

APPENDIX A. REFERENCES

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APPENDIX B. LIST OF ACRONYMS

AAG	Adaptation Advisory Group
ABI	Alaska Bureau of Investigation
ACCAP	Alaska Center for Climate Assessment and Policy
ACCKN	Alaska Climate Change Knowledge Network
ACE	Air convection embankment
ACIA	Arctic Climate Impact Assessment
ACIAC	Alaska Climate Impact Assessment Commission
ACRC	Alaska Climate Research Center
ADCCED	Alaska Department of Commerce, Community, and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADEED	Alaska Department of Education and Early Development
ADF&G	Alaska Department of Fish and Game
ADHSS	Alaska Department of Health and Social Services
ADMVA	Alaska Department of Military and Veterans Affairs
ADNR	Alaska Department of Natural Resources
ADOT&PFO	Alaska Department of Transportation and Public Facilities
AFS	Alaska Fire Service
AHRS	Alaska Heritage Resources Survey
AIDEA	Alaska Industrial Development and Export Authority
AIWFMP	Alaska Interagency Wildland Fire Management Plan
AISWG	Alaska Invasive Species Working Group
AK-DOT	Alaska Department of Transportation
AML	Alaska Municipal League
ANILCA	Alaska National Interest Lands of Conservation Act
ANTHC	Alaska Native Tribal Health Consortium
AOGCM	Atmosphere-Ocean general circulation model
AOOS	Alaska Ocean Observing System
ARRA	American Recovery and Reinvestment Act
AST	Alaska State Troopers
AVCP	Association of Village Council Presidents Regional Housing Authority
AWFCG	Alaska Wildlife Fire Coordinating Group
AWRVI	Arctic Water Resources Vulnerability Index
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BST	Bituminous surface treatment
BVS	Bureau of Vital Statistics
CCH	Center for Climate and Health
CDC	Centers for Disease Control (and Prevention)
CEQ	Council on Environmental Quality
CHIE	Community Health Impact Evaluation
CIP	Capital Improvement Project
CT	Common Themes
CNIPM	Alaska Committee on Noxious and Invasive Plant Management
CVRF	Coastal Villages Region Fund
CWPP	Community Wildfire Protection Plans
DCOM	Division of Coastal and Ocean Resources
DCRA	Division of Community and Regional Affairs
DEM	Digital Elevation Models

DHS&EM	Division of Homeland Security and Emergency Management
DOF	Alaska Division of Forestry
DOI	United States Department of the Interior
DPDP	Alaska Division of Policy Development and Planning
DPOR	Alaska Division of Parks and Outdoor Recreation
DPS	Alaska Department of Public Safety
EA	Economic Activities
EDA	Economic Development Administration (In the U.S. Department of Commerce)
EPA	Environmental Protection Agency
ESD	Energy Supply and Demand
FAA	Federal Aviation Administration
FAQ	Frequently Asked Question
FAW	Forestry, Agriculture and Waste
FEMA	Federal Emergency Management Agency
FTE	Full Time Equivalent
GCM	General circulation model
GHG	Greenhouse gas
GINA	Geographic Information Network of Alaska
GIS	Geographic Information Systems
HC	Health and Culture
HUD	United States Department of Housing and Urban Development (HUD)
IARC	International Arctic Research Center
IAWG	Immediate Action Work Group
IAPRC	Interagency Arctic Research Policy Committee
IfSAR	Interferometric Synthetic Aperture Radar
IHCA	Interagency Hydrology Committee for Alaska
IPCC	Intergovernmental Panel on Climate Change
ISER	Institute of Social and Economic Research
LIDAR	Light Detection and Radiation
LKSD	Lower Kuskokwim School District
LRIS	Land Resources Information Service
MAG	Mitigation Advisory Group
MOA	Municipality of Anchorage
MOU	Memorandum of Understanding
NAGPRA	Native American Graves and Repatriation Act
NCS	National Climate Service
NED	National Elevation Dataset
NEPA	National Environmental Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NFS	National Forest Service
NGO	Non-Governmental Organization
NLCCS	National Land Cover Classification System
NMFS	National Marine Fisheries Service
NOAA	National Ocean and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPRB	North Pacific Research Board
NPS	United States National Park Service
NRCS	Natural Resources Conservation Services
NS	Natural Systems
NSF	National Science Foundation
O&G	Oil and Gas
O&M	Operation and Maintenance

OHA	Office of History and Archeology
PI	Public Infrastructure
PRC	Project Review Committee
PWSRCAC	Prince William Sound Regional Citizen's Advisory Council
R&D	Research and Development
RD	Rural Development
RNWG	Research Needs Workgroup
RurAL CAP	Rural Alaska Community Action Program
SDMI	Statewide Digital Mapping Initiative
SME	State Medical Examiner
SNAP	Scenarios Network for Alaska Planning
STIP	Statewide Transportation Improvement Program
SWOT	Strengths, weaknesses, opportunities and threats
TLU	Transportation and Land Use
TWG	Technical Work Group
UA	University of Alaska
UAA	University of Alaska Anchorage
UAF	University of Alaska Fairbanks
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDA-RD	Rural Development (also RD)
USDI	United States Department of the Interior (also DOI)
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VPSO	Village Public Safety Officer
VSW	Village Safe Water Project
WCI	Western Climate Initiative
YKHC	Yukon-Kuskokwim Health Corporation

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Appendix C Administrative Order 238 Establishing the Alaska Climate Change Sub- Cabinet



Sarah Palin
GOVERNOR

STATE OF ALASKA
OFFICE OF THE GOVERNOR
JUNEAU

September 14th, 2007

ADMINISTRATIVE ORDER NO. 238

I, Sarah Palin, Governor of the State of Alaska, under the authority of art. III, secs. 1 and 24 of the Alaska Constitution establish the Alaska Climate Change Sub-Cabinet to advise the Office of the Governor on the preparation and implementation of an Alaska climate change strategy.

BACKGROUND AND FINDINGS

Scientific evidence shows many areas of Alaska are experiencing a warming trend. Many experts predict that Alaska, along with our northern latitude neighbors, will continue to warm at a faster pace than any other state, and the warming will continue for decades. Climate change is not just an environmental issue. It is also a social, cultural, and economic issue important to all Alaskans. As a result of this warming, coastal erosion, thawing permafrost, retreating sea ice, record forest fires, and other changes are affecting, and will continue to affect, the lifestyles and livelihoods of Alaskans. Alaska needs a strategy to identify and mitigate potential impacts of climate change and to guide its efforts in evaluating and addressing known or suspected causes of climate change. Alaska's climate change strategy must be built on sound science and the best available facts and must recognize Alaska's interest in economic growth and the development of its resources. Commercializing Alaska's great natural gas reserves through a new pipeline will improve the nation's energy security while providing a clean, low carbon fuel to help the nation reduce its overall greenhouse gas emissions.

PURPOSE AND DUTIES

The purpose of the Climate Change Sub-Cabinet is to advise the Office of the Governor on the preparation and implementation of an Alaska climate change strategy. This strategy

should include building the state's knowledge of the actual and foreseeable effects of climate warming in Alaska, developing appropriate measures and policies to prepare communities in Alaska for the anticipated impacts from climate change, and providing guidance regarding Alaska's participation in regional and national efforts addressing the causes and effects of climate change.

In view of its purpose, the Climate Change Sub-Cabinet shall develop recommendations on the following:

1. the assembly of scientific research, modeling, and mapping information in ways that will help the public and policymakers understand the actual and projected effects of climate change in Alaska, including the time frames in which those effects are likely to take place;
2. the prioritization of climate change research in Alaska to best meet the needs of the public and policymakers;
3. the most effective means of informing, and generating a dialogue with the public regarding climate change in Alaska;
4. the early assessment and development of an action plan addressing climate change impacts on coastal and other vulnerable communities in Alaska;
5. the policies and measures to reduce the likelihood or magnitude of damage to infrastructure in Alaska from the effects of climate change;
6. the policies and measures addressing foreseeable changes to the marine environment; the quantity, quality, and location of fish and game in Alaska; and the productivity of forests and agricultural lands in Alaska due to climate change;
7. the evaluation and response to the risks of new, or an increase in the frequency or severity of, disease and pests due to climate change in Alaska;
8. the identification of federal and state mechanisms for financing climate change activities in Alaska, including research and adaptation projects;
9. the potential benefits of Alaska participating in regional, national, and international climate policy agreements and greenhouse gas registries;
10. the opportunities to reduce greenhouse gas emissions from Alaska sources, including the expanded use of alternative fuels, energy conservation, energy efficiency, renewable energy, land use management, and transportation planning;
11. aggressive efforts toward development of an Alaska natural gas pipeline to commercialize clean burning, low carbon natural gas reserves;
12. the opportunities to reduce greenhouse gas emissions from the operations of Alaska state government;

13. the opportunities for Alaska to participate in carbon-trading markets, including the offering of carbon sequestration;
14. the identification of economic opportunities for Alaska that might emerge as a result of the growing response to this global challenge;
15. other policies and measures that the Climate Change Sub-Cabinet considers would help achieve the purpose of this Order.

COMPOSITION AND CHAIRPERSON

The Climate Change Sub-Cabinet consists of the commissioners of the Department of Commerce, Community, and Economic Development; Department of Environmental Conservation; Department of Natural Resources; Department of Fish and Game; and Department of Transportation and Public Facilities. The Climate Change Sub-Cabinet shall consult with the President of the University of Alaska or his or her designee and the director of State/Federal Relations and Special Counsel in the Office of the Governor, Washington, D.C., or another representative designated by the governor.

ADMINISTRATIVE SUPPORT

The member agencies shall provide administrative support necessary to carry out this Order. In accordance with law, these agencies may enter into intergovernmental agreements or apply for federal and other grants available to accomplish the purposes of this Order.

OTHER PROVISIONS

The Climate Change Sub-Cabinet shall serve as the executive branch contact to, and a resource for, the Alaska Climate Impact Assessment Commission established by Legislative Resolve 49 (2006).

The Climate Change Sub-Cabinet may form one or more workgroups that include members of the public to assist the sub-cabinet in achieving the purpose of this Order.

At times and locations to be determined by the Climate Change Sub-Cabinet, it shall convene public meetings to present and receive comments on its draft recommendations.

Nothing in this Order is intended to limit or otherwise modify any existing or future statutory or regulatory authority of any state agency.

This Order takes effect immediately.

DATED at Juneau, Alaska, this 14th day of September, 2007.

