portfolio is aging rapidly and in a 2006 study, the Residential and Civil Construction Alliance of Ontario estimated the cost to rehabilitate the province's public infrastructure to a 'state of good repair' would be $19 billion (www.fin.gov.on.ca, 2009). Maintaining assets to a 'state of good repair' means making necessary investments to infrastructure that ensure the physical asset is functioning as designed within their 'useful life' and that physical assets are sustained though regular maintenance and replacements schedules to minimize building failures (Washington Department of

Transportation, 2008). The 'useful life' of buildings is usually determined to be approximately 40 years and deferring maintenance (or not performing repairs at all) leads to much higher rates of deterioration and repair bills that can equal the cost of the original asset (www.pppcouncil.ca, 2010). As these facilities undergo capital repairs, there is a need to incorporate adaptive design practices so that these facilities emit less greenhouse gases and are able to respond to rapidly changing environments.

Currently, the Ontario government manages its assets through a systematic approach called the Results Based Plan (RbP) or Capital Plan (www.fin.gov.on.ca, 2009). The Capital Plan is an annual cycle whereby all ministries in government prepare business cases and provide justification for the approval of capital dollars to renew, refurbish or replace building assets (www.fin.gov.on.ca, 2009). Once all plans are submitted, the Ministry of Energy and Infrastructure (MEI) will make recommendations to Treasury Board as to which new and ongoing capital projects and renovations should be approved. Recommendations made by MEI are informed by the Asset Management Framework (AMF). There are two main drivers of the AMF that come together to form a comprehensive management approach to maintain public assets. The first driver of the AMP is maintaining existing assets in a 'state of good repair' (www.fin.gov.on.ca, 2009). This methodology helps to inform investment and upgrades to current buildings in order to keep up with deterioration and replacement schedules. Infrastructure dollars are estimated through this plan by calculating life-cycle costing of building elements and deterioration over the next ten years. The second driver of the AMP is the long term planning of government facilities. This can be considered a long-range planning process to rationalize government space and consider new or adaptive reuse facilities to house growing program needs. These two drivers combined actively manage the current and future needs of public assets across Ontario by allocating funds to facilities that have outstanding deferred maintenance and are considered to be core assets for the province.

The Premier of Ontario has realized that attention must be paid to what potential effects changing climates may have on Ontario's already aging infrastructure, "Climate change is the defining issue of our generation - we've come a long way, but we have more to do, together by helping Ontarians fight climate change at home, we're moving forward, together, towards a future that is greener and more innovative with a better quality of life and a stronger economy for all Ontarians" (www.premier.gov.on.ca, 2010). Furthermore, it has been identified that the Ontario government must do more to incorporate sustainable and resilient building planning and design into capital repairs, new construction projects, and long-term portfolio planning (www.fin.gov.on.ca, 2009). Bosher et al., 2007 state that "Designing, constructing and operating resilient built assets demands an in-depth integrated understanding of how to avoid and mitigate the effects of emergencies and disasters in order to secure a resilient and sustainable future for the built environment. Resilience should be systematically built into the planning and design processes rather than added on as an afterthought" (Bosher et al., 2007, p. 248).

This paper will explore current frameworks and methodologies in the Ontario Public Service (OPS) when managing the province's diverse building portfolio and how these fundamental processes can be managed to incorporate capital planning practices that promote an adaptive built environment and contributes to mitigating the impacts of climate change. The main question to be answered is: ***how can current building maintenance and building practices within the OPS incorporate sustainable and resilient methodologies***? Exploring the answer to this question will shine a light on other important questions including what are the current pitfalls in incorporating these practices into the OPS and how much effort is needed to effectively incorporate adaptive planning into current capital planning frameworks?

In order to explore the answers to these questions, academic articles on the topic will be analyzed to extract current literature on vulnerability, resiliency and sustainability as it relates to the

built environment. This research will be coupled with reports and action plans prepared for government to focus this research in Ontario. Current practices adopted by the Ontario government will also be explored to gain an understanding of present frameworks and methodologies that govern the way in which public infrastructure is managed. This method will allow for both a global and local review in identifying the most practical and efficient methodologies for planning and maintaining built environments for future generations in Ontario. As these methods are explored and documented, modern thinking pertaining to planned adaptation will be measured against the current framework informing action in Ontario. Comparisons will be made between the adaptive capabilities of Ontario's current system of managing the built portfolio against what research from literature reveals. Gaps in Ontario's current processes will be identified and recommendations to inform the Province's management of buildings, going forward, will be provided.

Increased deferred maintenance, an aging infrastructure and shifts in climate are only a few major factors creating a perfect 'storm' in Ontario that will inevitably lead the Ontario government to making difficult decisions about infrastructure in years to come. The sooner adaptation practices are built into the DNA of capital planning processes and optimization of current assets, the sooner Ontario's built environment will be able to respond to the changing program and climate needs of the future. With shrinking budgets and cost recovery programs in place, the government will need to focus on building materials and overall design that combat changing climate, operating buildings more efficiently to save energy and optimizing space for program delivery across the province.

2.0 Climate Change Vulnerability and Adaptation: Understanding Connections with Built Form

The concepts of vulnerability and adaptation have become increasingly more important to government organizations and the public at large over the past decade as climate change impacts have become more prominent and consistent. Olmos (2001) sates that the Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as "the extent to which climate change may damage or harm a system" and that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" (Olmos, 2001, p. 6). Furthermore, the chair of the IPCC has defined vulnerability as:

> The extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate. Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained (Olmos, 2001, p.7).

A common theme in academic literature relating to vulnerability and climate change impacts is the notion that there are differences between countries, regions and sectors in their ability to respond to vulnerabilities to climate change. This is due to the fact that changes in temperatures and natural disasters will be distributed unevenly across the world which will create a different set of climate change impacts for different geographic locations. Therefore, it is important, as a first step, for regional and provincial governments to understand local climate change patterns in order to determine their level of vulnerability.

Adaptation refers to both the process of adapting and to the conditions under which adaptation is taking place. The term has specific definitions depending on context and discipline. From an ecological perspective, adaptation can be referred to as "changes by which an organism or species becomes fitted to its environment" (Smit and Pilifosova, 2001, p. 880) where the social sciences may

define adaptation as "adjustments by individuals and the collective behaviour of socioeconomic systems" (Smit and Pilifosova, 2001, p.880). For the purposes of this report and looking through the lens of adaptation for the built environment, a combination of both definitions above will be used where 'organisms or species' is replaced by the built environment being fitted to its environment and the adjustments of individuals, within the built environment, have a direct impact on how those assets contribute to climate change.

The term adaptation is usually found coupled with vulnerability. This is due to the fact that these terms have a causal relationship in that if an organization is to measure their vulnerability to climate change, the next logical step would be to determine how to adapt in order to become less vulnerable. There are many definitions of adaptation found in climate change literature. For the purpose of this research, adaptation will be viewed as "the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions" (Watson et al., 1996, p.40). The Expert Panel on Climate Change adaptation in Ontario makes a distinction between three different types of adaptation:

Anticipatory Adaptation - Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.

Autonomous Adaptation - Adaptation that does not constitute a conscious response to climate stimuli but is triggered by ecological changes in natural systems and by markets or welfare changes in humans systems. Also referred to as spontaneous adaptation.

Planned Adaptation- Adaptation that is the result of deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

In order to explore how Ontario can be more inclusive when dealing with adaptation for the built environment, processes and practices related to *Planned Adaptation* will be examined. Spontaneous adaptation has been the most prevalent type of adaptation being practiced around the globe and has been recorded in the literature as the only real type of adaptation being practiced in the developed world, mainly due to the fact that spontaneous adaptation is in response to recent climate events or disasters. The IPCC states that adaptation "has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts, but will incur costs and will not prevent all damages" (Olmos, 2001, p.9). The IPCC also argues that human and natural systems can, to some extent, adapt autonomously and planned adaptation can supplement this process.

Vulnerability and adaptation are two fundamental concepts when determining how to manage a built form that is able to respond to changing climates. There are however, varying degrees and multiple approached when determining appropriate courses of action. The next section of this report will explain why the adoption of planned adaptation principles are the most promising in managing a built environment in the face of climate change.

3.0 Should Planned Adaptation be a Priority for the Province of Ontario?

The Ontario government currently manages the state of its buildings portfolio in somewhat of a piecemeal fashion where funds are dispersed year over year with minimal regard to long term strategies. The ORC maintains a 10 year capital infrastructure plan that is simply used to calculate funding needed and determine capital repairs (including replacement schedules) for the government's core asset portfolio. However, new construction projects approved by government are rarely linked to this capital plan, as ministries are able to request funding for new construction projects based on specific ministry needs or stakeholder 'wants'. At its very foundation, Ontario is only poised to be actively engaged in autonomous adaptation practices by responding to climate events as they happen. The province must turn its attention to strategies and frameworks that foster an understanding of the benefits of planned adaptation and the long-term benefits of having such a plan in place.

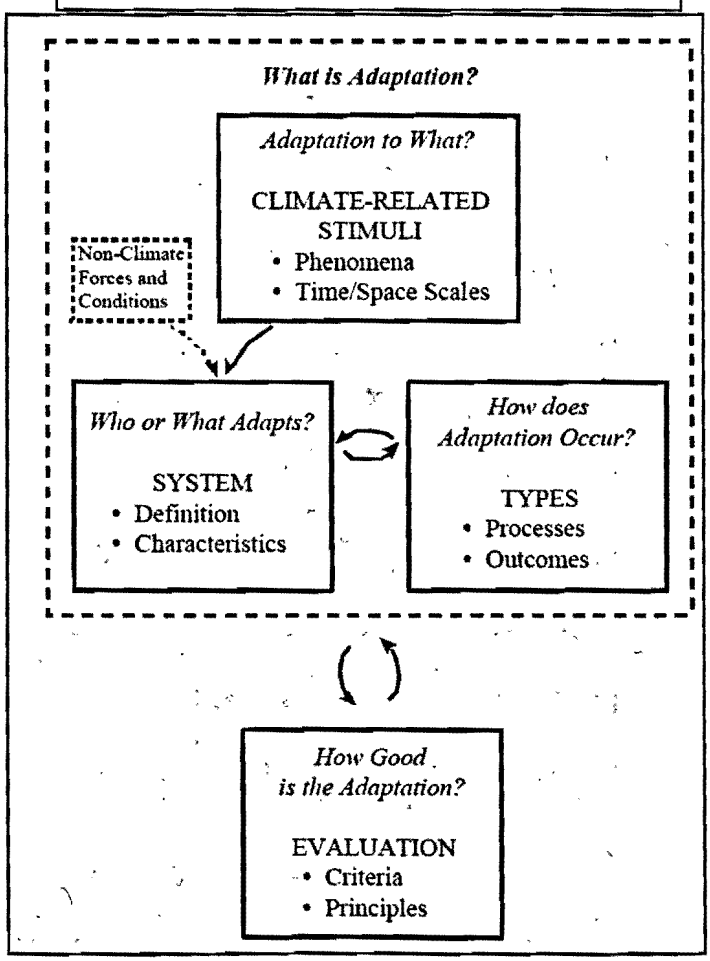
Adaptation can be viewed as either reactive or proactive under two circumstances. One instance relies on the 'stimulus' for adaptation, that is whether an action is in response to observed climate change impacts over time or is an activity that is in anticipation of the effects of future climate change (Burton et. al., 2006). Burton et al. (2006) agree that in this scenario, "adaptation historically has been largely if not entirely reactive" (Burton et. al., 2006, p.26). Human caused climate change presents unique challenges to adapting to climate change forecasts that have not yet been experienced by many societies around the world. On the other hand, reactive adaptation can be informed by direct experience and resources can be targeted to known and experienced risks (Burton et. al., 2006). The problem therefore lies in addressing future risks, making it harder to determine what changes might happen, appropriate levels of investment, what exactly needs to be measured, and at what scale.

The second instance of adaptation can be said to be reactive or proactive in 'form'. Burton et al. (2006) state that this "distinction concerns not motivation – whether the climate impact is observed or

anticipated- but rather the nature of society's response" (Burton et. al., 2006, p.16). A proactive response in this scenario would aim to reduce exposure to future climate risks (avoiding development in flood plains) while a reactive approach would only alleviate impacts once they have occurred (providing assistance to flood victims). If reconstruction were to occur in a flood-stricken area, related to the example above, this could be referred to as 'maladaptation'- when a reactive response to climate events increases exposure to known climate risks (Burton et. al., 2006). Similarly, proactive form adaptation usually requires a greater initial investment (to mitigate future risks) but is more effective at reducing future costs.

