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**DRAFT Catalog of Proposed Adaptation Actions and Policy Options
Public Infrastructure (HC) Technical Working Group**

July 16, 2008

Option No.	Adaptation Policy Option	Potential Impact Reduction	Cost	Externalities, Feasibility	Priority for Analysis	Notes / Related Actions in Alaska
	Principles to guide state policy development and adoption: a disciplined, comprehensive, purposeful, strategic, and efficient approach.					
	PUBLIC INFRASTRUCTURE - <i>This sector addresses the physical impacts of climate change on Alaska's built environment and transportation options.</i>					
PI-1	Highways, Roads, and Bridges					
1.1	Ensure Climate Change is considered as part of upcoming review of 'Alaska's State Transportation Plan'					

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1.2	Review Department of Transportation's Future Corridors Initiatives to insure it appropriately addresses climate change					
1.3	Require/Enable Metropolitan Planning Organizations to take climate into account					<p>Anchorage MATS http://www.muni.org/transplan/amats.cfm</p> <p>Fairbanks Metropolitan Area Transportation System (FMATS) http://www.dot.state.ak.us/nreg/planning/fmats/index.shtml</p>
1.4	Integrate Transportation and Land Use Planning					
1.5	Explore options for Community Planning Efforts, to address program for SLR (sea level rise) & other climate impacts					
1.6	Establish Climate Change and Public Infrastructure Task Force (focused on adaptation)					
1.7	Review public education funding criteria to address adapting behavior in light of climate risk					

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1.8	Re-evaluate evacuation Routes and modify as necessary					
1.9	Evaluate and address damage to highways, roads, and bridges from thawing permafrost					
1.10	Evaluate and address damage to highways, roads, and bridges from temperature changes					
1.11	Evaluate and address damage to and loss of roads from coastal and river erosion					
1.12	Evaluate and address buckling and submersion of boardwalks in village communities					
1.13	Evaluate and address damage to highways, roads, and bridges, from glacier melting, flooding, avalanches, and debris flows.					

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1.14	Evaluate and develop a management plan for vegetative growth along infrastructure (highways, pipelines, etc.) where vegetation has not previously been (North Slope)					
1.15	Evaluate infrastructure design standards/codes associated with retrofitting activities for existing infrastructure to address lower probability events and to recognize SLR and potential increased severity of storms and storm surges					e.g. some cities are protecting to the 500 year event rather than the 100 year event because of the increased vulnerability. Instead of using these storm events as the design benchmark, incorporate projected sea level rise in the design storm event
1.16	Minimize the installation of paved surfaces as a strategy for flood runoff control					
1.17	Add additional planning scrutiny to future infrastructure investments in undeveloped hazard-affected coastal areas					
1.18	Strengthen design codes for bridges, roads, and highways, to account for climate impacts					
1.19	Implement strict maintenance regulations for existing infrastructure in acute sea level rise hazard zones					

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1.20	Develop an inventory of potentially impacted infrastructure and maintain this database relative to emerging projected sea level rise findings					This is an essential first step in scoping relevance/viability of potential adaptation options
1.21	Evaluate the need for redeveloping structures to raise first floor elevations some distance above base flood elevation					Such action would need to be based on compliance with climate change-proofed comprehensive standards/codes; base flood elevation refers to the 100-yr flood incorporating sea level rise considerations
1.22	Evaluate the vulnerability of existing and future unprotected reaches of shoreline with respect to existing infrastructure.					Determine need for and type of shoreline protection appropriate to these reaches.
1.23	Develop and evaluate a public repurchase program for vulnerable lands and public/private infrastructure					This option would also seek to assess relevance to private sector infrastructure
1.24	Plant trees and other vegetation to reduce flooding and erosion					
1.25	Require that counties act on comprehensive planning requirements					

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1.26	Integrate critical area planning requirements with comprehensive planning laws, including emergency planning, emergency evacuation routes, and infrastructure planning requirements					
1.27	Develop and emergency evacuation plan – (evaluate infrastructure for emergency preparedness)					
1.28	Develop a strategy to regularly update floodplain maps					
1.29	Establish a coordinating mechanism to assure that local governments act in concert with the state to reduce future impacts from SLR and associated hazards					
1.30	Synchronize future design with emergency planning and evacuation infrastructure requirements					
1.31	Investigate opportunities and innovations with potential to benefit the economy, public services, and business sectors					