/s/Sarah Palin
Governor

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APPENDIX D. MEMBERS OF THE AAG AND AAG TWGs

Members of the Alaska Climate Change Adaptation Advisory Group

The Alaska Climate Change Adaptation Advisory Group (AAG) comprises representatives from Alaska's business community, utilities, petroleum producers and other key industries, environmental organizations, public interest groups, universities and research institutions, military installations, and state, local, and tribal government. The Governor's Office selected the following individuals to serve on the Alaska Climate Change Adaptation Advisory Group:

Elaine Abraham, Alaska Native Elder & Board member, Alaska Native Science Commission

Taunnie Boothby, Planner & State Coordinator, Floodplain Management Programs, Division of Community & Regional Affairs, Department of Commerce, Community & Economic Development

Bruce Botelho, Mayor, City and Borough of Juneau; former Alaska Attorney General

Michael Cerne (Captain), Chief, Planning and Force Readiness, U.S. Coast Guard

Stuart (Terry) Chapin, Professor, Ecology, University of Alaska Fairbanks

Billy Connor, Director, Alaska University Transport Center, University of Alaska Fairbanks

Jeffrey Demain (Dr.), Founder, Allergy, Asthma, and Immunology Center of Alaska

Stan Foo, Manager, Barrick Gold Corporation

Amy Holman, Alaska Regional Collaboration Team, National Ocean & Atmospheric Administration

Larry Hinzman, Director, International Arctic Research Center, University of Alaska Fairbanks

Steve Ivanoff, Planner, Transportation, Kawerak

Randy Hagenstein, Director, The Nature Conservancy

Marilyn Leland, Director, Alaska Power Association

Stephanie Madsen, Director, At-Sea Processors

Denise Michels, Mayor, City of Nome

Anthony (Tony) Nakazawa, Professor, Economics, Natural Resources and Agricultural Sciences, University of Alaska Fairbanks

Bob Pawlowski, Director, Alaska Fisheries Development Foundation; member Alaska Climate Impact Assessment Commission, Immediate Action Workgroup

Buck Sharpton, Vice Chancellor of Research, University of Alaska Fairbanks

Jeffrey Short, Pacific Science Director, Oceana

Orson Smith (Dr.), Chair, Civil Engineering, University of Alaska Anchorage

Bill Streever, Manager, Marine Mammal Program, British Petroleum Alaska

Dale Summerlin, Vice President, Health, Safety and the Environment, ConocoPhillips

Mead Treadwell, Chair, United States Arctic Research Commission

Fran Ulmer, Chancellor, University of Alaska Anchorage

Steve Weaver, Senior Director, Division of Environmental Health and Engineering, Alaska Native Tribal Health Consortium

Father Thomas Weise, Rector, Catholic Cathedral

Also invited to participate:

John Binkley, *President, Alaska Cruise Association; and Chair, Alaska Railroad Corporation*

Patricia Cochran, *Chair, Inuit Circumpolar Council*

Bryce Edgmon (Representative), *State Legislator, Western Alaska House District 37*

Richard Glenn, *Vice President, Arctic Slope Regional Corporation and Whaling Captain*

Members of the AAG Technical Work Groups

The Alaska Climate Change Adaptation Advisory Group (AAG) was advised by four Technical Work Groups (TWGs), comprised of representatives from Alaska's business community, utilities, petroleum producers and other key industries, environmental organizations, public interest groups, universities and research institutions, military installations, and state, local, and tribal government and AAG members. The Governor's Office selected the following individuals to serve on the Alaska Climate Change Technical Work Groups:

Public Infrastructure

David Atkinson, Assistant Professor, International Arctic Research Center, University of Alaska Fairbanks

Mike Black, Deputy Commissioner, Department of Commerce, Community & Economic Development

Taunnie Boothby, Planner & State Coordinator, Floodplain Management Programs, Division of Community & Regional Affairs, Department of Commerce, Community and Economic Development

Bruce Botelho, Mayor, City and Borough of Juneau; former Alaska Attorney General

Lawson Brigham, Alaska Office Director, U.S. Arctic Research Commission

Mike Coffey, Statewide Maintenance Manager, Department of Transportation & Public Facilities

Billy Connor, Director, Alaska University Transport Center, University of Alaska Fairbanks

Larry Dietrick, Director, Division of Spill Prevention & Response, Department of Environmental Conservation

Amy Holman, Alaska Regional Collaboration Team, National Oceanic and Atmospheric Administration

Steve Ivanoff, Planner, Transportation, Kawerak

Tara Jollie, Director, Community & Regional Affairs, Department of Commerce Community & Economic Development

Meera Kohler, President & Chief Executive Officer, Alaska Village Electric Cooperative, Inc.

John Kreilkamp, Vice President Alaska Operations, CruiseWest

John Madden, Director, State of Alaska Division of Homeland Security and Emergency Management

Greg Magee, Village Safe Water Program Manager, Department of Environmental Conservation

Chris Mello, Program Manager, RPSU & Bulk Fuel, Alaska Energy Authority

Denise Michels, Mayor, City of Nome

Patricia Opheen, Chief, Engineering, U.S. Army Corps of Engineers

Bob Pawlowski, Legislative Liaison, Denali Commission & member of AK Climate Impact Assessment Commission

Vladimir Romanovsky, Professor, Permafrost expert, University of Alaska Fairbanks

Mead Treadwell, Chair, United States Arctic Research Commission

John Warren, Director of Engineering, Alaska Native Tribal Health Consortium

Steve Weaver, Senior Director, Division of Environmental Health & Engineering, Alaska Native Tribal Health Consortium

Also invited to participate:

Herb Schroeder, Associate Dean, Alaska Native Science & Engineering, University of Alaska Anchorage

Health and Culture

Elaine Abraham, Alaska Native Elder & Board member, Alaska Native Science Commission

Jim Berner, Emergency Preparedness & Traditional Food Safety Coordinator, Alaska Native Tribal Health Consortium

Mike Bradley, Emergency Preparedness Program Manager & Traditional Food Safety Coordinator, Alaska Native Tribal Health Consortium

Don Callaway, National Park Service

Jeffrey Demain, (Dr.), Founder, Allergy, Asthma, and Immunology Center of Alaska

Bob Gerlach, State Veterinarian, Division of Environmental Health, Department of Environmental Conservation

Henry Huntington, Owner, Huntington Consulting

Joe McLaughlin, State Epidemiologist and Chief, Alaska Section of Epidemiology

Jeff Smith, Director, Environmental Health Services, Alaska Native Tribal Health Consortium

Jim Simon, Subsistence Program Manager, Department of Fish & Game

Father Thomas Weise, Rector, Catholic Cathedral

Also invited to participate:

Rose Barr, Resources Manager, NANA Corp

Patricia Cochran, Chair, Inuit Circumpolar Council

David Bill, Sr., Chair, Bering Sea Elders Advisory Group

Harry Brower, Whaling Captain, Barrow

Jerry Isaac, President, Tanana Chiefs Conference

Arthur Lake, Tribal Administrator, Native Village of Kwigillingok

Mike Williams, Chair, Statewide Alaska Inter-Tribal Council

Ron Klein, Program Manager, Food & Safety Sanitation, Department of Environmental Conservation

Josh Wisniewski, PhD Student, Dept of Archaeology, University of Alaska Fairbanks

Natural Systems

Terry Chapin, Professor, Ecology, University of Alaska Fairbanks

Steve Colt, Economist, Institute for Social & Economic Research, University of Alaska Anchorage

Chris Maisch, Director, Division of Forestry, Department of Natural Resources

Molly McCammon, Director, Alaska Ocean Observing Systems

Anthony (Tony) Nakazawa, Professor, Rural Development & Economics, University of Alaska Fairbanks Rural Development & School of Natural Resources & Agricultural Sciences

Thomas Paragi, Wildlife Biologist, Department of Fish & Game

Kurt Parkan, Director, External Affairs, The Nature Conservancy

Scott Rupp, Assistant Professor of Forest Measurements and Inventory, University of Alaska Fairbanks

Jeff Short, Pacific Science Director, Oceana

Bill Streever, Manager, Marine Mammal Program, British Petroleum Alaska

Kate Troll, Executive Director, Alaska Conservation Alliance

Gerd Wendler, Climatologist, Geophysical Institute, University of Alaska Fairbanks

Trish Wurtz, Research Associate, Boreal Ecology, U.S. Department of Agriculture - Forest Service, University of Alaska Fairbanks

Eric Volk, Science Director, Commercial Fish Division, Department of Fish & Game

Also invited to participate:

Bryce Edgmon, (Representative), State Legislator, Western Alaska House District 37

Stephanie Madsen, Director, At-Sea Processors

Roland Maw, Executive Director, United Cook Inlet Drift Association & Co-owner Charter and Salmon research business

Ken McHugh, Trident Seafoods

Robin Samuelson, Chief Executive Officer, Bristol Bay Economic Development Corporation

Economic Activities

Tim Bradner, Journalist, Alaska Journal of Commerce and Alaska Economic Report

Michael Cerne (Captain), Chief of Planning and Force Readiness, U.S. Coast Guard

Paul Dubuisson, ConocoPhillips

Ed Fogels, Director, Project Management, Department of Natural Resources

Stan Foo, Manager, Barrick Gold Corporation

Karl Hanneman, General Manager, Teck-Cominco Pogo Mine

John Hellén, Regulatory Coordinator, Pioneer Natural Resources

Larry Hinzman, Director, International Arctic Research Center, University of Alaska Fairbanks

Elden Johnson, Alyeska Pipeline

Orson Smith, Chair, Civil Engineering, University of Alaska Anchorage

Dale Summerlin, Vice President, Health, Safety & Environment, ConocoPhillips

Also invited to participate:

John Binkley, President, Alaska Cruise Association; and Chair, AK Railroad Corporation

Richard Glenn, Vice President, Arctic Slope Regional Corporation and Whaling Captain

Tom Krzewinski, Golder & Associates

Peter, Larsen, The Nature Conservancy

Crawford Patkotak, Vice President for Shareholder and Community programs, Arctic Slope Regional Corporation; Whaling Captain; city of Barrow Council Member