As both a process and condition, adaptation can be regarded as a relative term in that it involves an alteration in something (the system of interests, activities, sectors, regions) to something (the climate-related stress or stimulus) (Smit and Pilifosova, 2001). Figure 1 describes the interaction and description of adaptation that requires specification around who or what adapts, the stimulus for which the adaptation is needed and the process or form that it takes (Smit and Pilifosova, 2001).

Figure 1- Adaptation to Climate Change



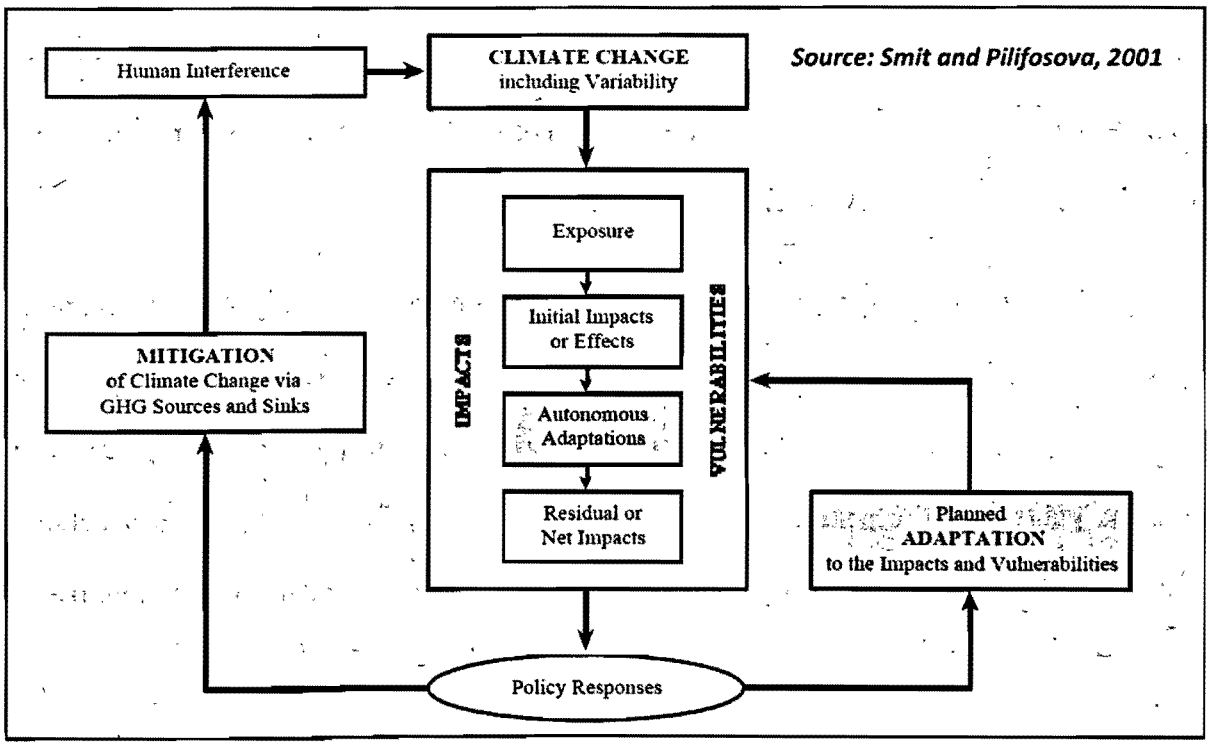
Source: Smit and Pilifosova, 2001

Planned adaptation techniques and investments are also dependant on the adaptive capacity of countries, regions and cities. At the ground level, adaptation to climate risks usually entail specific actions and projects that translate into construction of various barriers, hardening of

critical infrastructure, development of early warning systems or protection mechanisms for crops, to name a few. Some drawbacks to why these adaptation practices have not yet been as widespread as one would like will be discussed in another section of this report.

Recent literature suggests that many regions have the human capacity to adapt to long-term average climate change conditions, but they have been less successful in adapting to extreme weather events and year over year climatic variations (Smit and Pilifosova, 2001). Therefore, although human settlements and infrastructure have, for the most part, been able to respond to vastly different climate zones around the globe, these settlements are highly susceptible to deviations from normal weather patterns, especially severe weather events. As a result, the adoption of current adaptation techniques are "designed to address changed mean conditions may or may not be helpful in coping with the variability that is inherent in climate change" (Smit and Pilifosova, 2001, p.882). Figure 2 demonstrates how planned adaptation to impacts and vulnerabilities fit into the appropriate response to climate

Figure 2- Planned Adaptation Impacts



change frameworks. While efforts to reduce greenhouse gas emissions through mitigation strategies is necessary, global temperatures are expected to increase and other environmental changes which include severe weather events should be expected. Therefore, the development and implementation of planned adaptation strategies to deal with these future risks can be regarded as a necessary addition to current mitigation practices (Smit and Pilifosova, 2001).

Figure 3 details numerous reasons as to why planned adaptation is currently necessary. Government adaptation initiatives and programs should be regarded as a compliment, not a substitute, to GHG reduction emission targets and as a necessary factor in managing the impacts climate change may and will have on the built environment (Burton, 1996). Although planned adaptation is mostly viewed as a process by which results will only be realized over the long-term, it has been seen that adaptation can yield benefits in the short term regardless of the uncertain nature of climate change (Ali, 1999).

Figure 3- Reasons for Planned Adaptation

1) Climate change cannot be totally avoided.
2) Anticipatory and precautionary adaptation is more effective and less costly than forced, last-minute, emergency adaptation or retrofitting.
3) Climate change may be more rapid and more pronounced than current estimates suggest. Unexpected events are possible.
4) Immediate benefits can be gained from better adaptation to climate variability and extreme atmospheric events.
5) Immediate benefits also can be gained by removing maladaptive policies and practices.
6) Climate change brings opportunities as well as threats. Future benefits can result from climate change.

Source: Smit and Pilifosova, 2001

There are many reasons evident in current literature as to why planned adaptation is a necessary compliment to current autonomous adaptation. Leary (1999) states that "we cannot rely solely or heavily on autonomous adjustments of private agents to protect public goods and should examine public policy responses to do so" (Leary, 1999, p.32). Therefore, planned adaptation as it relates to infrastructure is aimed at reducing current vulnerabilities and diminishing future risks to core

assets as opposed to reactive responses to unexpected weather events. Smit and Pilifosova (2001) echo these same feelings by stating:

> Planned anticipatory adaptation has the potential to reduce vulnerability and realize opportunities associated with climate change, regardless of autonomous adaptation. Implementation of adaptation policies, programs, and measures usually will have immediate benefits, as well as future benefits. Adaptation measures are likely to be implemented only if they are consistent with or integrated with decisions or programs that address non-climatic stresses. The costs of adaptation often are marginal to other management or development costs (Smit and Pilifosova, 2001, p.890).

Although planned adaptation has been identified by many as a positive step in the right direction for protecting core assets and minimizing costs for recovery, it is sometimes difficult for governments to organize themselves in a way that maximizes their resources for future events. Klein and Tol (1997) identify five generic objectives of adaptation by which strategies should be measured against:

1) Increasing robustness of infrastructure designs and long-term investments – for example, by extending the thresholds of temperature or precipitation that a system can withstand without failure.

2) Increasing the flexibility of vulnerable managed systems – for example, by allowing mid-term adjustments and reducing economic lifetimes (including depreciation).

3) Enhancing the adaptability of vulnerable natural systems- for example, by reducing non-climatic stresses and removing barriers to migration (eco-corridors).

4) Reversing trends that increase vulnerability (maladaptation) – for example, by introducing appropriate setbacks for development in vulnerable areas such as floodplains and coastal zones.

5) Improving societal awareness and preparedness – for example, by informing the public of risks and possible consequences of climate change and establishing early-warning systems.

Adaptation occurs in what is called the system of interest ('who or what adapts' in Figure 1). Smit and Pilifosova (2001) explain that in an unmanaged natural system, adaptation takes place only through autonomous and reactive actions and is the mean by which natural systems and species respond to their changing natural environments. On the other hand, human system adaptation can be motivated by public or private interest. Private decision makers can be characterized as individuals, households, businesses and corporate enterprise while public interests are served by government entities. The roles of these two groups are distinct but related. Figure 4 displays the connectedness between these two groups and how they are related to both anticipatory and reactive adaptation. The reason that this distinction is important is because if societies are to change and adapt to varying climates, they must each know their role, influences and dependencies. Furthermore, distinguishing among the various decision makers involved in adaptation is important for progress (Smit and Pilifosova, 2001).

Figure 4- Types of Adaptation to Climate Change

Anticipatory	Reactive
	• Changes in length of growing season • Changes in ecosystem composition • Wetland migration
• Purchase of insurance • Construction of house on stilts • Redesign of oil-rigs	• Changes in farm practices • Changes in insurance premiums • Purchase of air-conditioning
• Early-warning systems • New building codes, design standards • Incentives for relocation	• Compensatory payments, subsidies • Enforcement of building codes • Beach nourishment

Source: Smit and Pilifosova, 2001

This distinction between private and public entities to collectively work together in adopting adaptation is described by Smit and Pilifosova (2001) as an important part of the climate change discussion. The miscommunication lies in the fact that private entities continually look to public figures and structures as leaders when it comes higher level issues such as climate adaptation, while governments look to private stakeholders as integral and active participants in achieving public policy

objectives. The interplay between these two parties must be clearly communicated and understood. Furthermore, the types of adaptation, as seen in Figure 1, are largely dependent on the 'actors' carrying out the activity. Planned adaptation is often characterized as the result of a "deliberate policy decision on the part of a public agency, based on an awareness that conditions are about to change or have changed and that action is required to minimize losses or benefit from opportunities" (Smit and Pilifosova, 2001, p.892). Conversely, autonomous adaptations are characterized as "initiatives by private actors rather than by governments, usually triggered by market or welfare changes induced by actual or anticipated climate change" (Smit and Pilifosova, 2001, p.892). Smith et al. (1996) echo this statement by explaining that autonomous adaptations occur naturally without public intervention whereas planned adaptation are pre conceived plans that are deliberately put in place to anticipate future change. Therefore, the difference between autonomous and planned adaptation practices can be attributed to either public or private units.

It is evident through this discussion that Ontario must rely more heavily on planned adaptation practices rather than autonomous ones. Planned adaptation strategies will allow for the appropriate planning and dedication of funds for Ontario buildings in a manner that not only adapts to future climate change, but also maintains current maintenance and replacement schedules. Planned adaptation strategies will also be beneficial to the province as they will save money on operational costs to government (as mitigation projects are implemented) and will save money for recovery costs if extreme weather events occur (buildings will be more readily prepared for catastrophic weather events rather than being severely damaged and may require significant investment to repair or replace). Although planned adaptation is clearly more responsive than autonomous responses, it will be difficult to implement and sustain. All government entities, including all ministries and agencies, must show leadership in implementing frameworks and strategies that are accountable to a strategic process. Policies must support ongoing efforts to continually scrutinize public funds dedicated to infrastructure

and must continually evolve as new information becomes available regarding changing climates. That is, flexibility and the capacity to adapt must be a foundational element in climate change efforts.

4.0 Impediments to Current Adaptation Practices

Although climate change and adaptation techniques have been a part of policy and decision making for the better part of the last decade, it seems as though the formula for success still eludes the most comprehensive minds and frameworks. It is evident that many attempts by government, some successful and others failures, have been developed and deployed to combat deteriorating effects of climate change. As it stands, current Ontario infrastructure planning practices such as capital planning frameworks and the setting of energy reduction targets are not robust enough to adapt to rapidly changing environments. Furthermore, the Ontario government is missing critical partnerships between federal and municipal counterparts and academic or public sector experts (www.ipac.ca, 2010).

Many critics, as identified below, of current public policies to combat this modern dilemma have voiced harsh but poignant words for our political leaders and decision makers. Bosher et al. (2007) state that the solution to a sustainable built environment lies in the power of 'multidisciplinary integration' as the 'holy grail' necessary to maximize the knowledge and skills required to achieve an appropriate solution. The first, most obvious, stumbling block to this integration lies in the natural environment of competing priorities at all levels of government, "people involved with the fiscal elements of local [or provincial] authority administration may be reluctant to invest more than they feel necessary in mitigating the effects of extreme events that may never occur, especially if government funding for emergency planning is 'ring fenced'" (Bosher et al., 2007, p.250). This statement rings true to all who have ever participated in a capital planning process whereby the standard tagline for handing out funding is providing the maximum amount of service from a limited amount of resources.