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1.32	Create inventory of infrastructure vulnerable to future SLR and associated hazards					
1.33	Create on-line mapping capability for multiple audiences including local governments					
1.34	Create visualization tool for SLR and associated hazards					
1.35	Establish structures training and vocational support for trades and others involved in implementation of new design standards					
1.36	Integrate climate change and adaptation issues into advanced training in university, community college, and technical training programs					
PI-2	Airports, Landing Strips, and Air Transportation					
2.1	Evaluate and address the impacts on airports and landing strips related to thawing permafrost					
2.2	Develop new standards for developing airport and landing strips in light of climate change impacts					

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2.3	Evaluate and address the need to relocate, re-align or repair airstrips due to coastal and river erosion and flooding					
2.4	Develop a comprehensive airstrip maintenance plan to address issues associate with climate impacts (thawing permafrost, ice, heavy precipitation, flooding, vegetative growth, etc...)					
2.5	Evaluate and address dangerous flying conditions, associated with icing, coastal fog, and non-traditional storms					
PI-3	Buildings					
3.1	Survey existing building damage and loss due to shoreline erosion, less shorefast ice, melting permafrost, storms, realignment of rivers and flooding and identify the need to relocate buildings (e.g. Koyukuk) and plan for future siting					

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3.2	Evaluate wild fire risk to buildings due to increased wild fire intensity and frequency and increased threat from diseased/dead trees (e.g. Caribou Hills fire in 2007)					
3.3	Strengthen existing building codes for new infrastructure and incorporate an increase in building inspection effectiveness as part of the strengthened codes as well as setback zones and phased-out or no development in areas vulnerable to sea level rise					Incorporating projected sea level rise in the design storm event, as the design criteria applicable to vulnerable infrastructure
3.4	Improve hazard preparedness of residential homes and commercial entities by providing operational assistance or incentives					
3.5	Assess sea level rise hazard insurance for businesses as part of standard operations					
3.6	Assess sea level rise hazard insurance for home owners in inundation hazard zones					
3.7	Develop and use insurance policies to drive and support retreat activities					

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3.8	Implement standardized community education materials on hazards that addresses the relationship between climate variability and climate change					
3.9	Conduct a comprehensive vulnerability assessment for all public and private properties					This would include critical facilities such as power stations, hospitals, etc, as well as cultural resources such as museums
3.10	Increase construction protocols/conventions for piers and wharves for wave strength					
3.11	Evaluate the riparian rights/property rights in the context of sea level rise					Current riparian rights are based on the paradigm that sea level is constant. Could include recommendations for resolving issues resulting from consequences of protective measures.
3.12	Relocation of threatened structures - Evaluate presence and significance of threatened historical structures and develop plans for their relocation and/or protection					
3.13	Guide future development out of areas vulnerable to sea level rise and associated hazards					

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3.14	End permitting of new homes in areas vulnerable to sea level rise and associated hazards					
3.15	Buy out unused properties in areas vulnerable to sea level rise and associated hazards					
3.16	Develop retreat strategies for the management of existing structures or conditions that may become submerged hazards to navigation or public health (e.g. effluent outfalls, water intakes, septic fields, rockwalls, docks, and piers)					
3.17	Develop strategies to address situations of changing ingress/egress to structures as support for access roads in areas vulnerable to sea level rise and associated hazards is withdrawn					
3.18	Modification of land use, agricultural , and landscape practices including aquaculture, saline-resistant crops, depending on location and purpose					
3.19	Raise shoreline structures					

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3.20	Establish a mechanism to evaluate and recommend new design standards for structures (and placement of mechanical and electrical equipment) that may be vulnerable to SLR and associated hazards					
3.21	Require all municipalities to have written and operational disaster response plans that are updated at least every 5 years, and that include consideration of likely changes in the frequency and intensity of extreme events due to climate change					
PI-4	Sea Walls and River Shoreline Protection					
4.1	Re-evaluate current icing and ice control methods due to more ice from longer seasonal transition periods					
4.2	Evaluate the effectiveness of hard structural options such as dikes, levees, floodwalls, saltwater intrusion barriers and install these options based upon effectiveness and feasibility					