Keith Silver, Director, Business Development, Nana Management Services

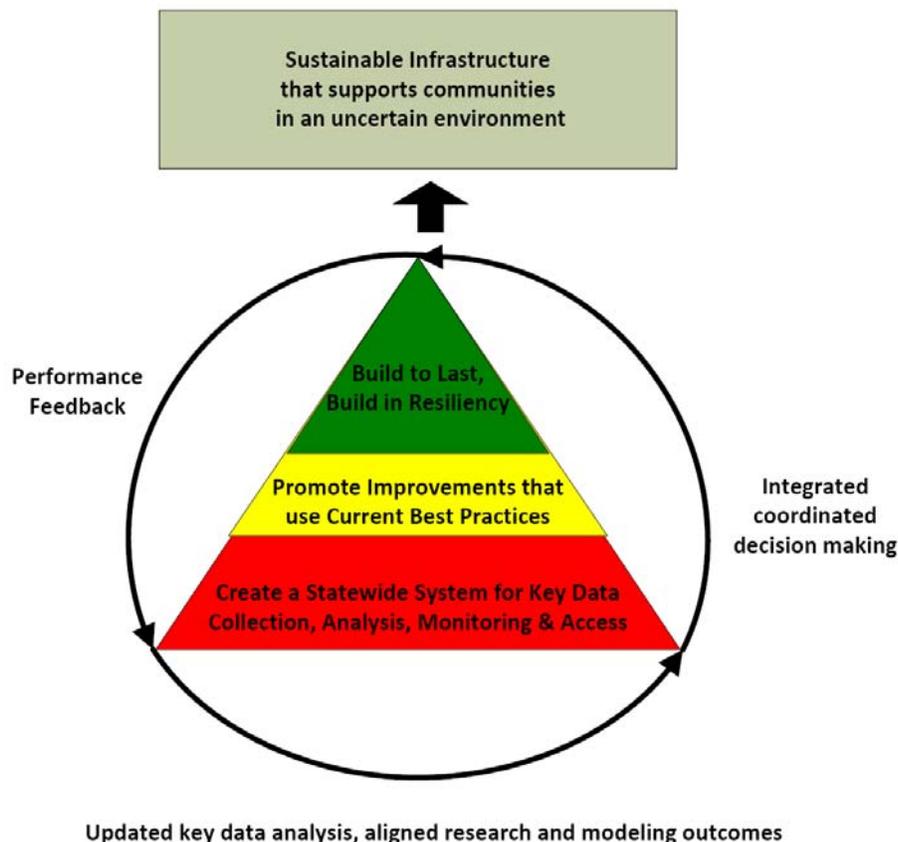
Appendix E. Public Infrastructure Technical Work Group Recommended Adaptation Options

Option #	Option Title	Page
Context	Introduction <ul style="list-style-type: none"> • Vision: Sustainable Infrastructure that supports Communities in an Uncertain Environment • Defining the Challenge • Increased Communication, Coordination and Information Sharing is Critical 	2
PI-1	Create a Statewide System for Key Data Collection, Analysis, Monitoring and Access	6
PI-2	Promote Improvements that Use Current Best Practices	14
PI-3	Build to Last, Build Resiliency into Alaska Public Infrastructure.	19

Introduction

Vision: Sustainable Infrastructure that Supports Communities in an Uncertain Climate

The key design feature of the three recommended adaptation options for public infrastructure is that it is an integrated system. Three policies (in the triangle and described below) build upon and support one another. Continued, routine communication and feedback is essentially to adapt and refine actions taken over time.



Policy Option 1 - Create a Statewide System for Key Data Collection, Analysis, Monitoring and Access.

Baseline data on the condition of current infrastructure and on regional and local environmental conditions needs to be collected. We need to know where and what the problems are. We need to know what is working and what is not working. Based on the best science and collected empirical data we need to predict our future. The resulting information needs to be available to all interested parties.

Policy Option 2 - Promote Improvements that use Current Best Practices.

Managing the risks and/or reducing the uncertainties associated with climate change will take time. Promoting sustainability, reducing operating costs, and protecting/extending the service life of existing infrastructure is always worthwhile. As PI-1 is enacted and we learn from new data and updated analyzes and assessments, improvements to existing infrastructure that use current best practices are worth doing regardless of climate change effects.

Policy Option 3 - Build to Last; Build Resiliency into Alaska's Public Infrastructure.

As Policy Options 1 and 2 are enacted and we learn more as a result, new and upgraded infrastructure needs to be sited, planned, designed, and built to be resilient and sustainable in an uncertain environment. Funders of public infrastructure need to require systematic feedback that includes performance review and analysis as a stipulation for funding, development, construction, and operations of infrastructure. This will provide information that planners, engineers, and builders need about "what works" and facilitate assessing and improving codes and standards to address changing and predicted future conditions as we strive to achieve the best results.

Defining the Challenge

Infrastructure is the platform upon which society functions. Public Infrastructure is the essential facilities and utilities under public, cooperative or private ownership that deliver goods and services to communities. Common examples in Alaska include, but are not limited to:

- Highways and bridges, railways
- Airports, landing strips
- Harbors, docks and ports
- Public buildings (schools, fire stations, health clinics, post offices, etc.)
- Seawalls and river shoreline protection
- Water, sewer, stormwater and solid waste systems including sewage lagoons, dumps/landfills, and related pipes and utilidors
- Publicly owned or essential utilities, distribution systems and power grids
- National defense infrastructure, military installations

Climate change in Alaska is creating the following potential impacts to public infrastructure, with significant regional variation:

- Increased flooding and erosion
- Decreased duration (cold season) and extent (warm season) of shore fast sea ice
- Increasing freeze/thaw cycles
- Changing wind and precipitation
- Increased storm frequency and duration
- Warming and thawing permafrost
- Increased fire risk

Climate change is impacting infrastructure in a number of ways that are well documented and dramatic (See for example: ACIA 2004, ACIA 2005, Nelson et al. 2003, Robinson et al. (in prep), Stephani et al. 2008, IAWG 2008, Hamlen et al. 2004, Larsen et al. 2007, Romanovsky et al. 2007, Infrastructure Canada 2006, Kelly et al. 2008).

As frozen ground thaws existing public buildings, roads, pipelines, utilidors, and airports are likely to be destabilized, requiring substantial maintenance, rebuilding and investment. This is causing pipeline, road, bridge and building instabilities. The Alaska Department of Transportation and Public Facilities (ADOT&PF) Northern Region is currently spending approximately \$10 million to combat warming permafrost on Alaska's highway system. ADOT&PF has already had to relocate entire airports due to flooding/erosion and there are several other airports that are being studied for relocation. Utilities have reported that telecommunication towers are settling due to warming permafrost (United Utilities, Yukon-Kuskokwim Delta).

Thawing permafrost can disrupt community drinking water supply. For instance the community drinking water source lake in Kwigillingok disappeared in June 2005 when the permafrost liner was lost and the lake drained overnight. The same risk of rupture exists for sewage lagoons. The added risk of contamination of surrounding areas is also a concern if the impermeable barrier for a sewage lagoon is lost. Increased failure rates and dramatically increasing operations and maintenance costs are due to freeze/thaw cycles that cause shifting soils in once permanently frozen ground. Transportation routes and pipelines are particularly susceptible and are already being disrupted and disturbed in some places by thawing ground and this problem is likely to expand. Future development will require new design elements to account for ongoing warming.

Changes such as declines in river flows and water levels, higher water temperatures, storm surges, and heavier short duration rainfalls may cause impacts such as a decline in hydroelectric power, declining water supplies, water quality problems, flash floods and overtaxing of drainage facilities. The U.S. Army Corps of Engineers reports that increasing erosion along the Bering Sea coast means the villages of Shishmaref, Kivalina, and Newtok in western Alaska will need to be moved in the next 10 to 15 years, at an estimated cost of up to \$455 million.

The U.S. General Accountability Office (GAO) has reported that “flooding and erosion affect 184 out of 213, or 84 percent, of Alaska Native villages to some extent. While many of the problems are longstanding, various studies indicate that coastal villages are becoming more susceptible to flooding and erosion caused in part by rising temperatures. Reduced sea ice allows higher waves and storm surges to reach the shore. It will enhance ocean access to northern coastlines. Communities and infrastructure are already threatened; some are being forced to relocate, while others face increasing risks and costs.

Coastal storms threaten infrastructure critical for community viability (harbors, docks, schools, fuel tanks, runways, power plants, water/sewer provisions and more) by eroding sea walls and other shoreline protection and exposing infrastructure to erosion, flooding and storm surge. In December 2004 a storm surge contaminated the drinking water supply of Nunam Iqua with salt water, creating an emergency that required drinking water to be flown into that community.

Erosion, flooding, and fires are threatening many villages along the Yukon River. For example, the entire village of Koyukuk lies within the floodplain of the Yukon River. Erosion occurs anytime the river is open and specifically during high flow events on the Yukon River. These events happen throughout the year, including floods during spring breakup ice jam events and during spring/ summer/fall significant rainfall events. These floods are often severe, inundating a majority of the village and sometimes requiring evacuation of citizens to other villages. In May 2009 the eastern Interior Alaska saw record high temperatures that quickly melted snow, pushing water into the Yukon River. That, combined with a winter of heavy snowfall and thick river ice made perfect conditions for ice jams that can act as dams that flood riverside. In Eagle and Eagle Village for example, an old Native cemetery was flooded, power and phones turned off, the clinic and Village Public Safety Office (VPSO) were lost, and all buildings and houses along the riverfront in the old village were flooded. In Koyukuk these problems have been persistent and serious enough – often flood warnings provide only a 2 hour window to evacuate – that the community has begun planning efforts to relocate themselves to higher ground above the floodplain of the Yukon River upon nearby Koyukuk Mountain.

The Vulnerability of and Risk to Public Infrastructure is Growing.

Most of these impacts are not new to Alaska. What is new, is the increased magnitude, rapid development and progression, and increasing geographic extent of these impacts and affected communities. In some locations entire Alaskan villages are at immediate risk. In other locations critical roads and public buildings are at risk. The immediacy and level of risk varies by region, and locally within regions, adding to the challenge.

Reliable and sustainable infrastructure is the foundation that the future of Alaska will be built upon. To ensure that Alaska is prepared to optimize investment opportunities and demonstrate that the return on investment for Alaska’s current and future infrastructure provides good value for the state and the nation, an on-going, aligned statewide effort to monitor, analyze and proactively adapt to our changing environment is required.

Adaptive Capacity is Low.

The adaptive capacity of public infrastructure is generally quite low. Most public infrastructure is hard and fixed (for example, roads, airport runways, bridges, buildings) and cannot easily alter its alignment, elevation, or structural foundation to accommodate coastal erosion or increased flood risk.

Increased Communication, Coordination and Information Sharing is Critical.

Impacted and potentially impacted communities, agency funders, and researchers often do not know about each other’s planning efforts, infrastructure improvement projects, funding opportunities, or research, materials testing and demonstration project results. Information is not being systematically shared with all who need it and could benefit. The lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure.

In order to successfully implement the PI TWG's three-policy system and achieve both short and long term success in adapting public infrastructure **the three bulleted actions that follow are required to increase communication, coordination and systematic information sharing.**

- **There must be across the board improvement in the coordination and accessibility of information.** This includes information on the condition of existing infrastructure and the environment where it is located; information on updated forecasts and trend analysis (such as rate of erosion, permafrost thaw, flooding); and ready access to community plans and infrastructure design.
- **Collection, coordination and communication of pertinent information needs to start immediately. A program partner should be identified with the capability to organize and host an Information Center or Clearinghouse.** The Center would standardize, coordinate, and link data among the many differing sources to enable queries and integrated use. It would also track and index readily available and cost effective infrastructure development techniques that are working, that didn't work, materials development and testing results, developing designs, and contact information.
- **Create/designate an Immediate Action Work Group (IAWG)-like entity to assume a coordinating role now.** A permanent, action-oriented, entity is needed to align and coordinate (not regulate) decisions. An IAWG-like entity is needed to coordinate communication horizontally among partner agencies and vertically among levels of government and other stakeholders. It will streamline processes, eliminate duplicate efforts, minimize unnecessary effort, and minimize transaction costs of developing and carrying out a statewide system. A State of Alaska Executive Order is likely needed to establish this entity or structure. A senior-level executive should be manager. Implementation will be through existing agencies and authorities.