That being said, how do decision makers allocate appropriate amounts of funding for events that are yet to happen? How do you put a price tag on capital improvements that will not realize their payback for many years to come? This is the dilemma that challenges many around the globe who are

faced with predicting how severe, or minimal, climate change effects will have on their critical infrastructures that power their society. There are however, societal benefits that must be taken into consideration when planning for the future built environment. The U.S. Environmental Protection Agency outlines that enhancing occupant (and worker) comfort and health, heightening aesthetic quality of interior and exterior building structures, minimizing strain on local servicing infrastructures and improvement of overall quality of life for citizens are all factors that should be considered when determining future investments (www.epa.gov, 2010). Although it is easy to look at financial hard lines to determine the cost-benefit of proceeding with certain projects, governments must also consider the social benefits of 'building green', even when the financial investment is not completely justified. Furthermore, decision makers are held to a higher standard for the decisions they make in predicting future outcomes, rather than present issues. This mentality is reflected in the current 'state of good repair' methodology whereby funds are allocated to the 'here and now' repairs that are necessary for current infrastructure, rather than investing in materials and hardening systems for future weather impacts that may either never happen, or may not have the detrimental effects as initially expected. Therefore, it is safer and more justifiable for current governments to invest their 'limited resources' to the issues they can feel and touch, so to speak, in order to justify current spending levels and to report on progress to the public rather than sinking funds into projects that may have the potential to return little payback.

Alejandro Camacho (2009) explains this phenomenon as 'a different order of uncertainty'. Although the best available data currently available indicates progressively worsening conditions on natural systems and the built environment, the primary challenge that presents itself for natural resource governance is "the extraordinary uncertainty surrounding the precise manifestation of these impacts" (Camacho, 2009, p.13). For decision makers, environmental and climate change problems are riddled with limited information and some consider this uncertainty as a fundamental element of

modern environmental risk (Camacho, 2009). This limit to information poses problems as "government regulators have long been tasked with addressing problems for which information as to the generation, transmission, impact, and probable occurrence of hazards is limited. As with other environmental problems, there is imperfect information about many existing effects of climate change simply because they have yet to be studied" (Camacho, 2009, p.16).

There has been ongoing emerging academic literature on governance requirements for adaptation that suggest there is a clear and defined role for public policy to play in adapting to climate change. These roles of governance, at the very core, should aim to reduce vulnerabilities of the most critical infrastructures by "providing information on risks for private and public investments and decision-making, and protecting so-called public goods..." (Adger et al., 2006, p.12). The academic literature available to public policy makers is somewhat mired by everyday realities that these decision-makers must face. There are many, as expected, limits to public policy action that make adaptation ineffective. Adger, Agrawala and Mirza (2006) describe these impediments in their fourth assessment report to the IPCC entitled 'Assessment of Adaptation Practices, Options, Constraints and Capacity.' Six limits identified include physical limits, technological limits, financial limits, informational limits, social limits and institutional limits (Adger et al., 2006). This body of work defines these limits as "the conditions or factors that render adaptation ineffective as a response to climate change" (Adger et al., 2006, p.14).

These limits as they relate to governance and adapting the built environment can be more narrowly focused on technology and institutional limits. Technological solutions to adaptation can serve as a realistic way in moving forward with climate change mitigation measures as new technologies can be developed and tested to allow structures and buildings to consume less energy and combat climate disasters (building hardening measures). There are, however, limitations to technology as an adaptation

response to climate change (Adger et al., 2006). Although some aspects of adaptation may be possible through technology, they may not always be economically feasible or culturally desirable (Adger et al., 2006). In Ontario, for instance, the Green Energy Act, 2009 has encouraged the use of renewable technologies and the government is willing to provide subsidies and grants to agencies and vendors who use them (www.mei.gov.on.ca, 2010). Furthermore, the government encourages vendors of these innovative products to step forward and demonstrate their adaptive and mitigation abilities when applied to government buildings. The issue, however, is that the government must determine which technologies are proven and suitable for varying types of assets, tying up substantial dollars and time before actual implementation. A second issue arising from this is that the government cannot fund all technologies nor can it fund technologies that require substantial investment. For example, if the Ontario government were to select a certain type of solar panel to install on the rooftops of all government buildings to curb electricity consumption, financial constraints would hinder the government's ability to install enough panels to make a difference in electricity consumption. Although some technologies are proven and can be applied with minimal costs, their benefit to the overall climate change strategy is minimal. Technology is also unlikely to be equally transferrable to all sectors (different types of building assets in Ontario's case) and jurisdictions. Using the same solar panel example, Ontario may look to California as the leader in solar panel use and policy development. The issue, however, is that solar panels perform differently in the hot California sun (higher heat intensity and longer sun exposures) than in Ontario. Therefore, Ontario must consider all factors when selecting emerging technologies, as the mitigation benefits in other jurisdictions are not always transferrable to Ontario.

Institutional and political limits are described as the bodies of government that are "needed to facilitate, implement, and sustain adaptations to climate change policy" (Adger et al., 2006, p.42). Literature suggests that that institutional barriers to adaptation lie in the improper fit or location of

climate change policymaking within government ministries (Adger et al., 2006). In Ontario, it may be somewhat confusing to understand what ministry is responsible for what activity and what policies each of these ministries are responsible for managing. For example, The Ministry of Energy and Infrastructure is tasked with managing the province's building portfolio, while the Ministry of Transportation is responsible for the government's automotive fleet and the Ministry of Environment is responsible for water conservation policies. Furthermore, there are several divisions and agencies that are present in each of these ministries with divided mandates and deliverables. The Ontario government has realized that in order to combat climate change in a coordinated fashion, oversight must be given to a centralized body to oversee all government operations. In September 2008, The Ontario Public Service (OPS) Green Office was created to help government focus on further reducing its environmental footprint and adapt to changing climates by maintaining oversight for internal government operations (www. doingbusiness.mgs.gov.on.ca, 2010). The OPS Green Office is responsible for:

1) ensuring an integrated approach to reducing the impact on government operations on the environment;
2) permanently embedding environmental sustainability and responsibility in the business practices and day-to-day culture of the OPS; and
3) creating the foundation for continuous improvement in environmental stewardship (www. doingbusiness.mgs.gov.on.ca, 2010).

Although the OPS Green Office has only been formed for slightly over one year, the intent by government to formulate a strategic approach to adaptive practices and have a body of public servants that monitor the interconnectedness of public policy and its ultimate intended effects on climate change is a step in the right direction.

Camacho (2009) identifies two fundamental features of climate change that are different from more conventional environmental policy making strategies. The first can be attributed to the anticipated level of disruption. Every ecosystem experiences periodic disturbances that temporarily alter their intended function, but these ecosystems naturally recover from these disturbances (flood, fire, etc.) due to their resilient and dynamic characteristics. Current climate change predictions, however, are predicting that changes in weather patterns will be so severe that it will compromise the fundamental resilient ability and existence of many ecosystems (Camacho, 2009). Secondly, these anticipated effects are expected to occur at a speed many times faster than any ecosystem or human system has ever faced. The unprecedented speed at which these changes will occur make it difficult, if not impossible, to extrapolate from current environmental knowledge and experience (Camacho, 2009). These two factors contribute significantly to the exceptional uncertainly for natural resource governance when trying to collaborate efforts toward climate change adaptation.

Over time, scientist predictions have been relatively acceptable in predicting macro-trends in climate variables such as temperature and air patterns (Camacho, 2009). Modern models are even more sophisticated in predicting climate change trends than previous ones. However, even the most modern technology and recent models to predict the most straightforward variables (i.e. surface temperature and sea levels) are already proving to be fairly inaccurate. This inaccuracy is rooted in the multivariate nature of changing climates. Exact outcomes or impacts is, for the most part, unknown as some factors may be dependant and nonlinear while other factors only arise after changes in climate occur (Camacho, 2009). Therefore, various features of climate predictions are not well understood by modern ecological scientists, nor will this task get easier as technologies evolve and historical data is available.

Camacho (2009) identifies two further uncertainties that climate change adaptation presents, adding to the mounting issues for decision makers. Current efforts to adapt natural systems and the built environment to climate change will be influenced by mitigation activities that decrease further climate change. This may pose problems, as mitigation activities can vary and contain their own levels of uncertainties because they will be implemented by various regulatory figures and these figures are likely to change over time, thus altering the intended mitigation strategy (Camacho, 2009). Furthermore, climate change models have already been explained as a troublesome task, but projections that are localized to a scale needed to provide practical results for adaptation decisions are even more daunting:

> Localized impacts of climate change will vary greatly depending on the adaptability of each ecosystem and many non-climate factors. As modeling is downscaled to particular ecosystems, these various additional courses of uncertainty limit the ability to make projections and small changes in assumptions can lead to widely varying results. These difficulties are made even more challenging because basic long-term data are lacking for many ecosystems. As a result, local modeling is still rare and only provides limited reliable information about the effects of climate change on specific ecosystems (Camacho, 2009, p.37).

There are many other impediments to adaptation that are continually faced by decision makers while trying to integrate sustainable building mechanisms into public infrastructure. Smit and Pilifosova (2001) report numerous lessons from adaptation experiences in North America. At a high level, not only has there been difficult transitions in human capacity to adapt to long-term mean climate conditions, but there has been less success in adapting to extremes and year-over-year variations in climate (Smit and Pilifosova, 2001). This poses an issue because although human settlements have adapted successfully in a large variety of climate zones around the globe, those settlements are often vulnerable to deviations from normal weather patterns or minimal changes to current conditions. As a result,

adaptation strategies designed to address a change in mean temperatures may not be helpful in dealing with the unpredictable changes that are inherent in climate models (Smit and Pilifosova, 2001).

On a broader scale, adaptation strategies have fallen short due to the many conflicting interests and the many decisions that need to be made to solve an unpredictable problem. There is often numerous adaptation options available to decision and policy makers and "rarely do people choose the best responses- the ones among those available that would most effectively reduce losses- often because of an established preference for, or aversion to, certain options" (Rayner and Malone, 1998, p.34). In most cases, options that are considered have limited knowledge of risks or alternatives attached to them and adoption of certain courses of action can be constrained by other priorities, limited resources, or economic and institutional mindsets (Smit and Pilifosova, 2001). There is also much evidence that the cost of adaptation are growing and that there is a steep increase in costs associated with damage caused by extreme weather events and natural disasters (Smit and Pilifosova, 2001). These increased costs can be attributed to increases in populations and improvements in the standard of living, with more disposable income being spent on improvements to comfort and safety. Although adaptation strategies take into account these factors and there are attempts to expand adaptation programs, they are not necessarily effective or without substantial costs (Smit and Pilifosova, 2001).

A further compounding problem to adaptation strategies is that societal response to large environmental challenges tend toward incremental and makeshift outcomes rather than fundamentally rooted (Smit and Pilifosova, 2001). In climate change adaptation cases examined by Glantz (1998), "Ad hoc responses were favored over long-term planned responses. As a result, there has been a tendency [by government] to 'muddle through'. This has not necessarily been an inappropriate response, but it is probably more costly in the long-term than putting a long-term strategy together in order to cope with

climate-related environmental change" (Smit and Pilifosova, 2001, p.48). These findings imply that issues demanding early or longer-term attention often fail to receive necessary resources and the most effective responses are not considered (Smit and Pilifosova, 2001). The awareness by decision makers that earlier action would prove to be more advantageous is troubling, seeing as though they often weigh options and continually land on courses of action that take place over the short-term. Furthermore, there is little evidence that these short-tem autonomous adaptations to climate change will be effective (Smit and Pilifosova, 2001).

Camacho (2009) details two fundamental flaws attributed to the poor adaptive capacity of existing governance: natural resource governance is fragmented and climate change adaptations are for the most part, inadequate. He states that a baseline assessment of the state of natural resource governance is essential for understanding the range of adaptations strategies (and capacities) for addressing the effects of climate change. As it currently stands, existing governance mechanisms in the United Stated and Canada are fragmented, poorly informed and conversely un-adaptive making them inadequately suited to respond to our changing climate (Camacho, 2009).

Although Canadian environmental laws and climate change regulations have matured over the past few decades, most jurisdictions have been flooded with government programs and intervention to 'green' the environment from the local to national level (Camacho, 2009). In Ontario, the passing of the Green Energy Act, 2009 has signaled a new era in Ontario, where the environment has somehow jumped to the top of the agenda after many years of neglect (www.mei.gov.on.ca, 2010). Furthermore, programs to facilitate clean energy generation have been introduced such as GreenFIT, which reduces red tape and streamlines approvals for small scale renewable energy projects (www.mei.gov.on.ca, 2010). These programs have proven to be somewhat of a 'patchwork of piecemeal' regulation, "this broad fragmentation has both impeded concerted agency action for adapting to climate change and

created significant barriers for agency learning" (Camacho, 2009, p.38). Though the considerable effects of climate change are widely known and recognized, its effects cross jurisdictional regions which encounter widespread regulatory fragmentation (Camacho, 2009). Although many policies and regulations currently exist, many experts claim that current regulatory programs are unprepared and will not stand up against the effects of climate change. Camacho states that "some natural resource regulators claim to be in the process of considering strategies for adapting to climate change, but few agencies have adopted any adaptations. Even in recent regulatory actions, many agencies simply ignore climate change, with at least some agency officials claiming that, because of their limited jurisdiction, they have insufficient information or capacity to respond" (Camacho, 2009, p.38).