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4.3	Review construction standards for piers and wharfs for wave strength					
4.4	Increase flood protection, e.g., dams, reservoirs, sea walls					
4.5	Limit infrastructure investments in hazard-affected coastal areas					
4.6	Develop an early warning system (i.e., enhance hazard preparedness) through incorporation of sea level rise in hurricane and storm-surge evacuation planning.					
4.7	Develop an inventory of potentially impacted infrastructure and maintain this database relative to emerging projected sea level rise findings					This is an essential first step in scoping relevance/viability of potential adaptation options
4.8	Evaluate the vulnerability of existing and future unprotected reaches of shoreline with respect to existing infrastructure.					Determine need for and type of shoreline protection appropriate to these reaches.
4.9	Develop operational protocols that specify disclosure requirements for coastal hazards					does not include underwater structures that may pose a risk to navigation, among other risks

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4.10	Evaluate shoreline erosion buffers for zones subject to flooding in which significant infrastructure is located					
4.11	Develop and implement a tree planting program along vulnerable coastal areas as a flooding control strategy					
4.12	Add additional planning scrutiny to prevent new development from infringing upon sensitive shoreline areas subject to sea level rise hazards					
4.13	Increase erosion and hazard planning focused on all coastlines, especially sheltered coastlines					
4.14	Evaluate structural and non-structural options for beach protection (flood walls, dune restoration and creation, and periodic beach nourishment)					
4.15	Develop and/or strengthen a system for the comprehensive surveillance, monitoring, documentation, and dissemination of rates and locations of sea-level rise.					

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4.16	Develop a system for the regular monitoring of sea level rise and updating of flood inundation mapping from changes due to sea level rise					
4.17	Initiate a study that examines the replacement of soft protection options with hard structural options such as dikes, levees, floodwalls, saltwater intrusion barriers (this presupposes a solution)					As a first step, this option calls for a pre-feasibility study to evaluate the pros and cons and potential applications of hard, structural options to large estuaries like the Chesapeake Bay.
4.18	Enhance public education programs aimed at informing the public about sea level rise and coastal hazards					
4.19	Develop a strategy for managing the retreat of (Small and large) ports and associated infrastructure, such as rail and roads					
4.20	Develop a strategy to assure long-term public access to water					

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4.21	Evaluate the effectiveness of soft structural options such as dune restoration and creation Wetland restoration, periodic beach nourishment, temporary barriers and other options and implement the best options based upon effectiveness and feasibility					
4.22	Design industrial systems to reduce vulnerability to future sea level rise and associated hazards.					
4.23	Investigate potential and limitations of eminent domain, vesting, grandfathering, and amortizing strategies to support retreat activities					
4.24	Assess financial impact of property value changes					
4.25	Evaluate existing shoreline protection structures to determine their effectiveness under varying sea level rise and the need for modification/ replacement/ abandonment					Should include a review of available Federal, state, and local shoreline protection programs; provide recommendations on how each could be modified to address future changes in seas level rise with respect to infrastructure and other land assets

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PI-5	Utility and Fuel Infrastructure					
5.1	Develop a mechanism that requires utility companies to relocate existing overhead utility wires underground and require new wires to be placed underground.					This option needs to be reviewed by a utility company representative as it may be risky from a reliability and serviceability perspective (i.e. submerged networks).
5.2	Site industrial systems away from areas vulnerable to changes in sea level rise and associated hazards					
5.3	Address impacts of sea level rise and coastal and river erosion on buried or above-ground utility and oil pipelines					
5.4	Address impacts of sea thawing permafrost on existing buried or above-ground pipelines					
5.5	Develop appropriate standards for the future development of buried and above-ground utility and oil pipelines taking into account sea level rise, coastal and river erosion, and thawing permafrost.					