PI-1: Create a Statewide System for Key Data Collection, Analysis, Monitoring and Access

Option Description

Baseline data on the condition of current infrastructure and on regional and local environmental conditions needs to be collected. We need to know where and what the problems are. We need to know what is working and what is not working. Based on the best science and collected empirical data we need to predict our future. The resulting information needs to be available to all interested parties.

Across the board improvement in the coordination and accessibility of information is needed. This includes information on the condition of existing infrastructure and the environment where it is located; information on updated forecasts and trend analysis (such as rate of erosion, permafrost thaw, flooding); and ready access to community plans and infrastructure design.

Enacting Public Infrastructure Policy 1 (PI-1) will establish a coordinated and integrated system to:

1. Observe, collect, catalog, and disseminate data on the existing condition of public infrastructure and the environmental conditions where it is located.
2. Use this information to prepare forecasts and trend analysis yielding up-to-date rates of erosion, permafrost thaw, flooding etcetera by region.
3. Systematically assess the vulnerability of Alaska's public infrastructure in communities to establish the local level of risk.
4. Share information in a useable format with communities to enhance local understanding of climate change and the effect on the community, and, to facilitate and coordinate project planning and development.

There are many ongoing data collection, applied research, and technology projects accumulating information on local environmental conditions, looking to find ways to better predict climate conditions and locate infrastructure accordingly, and design infrastructure to better adapt to new conditions. The challenge, and why an entity that can increase communication and coordination is so strongly needed, is that impacted and potentially impacted parties do not routinely know about each other's efforts nor are the results being routinely shared with all who could benefit.

This lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure. To be successful in implementing PI-1, PI-2 and PI-3, two new "entities" as outlined below, are needed.

Create/designate an IAWG-like entity to assume a coordinating role now. We recommend that it be permanent and action-oriented, and focus on aligning and coordinating (not regulating) decisions. Impacted and potentially impacted communities, agency funders, and researchers frequently do not know about each other's planning efforts, infrastructure improvement projects, or funding opportunities. An entity such as this is needed to coordinate communication horizontally among partner agencies and vertically among levels of government, scientists, academia, those engaged in applied engineering, and other stakeholders. It will streamline processes, eliminate duplicate efforts, minimize unnecessary effort, and minimize transaction costs of developing and carrying out a statewide system to implement the three policies recommended by the public infrastructure TWG (and other climate change related decision-making and programming). A State of Alaska Executive Order is likely needed to establish this entity or structure. A senior-level executive should be manager. Implementation will be through existing agencies and authorities.

Immediately establish an Information Center or Clearinghouse that networks professionals across government and academia to collect, coordinate and link pertinent information. A program partner (such as University of Alaska) should be identified with the capability to organize and host. The Center would

standardize, coordinate, and link data among the many differing sources to enable queries and integrated use. Focus on key or critical data needed to adapt to climate change. The Center would also track and index readily available and cost effective infrastructure development techniques that are working, that didn't work, materials development and testing results, developing designs, and contact information.

Option Design

Sub-Option 1: Standardize information to be gathered. Establish a baseline and benchmarks, so data comparison and analysis is possible over time and across agencies/parties. Identify key data needs, mechanisms to share and link databases, and fill data gaps.

Targets

1. Standardize information to be gathered. Establish a baseline and benchmarks so that data from differing sources can be compared and to enable analysis over time, regional geographic areas, and across agencies/parties. Do not replicate existing databases, instead set up a system to link data and enable queries and integrated use.
2. Gather two types of data; on the condition of existing infrastructure and on regional and local environmental conditions. Specific environmental data to gather routinely are:
 - a. Soil temperature
 - b. Air temperature
 - c. Precipitation
 - d. Surface runoff
 - e. Shore fast sea ice duration (cold season) and extent (warm season)
 - f. Coastal wind speed and duration
3. Organize data around designated climatic regions that are based on geopolitical boundaries. Identify and fill data gaps over time.

Timing

Begin immediately. These efforts are scalable; work can begin with existing resources and data. The effort can be enlarged over time as resources permit. Even initial efforts will contribute to significant improvement in project effectiveness. Data gathering priorities should be determined by region based on the most significant vulnerabilities and risk factors. As an example, for the Northwest Arctic Borough permafrost temperature should be monitored, data on permafrost ice content, and development of surface processes (as thermokarst, thermal erosion, ponding, slope processes) collected.

Evaluation

Conduct a baseline survey of existing and needed data. Future evaluation can be based on subsequent surveys to determine: (1) If all the data that are needed are being collected? (2) If these data are being collected at all needed locations to be able to reach regional conclusions and local applications? (3) If the data is broadly available, and if representation of data are good enough to be understood and easily used? (4) Is there a feedback loop to link scientists and academia to applied scientists, engineers and builders to guide data collection and use?

Research and Data Needs

Measurements Needed:

- Air temperature
- Soil temperature
- Wind velocity, duration (for gusts) and direction
- Precipitation (snow and rain)

- Arctic coastline wave frequency and height, storm surge, sea ice formation and seasonal extent
- Other as needed, tailored to specific regional weather changes

Evaluate use of remote sensing technologies to gather measurements. Recommend appropriate remote sensing applications to all parties that collect data and design, install or maintain infrastructure. Establishing the locations for installation of remote sensing technology can be optimized through modeling that interpolates between data collection points.

Engineers typically look back in time using climatic data to predict the future but this methodology is not as valid if the system is at a change point; there is significant uncertainty as to whether we are near or at change points (example: permafrost degradation). In the interim, use the best available data to project trends over time. Conduct modeling, based on measurements and data (above), to produce predicted regional trends over time.

Sub-Option 2: Systematically conduct local hazard analyzes for public infrastructure based on up-to-date climate data that takes regional variation into account. Produce vulnerability assessments to rank the risk level or vulnerability of existing infrastructure for each administrative region. Create easy to use products (such as isograms maps) to facilitate sharing and use by municipal and tribal governments, state and federal agencies, and non-governmental users.

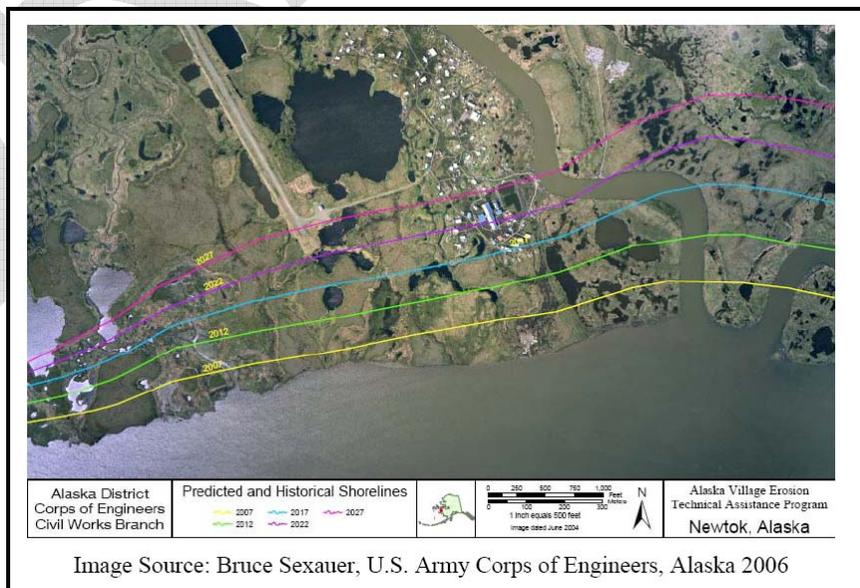
Infrastructure vulnerabilities vary both across regions as well as for site specific conditions such as ice rich permafrost, erosion or flooding. Conditions must be evaluated for each specific location based on known regional vulnerabilities in order to determine the types and levels of risk each community will face. Information derived from this analysis should be used to focus initial efforts on those communities determined to be at greatest risk from climate change impacts.

Targets

1. Use data gathered through implementation of sub-option 1 (above) to run predictive models. Modeling is needed that yields up-to-date rates, trends and maps for:
 - a. Soil temperatures
 - b. Coastal and riverine erosion
 - c. Event intensity
 - d. 100 year floodplain

Trend analyzes should address extreme events as well as averages.

2. Conduct systematic hazard analysis based on up-to-date regional climate data.
3. Produce local vulnerability assessments to rank the risk level or vulnerability of existing infrastructure in communities. Determine the status, capability and vulnerability of current infrastructure. Determine the useful life of current infrastructure.



4. Share information in an easy-to-understand format to facilitate its use by municipal and tribal governments, state and federal agencies and Non-Governmental Organization (NGOs) users. Distribute results to: infrastructure designers, engineers and professional organizations, and to municipal/tribal governments, state/federal agencies and NGOs. The environmental data and modeling completed in this step is also needed to update engineering designs and codes (Policy Option PI-3) to reflect changing conditions.

An example of an easy to use format is the isogram map to the right for Newtok that shows historic and predicted coastal erosion and shorelines .

Timing

Ideally, a baseline of current local environmental and infrastructure conditions is needed before hazard analyzes and vulnerability assessments are completed. However, because establishing this baseline will take several years to complete, and because public infrastructure in some areas is clearly threatened, the hazard analyzes should begin immediately with best available data in high risk areas. This would include thawing permafrost in areas of discontinuous or warm permafrost that are most vulnerable to change, erosion and flooding in the Arctic coastal areas, and areas in northern southeast Alaska with geotechnical instability caused by isostatic rebound.

Evaluation

Evaluation can be measured by determining the status of:

1. The state Division of Homeland Security and Emergency Management's (DHSEM) situational awareness and possession of trend analyzes so it can effectively prioritize use of resources to complete state emergency management plans.
2. Documenting the number of communities that received useable products (such as maps documenting result of a hazard/vulnerability analyzes, updated floodplain maps etc.) every 1-2 years
3. Documenting the number of community's each year that request assistance with adapting public infrastructure by asking for updated hazard/vulnerability assessments, updated hazard maps, requesting emergency planning assistance, or similar activities.

Research and Data Needs

Information necessary to perform a hazard analysis and conduct a vulnerability assessment is not readily available for most communities. Research and data needs include:

1. Orthographic suite of mapped physical and environmental conditions, current flood plain delineation based on up-to-date trend analysis on what risk changes are likely to occur.
2. Population demographics
3. Supply chain information: movement of goods and services (barge or shipping access, airfield access, weather conditions, etc.).
4. Establish a mechanism for regular information sharing so that a feedback loop can be established to continually adapt "No Regrets" Improvements (PI-2) and Build Infrastructure to Last (PI-3).