In addition to widespread fragmentation, Camacho (2009) identifies that governance is also fairly un-adaptive. Programs that are currently in place are not designed to manage uncertainty or reduce the likelihood of miscalculations that often result from facing difficult problems with improper tools (Camacho, 2009). Historically, the foundation of adaptation planning includes policy and regulation development, preparing and implementing management plans and the licensing of activities. These actions have been mainly premised and depended on agency expertise and these agencies have been expected to rely heavily on their alleged expertise at forecasting fairly detailed, long-term management plans (Camacho, 2009). Once plans have been adopted, agency responsibility is expected to be somewhat straight forward in its delivery, implementation and enforcement. In Ontario, these agencies may include the Ontario Realty Corporation (ORC), Infrastructure Ontario (IO), Independent Electricity System Operator (IESO), Hydro One, the Ontario Energy Board (OEB), the Ontario Power Authority, and Ontario Power Generation (OPG) (www.mei.gov.on.ca, 2010).

This model of adaptation, however, does not match the current realities associated with climate change. Due to the limited capacity of information regarding the future of natural systems and the true

impacts of a changing climate, agencies often adopt plans that are based on a set of incomplete or incorrect statistics, "as circumstances change, even plans based on rigorous data can quickly become obsolete" (Camacho, 2009, p.29). As the basis for any successful long-term plan, the monitoring stage and adjustments to the plan are necessary, but often deficient in agency adaptive planning. Furthermore, government oversight to hold agencies accountable to intended targets is not comprehensive and often lacks the necessary rigor to fully understand the inner workings of its agencies. Camacho explains this by stating "though monitoring of agency decisions is routinely required by statutes and regulations, and though agencies expressly acknowledge the importance of accountability, agency attention to such directives is notoriously poor. As a result, agencies rarely ensure that their actions are actually achieving regulatory goals, let alone adjust these decisions when new information is learned or circumstances change" (Camacho, 2009, p.30). Additionally, this approach to planning inevitably leaves natural systems and infrastructure open to numerous foreseeable and unforeseeable risks as initial projections may be incorrect, initial strategies may be ineffective and adjustments to the plan are ignored when new information is available (Camacho, 2009).

The lessons presented by the literature are indicative of the current framework in Ontario. An active response to adaptation must be considered in Ontario to promote investments in the built infrastructure that combat changing climates. Decision makers must address climate change concerns by investing in up front capital costs that will reap benefits down the road. All ministries and agencies should be part of the solution by identifying how projects will benefit the environment and overall delivery of programs, while decision makers should commit to funding projects that demonstrate adaptive abilities regardless of the uncertainties inherent in climate change predictions. Furthermore, adaptation and mitigation should be built into capital plan submissions and be considered as a necessary element in justifying the approvals for new capital dollars.

5.0 Ontario Government's Overall Approach to Climate Change

In Canada, climate change efforts are mainly guided by the Kyoto Protocol, which is a protocol developed by the United Nations Framework Convention on Climate Change (UNFCCC) aimed at fighting global warming and climate change. The Protocol was initially adopted on December 11, 1997 in Kyoto, Japan and entered into force on February 26, 2005 (http://unfccc.int, 2010). At the time of signing, this protocol required 37 industrialized countries (including Canada) in reducing their greenhouse gas emissions by 5.2% from 1990 levels by the year 2012 (http://unfccc.int, 2010). As this commitment was made by the Federal government, agreements were struck with individual provinces as to what their contributions to the national climate change commitment would be. In Ontario, the Climate Change Secretariat was formed in February 2008 to work with ministries and agencies from across government to drive results on the provincial Climate Change Action Plan (www.ene.gov.on.ca, 2009). The secretariat's mandate is to provide corporate leadership and support for government wide efforts on all aspects of climate change, particularly in tracking progress and risks related to achieving climate change commitments (www.ene.gov.on.ca, 2009). Therefore, the secretariat will act as the central government body in coordinating policies and approached to achieve Ontario's commitments.

Ontario's climate change efforts are largely guided by the Climate Change Action Plan which is publicly released on an annual basis by the Ministry of the Environment that reports on annual progress by the province on climate change initiatives (Climate Change Action Plan, 2009). Through this plan, the Ontario government has set ambitious targets to reduce greenhouse gases by 6 per cent by 2014 and 15 per cent by 2020 below 1990 levels (Climate Change Action Plan, 2009). The overall plan guides a holistic view to climate change in "building a greener, more sustainable economy" and fostering a "safe, healthy and prosperous future" (Climate Change Action Plan, 2009, p.3). The successful development and adoption of the plan depends on the creation of a green economy infrastructure and funding

alternatives to traditional construction and energy supply including increased conservation and renewable energy (Climate Change Action Plan, 2009). The Environmental Commissioner of Ontario (ECO) is responsible for monitoring the progress of Ontario's action toward climate change. The first annual climate change report, released by government in 2008, was identified by the ECO as a good step forward, but that the government must realize that "virtually all government ministries, agencies and related stakeholders will have a role to play in delivering on the plan's initiatives" (Climate Change Action Plan, 2009, p.4). The Ontario government is in agreement with this statement and has committed to a collective effort and comprehensive approach to climate change initiatives by including communities, sectors and ministries across the province (Climate Change Action Plan, 2009). These activities are all coordinated by the Climate Change Secretariat.

In September 2008, The Ontario Public Service (OPS) Green Office, who reports to the Climate Change Secretariat, was created to help government focus on further reducing its environmental footprint and adapt to changing climates by maintaining oversight for internal government operations (www. doingbusiness.mgs.gov.on.ca, 2010). The creation of this office demonstrates Ontario's ambition to be a leader in climate change efforts for other sectors of the province to follow. The OPS Green Office has internal government reporting responsibilities for three categories: facilities, fleet and fuel consumption. Facilities in the OPS are managed by the Ministry of Energy and Infrastructure while fleet management is the responsibility of the Ministry of Transportation and fuel consumption is managed by the Ministry of Government Services. It is evident that many different areas of government are responsible for separate responsibilities in response to climate change, but it is the mandate of the OPS Green Office to bring these efforts together. In focusing on facilities, the Ministry of Energy and Infrastructure has advanced the climate change agenda in two fundamental ways: the setting of greenhouse gas targets for government facilities and adopting recommendations to improve building adaptation from the Expert Panel on Climate Change Adaptation.

These advancements in the built portfolio will see infrastructure projects, including new construction, incorporating sustainable building practices and methodologies from design to implementation. Overall lifecycles and depreciation times will also be considered, as more robust building materials are introduced to withstand weather impacts. Furthermore, investments in capital upgrades and construction are balanced with long-term operation costs that will be saved over time by investing in building technologies that save energy. In reducing electricity and energy consumption in Ontario buildings, the province has already made significant advances through building renovations and upgrades. MEI has also committed to piloting the Expert Panel's protocol for the built environment, which will assess Ontario's current and future vulnerabilities from climate change on the built environment. These assessments are a good first step in incorporating adaptation techniques for the ground up and continuing to manage the government's portfolio in a responsible way.

In addition to these current practices, the government of Ontario has also made significant advancements in the way in which new construction is located geographically through the Growth Plan for the Greater Golden Horseshoe. This plan sets the framework for the province and municipalities in promoting more compact development and maximizing the utilization of existing servicing infrastructures to help reduce urban and suburban sprawl. The plan will help direct growth to already developed areas where capacity exists to support increasing populations and employment growth. The plan also focuses on intensification targets that will support the use of public transit and a healthy mix of residential and employment land uses (Growth Plan for the GGH, 2006). This plan is integral to the government's overall infrastructure strategy due to the geographic aspects of building infrastructure. A 'green' building must not only conserve energy and be sustainable, but should also be located in a place that utilizes existing servicing infrastructures and promotes higher densities. The most efficient building located on a greenfield site in a secluded location that is only accessible by car and requires entirely new servicing infrastructure is not ideal. The province has taken steps to consider both sides of the

sustainable equation when considering new infrastructure by constructing buildings that reduce overall GHG emissions and are located in places that contribute to the overall principles of intensification.

The Ontario government has also committed to adopting Leadership in Energy and Environmental Design LEED™, an internationally recognized green building standard, for new construction and major renovation projects in the province (ReNew Ontario Progress Report, 2007). The LEED™ standard was developed by the United States Green Buildings Council and was introduced in Canada through the Canadian Green Building Council. LEED™ promotes a whole-building approach to sustainability through five key areas including sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality (ReNew Ontario Progress Report, 2007). The adoption of this standard has played a key role in guiding investment decisions in Ontario, by requiring all new construction projects to achieve the LEED™ certified standard. Many projects in Ontario have gone a step further by producing new infrastructure that meets LEED™ Silver and Gold requirements. As expected, higher up front capital costs are required to meet these standards but are balanced by the long-term operational savings and net social benefits that these types of projects produce.

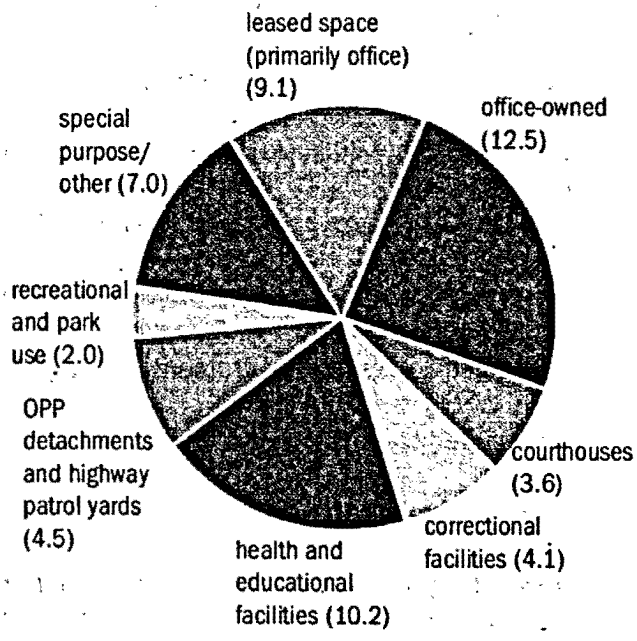
Although Ontario's overall strategy to climate change is fairly new and somewhat fragmented, concerted efforts have been made to coordinate internal government options to produce results and involve necessary stakeholders and agencies when making environmental decisions such as the adoption of policies through the *Green Energy Act, 2009* that require municipalities to report their energy consumption publicly and the appointment of the OPS Green Office to monitor internal government climate change operations. This will allow for both the province and municipalities to monitor progress in GHG savings while managing overall building portfolios. Taking both energy consumption statistics and capital repair schedules, governments across the province will be armed with

a more holistic approach to asset management implementation. Future annual climate change plans reported by the Ontario government should show progress in furthering internal and external coordination while fostering a culture of conservation.

6.0 Management Frameworks: Ontario Government Capital Asset Portfolio

The government of Ontario manages a wide variety of assets and provides capital repairs for a diverse portfolio. As it currently stands, there are approximately 6000 facilities managed by the government province-wide that support program areas and the delivery of services to Ontarians (Office of the Auditor General, 2006). Of this total, the Ontario Realty Corporation (ORC), on behalf of the Ministry of Energy and Infrastructure (MEI) manages a large portion of the portfolio, while the remainder of the portfolio is managed and operated by various ministries referred to as 'custodial ministries'. Eighty-one per cent of the portfolio is owned by the government while the remainder is leased (Office of the Auditor General, 2006). The ORC was established in 1993 as a Crown corporation under the *Capital Investment Plan Act, 1993* (Office of the Auditor General, 2006). The ORC provides real-estate, property and project management services to most ministries and agencies of the province (Office of the Auditor General, 2006). Custodial ministries include the Ministry of Transportation (salt domes, truck inspection stations), Ministry of Natural Resources (provincial parks), Ministry of Education (provincial schools), Ministry of Community Safety and Correctional Services (Jails) and the Ministry of children and Youth Services (youth detention centers). The breakdown of facilities in the province specific to their program use can be seen in Figure 5. Operating costs in 2006 to manage the government's portfolio for the ORC can be seen in Figure 6.