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5.6	Address the impacts of thawing permafrost and erosion on shoreline and river-side fuel delivery, storage, and piping.					
5.7	Develop new standards for the future development of shoreline and river-side fuel delivery, storage, and pipeline facilities.					
5.8	Engage Utility Siting Board in incorporating SLR and climate risk factors					
PI-6	Landfills					
6.1	Address the impacts currently occurring in landfills such as failures and losses associated with shoreline erosion and river erosion resulting from sea level rise and more intense storms					
6.2	Develop new standards for the future development of landfills that will address impacts associate with climate change such as sea level rise, thawing permafrost, and more intense storms.					
PI-7	Sewage and Septic Systems					

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7.1	Provide incentives for the development of septic systems that can better operate under the conditions associate with climate change.					
7.2	Develop new standards for sewer and septic systems that address having less snow cover, thawing permafrost, sea level rise, and increased organics					
PI-8	Water Systems					
8.1	Evaluate and improve capacity of storm water infrastructure for high intensity rainfall events					
8.2	Increase water system design standards to address lower probability events (e.g. some cities are protecting to the 500 year event rather than the 100 year event because of the increased vulnerability)					
8.3	Enhance existing storm water infrastructure capacity in zones subject to increasing high intensity rainfall events					

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8.4	Identify public and private systems and facilities at serious risk from sea level rise and initiate a system for siting such facilities away from vulnerable areas					
8.5	Identify the causes of drying lakes and diminished community water sources					
8.6	Develop policies for the conservation of community water sources					
8.7	Develop methodologies to stop or minimize the drying of lakes					
8.8	Provide incentives for the development of well-based water system technologies that avoid freezing due to increased deep frost levels					
8.9	Develop new standards for the development and deployment of new well-based water systems, taking into account deep frost levels.					
8.10	Provide incentives for the development of increased efficiency of hydroelectricity facilities. (ability to operate with less water)					

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8.11	Develop new, or expand current stormwater management facilities and systems to address increased precipitation and possible flooding					
PI-9	Ocean Transportation					
9.1	Evaluate the potential risks from climate impacts to a ferry system (incl. public transportation and emergency planning)					
9.2	Develop an emergency evacuation plan for the ferry system					
9.3	Create new standards for floating piers to accommodate both higher water levels and flooding events					
9.4	Evaluate the potential opportunities, risks, and needs associated with new shipping lanes opening up in the Arctic Ocean and Bering Sea, associated with less ice.					
9.5	Identify navigation problems associated with melting glaciers					

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9.6	Develop new shipping lanes through the Arctic Ocean and Bering Sea.					
9.7	Monitor shipping lanes through the Arctic Ocean and Bering Sea for ice melt, glacier melt, and security.					
9.8	Study the impacts of increased siltation in harbors stemming from glacier melt and flooding events.					
9.9	Develop measures to minimize the impacts of siltation in harbors stemming from glacier melt and flooding events.					
9.10	Provide incentives for the development of mechanisms that can minimize the levels of and impacts from siltation in harbors					
PI-10	Rural Non-Road Ground Transportation					
10.1	Develop rural infrastructure to supplement lost rural routes due to thinner winter ice, insufficient snow, and ground that does not freeze					

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10.2	Provide incentives for the development of new modes of transportation that can travel across the altered rural landscape					
10.3	Identify new rural transportation routes					
10.4	Provide rural public transportation across new and existing rural transportation routes to more efficiently move people and freight across the altered rural landscape.					
10.5	Develop new regulations for traveling across ice roads, taking into account thinner ice and shorter season length					
10.6	Identify alternate routes to accommodate for the shortened ice road season					
10.7	Further develop rural airstrips to accommodate larger planes with greater cargo capacity to compensate for the shortened ice road season					
PI-11	River Transportation					

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11.1	Create new standards for floating piers to accommodate both lower water flow and flooding events					
11.2	Further develop river transportation routes to accommodate lower water flow as well as flooding events.					
11.3	Provide incentives for the development of nautical vessels capable of navigating rivers during times of low water flow and flooding events.					
11.4	Provide incentives for the purchase of nautical vessels capable of navigating rivers during times of low water flow and flooding events.					
PI-12	National Defense Infrastructure					
12.1	Address national security concerns associated with new shipping lanes opening up due to less ice in the Artic Ocean and Bering Sea.					

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12.2	Promote the new development of Early-Warning-Radar Sites capable of withstanding thawing permafrost and erosion.					