PI TWG POLICY COMPONENT 3
BUILD TO LAST, BUILD RESILIENCY INTO ALASKA'S PUBLIC INFRASTRUCTURE.

A. Current codes address material strength for regional historical conditions.

Codes provide users with material strength data, load combination criteria, and loads for self weight and various live load magnitudes depending on the application. Codes when properly implemented will provide safe infrastructures for known historical climatic conditions. So, the code is focused on safety, it does not provide for performance or asset management. These are policy issues.

If the climate changes and the weather conditions change, factors such as flooding, erosion, thawing, wind speed, and seismic activity may render the design load conditions to be unsafe. In other words, we are currently designing for history and not for the future.

Maps for wind, snow, and seismic are included with criteria for applying the conditions to a design application are provided in each code. Load combinations (e.g. dead load combined with wind has a different probability than dead load combined with wind snow and live load). Therefore, the code is specific on how to combine each type of load to produce maximum design loads. The maps in code are based on accumulated historical records. Therefore, maps for climatic exposures involving wind gusts, snow accumulation, and seismic may require modification for a specific city, community or borough.

Other extreme events such as tornadoes, hurricanes, earthquakes, coastal tidal waves, inland flood events are impacting some communities. Therefore, we should periodically evaluate our design maps with a focus to minimize risk to people and property. The findings may be used to provide amendments to the codes and updated risk based load maps to accommodate a probabilistic historical design.

Deleted: life.

Climatic conditions may be different from region-to-region. Local officials (such as zoning boards) typically lead the effort to provide amendments to accommodate regional conditions in the code. For example, in mountainous areas, the snow accumulation may be higher than the code map. Near coastal areas, it is likely that the wind speeds will be higher than provided for in the code map.

- We need to consider developing our designs based on anticipated future trends, not for trends based on solely past data.
- The elements of the code are satisfactory and therefore, we recommend that any revisions to accommodate climatic changes should be handled through living amendments that can be updated as information improves.
- Current codes address safety (strength). The code does not address infrastructure performance policies or management of assets over their life.

Deleted: and

Deleted: the

Deleted: through better information

Deleted: accommodate

Deleted: t management;

Deleted: this is a policy issue and not a code issue.

- Although codes do not address performance, we should consider policies that provide a methodology to accommodate designing for extreme events (a strength or functional safety consideration) and performance design for normal conditions.
- Implementation of this approach is not possible unless there are scientific data available to meet this goal. At present futuristic climatic events are scientifically not available at a sufficient resolution usable by the engineering profession. Therefore, the science must be developed first.

Deleted: for use

Certain attributes of infrastructure influence its adaptability to change. For example, most infrastructure is built to last for several decades: bridges, housing, commercial buildings, seaports, and rail infrastructure typically require reconstruction or major upgrades every 50 to 100 years; dams, water supply infrastructure, sewers, and airports have an expected lifecycle of 50 years; and roads and waste management facilities require major upgrades every 20 to 30 years. These life spans create a significant hurdle for climate change adaptation, since the replacement of such structures is economically and logistically impossible. For infrastructure with long life spans "expected changes in climate may occur considerably earlier during the expected service life, possibly forcing expensive reconstruction, retrofit or relocation." Most infrastructure, however, requires upgrades or major refurbishment or, as in the case of roads, resurfacing, on a regular basis. Roads need resurfacing every 5 to 10 years; rail, airports, and seaports need major refurbishments every 10 to 20 years; and dams/water supply and waste management infrastructure need major refurbishment every 20 to 30 years. These timelines are not always followed. Much municipal infrastructure in Canada is in need of maintenance, rehabilitation or replacement. In 2003, Mirza and Haider estimated that the infrastructure deficit in Canada exceeded $100 billion. This is the cost of bringing all municipal infrastructure up to an acceptable level (approximately $44 billion), plus the cost of rehabilitation of all infrastructure under the provincial and federal jurisdictions and the private sector. Clearly, there are limited funds for maintaining our infrastructure and building new infrastructure, let alone researching, redesigning and retrofitting infrastructure for climate change impacts. On the other hand, if so much of our infrastructure is in need of replacement or rehabilitation, then this may be an opportune time for climate change adaptation to become an element of infrastructure design.