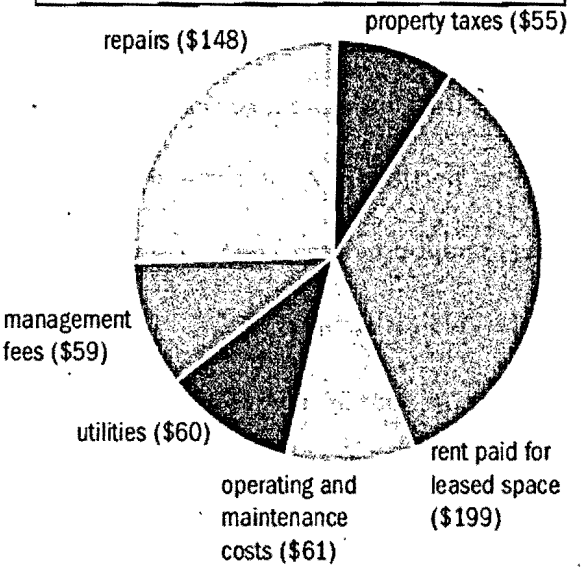
Figure 5- Ontario's Portfolio Mix in 2006



Source: Office of the Auditor General, 2010

In 2006, the ORC estimated that it needed about $160 million a year to manage ongoing capital repairs, renewals and modernization of programs for owned buildings (Office of the Auditor General, 2006). The ORC reported that they had not been able to secure such funding, and that as of March 31, 2006, deferred maintenance costs for its buildings totaled approximately $382 million (Office of the Auditor General, 2006). In addition, most of the government's buildings are reaching the end of their useful lives, as more than 80% of the portfolio is over 20 years old and almost half is 40 years old or older as seen in Figure 7.

Figure 6- ORC Operating Costs in 2006



Source: Office of the Auditor General, 2010

Currently, the Ontario government manages its assets through a systematic approach called the Results Base Plan (RbP) or Capital Plan. The RbP is prepared annually and submitted by individual ministries to the Ministry of Energy and Infrastructure (MEI) to assess how infrastructure dollars will be dispersed across government. MEI is considered to be the central agency in government that has an overarching view of Ontario's assets and will recommend the intended course of action for the upcoming year to Treasury Board for approval (www.fin.gov.on.ca, 2010). Recommendations made by MEI are informed by the Asset Management Framework (AMF). There are two components of the AMF that come together to form a comprehensive management approach to maintain public assets (www.fin.gov.on.ca, 2010).

Figure 7- Average Age of Government-owned Buildings as of March 31, 2006

	# of Buildings	# as % of Portfolio	Area (rentable million sq. ft.)	Area as % of Portfolio
< 11 years	39	2	2.5	8
11-20 years	205	12	3.7	13
21-30 years	171	10	3.1	11
31-40 years	295	18	6.8	23
> 40 years	825	49	11.9	40
age unknown	148	9	1.4	5
Total	**1,683**	**100**	**29.4**	**100**

Source: Office of the Auditor General, 2010

The first is maintaining existing assets in to an appropriate level so that facility operations are not compromised or pose dangers for its occupants. This methodology helps to inform investment and upgrades to current buildings in order to keep up with deterioration and replacement schedules (www.fin.gov.on.ca, 2010). Infrastructure dollars are calculated through this assessment by estimating life-cycle costing of building elements and deterioration over the next ten years, as this time frame seems to be sufficient for long-term planning purposes for government assets. Typically, Ontario approves funding for a 5 year capital envelope that addresses upgrades and capital improvements necessary over the short-term (www.fin.gov.on.ca, 2010). However, when planning for buildings that typically have a lifespan of 40 years or more, a ten year plan is required so that projects on the horizon can be flagged for better allocation of funds (www.fin.gov.on.ca, 2010).

A 'Facility Condition Index'(FCI) is used to determine the remaining service life and replacement values of assets across the portfolio by comparing the property (and building's) total deferred maintenance cost to its replacement cost in order to allocate funding levels necessary to keep the portfolio operating at an optimum level. This optimum level is referred to as a state of good repair, where government maintains assets to a certain level so that they do not fall into disrepair or pose health and safety concerns (www.fin.gov.on.ca, 2010). The Asset Management Planning process, over the past 3 years, has incorporated adaptation and mitigation elements to these projections by taking into account the longevity of certain building materials and allocating funds to base building repairs that will reduce electricity and greenhouse gas (GHG) consumption in government facilities (www.fin.gov.on.ca, 2010). Individual ministries are also beginning to be required to justify how new capital projects will contribute to Ontario's overall adaptation strategy.

The second driver of the AMP is the long term planning of government facilities. This can be considered a long-range planning process to rationalize government space and consider new or adaptive

reuse facilities to house growing program needs. Program needs identified by ministries could include dispersion of program delivery (i.e. spreading services over larger geographic areas), the need for more innovative infrastructure services (i.e. space adjacencies that respond to evolving social needs) and increased demands on current services (i.e. increasing caseloads for Ontario courthouses). Based on the remaining life of certain assets, a determination is made to renovate, renovate and expand, demolish and build new, or dispose. The remaining life and performance of assets is determined by the execution of building condition assessments (which evaluate buildings through a robust mechanism involving performance measures and performance indicators) that produces the FCI.

These two drivers combined actively manage the current and future needs of public assets across Ontario. It must be noted however that the government's main reason for investing in provincially owned corporate real estate is to maintain or increase effectiveness for program delivery. Asset condition, in terms of dollars spent and planned adaptation, plays a secondary role when managing these assets. That is, the asset condition rating can act as a indicator to incorporate adaptation measures into existing infrastructure in a planned fashion (assets with larger backlogs are likely to receive funding in the next coming years and can incorporate adaptation into these improvements, while newer facilities will likely have to wait for adaptation upgrades) while also determining if those adaptation measures will prove to be the most useful dollars spent (if an asset has surpassed its useful life, spending adaptation dollars on a building that will likely be replaced in the near future would not be wise). This management framework is the driver behind managing the government's portfolio only to a state of good repair to maximize program benefits to Ontarians and maximize service delivery from a limited amount of resources. If the government is to seriously adapt its building portfolio to a changing climate, the current managing framework must go further than the today and now and more attention must be paid to adapting current infrastructure to future impacts.

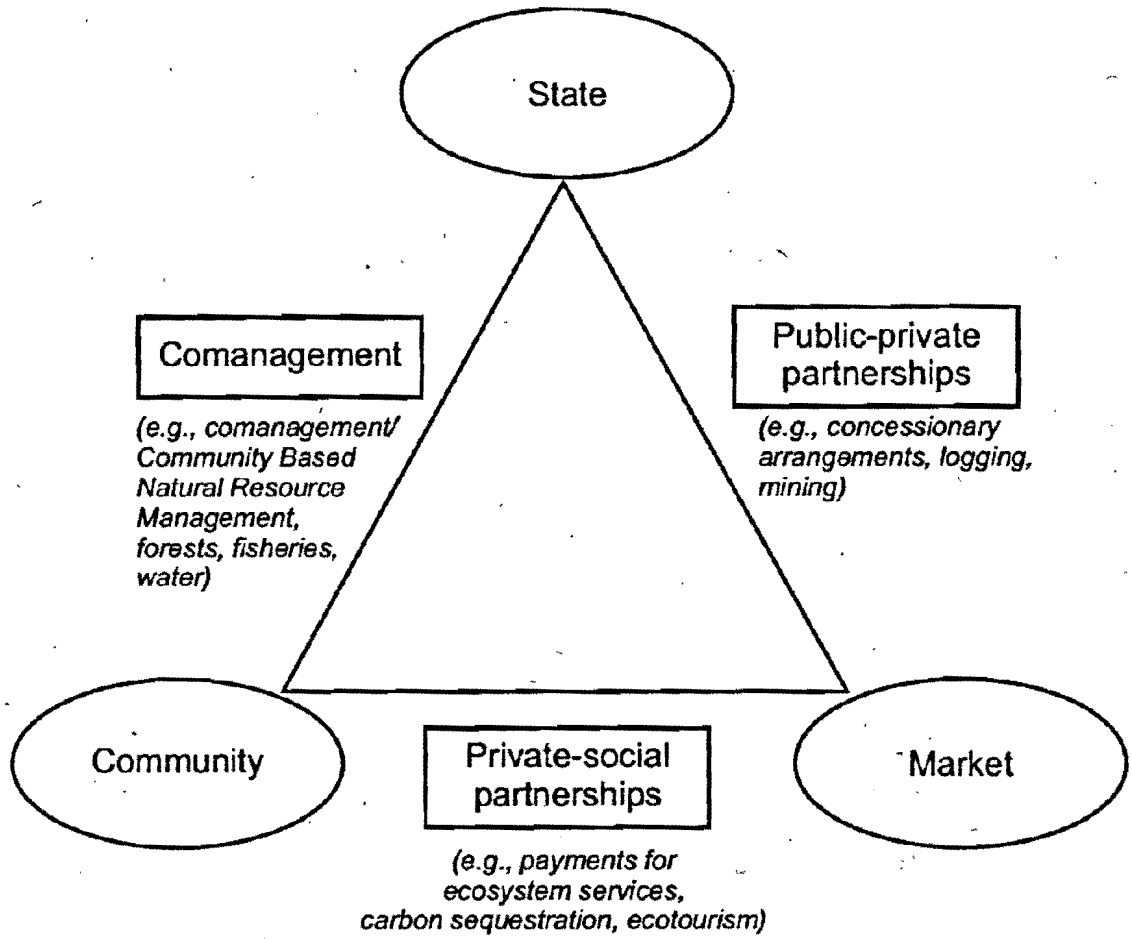
Although this process in Ontario has been in place for numerous years and is constantly evolving, there are a couple recommendations from best practice theory to be incorporated into current planning models to realize early successes. First, as previously discussed, decision makers are reluctant to invest funds in project for capital infrastructure due to the uncertainty of climate change and whether or not these investments will return any benefit to the portfolio. The Ontario government must develop, a more robust reporting system whereby annual capital projects and construction can be measured by the amount of GHG's reduced into the atmosphere and any other social benefits provided by the investment. This evaluation of implementation will guide government in making decisions based on experience rather than science. Second, infrastructure dollar approval criteria must go beyond current policy thinking. In handing out annual funds, Treasury Board submissions should require a holistic view of Ontario's assets and provide an explanation as to the overall benefit to Ontarians, including preparing for climate change effects. In allocating more funds to build and maintain robust infrastructures capable of withstanding large fluctuations of temperature and precipitation today, the government may be avoiding future pitfalls in losing operating functionality of its core asset base and having to invest additional funds to bring infrastructure back online. The current RbP process provides a streamlined avenue for appropriate approvals for infrastructure projects in government, but must incorporate evaluation methods pertaining to cost-benefit analysis and integrate adaptation costs in upfront capital allocations.

7.0 How Can Governance over Adaptation be Improved? Lessons from Research

As governments try to wrestle with the many issues associated with climate change, experts and watchdog groups alike continually offer suggestions and improvements to the way in which policies and frameworks are currently approved and implemented. There is much academic literature available from scholars that detail adaptation policy options that can be either fully adopted or used to augment current adaptation practices.

In Rob de Loë's report submitted to the government of Alberta on environmental governance, he suggests that the transition from government to governance is the acknowledgement of the fact that governments are not, and cannot be, the only source of environmental decision making authority (de Loë, 2009). Environmental governance has become a major concern because traditional approaches to achieve desired outcomes have not produced substantial results. He sites Glasenburgen's (1998) concept that the current actions of governance are mainly concerned with what could be and what should be (de Loë, 2009). Furthermore, all current styles of governance are founded on norms and desired objectives that reflect assumptions about how society should be organized, how problems should be addressed and by whom (de Loë, 2009). It is critical to realize, however, that environmental governance is dynamic and should be reconfigured to adapt to changing government accountabilities. In moving beyond the current models, he identifies 'hybridization' as a form of environmental governance that concentrates on innovative mechanisms or strategies to promote change (de Loë, 2009). One of these models is presented by Lemos and Agrawal (2006) with a diagram that identifies three common governance models that can be altered to cross boundaries in the way current governance structures are managed.

Figure 8- The Hybridization of Environmental Governance



Source: Lemos and Agrawal (2006)

Figure 8 represents a relatively tidy set of models, however, the concept of hybridization emphasizes that the realities of environmental governance should not work in silos, but rather have virtually endless combinations of communication and innovation that "reflect a better understanding of the functioning interconnectedness..." of social and government systems (de Loë, 2009, p.38).

This interconnectedness, or lack thereof, is described at length by Gore, Robinson and Stren (2009) by focusing on Canadian municipalities and the absence of a national framework. When looking at all public assets across the province, they are managed by different government entities whether it be

the province, municipalities, hospital boards or transfer payment partners. The general public does not recognize the distinction between these entities, but rather view all public buildings, from libraries to courthouses, to be managed by 'government'. It is because of this generalization that it is important for the province to integrate municipalities and the broader public sector into long-range conservation and adaptation plans. Furthermore, municipal and broader public sector infrastructures make up a significant amount of the overall building stock across the province. The province should also poise themselves to give necessary resources to lower levels of government in order for the entire public infrastructure portfolio to keep pace with current asset management practices at both the provincial and municipal level.