Sub-Option 3: Gather and review planning documents for proposed public infrastructure. Analyze and eliminate conflicts for renovation, retrofit, replacement, or relocation of existing infrastructure.

Many community plans address public infrastructure. Better communication and integration of these efforts will ensure up-to-date climate change information is being used, and that the timing and nature of public infrastructure investment is being coordinated. The suite of community plans that typically address public infrastructure planning in some way includes: community evacuation plans; community emergency operation plans; hazard mapping, analysis, and mitigation plans; preparedness activities such as outreach, training, and exercises; community wildfire protection plans for communities at significant risk of wildfire; community comprehensive plans; and strategies that address incorporated and unincorporated community eligibility for the National Flood Insurance Program.

Awareness of current efforts to fund and build public infrastructure is also important to implement Public Infrastructure Policy 3 – Build to Last, Build in Resiliency, and Public Infrastructure Policy 2 - Promote Improvements that use Current Best Practices.

Targets

Coordinated planning efforts between projects across agencies must become a best management practice.

Coordinate statewide and regional public infrastructure planning efforts, link to comprehensive community planning, and systematically address climate change.

Review agency infrastructure plans. Identify and resolve conflicts between agency plans. Determine future plan for use of current best practices to repair, renovate, retrofit, replace or relocate public infrastructure.

Timing

Begin immediately. Planning and coordination can occur independently within regions. Prioritize the regions where public infrastructure and populations are most at risk and vulnerable.

Evaluation

To evaluate effectiveness, assess whether:

1. A statewide infrastructure planning network is up and running that includes all involved parties (across agency, state/federal/NGO).
2. Electronic sharing of project planning information is occurring.
3. Integrated efforts are occurring to establish financial, managerial and other local community capacity needed to achieve sustainable infrastructure management and monitoring.

Research and Data Needs

As Public Infrastructure Policy 1 is implemented and regional insights are obtained from data collection and analysis of infrastructure vulnerabilities, reference documents will need to be updated to reflect this information and plan reviewers will need updated training.

Establish a tool for sharing state, regional and local conditions and projects.

Research efforts by other states to address planning for climate change impacts on infrastructure.

Sub-Option 4: Identify measures to adapt design criteria for public infrastructure using a performance feedback loop.

Use a performance feedback loop to adapt infrastructure design; improve policy coordination; to update analyzes based on new information on weather, economic assumptions, or demographic changes; and to

integrate results of research, foundation and material testing. Use modeling to improve data alignment, scenarios, and assumptions for future infrastructure policies and plans.

A feedback loop that allows parties to learn from ongoing efforts and adapt accordingly is important. This will allow infrastructure to be designed to better withstand climate change throughout its design life without the need for costly over-design. This has the potential for a significant payback in reduced construction and life-cycle costs.

Targets

Prioritize and coordinate research /computer modeling so that environmental data, modeling and engineering needs are as up-to-date and as accurate as possible to meet each region's varying infrastructure development needs.

1. Regional data (PI-1 sub-option 1) and trend analysis (PI-1 sub-option 2) are critical components to adapt site specific criteria to improve infrastructure and provide resilience to climate change conditions (PI-3).
2. Uncertainties can be reduced by modeling/projecting environmental conditions (PI-1 sub-option 2).
3. It is important to critically evaluate performance of existing models on an ongoing basis, improve predictive capabilities, and develop mechanisms and procedures for how to best use modeling outcomes.
4. Establish a system to identify and track modeling efforts.

Timing

Ongoing

Evaluation

To effectively implement this policy:

1. Update to the Environmental Atlas of Alaska.
2. Forward recommendations to Uniform Building Code committees on needed criteria changes.
3. Conduct a retrospective evaluation of model's predictions to evaluate the model's performance.

Research and Data Needs

Improvement in model performance will be needed. This might be achieved by improving the models themselves, by improved parameterization used in these models, or by better assimilation of remote sensing and ground observation data.

As Public Infrastructure Policy 1 is implemented and regional insights are obtained from data collection and analysis of infrastructure vulnerabilities, reference documents will need updated to reflect this information and plan reviewers will need updated training.

Participants/Parties Involved

There are many ongoing data collection, applied research, and technology projects accumulating information on local environmental conditions, looking to find ways to better predict climate conditions and

locate infrastructure accordingly, and design infrastructure to better adapt to new conditions. The challenge is that participating, impacted and potentially impacted parties do not routinely know about each other's efforts nor are the results being routinely shared with all who could benefit.

This lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure. To be successful in implementing PI-1 (and PI-2 and PI-3) two new "entities" are needed:

1. Create/designate an IAWG-like entity to assume a coordinating role now. We recommend that it be permanent and action-oriented, and focus on aligning and coordinating (not regulating) decisions. Impacted and potentially impacted communities, agency funders, and researchers frequently do not know about each other's planning efforts, infrastructure improvement projects, or funding opportunities. An entity such as this is needed to coordinate communication horizontally among partner agencies and vertically among levels of government, scientists, academia, those engaged in applied engineering, and other stakeholders. It will streamline processes, eliminate duplicate efforts, minimize unnecessary effort, and minimize transaction costs of developing and carrying out a statewide system to implement the three policies recommended by the PI TWG (and other climate change related decision-making and programming). A State of Alaska Executive Order is likely needed to establish this entity or structure. A senior-level executive should be manager. Implementation will be through existing agencies and authorities.
2. Immediately establish an Information Center or Clearinghouse that networks professionals across government and academia to collect, coordinate and link pertinent information. A program partner (such as University of Alaska) should be identified with the capability to organize and host. The Center would standardize, coordinate, and link data among the many differing sources to enable queries and integrated use. Focus on key or critical data needed to adapt to climate change. The Center would also track and index readily available and cost effective infrastructure development techniques that are working, that didn't work, materials development and testing results, developing designs, and contact information.

Specific to establishing the Information Clearinghouse/Center that sub-option 1 addresses, note that there are several government agencies and academic databases already in use but not integrated. Each has a database manager or monitor. Examples of climate databases: Alaska Climate Research Center (<http://climate.gi.alaska.edu>), Scenarios Network for Alaska Planning (SNAP), permafrost databases: University of Alaska Fairbanks (UAF) Geophysical Institute Permafrost Lab (www.permafrostwatch.org), CALM (www.udel.edu/Geography/calm/). An example of an existing infrastructure database is the Alaska Department of Commerce, Community, and Economic Development Alaska Capital Projects Database that hosts partial data for on-going projects. Sources for data on public and critical infrastructure include State agencies; Federal agencies; Denali Commission; local governmental entities, including tribal entities; NGOs; private sector and industry groups; and academia.

Specific to establishing the 'feedback loop' that sub-option 4 addresses, every municipal and tribal government, state and federal agency, and NGOs that invests in or builds infrastructure has a role. An example of what could be done is occurring at the Alaska Department of Environmental Conservation (ADEC), Village Safe Water Program (VSW), which now includes a sustainability review in its projects by asking how climate change conditions are to be addressed.

Implementation Mechanisms

This policy can be implemented by existing state and federal agencies, however greater efficiencies and cost savings will be achieved if the two entities, an IAWG-like coordination entity and an Information Center, as described in the previous section (Participants/Parties) are established to align implementation and communication horizontally among partner agencies and vertically between the various layers of government.

Four steps required to implement the Public Infrastructure Policy 1 are:

1. Conduct a hazard analysis and vulnerability assessment; the product will be a regional risk assessment map for the Alaska.
2. Starting with the most vulnerable sub-regions, develop an inventory of public infrastructure and the current technical condition of each component.
3. Establish an efficient interagency environmental monitoring system to include only those components that are essential to keep the risk assessment products updated. This system should also be capable to produce future projections of changes in regional and local risk assessments.
4. Establish an effective system of dissemination of gathered and processed information among all potential local and tribal government, state and federal agency, NGO and other users.

Related Policies/Programs and Resources

Climate Change Executive Roundtable hosted by federal Fish and Wildlife Service.

Memorandum of Understanding (MOU) group meetings hosted by the Denali Commission.

Resources and potential of the University of Alaska.

National Science Foundation's (NSF) Interagency Arctic Research Policy Committee (IARPC) led by NSF and NOAA

U.S. Arctic Research Commission has initiated coordinated efforts to establish an Arctic Observing Network and to report on existing plans of stakeholders across federal, state, industry and academic consortia on topic areas of "Arctic Infrastructure."

Benefits and Costs

Implementing the programs described and establishing a communication and decision-making network will significantly improve coordination on public infrastructure projects that involve State, Federal, municipal and tribal agencies. There is a potential for significant savings as multiple agencies that fund, design, build and operate infrastructure in Alaska develop common planning assumptions and coordinate on the timing and sequence of otherwise disparate projects. The costs will vary with the scale of implementation from low (network of existing planners and database managers) to moderate (small professional cadre for analysis and a standing resource for policy makers).

Feasibility Issues

Implementing this approach and these programs is feasible. The coordinated, networked approach described here is similar to that used over the last two years by the IAWG. It is also similar to that used by the State of Iowa to rebuild or repair 8,000 elements of public infrastructure damaged or destroyed by the 2008 floods. The Rebuild Iowa Office, with a small group of professionals working under the Lieutenant Governor and a coordinated network of public and private sector agencies has coordinated, prioritized, and monitored the rebuilding effort of dozens of state and federal agencies with many funding sources. On the state side, it is also similar to the Alaska State Division of Policy Development and Planning (DPDP) instituted by Governor Hammond and subsequent policy that utilized a resource sub-cabinet for coordinated state decision-making.

Status of Group Approval

Approved unanimously, with no objections.

PI-2: Promote Improvements that Use Current Best Practices

Option Description

Managing the risks and/or reducing the uncertainties associated with climate change will take time. Meanwhile, as data is being collected and analyzed, the focus should be on implementing public infrastructure improvements that are worth doing regardless of climate change effects. This is the goal of PI-2: Promote Improvements using the Current Best Practices. Promoting sustainability, reducing operating costs, and protecting/extending the service life of existing infrastructure is always worthwhile.

How we deal with these uncertainties about the impacts of climate change on the public infrastructure will ultimately determine how we adapt to a changing climate. For sure, as predictions on future climate change become more accurate with the execution of PI-1 the uncertainties will be reduced. By accurately forecasting future climate change and its effects, we can better protect our existing infrastructure and better plan and design new infrastructure. This approach is cost-effective and provides cost-saving benefits regardless of future climate changes. It creates balanced awareness by promoting agility and resiliency that does not overly depend on the potential consequences of future climatic events on infrastructure in Alaska.

The state (and others) can systematically improve existing infrastructure by using current best practices while PI-1 is being enacted and we are obtaining new data and updating analyzes and assessments. Use of current best practices that are continually being improved as we get better information from a performance feedback loop creates a transition to use of new and updated designs and procedures called for in PI-3: Build to Last; Build in Resiliency. PI-2 thus serves as a “bridge” between PI-1 and PI-3.