Water Supply and Wastewater Infrastructure- The literature explains that the design phase of water infrastructure needs to change to accommodate climate changes. Vulnerability and risk assessments should replace the current dependence on historical climate data. Regularly updated climate design values that reflect the latest changes in regional climate, including precipitation variables, are required for the updating of design codes and standards. Currently, engineers use historical climate records when designing most urban water drainage systems. If precipitation patterns change, urban drainage systems could fail, causing problems such as sewer backups and basement flooding.

Transportation Infrastructure-The current and potential impacts of climate change on transportation infrastructure include both beneficial and detrimental impacts. Beneficial impacts include, for example, reduced winter road maintenance costs as a result of milder winters and the opening of the Northwest Passage. Detrimental impacts are already felt in the North, where warmer temperatures are degrading northern roads and runways, and reducing the usefulness of ice roads and ice bridges. An example of infrastructure design that included climate change adaptation is the Confederation Bridge, which required an environmental assessment under the

Canadian Environmental Assessment Act. The bridge incorporated design specifications to withstand potential climate change impacts such as a one meter rise in sea level.

Literature Related to Engineering Needs- The vulnerability of different types of infrastructure and the potential impacts that new engineering requirements, codes and standards will have on climate change vulnerability are largely unknown. Further study is needed to determine the correlation between climate change impacts, building materials, maintenance schedules, and the lifespan of infrastructure. Further, design techniques vary in their resilience to climate change. For example, slab on grade constructed on permafrost will likely be more proned to damage in a warming climate than pad and post techniques. Few methodologies integrate climate change scenario information into infrastructure design. 110 Several reports emphasize the importance of modifying engineering practices and codes and standards for infrastructure to incorporate climate change impacts. According to the Canadian Standards Association, high priorities for climate change adaptation are those without existing national standards and include storm water management, rehabilitation of existing infrastructure, northern infrastructure, and coastal regions.

Our existing infrastructure has been adapted to the variable climate conditions of the past using a set of climatic design values in building codes and other infrastructure standards. Climatic design values such as 100 year wind storm speed or 50 year flood are estimations of the probability that a severe weather event will occur in any given year. For example, in any given year, a 20 year return period value indicates that there is on average a one in 20 chance that this 20 year wind storm speed could be reached or exceeded. At present, almost all infrastructure has been designed using climatic design values that have been calculated from historical climate data under the assumption that the average and extreme conditions of the past will represent conditions over the future lifespan of the structure. With climate change, these climatic design values will need to be assessed regularly, improved, updated and probably changed to reflect changing climate extremes (e.g., a one in a century storm may occur much more frequently, or the weight of snow or amount of rain that a structure is designed to endure may change). Structures designed using climatic design values that are based on sparse climate data or previously short dataset records are particularly vulnerable.

To ensure effective “no regrets” adaptation to current and expected climate variability, it is critical that these uncertainties and deficiencies be climatic design values be addressed .

Deleted: would be important that such

Deleted: in

There are many reasons why climate change adaptation options are not yet regularly incorporated into infrastructure design and why climatic design information does not include climate change projections. These include uncertainties in climate change projections, uncertainties and gaps in existing climatic design values, and a shortage of sufficient climate station records. Climate monitoring and analyses programs provide the essential raw information needed for climate change adaptation, including improved and new codes and standards. 118 One of the federal government’s key roles related to climate change is to maintain climate monitoring, data collection, analyses, and other scientific activities essential for adaptation (e.g., developing climate change scenarios and research on impacts). As noted in the 2006 Report by the Commissioner for the Environment and Sustainable Development, budget reductions have constrained these monitoring networks, as well as the archiving and analyses of the data in support of infrastructure design. Climate data must be analysed before it can be useful and, "key analysis of climate data to support infrastructure design was not conducted." According to Heather Auld, while engineers have come knocking on government's door to ask for new or updated climatic design values for codes and standards for infrastructure, progress has been slow in spite of best efforts.