Gore, Robinson and Stren (2009) state that "cities have largely been taking action independent of the national government and provinces" (Gore et al., 2009, p.3). Intergovernmental coordination is seen as a necessary component of governance over adaptation, however Canada and Ontario, have largely been ineffective in combating climate change issues. The main reason for this is the way in which powers are divided in Canada (Gore et al., 2009). The responsibility for stewardship over the many aspects of the environment in Ontario has been delegated to the provincial level and there seems to be ongoing conflicts between all levels of government pertaining to who has ultimate responsibility over what 'environmental' parts. In contrast to this current scenario, Gore et al. (2009) state that "most policy arenas, especially climate change, can and should be simultaneously addressed by several levels of government" (Gore et al., 2009, p.2). Cities in Ontario have, for the most part, been bearing the burden of climate change impacts in the absence of formal provincial guidance and necessary municipal powers (Gore et al., 2009). That said, the provincial government must bring municipalities 'into the fold' of their long range Climate Change Action Plan. The province's plan to shrink their carbon footprint and reduce greenhouse gas emissions currently focuses on the province's direct impacts to the environment with a secondary focus on the broader public sector (BPS). The BPS includes municipalities, schools,

academic institutions and hospitals that are significant contributors to greenhouse gas emissions in the province and should play a more vital role in the development and implementation of the provinces long term plan. Regulations through the Green Energy Act, 2009 have introduced mechanisms by which BPS organizations will be required to report their energy consumption publicly and to the province in order to keep track and measure progress (www.mei.gov.on.ca, 2010). Although this is a good first step, many lines of communication between all levels of government must serve as the way forward in collectively combating climate change effects.

There is currently no single set of adaptive policy recommendations that are universally appropriate (nor should there be) and there are several studies available that suggest proposed adaptation techniques that may be used and evaluated. Smit and Pilifosova (2001) state that "at a very basic level, the success of potential adaptations is seen to depend on the flexibility or effectiveness of the measures, such as their ability to meet stated objectives given a range of future climate scenarios (through either robustness or resilience), and their potential to produce benefits that outweigh costs (financial, physical, human, or otherwise)" (Smit and Pilifosova, 2001, p.48). This philosophy in adaptation policy has clearly eluded the most prominent and forward thinking decision makers in Ontario, mainly due to the issues already identified: the complexity of adaptation measures, the variable sensitivities with capacities of regions, and the general uncertainties associated with climate. Research collected by Smit and Pilifosova (2001) describe supplementary characteristics of the identification of adaptation measures:

1) The measures must generate benefit to the economy, environment, or society under current conditions (i.e. independent of climate change).

2) The measures should address high-priority adaptation issues such as irreversible or catastrophic impacts of climate change, long-term planning for adaptation (planned

adaptation) and unfavorable trends (i.e. deforestation) which may contribute to future inability to be flexible to adaptation options.

3) The measures should target current areas of opportunity (i.e. purchasing of land, hardening infrastructure).

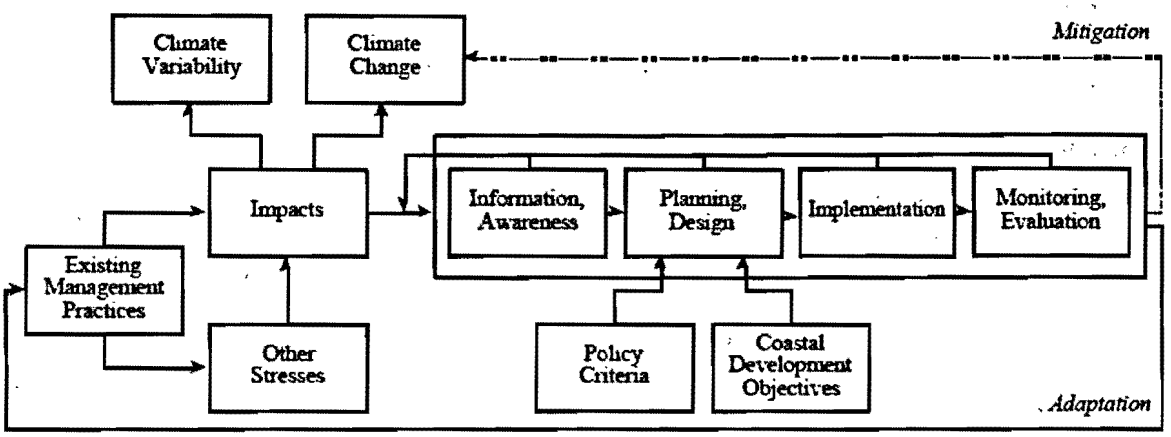
4) The measures should be feasible. Adoption of measures should not be significantly constrained by institutional, societal, financial or technological obstacles.

5) Measures should be consistent and complimentary to adaptation or mitigation efforts in other sectors and adjacent jurisdictions.

Smith and Lenhart (1996) explain more detailed procedures in identifying and evaluation adaptation methods. Their approach addresses the management of institutional processes and players where the central element of success relies on the 'net benefit' of the adaptation method selected (Smit and Pilifosova, 2001). Other considerations that must be taken into account include flexibility, benefits independent of climate change ('no regrets'), local priorities, level of risk and time frames of decision and implementation (Smit and Pilifosova, 2001).

Klein et al. (1999) outline a framework of the preferable process of planned adaptations that is aimed at changing existing management practices in government structures. The example portrayed in Figure 9 is developed for coastal zones. In the model, adaptation techniques are a continual and iterative cycle that involves several steps: information collection and awareness raising, planning and design (that incorporate policy criteria and development objectives), implementation, monitoring and evaluation (Smit and Pilifosova, 2001).

Figure 9- Preferable Framework for Planned Adaptation- Coastal Zones



Source: Smit and Pilifosova, 2001

Camacho explains an alternative, but similar solution for governments to be more inclusive and accountable for integrating adaptation into governance practices – called Adaptive Management. Adaptive Management is a useful strategy for managing the uncertainties inherent in climate change impacts as this strategy increases the ability for both natural (and built) systems and government policy to absorb and adapt to multiple climate change situations (Camacho, 2009). Although operating and delivering adaptation techniques in a world where effects are foreseeable and somewhat predictable would be ideal, waiting for the effects of climate change to surface will cause some irreparable losses to the natural world and would cause numerous built infrastructures and core assets to fail. Adaptive Management strategies definitely have the capacity to incorporate estimates as new information becomes available, rather than landing on 'black and white' scenarios and frameworks from the outset (Camacho, 2009). This allows policy decision makers to use current information which is not entirely correct at a particular point in time rather than waiting to act until science can validate the information because Adaptive Management allows for the strategy to be changed as more information becomes available. Furthermore, adoption of this framework allows for reliance on historical conditions as a comparison for future trends which helps evaluate assumptions for current asset management plans (Camacho, 2009). These features of Adaptive Management allow for an approach to addressing long-term strategies that may have uncertain outcomes.

Camacho's findings depict numerous actions that can be taken by government to incorporate planned adaptation into policy on a go-forward basis. He classifies government adaptation measures according to three relevant measures: (1) whether the adaptation measures primarily anticipate or react to climate change; (2) whether strategies focus entirely, partially or only indirectly on projected climate change effects; and (3) whether the strategy is substantive enough to respond to the direct effects of climate change, or is simply an indirect 'procedural' adaptation measure to demonstrate progress (Camacho, 2009). All of these government measures will likely have a role to play in a focused, comprehensive approach to planned adaptation. The following strategies will help develop a more robust policy framework and help government regulators manage uncertainty and reduce the risk of policy pitfalls.

7.1 Proactive and Reactive Strategies

As previously discussed, the timing of any adaptation strategy will have a significant effect on the success of the strategy and have an impact on the overall costs of implementation. A proactive adaptation strategy "takes place before impacts of climate change are observed" (Camacho, 2009, p.22) and seek to develop long-term solutions for infrastructure, education and collective adaptation capacity to adapt (Camacho, 2009). All strategies are at risk to the unpredictable nature of climate change effects, but in order for these strategies to be successful, the foundation of the strategy must be designed to adapt to a range of future possibilities and be flexible enough to respond to changing political and natural environments throughout implementation (Camacho, 2009). On the other hand, reactive strategies are "a deliberate response to a climatic shock or impact, in order to recover and prevent similar impacts in the future" (Camacho, 2009, p.23). These responses have only one key advantage over planned adaptation – strategies are implemented only after risks have been realized and the level of uncertainty is diminished. However, because they are implemented only after a

catastrophic event has occurred, there is a high level of natural and infrastructure damage that has occurred and sometimes can be irreparable (Camacho, 2009). Reactive adaptations may be highly vulnerable to higher long-term administrative and construction costs and damages because "inefficiencies in the response when it is needed, wasted investments made in ignorance of future conditions, or potentially even greater damages because precautionary actions were not taken" (Camacho, 2009, p.23). Therefore, when governments seek to adapt to the effects of climate change to infrastructure and natural resources, it is better to prevent negative impacts by investing in proactive adaptations to mitigate further future potential losses. Reactive responses should only be used where proactive strategies were unsuccessful in preventing or predicting a potential hazard from occurring, "establishing a systematic approach for cultivating successful proactive adaptations is thus crucial to developing effective adaptation strategies" (Camacho, 2009, p.24).

7.2 Exclusive, Co-benefit and No-Regret Strategies

A second main variable in establishing adaptation strategies is the effect of the adaptation method selected on the benefits provided (Camacho, 2009). Camacho delineates three strategies based on this variable as "*exclusive adaptations* are directed exclusively at reducing the effects of climate change. A *co-benefit adaptation* strategy is in part directed at reducing vulnerabilities related to climate change but also expected to produce other public benefits. *No-regrets adaptations* are directed at providing net benefits irrespective of the effects of climate change" (Camacho, 2009, p.40). Because there are uncertainties about future effects, Camacho (2009) suggests that decision makers should adopt and maximize the use of a no-regrets approach whenever possible. This strategy will reduce the risk of 'regulatory waste' from dreaded uncertainties because they will produce a net benefit to the regulatory system regardless if intended climate change impacts occur (Camacho, 2009). Camacho warns, however, that due to the magnitude and speed of anticipated impacts, reliance on no-regrets

strategies alone could remove attention away from adaptation to climate change and induce harsh impacts to the built environment down the road (Camacho, 2009). Adopting both partial or co-benefit strategies in conjunction with no-regrets will be beneficial, especially if the adaptations maximize supplementary public benefits in order to mitigate the risks from costly adaptations (Camacho, 2009). Lastly, exclusive adaptation should only be considered by government when it is used as a "precaution against particularly large or catastrophic risks" (Camacho, 2009, p.41).

7.3 Substantive and Procedural Government Strategies

When determining potential adaptation strategies, consideration should be given to whether or not the strategy seeks to address direct effects of climate change (substantive) or to change a process for deciding among numerous substantive adaptations (procedural).

Most adaptation strategies considered by government officials and outlined in literature pertaining to climate change adaptations are, for the most part, substantive. Substantive protocols and mechanisms, such as construction of dams and levees or the removal of harmful species, are more often than not, reactive. Furthermore, substantive adaptations generally alter the way society (and government) interact with the environment through the sharing of information or changes to regulations that encourage 'private conduct' (Camacho, 2009). An example of this, as explained by Camacho (2009), is when "regulatory adaptations that address increased risks to coastal resources could include (1) public information disclosure...; (2) early warning systems; (3) changes to government flood insurance; (4) subsidies or changes to zoning and building codes to increase the capacity of...property..." (Camacho, 2009, p.46). These solutions do not have the effect of mitigating the event in the first place, but rather sets up a procedural and policy framework to react more efficiently once the event has occurred.

Rather than focusing on the direct reactions to effects of climate change, procedural government strategies are intended to develop strategies that manage the regulatory programs and frameworks that derive long-term, planned adaptation methods (Camacho, 2009). Furthermore, procedural adaptation should be developed so that flexibility is built into the system to avoid uncertain future impacts and minimize mistakes made in the regulatory arena (Camacho, 2009). In order to do this, considerations to revamp current statutory frameworks, creation of new programs, or other fundamental changes to decision-making should be considered by government (Camacho, 2009). Policy development and allocation of funds should be geared towards programs and agencies that will help minimize future catastrophic events to core assets and infrastructures so that risks and costs can be minimized over the long run.