Option Design

PI-1 will establish a data baseline, continue data collection over time, and improve trend analysis and forecasting tools to achieve the best value in our future infrastructure development. The ability to accurately forecast the effects of climate change are critical to success. However, our understanding today of climate change processes and the associated impacts in Alaska are incomplete, which makes it difficult to adapt existing and new infrastructure to future changes in the environment. Due to these uncertainties, the overall infrastructure strategy and the purpose of Public Infrastructure TWG Policy PI-2 is to balance the short term need for agility with the long term need for resiliency of facilities.

Current best practices are actions to adapt infrastructure so that it can better withstand impacts due to the changing climate and the use of measures that are designed to address the vulnerabilities of existing infrastructure. Utilizing the most current information and technology, public infrastructure projects need to protect Alaska’s infrastructure investment regardless of climate change impacts by:

1. Protecting and extending the design service life of infrastructure,
2. Reducing infrastructure operating costs and complexity, and
3. Promoting sustainability in the development, design and construction of new infrastructure.

Implementing sustainable infrastructure improvement projects will provide cost-effective benefits to communities even if the underlying climate change assumptions are incorrect.

Implementation of a policy to repair and improve existing infrastructure will continue to build resilience that starts with Policy PI-1 and ends with Policy PI-3, which requires regular reporting of environmental data and infrastructure performance to create a systematic feedback loop and thereby continually better measures and options.

An example of using current best practices are the efforts of the IAWG, part of the Governors Climate Change initiative.

Over the past year the IAWG methodically labored to prevent loss of life and infrastructure and protect what is already in place in six imminently threatened rural Alaska communities. The IAWG functions as a central coordination entity. Membership is comprised of an array of senior agency staffers that coordinate the various agency authorities and ensure that each agency acts in alignment with the others. These experienced members know who to coordinate with and how to make things happen within state and federal governments.

Each of the six immediately imperiled communities had an overall vulnerability assessment completed and recommended infrastructure improvements have been integrated into a series of near term plans to protect an/or extend the service life of each town site. Individual analysis of each location has enabled them to tailor current best practice recommendations to each site. The examples below show applicant of current best practices. PI-2 recommends routinely using adaptation actions like this.

- An emergency evacuation road has been proposed for Shaktoolik potentially enabling the current town site to be occupied for many more years. The availability of a safe evacuation route during winter storms will greatly reduce the risk of injury or death for residents and enable the continued utilization of town infrastructure for many years to come.
- Strengthening the existing revetment in Unalakleet was judged to be the appropriate approach to protect and extend the operating life of existing core town site infrastructure while a migration plan to the hillside is being developed.
- The concept of incremental relocation has been introduced at Newtok. The design and incremental construction of new community infrastructure has started at a new townsite in close proximity, but away from hazard zones.. This will enable the State to maximize the remaining service life of existing infrastructure and then incrementally build replacement stock in the new location. New homes are being designed to be relocateable, relying on the concept of resilience rather than strengthening foundations and armoring current locations.
- Kivalina and Shishmaref are relying on extensive new revetments to slow erosion and extend the service life of existing infrastructure.
- No infrastructure improvements have been approved for Koyukuk yet. A feasibility study and community planning grant will help the community create a plan supported by residents to help protect the community from seasonal flooding.

Each community has been assessed and an individual plan that utilizes current best practices has been put in place or is under development that will enable residents to better cope with their changing environment. The current best practice approach enables the state to incrementally respond to communities across Alaska with available resources. The efforts and successes of the IAWG provide an excellent model of how to effectively and efficiently protect our current infrastructure investment, while data is being collected and a longer term climate change strategy is being developed.

Targets

The goal of Public Infrastructure Policy 2 is to use current best practices to make infrastructure improvements that are worth doing regardless of climate change's effects. This is both critical and practical because we can't stand still while we gather and analyze data and reduce the uncertainties associated with climate change. In the interim PI-2 focuses efforts on accomplishing actions that promote sustainability, reduce operating costs, and protect/extend the service life of existing infrastructure.

Utilize a communication and coordination network, and implement techniques such as changing funding formulas, in order to routinely enact actions that adapt public infrastructure by using current best practices, such as:

- Use of existing technology such as adjustable and/or mobile building foundation systems.
- Building foundations that use thermosiphons or thermopiling.
- Protecting facilities from flood or erosion damage.
- Providing energy conservation upgrades.

- Long-term planning and preparedness.
- Building local capacity for operations and maintenance.
- Promoting energy-efficient technologies.
- Using alternative energy sources.
- Building with better materials.

Timing

Implementation of PI-2 can begin immediately. During an initial phase (years 1-5) implementation of Policy PI-2 will proceed concurrently with Policy PI-1. As both efforts progress, Policy PI-3 (Build to Last, Build in Resiliency) will be introduced. PI-3 will eventually overtake and replace PI-2 once the ability to accurately forecast the effects of climate change is firmly in place and adaptation strategies for future infrastructure are created.

Participants/Parties Involved

Use of current best practices can be readily integrated into investment prioritization formulas now in use by funding agencies. This will enable federal and state agencies that already fund infrastructure development, construction and/or operation to transition to use of new and updated designs and procedures as called for in PI-3: Build to Last; Build in Resiliency.

Infrastructure development, construction and operation are key responsibilities throughout all levels of government. Participation by federal and state agencies, municipal and tribal governments, design professionals and others will be necessary for the successful deployment of this policy.

Implementation of PI-2 will be much more efficient if routine coordination and information sharing is occurring through an IAWG-like entity. (See the "Participants/Parties" section in PI-1 or PI-3 for a full description.)

Evaluation

Evaluation of the effectiveness of this policy will depend on establishing a regular schedule and process for sharing the results of already built improvements. Opportunities for sharing current best practices and information on the performance of new techniques through a feedback loops needs to be integrated into infrastructure funding awards, reporting and follow-up processes. The Information Center/Clearinghouse (recommended in PI-1) should receive and index infrastructure retrofit, repair, replacement techniques that are working, that didn't work, materials development and testing results, developing designs, contact information, and more.

Research and Data Needs

While research and data are critical to the PI-1 and PI-3 and thus to the overall implementation of the Public Infrastructure three-policy system to adapt infrastructure, PI-2 has no independent research and data needs.

Implementation Mechanisms

PI-2 can be best implemented through close coordination among federal, state and local government agencies, academia and design professionals that fund and build infrastructure. This will allow alignment of process and purpose. This will be achieved most efficiently if an IAWG-like coordination entity is established to align implementation and communication horizontally among partner agencies and vertically between the various layers of government and other stakeholders.

Implementation can begin immediately by:

1. Routinely gather and make available information on measures and practices that are, and are not, working to adapt infrastructure. A program partner should be identified with the capability to organize and host an Information Center or Clearinghouse for tracking sustainable and resilient best practices. This Center/Clearinghouse could index readily available and cost effective infrastructure development and protection techniques that are working, that didn't work, materials development and testing results, developing designs, contact information, and more.
2. Integrate factors into agency funding and prioritization formulas (such as Alaska DOT&PF Statewide Transportation Improvement Program evaluation or VSW Capital Improvement Project) to reward consideration of climate change and use of current best practices. For example, funding agencies could give higher scores to projects that:
 - Include an engineering peer review process that incorporates current best practices (as catalogued by the to-be-established Information Clearinghouse/Center),
 - Include a value engineering review process that demonstrates improved performance, reliability, quality and life cycle costs.
 - Present a project site or community vulnerability assessment to document its location compared to expected hazards.
 - Commit to a schedule of reporting environmental data and infrastructure performance (to the to-be-established Information Clearinghouse/Center) following project construction.

By systematically rewarding behavior that promotes more resilient and sustainable infrastructure, the state will be better prepared to meet the future. More efficient information exchange will reduce the time typically needed to accomplish cycles of learning and performance improvement, further enhancing the effect.

As more climate change data becomes available it can readily be introduced into the information feedback loops established by this process and allow for a smooth transition to PI-3.

Related Policies/Programs and Resources

Policies PI-1 and PI-3 of the Public Infrastructure system are integrally related to the long term success of policy PI-2. All three policies must be initiated as a system to achieve the vision and to ensure the maximum return on investment.

Benefits and Costs

The public relies on infrastructure to provide a safe and healthy environment. Maintaining transportation and sanitation infrastructure are key to ensuring public health, safety and welfare are protected. Existing public infrastructure that is required to protect public health, safety and welfare must be repaired and upgraded so it is safe and operable. Implementing modifications and repairs using current best practices will maintain the functionality of existing infrastructure, extend its service life, potentially reduce or contain operating costs and sustain capital investment. The benefits to protecting public health, safety and welfare will outweigh the costs associated with the implementation of this methodology.

Feasibility and Constraints

The United States has the required technology and needed capacity to be successful in this endeavor. Public Infrastructure Policy PI-2 can be initiated with minimal additional resources. To optimize its effectiveness an IAWG-like central coordinating entity should be established to ensure existing infrastructure funding, development, construction and operations agencies are better aligned.

Existing resources of the agencies that currently fund the development, construction and operation of infrastructure can be used to implement this policy. Adequate funding is not available to repair, retrofit or relocate all vulnerable infrastructure; however, this policy will help align funding opportunities and priorities.

Sufficient Alaska specific scientific research capacity does not yet exist to assure the long-term success of the overall three-policy public infrastructure sustainable infrastructure system.

A coordinated statewide database with key information displayed and readily available to decision-makers in an understandable and actionable format does not currently exist.

The ability does not yet exist for state and federal agencies, and municipal and tribal governments to regularly communicate and share data or establish connected and aligned policies, procedures, and information to empower decision-makers.

Status of Group Approval

Approved unanimously, with no objections.

PI-3: Build to Last; Build Resiliency into Alaska's Public Infrastructure

Option Description

To adapt Alaska's existing and future public infrastructure to the effects of climate change we must build in resiliency so that it lasts. This can be accomplished by building it in locations outside of hazard zones (that have been updated and defined using climate change modeling), or by designing and locating public infrastructure to meet acceptable risk limits or expected forces at the location over the life of the infrastructure.

Accomplishing this presumes that climate change modeling has occurred that has produced updated hazard zone locations and revised data on expected forces and conditions for which infrastructure must be designed (all per Policy PI-1). This will also require modification of some engineering design standards, building codes, and operation and maintenance practices.

Building resiliency into Alaska's public infrastructure will require:

1. Meet or exceed infrastructure design life.
2. Optimize life cycle costs/asset management practices.
3. Design infrastructure using the best science combined with appropriate building codes and engineering standards in order to withstand expected weather events and a changing environment.

Institutionalizing a feedback loop to report on how infrastructure is performing (and to transmit updated climatic data) is critical to success as this enables adaptation over time.

Option Design

Sub-Option 1: Meet or exceed infrastructure design life.