Deleted: Furthermore, although climate

The engineering community in Canada is beginning to work on climate change adaptation options for infrastructure. The Engineering Institute of Canada held a Climate Change Technology Conference in May of 2006. The conference drew participants from around the globe, and papers presented included topics such as engineering adaptations for urban drainage infrastructure planning and design considerations, municipal infrastructure decisions and incorporating climate change adaptation into InfraGuide type decision making. The Canadian Council of Professional Engineers (CCPE) began a climate change adaptation program in 2004. According to the CCPE: "climate change will, over the years, necessitate changes to building codes, engineering practices and standards, and will affect the way facilities are designed, ultimately altering the economic lifespan of infrastructure and thereby impacting commerce and industry." [123] As part of its program, CCPE formed the Public Infrastructure Engineering Vulnerability Committee (PIEVC) with the task of facilitating a national assessment of the vulnerability of Canada's public infrastructure to climate change impacts. The committee is comprised of representatives from key nongovernmental organizations and senior level representatives from three orders of government. The Director General for the Issues Management Directorate – Program Operations Branch is the current INFC representative on the PIEVC. INFC's Research and Analysis Division is funding an engineering initiative through its Knowledge building, Outreach and Awareness Program. The Canadian Standards Association is conducting the project *Developing Engineering Curriculum Needs: Climate Change and Infrastructure* to develop engineering curriculum on climate change and infrastructure. The climate change adaptation work of the Canadian engineering community is significant, but in terms of engineering design changes, work is still at an early stage.

Conclusion- The main findings from this literature review can be summarized as follow:

1. Adaptation is a relatively new concept and work in this area is in its infancy. Adaptation research has not been initiated within Alaska resulting in lack of coordination between the science and engineering community. This is particularly true at the federal level. The federal government is supporting research on climate change adaptation for infrastructure, but it has made little progress on implementing changes: most examples of adaptation efforts are at the provincial, territorial, or local level.

Deleted: in

Deleted: Canada

Deleted: Mainly research not implementation of adaptation actions has been completed to date.

2. Adaptation is expensive; however, the costs of not adapting infrastructure will be greater in many cases. Uncertainty and cost should not be barriers to implementing adaptation options. "No Regrets" adaptations provide cost effective benefits regardless of future climate changes. "No Regrets" adaptations for infrastructure include actions such as analyses of infrastructure failures; regular infrastructure maintenance; community disaster management planning; updating climatic design values and engineering codes and standards; and improving the quality and length of climate data records.

3. The vulnerability approach, which is based on the concepts of vulnerability and

adaptive capacity, is the best method for determining and choosing adaptation options. This approach is used and promoted by Natural Resources Canada and many international organizations.

4. There are specific challenges related to infrastructure adaptation such as the long life spans of some infrastructure; however, due to the need for rehabilitation or replacement of existing infrastructure and current federal funding commitments, this may be an opportune time for climate change adaptation to become an element of infrastructure design.

5. Rural and agricultural communities face specific challenges related to adaptation for infrastructure.

6. Most research on climate change adaptation for infrastructure relates to the water and transportation sectors. More research on adaptation is needed in all sectors, including infrastructure such as energy, communications, buildings, and solid waste management.

7. Although much research has been completed on infrastructure adaptation in northern Canada, more work is needed in other regions. As the climate change adaptation literature becomes more regionally specific, it becomes increasingly clear that regional or local assessments and adaptation strategies are essential for effective adaptation.

8. We do not have a good understanding of the vulnerability of different types of infrastructure, nor do we know what potential impacts new engineering requirements and codes and standards will have on climate change vulnerability.

9. Infrastructure design parameters must accommodate climate change and future impacts. Engineers need new and updated climatic design values, revised codes and standards, and new methodologies to incorporate potential climate changes into engineering procedures. More current climate data and its analyses are needed for this work. The federal and state role in monitoring and reporting is essential. The impact of climate change on infrastructure have not been quantified through any rigorous study.

10.There is a need for improved communication (information sharing and training) between climate change researchers, policy makers, engineers, architects, operators or asset managers in order to mainstream climate change adaptation into design, maintenance and restoration of infrastructure.

Building codes and their relationship to impacts of climate change essentially are sound and should not be changed. What may be considered are modifications to weather design events (these are typically developed to provide public safety). A corresponding set may also be considered to accommodate performance.

Climate change conditions may impact the number, and intensity of storms temperature precipitation, windstorms and sea states. These conditions do not affect the design codes. It does affect asset management and governmental policies related to appropriation for handling the location and size of population centers. The codes are adequate in designing infrastructure to handle loadings and predicted change. What is missing is the weather and

Deleted: in Canada.

Deleted: must change.

Deleted: areas

Deleted: such as monitoring and reporting is essential.¶

Deleted: more

Deleted: Leroy's Ideas-

Deleted: and/or

Deleted: size

Comment [B1]: Need input from other disciplines to coordinate with engineering viewpoint.

Deleted: (water, snow, ice, sun),

Deleted:

Deleted: volcanic, seismic, and hurricane events.