The Ontario framework for managing the building portfolio should start to incorporate these strategies such as no-regret and procedural adaptation strategies. Currently, Ontario has only managed to respond to climate change effects once they have occurred mainly due to current tools and frameworks available. In order to increase the anticipation of these effects, capital planning mechanisms should incorporate both overall net benefit of capital projects (that is, no-regret strategies that demonstrate the benefits of projects even if the expected climate change effect does not occur) and planned adaptation strategies that actively anticipate future effects on the building portfolio. Risk assessment methodologies that quantify the likelihood of future events should be conducted (based on weather modeling and historical weather data) to provide additional justification to the no-regret strategy. This can be achieved by requiring all capital construction and renovation projects to justify how the project will benefit the province's overall adaptation strategy including intended contributions to reduction of the carbon footprint. The justification of capital funding approvals should be demonstrated through both a qualitative and quantitative manner in that actual GHG emission benefits

should be calculated (quantitative) and other potential benefits of the project should be described (qualitative).

8.0 How Can Governance over Adaptation be Improved? Reflections from Ontario's Expert Panel of Climate Change Adaptation

In December 2007, the Minister of the Environment appointed 11 members to the Expert Panel on Climate Change Adaptation with a mandate to help the government, municipalities and Ontarians prepare and plan for the impacts of climate change on health, environment and infrastructure.

In November 2009, the Expert Panel presented their advice in the report, "Adapting to Climate Change in Ontario" on how to build a climate-resilient province. The report included 59 recommendations across a broad scope of sectors. The key overarching recommendation is the development of a province-wide climate change adaptation action plan, guided by a strategy. The government of Ontario should continue to utilize the Expert Panel's recommendations to inform actions to better prepare for the impacts of climate change. The Expert Panel describes Ontario's current situation as "an opportunity for both economic and moral leadership by connecting its investment in reducing GHG emissions with

Figure 10- Recommendation 1 from the Expert Panel

Recommendation 1

The Minister of the Environment should take immediate steps to seek Cabinet support for launching, by Spring 2010, a province-wide climate change adaptation action plan based on the advice provided by the Panel and guided by a strategy founded on the following goals:

STRATEGIC GOAL 1: ENHANCE GOVERNMENT LEADERSHIP

Enhance provincial government capacity to take leadership in effectively assessing, reducing and managing climate change and related natural disaster risks, as well as taking advantage of beneficial opportunities.

STRATEGIC GOAL 2: INTEGRATE ADAPTATION

Integrate adaptation to climate change into the policies and programs of government ministries for the purpose of continuously reducing risks as well as taking advantage of beneficial opportunities resulting from climate change.

Theme 1: Increase the climate change resilience of physical infrastructure, agriculture, and human health.

Theme 2: Increase the climate change resilience of ground and surface water, especially the Great Lakes; the diversity of Ontario's biological heritage, including species at risk, forests; and the carbon rich wetlands of the Hudson Bay Lowlands.

STRATEGIC GOAL 3: SUPPORT COMMUNITIES

Increase efforts by communities to improve climate change resilience by providing information, training and tools to support an adaptive, risk management-based approach to the impacts of climate change.

STRATEGIC GOAL 4: DEVELOP AND DISSEMINATE KNOWLEDGE AND TOOLS TO MANAGE RISK

Develop and strengthen the continuous creation and communication of knowledge about adapting to climate change, reducing climate risks and taking advantage of beneficial opportunities through programs of research, monitoring, public awareness and education.

STRATEGIC GOAL 5: COLLABORATE WITH OTHER GOVERNMENTS

Seek opportunities to influence and collaborate with other governments in Canada and internationally for the purpose of sharing climate change adaptation experience and developing cooperative activities.

Source: Expert Panel on Climate Change, 2009

investments in limiting the impacts of climate change that are now inevitable" (Expert Panel on Climate Change, 2009, p12).

The Expert Panel puts forth a few recommendations that impact how the built environment in Ontario is managed and sets a framework to initiate change in the OPS. These recommendations set a framework to be followed by the province to develop and incorporate climate change adaptation strategies over the long term through policy development and coordination between ministries. The first recommendation is launching a province-wide climate change adaptation action plan base on all the recommendations provided by the panel. This plan should include the five strategic goals outlined in Figure 9. More specifically, the panel suggests ways in which the province can focus on the built environment (core assets) to minimize further depreciation and increase resiliency. These two recommendations have been excerpted from the panel's report below:

Figure 11- Recommendation 10 from the Expert

Recommendation 10

The Ministry of Energy and Infrastructure should support the development of case studies for representative asset types and geographical locations to better understand the climate change risks to physical infrastructure. Where case studies or previous assessments indicate significant risk of failure for specific types of infrastructure, then:

- More detailed site specific risk assessments should be undertaken, and potential remedial adaptation actions identified and implemented; and
- Proponents of infrastructure projects for which provincial investment is sought should be required, after January 1, 2013, as a matter of due diligence, to provide a climate change and infrastructure risk assessment. In the meantime, proponents should provide a site specific vulnerability assessment of known climate risks such as flooding.

Source: Expert Panel on Climate Change, 2009

Figure 12- Recommendation 11 from the Expert Panel

Recommendation 11

The Ministry of Energy and Infrastructure should consult with the Canada Green Building Council and other relevant and experienced parties and establish a minimum climate-resilient, sustainable environmental standard for public buildings in Ontario in order to proactively demonstrate and support climate adaptive building design, materials, technology, and construction.

Source: Expert Panel on Climate Change, 2009

Both of these recommendations have been welcomed by the province and have already been seen to be incorporated into forward looking strategies. In fiscal year 2010-11, the Ministry of Energy and Infrastructure (MEI), along with its agent the Ontario Realty Corporation, have considered embarking in pilot studies that will undertake vulnerability assessment case studies for a sample of government buildings in conjunction with Engineers Canada's Public Infrastructure Engineering Vulnerability Committee Protocol (PIEVC) (www.mei.gov.on.ca, 2010). These assessments will assist MEI and ORC in ensuring the long-term resilience of government infrastructure to a changing climate. In the years to come, MEI should consider expanding this exercise to conduct additional case studies across different geographic regions and varying government building asset types. Furthermore, MEI has been in consultation with the Canada Green Building Council (CaGBC) to develop further requirements when conducting new construction and major renovation projects for Ontario government buildings (www.mei.gov.on.ca, 2010). Currently, the provincial government has mandated that all new construction and major renovations for government buildings achieve LEED™ certified standard. The province is considering changing this standard to a higher level under CaGBC requirements. Some cities in North America and jurisdictions have adopted LEED™ Silver or Gold as the minimum standard for construction of publicly owned buildings such as Portland, OR; Scottsdale, AZ; and Vancouver, BC (Expert Panel on Climate Change, 2009).

The need to introduce climate change risk assessments into the overall day to day infrastructure planning and investment strategies in Ontario comes at a time when all levels of government are facing challenges in meeting current and deferred infrastructure needs (Expert Panel on Climate Change, 2009). The panel recommends that Ontario's public infrastructure should be properly documented and tracked based on key indicators such as location, age and current physical condition to enable proper planning of adaptation measures (Expert Panel on Climate Change, 2009). To address this recommendation, the provincial government has adopted asset management plans for provincially-

owned infrastructure and has started to consider and incorporate climate adaptation practices into the capital planning process (www.mei.gov.on.ca, 2010).

These climate change risk assessments may uncover vulnerabilities in assets across the province by which the government may be inclined to mitigate. It is evident that adaptive practices are more beneficial and cost effective when integrated into the planning and design of facilities rather than as a retrofit to existing structures. However, modifications to the current built environment may be needed to respond to changing climates and increased flood risks. These modifications to the current building stock can include building hardening mechanisms that can withstand flooding or extreme heat. Replacement of building systems and materials can be chosen that are able to withstand more extreme weather which in turn, will not fail as often as inferior systems and materials. Furthermore, the upkeep and management of public infrastructure to maintain assets in good condition and mitigate depreciation will enable public infrastructure to have a greater ability to withstand the stresses on building structures presented by changing climates. This would entail the systematic funding of capital repair projects on an annual basis and the upkeep or replacement of building systems in a timely manner to provide the most resiliencies against extreme weather events.

The province's annual capital planning process is by far the most integral part in establishing a sustainable way forward for adapting the built environment to climate change. As annual and long-term plans are developed by all ministries, they must consider the effects that new capital requests may have on the future of Ontario's infrastructure. The annual capital plan process is where the province has the most leverage to incorporate funding and commitments in meeting Ontario's adaptation plan. The Expert Panel reports that they were encouraged to see revisions to the annual infrastructure planning guidelines to ministries to enhance considerations of climate change in infrastructure investments (Expert Panel on Climate Change, 2009). Furthermore, the province has incorporated a multi-year

Infrastructure Plan, called the Long-term Infrastructure Plan (LTIP) to accompany annual capital plans in order to require ministries to consider the impacts on infrastructure and identify capital renewal projects that address climate change adaptation and mitigation (Expert Panel on Climate Change, 2009). The annual reporting cycle will allow MEI to have oversight on the capital requests brought forward, as well as monitor long-term progress toward targets as identified by ministries.

In addition to the LTIP and annual plans, MEI introduced the Green Energy Act in 2009 which will have prominent positive effects toward the built and natural environments. This 'first of its kind' legislation in Ontario will place a greater emphasis on energy efficiency and conservation as well as a focus on generation from renewable power sources such as wind, solar and biofuels (www.mei.gov.on.ca, 2009). The introduction of this legislation will help foster a culture of conservation in Ontario and will produce new and emerging adaptation opportunities throughout the province. The province can also be commended on its new energy saving target, whereby the province intends to achieve a 19% reduction in GHG emissions by 2014 over 2006 levels in government facilities (www.mei.gov.on.ca, 2009). Although adaptation strategies are necessary, less adaptation will be required if climate change can be somewhat mitigated through the conservation of energy and the reduction of Ontario's carbon footprint.

When taking the considerations presented to Ontario by the Expert Panel on Climate Change Adaptation and lessons from research demonstrated through alternative governance models on adaptation, the province has room to rework current frameworks in place. Although the annual capital planning cycle for the maintenance and construction of government facilities has been the main tool for maintaining infrastructure in Ontario, there are significant gaps when focusing on climate change adaptation and mitigation.

Current forms of planning, review and implementation can all be revised in order to capture the effort and funding needed to manage the government's infrastructure in a responsible and environmentally friendly way. The current planning model for managing Ontario's infrastructure over the long-term is potentially the biggest area for improvement. Ministries currently request infrastructure dollars in a piecemeal fashion from government with little attention paid to future long-term impacts of infrastructure and mitigating factors. For instance, the Ministry of the Attorney General (MAG) may request planning funding from government to undertake a study for a new consolidated courthouse in any given area of the province. Currently, the capital planning guidelines require MAG to justify why the new courthouse is necessary from strictly a program perspective. That is, demonstrating that current facilities in the area have outgrown their usefulness to deliver consistent and convenient justice services to the public and that caseload demand has increased beyond the capacity for the courthouse to manage. Factors that are not taken into consideration relate to the overall management and impact this new capital project may have on the government's portfolio as a whole. For example, before capital dollars are allocated to construct a new courthouse on a greenfield site, considerations should first be given to existing assets currently present in the government's portfolio and under the province's control. Ontario's current building portfolio contains buildings that may be underutilized or vacant which may be suitable candidates for the expansion of MAG's program. These types of facilities are already contributing to the government's carbon footprint and it would make more sense to make use of the building that is already built, rather than building new. Obviously, necessary building upgrades such as window replacement, boiler and chiller upgrades, for example, may be necessary to make the building as energy efficient as possible while incorporating planned adaptation building element specific to the climate zone in which that building exists.

Furthermore, if MAG's request to build a new courthouse were to be approved, what would happen to the current facilities they are currently occupying? In many cases, two or three courthouses

are vacated in a certain geographical location to 'consolidate' into a newer, larger facility. MAG would not be required to consider the impacts of vacating these facilities, nor would they be required to produce a planning report that would make suggestions to government about the highest and best use of these facilities once MAG is gone. The capital planning cycle is meant to require ministries in government to think about their long term plans for occupying facilities across the province. This plan, however, is only concerned about the service delivery models presented by individual ministries. These service delivery models vary greatly by ministry and program area therefore presenting an ad-hoc approval process across sectors. The annual planning cycle must also incorporate overall attention to the built environment as well and the impacts that new construction or major renovation may have on the GHG emissions for buildings and the assets left behind. Attention to this will contribute to a planned adaptation framework that is revisited and revised on an annual basis.