Current building codes address safety and performance of infrastructure by both manmade and natural forces. The concept of service life focuses on the ability of structures to fulfill their intended function over the design life. The design life is often set by either the infrastructure owner or by public policy rather than an engineer. For example, buildings for 'box stores' have a design life of 20 years; whereas dams for mining sediments have an infinite design life.

Some infrastructure design also considers natural forces. For example, highway, railroad and airport design considers not only structural design criteria but also erosion, flooding and thermal impacts. Erosion control features are commonly incorporated into the design. Building design on the other hand primarily focuses on the function, safety and on sites which provide an adequate foundation for the function with little consideration to natural forces. Schools are sited close to housing, post offices are sited close to business areas, and power generation plants are located safely away from populated areas.

Consideration of natural forces is the focus of the impacts of climate change on infrastructure. Coastal erosion, increased flooding, and thermal degradation potentially threaten to shorten the life of infrastructure if not properly managed. Practices of predicting the future environmental parameters based on past conditions are proving inadequate. Scientific evidence leads us to believe this practice must be altered to address a changing environment.

Unfortunately a lack of both supportive public policy and information makes it difficult for engineers to incorporate climate change in infrastructure design.

To improve we must use the collective experience of both infrastructure owners and design professionals; compile best practices for planning, design, and maintenance of infrastructure; and provide a continuous feedback during the project development cycle.

Targets

Two changes are required to ensure public infrastructure achieves its design life.

1. Develop a policy to ensure public buildings are sited in locations which preclude damage by natural forces such as flooding, erosion or thermal degradation. If that is impractical then appropriate measures must be part of the design.
2. Require sufficient climatic data is included in design codes. At present, engineers use historical data to predict the future. Unfortunately, climatic models indicate this procedure may not adequately predict future environmental parameters. Without improved prediction models of adequate resolution and reliability, designs will be a speculative patch work.

Timing

All aspects of Public Infrastructure Policy 1 must be enacted before PI-3 can begin in earnest because the information generated by PI-1 is needed to enact PI-3. This demonstrates the systems approach to the Public Infrastructure TWG's suite of three interrelated policies and why continuous monitoring and feedback are needed.

PI-1 requires collection of usable climatic data; to implement PI-3 policy makers and engineers must use this data to make and refine criteria for locating, designing, constructing and maintaining infrastructure. It may take years to fully develop a widely accessible information platform however, as information becomes available over time policies and best practices can be updated and implemented. This is why implementation of PI-2 takes place in the interim.

PI-1 recommends conduct of a vulnerability assessment of existing public structures to identify potential impacts and determine courses of action. In some cases simple action may be sufficient; in others the loss of the structure may have to be accepted. In all cases, it is important to avoid a crisis. Implementation of PI-1 also requires a vulnerability assessment for all proposed, publicly funded, new infrastructure leading to policy and design requirements which limit or eliminate these threats.

Participants/Parties Involved

Infrastructure development, construction and operation are key responsibilities for all levels of government. Participation by federal, state, municipal and tribal governments will be necessary for the successful implementation of this policy.

A lead entity needs to be designated to integrate the overall efforts, whether it is an existing or new state agency. Given the unique characteristics of Alaska compared to the rest of the Nation, it is suggested that the state assume a lead role in assembling and coordinating this partnership of agencies, owners and users.

Engineers must assess codes and engineering practices to ensure public safety is adequately addressed. The engineering community must unite on these issues to provide feedback to the building and infrastructure owners and policy makers about the consequences of decisions. In the end, as long as codes, regulations and public safety concerns are met, it is the governmental agencies that make the final decisions.

Evaluation

There are numerous examples of ongoing evaluation to see if design life is being achieved. Bridges are evaluated every two years for structural and functional deterioration. Roadways are evaluated every two

years to find deficiencies. Unfortunately, not all infrastructure undergoes routine evaluation to assess how it is performing and to encourage timely corrective action.

Establishing a regular schedule and process for sharing the information on infrastructure design life will enhance effectiveness. Opportunities for sharing best practices and setting up regular feedback loops for planning, design and construction of public infrastructure will lead to longer lasting, more cost effective programs. This approach, often termed Asset Management, provides tools to assess the condition and performance of the infrastructure and to suggest appropriate and timely corrective action. Unfortunately, many agencies have little information concerning the infrastructure or its condition that is under its jurisdiction.

Research and Data Needs

Research and data are critical to successful implementation of PI-1 and PI-3. The two major data needs to implement PI-3 and meet or exceed infrastructure design life are:

1. Climatic data must be available at a resolution and accuracy to be useful to decision makers and design professionals. Statements like 'increasing precipitation expected' provide little information to assist the design process for snow loading on a roof structure. More useable information would be, for example, "the snow load has increased to 100 pounds per square foot."
2. Regular sharing via a feedback loop of the condition inventory and infrastructure vulnerability assessment developed under policy PI-1 is needed to provide information to update best practices.

Sub-Option 2: Optimize life cycle costs/asset management practices.

Life-cycle costing uses all costs including first costs, repair, and maintenance and operating costs to select the best alternative. For example, if decisions are based solely on first cost, it is likely that the structure built will minimally meet the need even though this option may have high heating or maintenance costs. In some cases, these structures become obsolete before achieving their design lives.

Asset Management provides a tool to evaluate all an agency's assets and develop a program that either maximizes the performance with a given budget or minimizes the budget for a set performance criteria. This process helps decision-makers put limited funds to best use. Asset management also allows decision-makers to plan for upgrades and replacement over a 10 to 20 year time span. However, it is important to understand that political and social needs are also a part of the decision process. Asset management techniques allow an understanding of the impact of these decisions.

Targets

Implementing life cycle costing and asset management is a management decision of both the funding agency and the improvement owner. Both of these tools have been available for many years and when used have either improved the overall condition and performance of infrastructure, reduced the budget, or both. The complexity of these procedures is predicated on the desired outcomes and the size of the inventory.

Timing

For work to begin, all levels of government must first support the concept of life cycle costing. At the present time, many agencies award infrastructure projects based solely on the capital costs. As a first step, development of a consensus may require changes in program authorities and priorities.

Participants/Parties Involved

Development of life-cycle costing and asset management requires buy-in from all decision-makers including the agencies affected, the legislature and to a limited extent the engineering community. If it is to be accepted, the public must see the benefits. The major barriers are the feeling by both decision-makers and the public that they lose control. While these procedures provide input about the impact of a decision, they do not dictate the decision. They do tend to force a more thorough discussion and rationalization of decisions which go counter to life-cycle costing and asset management.

Evaluation

Both life-cycle costing and asset management require collection and input of cost data, condition inventories and performance data. Further, performance-life curves will be required as feedback into the process to ensure we learn from experience. A major benefit is that we can begin to document and understand the impacts of climate change on the performance of infrastructure and to implement appropriate design changes.

Research and Data Needs

These techniques are well established. If the State of Alaska chooses to implement them, data collection and inventories will be required. These data may include energy costs, structural deficiencies, and vulnerabilities.

Partnerships among federal and state agencies, municipal and tribal governments will be required to ensure data sharing and consistent procedures.

Sub-Option 3: Design infrastructure using the best science combined with appropriate building codes and engineering standards in order to withstand expected weather events and a changing environment.

The easiest and often the most cost effective means of coping with natural disasters is to locate the infrastructure outside the hazard zone. For example, locate power plants beyond the anticipated 50 or 100 year coastal erosion zone. This requires developing models that are able to predict erosion over this time frame, per Policy PI-1. Where it is impractical to locate the structure outside the hazard zone, the structure must be designed to withstand the hazard or provide protection against it. For example, a power plant designer could include erosion control measures in the plant design. In the case of an existing structure, engineers and the owners must assess the structure and determine whether to move or protect it. Each case is different, but the process is the same. Through the use of benefit/cost analysis, each alternative can be evaluated to determine the most attractive solution to provide resilience to withstand expected weather events and a changing environment.

At present, outside of the boundaries of major cities, these decisions are typically left to the project manager without guidelines or policy. In most states, when there are no local government regulations, state requirements become the default standard.

Targets

If infrastructure across Alaska is to withstand impacts of climate change throughout its life, uniformly deployed policy, guidelines, standards and codes are needed. This requires active adaptation to the changing environment. Planning, designing and maintaining infrastructure against thermal changes, coastal erosion, flooding and other climate related impacts must be conscientiously included in the decision process.

Timing

First, establish a policy recognizing the impact of climate change on public infrastructure. Agencies must recognize they have the opportunity and responsibility to locate public facilities in a safe location and that the design of the structure can include resiliency against climate change. Further, agencies must recognize that they are responsible to establish consistent performance criteria for the infrastructure.

Engineering codes should be modified to adopt these new requirements. The time frame is a function of the sense of urgency of funding and operating agencies. Many of the changes can occur almost immediately.

Participants/Parties Involved

Federal, state and local agencies that own and operate the facilities are responsible for establishing the performance standards for their facilities. Engineers are responsible for ensuring these performance standards are met within the framework of engineering codes. As has been repeatedly stated, climate data required to carry out implementation of these decisions must be developed in a usable form. This is called for in Policy PI-1.

Evaluation

Routine inventory and inspection of infrastructure provides data on how well resilience is being designed and built into Alaska's public infrastructure. For example, if we regularly see displacement of pile foundations in thawing permafrost, we need to alter design procedures. Without collecting that information engineers can only assume the designs are adequate.

Evaluation of the effectiveness of this policy will depend on establishing a regular schedule and process for sharing the results of infrastructure inspections. Opportunities for best practices information sharing and project administration/ outcome feedback loops should be integrated into infrastructure funding awards and follow-up processes.

Research and Data Needs

Again, obtaining up-to-date climatic data is critical, as called for in Policy PI-1. It is also important to evaluate existing infrastructure to identify common failure modes and routinely transmit this information into the engineering design and code creation process. A Canadian study has shown that some foundation types perform better in permafrost areas than others, and that some are more resilient to climate change. Research and testing like this to identify which designs are successful and which are not is needed.

Implementation Mechanisms

Four steps required to implement PI-3:

1. Establish performance standards and policies, and modify engineering codes, to incorporate hazard analysis and vulnerability assessment in a changing environment.
2. Revise engineering standards based upon updated information and new policies.

3. Obtain climatic and performance data to be incorporated into 1 & 2 above; this feedback process will ensure improvements with time.
4. Establish processes to align communication among partners and government agencies.

No new group need be established to implement this policy although some agencies and other organizations may need to refocus efforts. Greater efficiencies could be achieved however if a central coordinating entity with membership from partnering agencies existed.