Formatted: Font: Times New Roman, 12 pt

environmental data the infrastructure is anticipated to endure and adequate performance expectations for local conditions. Consequently, we should amend the codes to address local conditions including a changing climate.

It is worthy to amend our codes to provide for service and maintenance as part of the design process. The details may be deterministic or may be more general. At present, If it is to be deterministic, we do not have the necessary data to incorporate these issues in our codes.

As a matter of policy, we should seek to use design construction and maintenance techniques which lower the vulnerability of the infrastructure to climate change.Further , it would be reasonable to request a vulnlerability assessment and maintenance plan for each new project and an emergency preparedness plan for facilities should conditions change. Further, revisions to recurring events that are in the code should be revisted to accommodate the latest probablistic scientific knowledge.

B. Option Design

Codes for Alaska have several potential conditions that climatically may affect public facilities and the peoples of this state. For example, we know that the coastal areas are changing, the expected recurrence flood levels are more frequent with higher water elevations, seismically the state continues to be active and conditions may be more difficult in winter (frozen-stiff) than summer (thawed-less stiff). Further, climaticconditions appear to be cyclic and therefore we must not only consider that warming may produce unstable subsurface foundations in permafrost areas, it is equally complicated and difficult when we are in a cooling cycle and the subsurface freezes causing frost heaves. A methodology (this is not a code provision) should be developed to accommodate these considerations.

- **Structure/design:** In Alaska, there are several situations that are different than other states. These include:
    - Subsurface Conditions: In the Interior, there is Permafrost and Discontinuous permafrost. If the climate changes and it warms, the designer must consider possible differential movements and the infrastructure should be sufficiently flexible that it can move with minimal damage. The same conditions should be considered if the temperature because colder and these marginal soils freeze causing frost jacking and excessive heaving. Thus, amendments or design guidelines are needed to address these conditions.
    - Floods: The frequency of floods and the water elevation of these events is putting some of the infrastructure at risk. Therefore, climatic conditions may either make this worse or as events change it may improve. It is important to consider that we only two roads connecting the state to the North American Freight system.
    - Coastal areas – There are a number of areas within the state of Alaska in which land near the sea is being removed and Villages and small communities will need to move. In addition, unlike many other areas in North America, the tides in Alaska change are extreme and designing for this condition at ports and harbors is a special challenge.

Formatted: Font: Times New Roman, 12 pt

Comment [B2]: I think we should indicate the codes are adequate in designing infrastructure to handle loadings and predicted change. What is missing is the weather and environmental data the infrastructure is anticipated to endure and adequate performance expectations for local conditions. Consequently, we should amend the codes to address local conditions including a changing climate.

Deleted: For example, water, waste water, facilities may be at risk in some areas due to lack of sufficient clean water and in other areas where people may be living in coastal areas that are becoming potentially unstable or at risk. In the arctic, both higher temperatures and lower temperatures providing challenges for the engineer. These are engineering issues and not code enforcement issues. ¶

Formatted: Font: Times New Roman

Formatted: Font: Times New Roman

Formatted: Font: Times New Roman

Deleted: ¶
¶
As a part of policy

Deleted: may

Deleted: that it would be

Comment [B3]: I might also suggest we seek to use design techniques within the code which lower the vulnerability of the infrastructure to climate change.

Comment [B4]: Barbara, we can use a bit of help understanding what is needed here.

Deleted: ally

Comment [B5]: We may also wish to include increased potential for ice jams including those which may occur mid-winter.

- **Targets/goals:** We suggest that the special conditions that may put the performance or safety of parts of our infrastructure at risk should be studied and this information in the form of design guidelines should be distributed through short courses. In addition, these design issues may be prepared as an amendment to the existing codes. For example, the following items may be considered:

We recommend these codes be amended to accommodate climatic changes. The added load conditions should include:

- Risk assessment (this affects location and usage);

- At present the design codes are developed around the best historical data to date. Thus, any design is expected to do well for a given life within that historical period. The approach needs to accommodate some scientifically expected climatic condition for the future, so the in-service life and the code life are within the same time period.

Deleted: futuristic

Deleted: design

Attention must be given to:

a) Hazards caused by wind (tornados, hurricanes), precipitation (storm surge, river ice, floods, snow and ice), thermal (damage design for diurnal temperatures and overall changes in temperature), earthquakes and volcanoes. These conditions are regional and should be statistically based so that the codes can accommodate the best information available and with provisions to accommodate change.

b) Current designs are typically based on single year temperature range. A better approach is to use a probabilistic based approach using a three year average. Doing so allows us to do a better job of estimating impacts.