The current approval process and implementation of capital projects can also be refined to include attention to adaptation and mitigation. As with the planning stage, approvals must coincide with projects that make a concerted effort to either reduce GHG emissions or adapt to changing environments, or both. Decision makers must advocate certain requirements from government as a whole to produce plans and program directions that contribute to the provinces Climate Change Action Plan. Although there are many competing interests for the built environment, such as security threat risk assessments, making buildings more accessible to disabled Ontarians, and general maintenance schedules, more funding must be allocated to projects that demonstrate adaptive capabilities and mitigation technologies, such as renewable technologies. Gone are the days where decision makers can solely defend their investment decisions on the cost benefit of return on certain projects. Decision makers must now consider the net benefit as a whole to government and the society at large in terms of adapting to changing climates before core infrastructures are imminently damaged. Increased up front capital investments in public infrastructure will lend itself to both financial and environmental benefits

down the road, that far surpass initial investments. Furthermore, the implementation of projects conducted by government should include an evaluation mechanism that appraises the overall benefit of the project including financial, environmental and social. Over time, government will attain enough historical information to determine which projects will have the greatest overall benefit and will also be able to change spending patterns as new scientific information about climate becomes available. Therefore, the current review, approval and implementation practices in Ontario should be modified to include these considerations in working toward a more holistic approach to planned adaptation.

These alterations to the current capital planning process should not be borne solely by the Ministry of Energy and Infrastructure (MEI) alone. All ministries and agencies responsible for government assets have a role to play. As previously discussed, the Climate Change Action Plan sets the framework for Ontario in terms of reducing GHG emissions and adapting to future climates. The OPS Green Office should continue to have oversight on the overall progress from government as a whole and bring together achievements from individual ministries so that knowledge can be shared. MEI will continue to be the ministry responsible for managing the government's portfolio and making recommendations to Treasury Board on annual capital spending. MEI should continually revise planning guidelines to improve consistency and justification for new projects through language and requirements that signal mitigation and adaptive capacities will be taken into consideration when evaluating approvals. These guidelines must also force ministries to look at long-range planning for their facilities from both a *program* and *portfolio* perspective. MEI should also promote and reward projects that focus on mitigation and adaptation strategies and techniques. The larger, more difficult challenge will be for individual ministries to include justification for capital dollars through an analysis of environmental benefits and reduction of emissions. In many cases, ministries do not have stand alone departments that have a firm grasp on climate change issues, nor do they have the expertise to demonstrate to government how their project will be an adaptive one. As the agent on behalf of MEI,

the Ontario Realty Corporation must help with this analysis while capital plans are being developed at the ministry level. The ORC will be able to give insight into how to make projects more adaptive and increase adaptive capabilities. The ORC will not be able to do this comprehensively for all ministries and projects. It is therefore necessary for ministries to attain necessary in-house expertise to manage their long-term plans with a focus on environmental benefits. Ministries must also be accountable for taking into account broader portfolio issues, such as vacated facilities and the impacts of new construction, when submitting annual requests to MEI.

9.0 Conclusion

As discussed throughout this paper, the effects of climate change are inevitable and governments must strive to formulate goals and action plans that mitigate climate change and prepare the built environment for unforeseeable circumstances. The two main drawbacks for implementation of a comprehensive climate change adaptation strategy in Ontario can be attributed to (1) the inability to properly project or anticipate future effects of climate change and (2) the inability for decision makers to allocate appropriate funding to projects that may not result in substantial benefit.

In Ontario, substantial effort has been made to incorporate best practices and resilient design when managing the government's portfolio. There is, however, a long road ahead. The Expert Panel on Climate Change Adaptation has given the province a grab-bag of solutions to further incorporate adaptation techniques into current and future policy frameworks. These recommendations will need to be a focus for the Ontario government over the long-term as populations increase and demands for public infrastructure become overwhelming. These recommendations start the conversation at the policy level in attaining a long-term planned adaptation strategy for the province while mitigating greenhouse gas emissions and conserving energy.

In order for the government to fully accept and incorporate climate change adaptation into both policy and operations, there must be a shift in thinking toward who and what our public assets are serving. As previously discussed, the primary focus and reason why government invests in its building portfolio is to provide accessible, safe and adequate services to all Ontarians. Not only should this focus be on serving the public, but serving the environment as well. Shifting the tools and information available to decision makers to build and manage the government's portfolio in a way that is responsible to the environment as well as the public will serve to be beneficial in the long run. Not only will up-front investments in energy upgrades save operational costs for government, but it will also allow for the

reduction of GHG's emitted from Ontario buildings. Furthermore, building in sustainable and planned adaptation techniques today will allow for the building portfolio to have a longer lifespan and be more responsive to catastrophic weather events. This is especially important for Ontario's core assets, where they are often used as shelters and command centers in the event of major climate events. Therefore, regardless of the payback periods or overall 'net' benefit to government, climate change adaptation should be built into infrastructure planning immediately, as the costs associated with repairing assets after weather events have occurred can be much greater. Furthermore, Ontario's long-term adaptation plan should be flexible enough to change and adapt as new weather or infrastructure information becomes available. This flexibility will prove to be useful as government and policy makers change and as political agendas are altered.

The available options for change in Ontario's current capital planning process have been identified as having prominent effects on the way infrastructure is managed. It has been noted that all ministries and agencies are responsible for paying attention to and including adaptation in their annual capital plans. While the OPS Green Office should continue to expand its mandate over the governance of climate change internal to government, ministries should begin to address climate change benefits into the foundation of their long term plans. MEI should continue to require individual ministries to demonstrate capital benefits to adaption while maintaining a holistic approach to the current built environment. Decision makers should begin to loosen the purse strings on adaptive investments and realize the numerous benefits, including financial, that adaptation and mitigation projects will have on managing a sustainable building portfolio. Individual ministries should also begin to arm themselves with necessary expertise in managing long-term infrastructure plans.

The Ontario government should continue to move forward in establishing focused research in the arena of adaptation and mitigation. Research on the substantial benefits adaptation and mitigation

projects can have and the impacts or savings to operational budgets will be beneficial in tendering future infrastructure projects. Further research must also be paid to the ever changing advancements in renewable technologies and building systems that can help mitigate the effects of climate change. More attention on the structuring of long-term plans and the management of deteriorating assets will be beneficial to Ontario's success. With population in Ontario expected to rise and increased deferred maintenance to the building portfolio on the horizon, a delicate balance between creating new and maintaining current infrastructure will play an important role in establishing a reliable infrastructure network for the future.

The Ontario government can be proud of the groundbreaking legislation it has introduced over the past five years to focus on energy conservation, the promotion of renewable technologies, and support to build more compact and complete neighborhoods. Although there is still much to be done, Ontario has poised itself to be one of the 'green' leaders in North America and now has the opportunity to capitalize on its past by adopting more robust planned adaptation methodologies for the future.

Bibliography

Ali, A., 1999. Climate Change Impacts and Adaptation Assessment in Bangladesh. In: National Assessment Results for Climate Change: Impacts and Responses. Inter-research, Oldendorf, Germany, pp. 109-116.

Adger, W. N., Huq, S., Brown, K., Conway, D., and Hulme, M, 2006. Adaptation to climate change in the developing world. Progress in Development Studies 3(3): 179-195.

Bizikova et al., 2008. Canadian Communities' Guidebook for Adaptation to Climate Change: Including an approach to generate mitigation co-benefits in the context of sustainable development.

Bosher, Lee, Patricia Carrillo, Andrew Dainty, Jacqueline Glass and Andrew Price, 2007. Realising a resilient and sustainable built environment: towards a strategic agenda for the United Kingdom Department of Civil and Building Engineering, Loughborough University, Leicestershire, United Kingdom Disasters 31:236-55.

Burton, I., 1996. The growth of adaptation capacity: practice and policy. In: Adapting to Climate Change: an International Perspective. Springer-Verlag, New York, NY, USA, pp. 55-67.

Burton, Ian, Elliot Diringer and Joel Smith, 2006. Adaptation to Climate Change: Internal Policy Options. PEW Centre on Global Climate Change, Arlington, VA, USA.

Camacho, Alejandro E.,2009. Adapting Governance to Climate Change: Managing Uncertainty through a Learning Infrastructure . Emory Law Journal, Vol. 59, No. 1, 2009; Notre Dame Legal Studies Paper No. 09-06.

De Loe, Rob, 2009. From Government to Governance: A State-of-the-art Review of Environmental Governance. Guelph, Ontario, Canada.

Environmental Commissioner of Ontario, 2009. Building Resilience: Annual Report 2008-09.

Expert Panel on Climate Change Adaptation, 2009. Adapting to Climate Change in Ontario : Towards the Design and Implementation of a Strategy and Action Plan. Report to the Minister of the Environment

Glantz, M. H., 1998. Societal Responses to Climate Change: Forecasting by analogy. Westview Press, Boulder, CO, USA, pp 428.

Gore, Christopher, Pamela Robinson and Richard Stren, 2009. Governance and climate change: assessing and learning from Canadian cities. Presented at 5th World Bank Research Symposium, Marseille, France.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: Impacts, Adaptation Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: UNEP/WMO.

Intergovernmental Panel on Climate Change, 2007. Climate Change 2007: Impacts, Adaptation, and Vulnerability. Cambridge University Press, Cambridge, UK.

Klein, R.J.T and R.S.J. Tol, 1997. Adaptation to Climate Change: Options and Technologies, An Overview Paper. United Nations Framework Convention on Climate Change Secretariat, Bonn, Germany, pp.33.

Klein, R.J.T., R.j Nicholls and N. Mimura, 1999. Coastal adaptation to climate change: Can the IPCC Technical Guide be applied? Mitigation and Adaptation Strategies for Global Change, 4 (3-4), 239-252.

Leary, N.A., 1999. A framework for cost-benefit analysis of adaptation to climate change and climate variability. Mitigation and Adaptation Strategies for Global Change, 4(3-4), 307-318.

Lemos, M. C. and A.Agrawal (2006). Environmental Governance. AnnualReview of Environment and Natural Resources, vol. 31, pp. 297-325.

Ministry of Energy and Infrastructure. Green Energy Act, 2009. Retrived June, 2010, from www.mei.gov.on.ca.

Ministry of the Environment, 2009. Climate Change Action Plan: Annual Report 2008-09. Queen's Printer for Ontario. Retrieved online from www.ene.gov.on.ca.

Ministry of Finance. Ontario's Current Infrastructure. Retrieved July, 2010, from www.fin.gov.on.ca.

Ministry of Government Services. Supply Chain Management. Retrieved July, 2010, from www.doingbusiness.mgs.gov.on.ca

Ministry of Public Infrastructure Renewal, 2006. Places to Grow: Growth Plan for the Greater Golden Horseshoe, Queen's Printer for Ontario.

Ministry of Public Infrastructure and Renewal, 2007. ReNew Ontario Progress Report 2007, Queen's printer for Ontario.

Office of the Auditor General of Ontario, 2006. 2006 Annual Report of The Office of the Auditor General. Queens Printer for Ontario.

Olmos, Santiago, 2001. Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Methods. Climate Change Knowledge Network Foundation Paper.

Ontario Premier's Office. Greening Ontario's Economy. Retrieved July, 2010 from www.premier.gov.on.ca.

Ontario Realty Corporation. The Management of Ontario's Realty Assets. Retrieved June, 2010, from www.ontariorealty.ca.

Rayner, S. and E.L. Malone, 1999: Climate change, poverty and intergenerational equity: the national level. In: Climate Change and Its Linkages with Development, Equity and Sustainability: Proceedings of the IPCC Expert Meeting held in Colombo, Sri Lanka, 27–29 April, 1999. LIFE, Colombo, Sri Lanka; RIVM, Bilthoven, The Netherlands; and World Bank, Washington, DC, USA, pp. 215–242.

Smit, B., Pilifosova, O., Burton I., Challenger B., Huq S., Klein R.J.T. and Yohe, G., 2001. Adaptation to climate change in the context of sustainable development and equity; in Climate Change 2001: Impacts, Adaptation and Vulnerability, contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, p. 877-912;

Smith, J.B. and S.S. Lenhart, 1996: Climate change adaptation policy options. Climate Research, 6(2), 193–201.

The Canadian Council for Public Private Partnerships. Defining 'State of Good Repair. Retrieved April, 2010 from www.pppcouncil.ca.

The Institute of Public Administration of Canada. Government Partnerships. Retrieved May, 2010 from www.ipac.ca.

United Nations Framework Convention on Climate Change. Kyoto Protocol. Retrieved June, 2010 from http://unfccc.int.

United States Environmental Protection Agency. Retrieved July, 2010 from www.epa.gov.

Washington State Department of Transportation. 'State of Good Repair' Definition. Retrieved April, 2010 from http://www.wsdot.wa.gov.

Watson, R.T., Zinyoera, M.C., and Moss, R.H. 1996. Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analysis. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.