Asset management is a very real part of our economy requires we have a clear understanding of how infrastructure ages and how climate change may affect this. Climatic changes will further complicate these issues and should be considered as part of state and local policy.

Deleted: and yet the codes do not address these aspects in either the design or the maintenance of our infrastructure.

Deleted: the amendments to the code

Risks to the public infrastructure caused by higher temperatures:

- increased flooding and erosion
- decreased duration and extent of sea ice
- increased wind and precipitation
- thawing permafrost
- increased fire risk

A. Build to Last.

1) Meet or exceed design service life
2) Best in class life cycle costs/asset management practices
3) Able to withstand disasters and changing environment
4) Based on the best science and appropriate building codes & engineering standards

Comment [B6]: We may want to include the possibility of short lived or mobile facilities in some cases where they are economically and socially attractive.

B. Promote "No Regrets" Improvements

1). Provides benefits regardless of future climate changes
2). Enhances Sustainability
3). Protects investments/increases return on investment

C. Mandate Systematic Key Data Collection, Analysis and Monitoring

1) Baseline inventory and current conditions
2) Conduct hazard and vulnerability assessments
3) Analyze to identify future conditions and vulnerabilities
4) Identify adaptation measures and tools to assess and adopt options
   Prioritize and coordinate research /computer modeling Mandate

(After Chapter 17: Yuri and Goering)

Table 17.1 Recommended modulus of ventilation (based on Saltykov 1959)

Thermal resistance of structure above crawl space ($m^2 h^\circ C$ $kkai^{-1}$)	Indoor air temperature (°C)	Modulus of ventilation for permafrost zones		
		Northern	Central	Southern
1	15	0.0025–0.005	0.005–0.02	0.02–0.03
	30	0.0075–0.015	0.015–0.05	0.05–0.08
2	15	0.0015–0.003	0.003–0.01	0.01–0.015
	30	0.0035–0.007	0.007–0.02	0.02–0.03
3	15	0.0008–0.002	0.002–0.006	0.006–0.009
	30	0.002–0.0035	0.0035–0.01	0.01–0.015

Comment [B7]: While this is good information, not sure how this ties in to this discussion. Consider deleting.

Table 17.3 Comparison of North American and Russian approaches to designing foundations with ventilated crawl space

Characteristics	North America	Russia
Safety factor	2.5–3	1.05–1.56 (Khrustalev 2001)
Tip bearing capacity of piles	Usually not taken into account	Taken into account
Type of air space beneath a building	Open	Often closed with openings, whose area is calculated from modulus of ventilation (MV)
Central heating line in crawl space	Usually not installed	Often installed
Pile material	Steel	Concrete
Building construction material	Light	Heavy

Reassessment of existing approaches to infrastructure construction in permafrost regions has been triggered recently by concerns associated with the potential impact of climate change on permafrost. At sites with ice-rich soils, preservation of permafrost beneath buildings remains the main approach. Most permafrost soils are highly thaw-unstable, and their thaw settlement cannot practically be accommodated. Preliminary thawing of permafrost prior to construction has not found wide application so far. As long as the mean annual surface temperature remains below 0°C, means of permafrost protection without artificial refrigeration could be applied. Numerous building failures in permafrost regions are related to changes in permafrost due to poor design, and to poor maintenance of buildings, which are more powerful factors than the natural change in permafrost temperature. In other words, improper design will trigger premature failure with or without climate change.

Deleted: building

Timing: (Needs further discussion)Needs to start immediately. When would the policy/program/action take place, how long would it take, over what time frame can results be expected? Would the benefits provided be only in the short-term or over the longer term as well? Will the proposed action be adjusted in response to changing conditions or will it be effective under different plausible climate scenarios? (e.g., no regrets if the option is implemented and changes don't occur or occur differently than anticipated.) Is the policy, program or action needed in response to likely immediate impacts (e.g., thawing ice and permafrost) or longer term impacts?

Comment [B8]: With each new building, road, erosion control structure or dock, we lose an opportunity. Many of the suggestions provided herein can be adopted with little effort and improved with time.

Participants/Parties involved: Individuals, federal/state/local government agencies, non-governmental organizations, private foundations, corporations, and others involved in this issue. Describe how they are involved.

Comment [B9]: We need to include all agencies that plan, design, construct, and maintain our infrastructure. In addition funding decision makers must be convinced of the value of this approach and that we must consider all costs of the infrastructure not just the first costs.

Evaluation: What type of monitoring and evaluation of the adopted policy, once implemented, would be needed to gauge effectiveness and any corrections that would be needed overtime.

Research and Data Needs: What R/D will be needed before this option can be implemented (note that this will float over to the RN WG as well as remain here).

Comment [B10]: Several research and data needs are mentioned in the document. We can gather them up and reiterate them here.

C. Implementation Mechanisms

This is an indication of how the option could be implemented, for example:

- Steps that would be taken to get it in place (does a feasibility study need to be done first?).
- Is new legislative authority needed?
- Does a new agency or group need to be formed? A new activity added to an existing government agency, or expansion of an activity already undertaken by a non-governmental entity?
- Is there anything else that needs critically to happen before this option can be implemented?

Comment [B11]: Probably the best approach is to develop code amendments for public structures which include climate change and performance standards for Alaskan conditions.

D. Related Policies/Programs and Resources

(Needs further discussion)

- **Related Policies and Programs:** Do current governmental, non-governmental, or private programs exist that are relevant to this policy option? Please list them and describe in some detail. Err on the side of including too much information and too many potentially relevant programs (these can be trimmed down later). Are there potential synergies with other efforts being undertaken in other sectors, states, or otherwise?

- **Available Resources:** What resources already exist to address this issue? Are there funding mechanisms in place to institute this policy? Is the necessary expertise available? Does an existing governmental body have the necessary authority and/or practical ability to implement this policy option? Are there unconventional resources available, such as indigenous knowledge or social networks?

Comment [B12]: DOT&PF is responsible for the design and construction of state facilities. It would be logical for DOT to take a leadership role, but they may have to be pushed there.

Comment [B13]: First costs may go up, but agency costs may go down.

E. Benefits and Costs

Needs further discussion

Still working on details, but likely will include:

- Qualitative or quantitative estimate of effectiveness of option.

Comment [B14]: This would be better understood after a vulnerability assessment. Canada performed a similar study for Yellowknife which may provide insight.

- Qualitative discussion or quantitative estimate of the cost of the option (both governmental and private sector, if the option involves private sector investment or other costs). Cost includes the initial costs of implementing the policy/program/action, and also costs over time - such as operation and maintenance, administration and staffing, expected frequency of reconstruction, non-economic and non-quantifiable costs such as the "cost" of resource value lost if action is not taken. For example, costs such as an increased impact on human health should be considered along with more traditional costs.
- Co-benefits—non-impact related, or ancillary, benefits.
- What governs effectiveness of adaptation options?
- Key assumptions about effectiveness and key uncertainties.
- Documentation of data sources used for estimates.

Comment [B15]: This one is really difficult and may be handled on a case by case basis. ISSER made an attempt at this, but that effort had a lot of assumptions that need refining. We can talk about this in general terms including foundation failure, flood damage, etc.

F. Feasibility Issues

Needs further discussion

Comment [B16]: Feasible but requires careful coordination between the engineering and scientific community.

- **Feasibility:** Can the state realistically implement the proposed action. Is the proposed action within state authority or is it more appropriately the role of the federal government, localities, individuals, etc? Do the necessary legal, administrative, financial, technical, and other resources exist, and are they available for use on this proposed state action? (Question for Jackie/Larry: can the TWGs leave the issue of political feasibility entirely to the Governor's Sub-Cabinet?)

  Include in this discussion other aspects of the context for the option, such as substantive or procedural issues involved with this policy option, including potential conflicts of interest, different levels of governmental or non-governmental involvement in this issue.

Comment [B17]: No doubt the state can easily implement this. I would suspect the incremental cost may not be very large.

- **Constraints:** Are there potentially limiting factors for this policy option? Does the policy require public buy-in? Will there be a long delay between actions taken and benefits realized? Are there other potential logistical, geographical, financial, technical, or procedural constraints?

  Note that the discussion does not need to be broken into two separate sections as indicated above. The sections are more of an indication of the types of issues that can be raised in the feasibility section.

Comment [B18]: The biggest constraints are lack of data, increased first costs and the lack of commitment to invest in our own future.

G. TWG Approval and Deliberations

This is particularly of interest for the AAG. This section indicates the level of approval within the TWG, and is a place to indicate any minority views on the option, as well as caveats or ideas to keep in mind as implement the policies. This will likely appear only briefly in the final appendix of options, but is important for the AAG.