Related Policies/Programs and Resources

There are many ongoing applied research and technology projects looking to find ways to design infrastructure to better adapt to new conditions. The challenge, and why an entity that can increase communication and coordination is so strongly needed, is that impacted and potentially impacted parties do not routinely know about these and other efforts, nor are the results being routinely shared with all who could benefit. The lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure. A few relevant efforts are:

- UAF Permafrost Research Project (partners: US Federal Highway Administration, Yukon Highways & Public Works, Alaska University Transportation Center, Transport Canada, Université Laval, Public Works and Government Services Canada) A 10-year project is testing 10 adaptive techniques including: Full air convection embankment (ACE), Full heat drain embankment, Covered ACE shoulder treatment, Uncovered ACE shoulder treatment, Heat drain shoulder treatment, Longitudinal convection culverts, Heat drain shoulder treatment with insulation, Snow-free side slopes, Grass covered side slopes, and Light colored BST treatment.
- Cold Climate Housing Research Center –Sustainable Northern Shelters Project was developed to address the needs of sustainable rural housing for northern climates.

All three Public Infrastructure policies must be initiated to enact a comprehensive program of sustainable infrastructure in Alaska and help ensure that the state achieves the maximum return on its investments. PI-1 and 2 are integrally related to the long term success of PI-3.

Existing resources of agencies that fund the planning, design, construction and operation of the state's infrastructure can be utilized to implement this policy.

The professional engineering design community has well established mechanisms to maintain standards, codes and best management practices. Oversight agencies have the responsibility to see that social and environmental requirements are met.

Benefits and Costs

Adapting public infrastructure to a changing climate will be expensive. However, the cost of not adapting infrastructure will be greater.

Feasibility and Constraints

Technology exists to allow us to address the changing climate. However, we do not have adequate resolution or accuracy of climate data to include in engineering design processes. Further, as we gain this information, professionals must change how we predict the environment in which the infrastructure must perform.

The ability does not yet exist for municipal and tribal governments, state and federal agencies, and non governmental organizations to regularly communicate and share data, or establish aligned and connected policies, procedures, and information to empower informed and coordinated actions.

Status of Group Approval

Approved unanimously, with no objections.

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Appendix F. Natural Systems Technical Work Group

Recommended Adaptation Options

Option #	Option Title	Page
NS-1	Incorporate climate change into fisheries management and assist fishing communities and users in adaptation.	3
NS-2	Review and modify Alaska's wildland fire policy and programs.	6
NS-3	Address the effects of climate change on Alaska's freshwater resources through adaptive management, supported by improved hydrologic data.	13
NS-4	Reduce introduction and spread of invasive species and eruptive species in the context of climate change.	20
NS-5	Prepare for adaptive management of fish and wildlife .	25
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Introduction

Alaskans (as well as humans across the globe) benefit from a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as **ecosystem services** and include products like clean drinking water, timber, habitat for fisheries, and pollination of native and agricultural plants. Ecosystems provide “services” that moderate weather extremes and their impacts, mitigate drought and floods, cycle and move nutrients, maintain biodiversity, and contribute to climate stability. These services are distinct from other ecosystem products and functions because there is human demand for these natural assets. Ecosystem services can be *provisioning* such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and crop pollination; *cultural*, such as spiritual and recreational benefits; and *preserving*, which includes guarding against uncertainty through the maintenance of diversity. Decisions on land use (Foley et al. 2005) and water use have important consequences on provisioning of ecosystem services for human needs. (See also Daily 1997.)

Changing climate is having broad impacts on many ecosystems in Alaska. The potential changes to habitats within marine, freshwater, and terrestrial ecosystems and their dependent species were highlighted by the Natural Systems Technical Work Group (NS TWG) in Section I of the *Catalog of Adaptations and Policy Options* presented to the Adaptation Advisory Group (AAG) for Alaska’s Climate Change Strategy, December 17, 2008. (NS TWG 2008.)

Climate change could alter many essential ecosystem services that provide life requisites and cultural well being in Alaska, including clean air and water, wild foods, renewable resources, and timber and agricultural systems. The seven adaptation options recommended by the NS TWG for approval by the AAG and the Governor’s Climate Change Sub-Cabinet are intended to sustain the ecosystem services that meet society’s needs.

NS-1 Incorporate Climate Change into Fisheries Management and Assist Fishing Communities and Users in Adaptation

Recommended Adaptation Option

The State of Alaska will take into account climate change impacts when developing fisheries policy and management options for the state's commercial, recreational, subsistence and personal use fisheries. In addition, because of its contribution to Alaska's economy and jobs, the State will develop a program to assist the commercial fishing industry, including the communities and user groups reliant on the industry, in adapting to the impacts from climate change.

Option Description

Recent scientific evidence indicates the seas and rivers in and around Alaska are responding to warming trends in the last few decades in ways that may substantially influence circulation patterns, food webs and productivity regimes. In addition, carbon dioxide from human emissions that is independent of the effects on warming is causing about a 30% increase in the acidity of the oceans worldwide, and is projected to increase substantially by the end of this century. Some of these changes could have major impacts on Alaska's bountiful fisheries with potentially different consequences in the Gulf of Alaska, the Bering Sea and the Arctic Ocean. These impacts include:

- Changes in fish distribution, abundance, catch composition, and run timing;
- The northern migration of species such as pollock (in some cases outside of U.S. waters);
- Movement of some fish farther away from on-shore processors, harbors, and communities, requiring further travel;
- The transient appearance of new species such as tuna;
- Establishment of invasive marine species (see NS-4); and
- Declines in the Bering Sea in the catch of crab, shrimp, and in some locations, halibut, with a corresponding increase in some species such as cod.

Increased ocean acidification could also result in the elimination of important components of the food web in the Gulf of Alaska, deleterious effects on cold water corals in the Bering Sea, and adverse impacts on ecologically and economically important shellfish such as krill, crabs, and shrimp.

Although scientists and managers may not know the exact cause or the precise nature of the changes currently being observed, nor those projected for the future, we do know they could have significant ecological consequences, as well as potential economic impacts on businesses, fishing reliant communities, and individual Alaskans. Some changes and impacts could be positive, others negative. There is sufficient information to begin to act in response to the changes being observed and predicted.

Alaska's system of abundance-based fisheries management is designed to be broadly responsive to changing species and abundance distributions. However, climate change, ocean acidification, and other unpredictable environmental impacts are not explicitly considered in current Alaska fishery policies and management plans and practices, likely due to their uncertainty and complexity. This option would enable the State of Alaska to consider climate change impacts on species abundance and distribution when developing fisheries policy and management plans, including a continued precautionary approach to the opening and management of new fisheries, and taking climate change into account when considering the rationalization of various commercial fisheries.

It is essential that the State of Alaska and federal government coordinate closely on adaptation of fisheries management in response to climate change. The State could urge National Oceanic and Atmospheric Administration (NOAA) Fisheries and the North Pacific Fishery Management Council to continue to consider climate change impacts when making decisions affecting federally managed fisheries. The proposed 10-year moratorium on commercial fishing in the Arctic EEZ is one example. Because environmental impacts on commercial fisheries can be extremely difficult to predict, the success

of these options would be greatly enhanced with a robust system of monitoring and stock assessment and the design of policies that are flexible enough to respond to unexpected changes in conditions.

Most fisheries-reliant communities and many components of the fishing industry itself do not have sufficient information to respond to these potential changes. They don't know how imminent those changes might be, and if they are of sufficient significance to warrant infrastructure development such as retooling of fish processing plants, the development of new harbors and industry support facilities. This option would facilitate development of a program to provide information about current and projected changes in commercial fishing due to climate change, and work with communities and the fishing industry to develop the capacity and the infrastructure needed to adapt to those changes.

The challenge will be to provide information about extremely uncertain impacts due to mechanisms we do not fully understand. A robust monitoring program covering both physical and chemical ocean conditions and biological populations would however, allow us to document the important changes in ocean and river conditions, including ocean acidification, and fish abundance and distribution that are likely by-products of climate change. As such, we could respond, even without full understanding.

Without this option, fishing-reliant communities, industries and individuals will be less certain about how to respond to current and projected environmental changes that will affect Alaska's fisheries. Fishing has always been an uncertain endeavor and history shows tremendous fluctuations in stock abundance, particularly for salmon; yet the changes we face under various projected climate change scenarios will alter the scale of past experience. To support fisheries conservation and avoid substantial economic losses, the State of Alaska must coordinate with the federal government, local communities and industry to develop and implement appropriate fisheries policy and management responses to these changing conditions.

Option Design

Structure/design: The option is divided into four major components that meet short-term, intermediate, and long-term needs.

1. The first component is a review of the State of Alaska's fishing-related statutes, policies, management actions, and programs to determine if and how climate change considerations might be included in these. This review could begin immediately and be completed within one year, with possible changes to state laws and regulations requiring additional time. It could be implemented by state agencies (including the Alaska Departments of Fish and Game-ADF&G, Law, Environmental Conservation-DEC, Natural Resources-DNR, and Commerce, Community and Economic Development-DCCED) or by an independent commission that would include climate change experts, stakeholders (including fisheries-reliant communities and fishing industry representatives), and agency representatives.
2. The second component is a comprehensive assessment of existing habitat, fish species and stock monitoring programs to determine their current effectiveness and to recommend changes to improve the State's ability to predict and adapt to the effects of climate change on fish resources. This assessment would include an analysis of which geographic regions, habitats and species in Alaska waters are particularly sensitive or vulnerable to ocean acidification and temperature change and recommendations on potential actions to ensure their future protection. A panel of agency scientists and independent scientific experts could provide this analysis. This assessment must go hand-in-hand with development of a comprehensive long-term monitoring program that builds upon existing federal and state agency programs. Monitoring must address physical and biological components to monitor ecosystem changes; fisheries abundance and distribution (including keeping the State's catalog of anadromous fish streams current); monitoring of ocean, coastal and riverine habitats, including ocean currents, temperature, salinity, and acidification; and an assessment of species and habitat values and vulnerability. Associated with this is the need for monitoring of human activities, their potential effects on the ecosystem, and monitoring of community and industry socioeconomic data to track trends. Improved monitoring would provide policy and decision makers greater confidence when allocating resources and managing fisheries, by distinguishing human-caused changes due to climate change from natural variability.

3. The third component is development of a centralized source of information regarding climate projections on the fishing-dependent environment, adaptation tools, technical assistance, and support for communities and businesses to enhance their capacity to plan for and adapt to climate change. This need can be addressed through implementation of the *Alaska Climate Change Knowledge Network* that is proposed as a separate Overarching Option #1.
4. The fourth component is a long-term strategy to work with fishing-reliant communities and businesses to identify the needs for modified or new infrastructure to meet the changing needs of the industry and fishermen, including possible construction, loans, etc. These actions would depend on how short- or long-term projected changes occur and would need involvement of communities, fishing businesses, climate change scientists, and state and federal agencies. (Note: This recommendation focuses on fisheries-related infrastructure, such as ports, docks and/or processing facilities. The Public Infrastructure TWG is recommending responses to climate change impacts on a wider range of public infrastructure.)

Participants/Parties involved: Described above.

Evaluation:

- Review of existing statutes, regulations and policies will determine the efficacy of including climate change considerations and a possible framework for doing so.
- A periodic assessment of existing research and monitoring programs should occur, with identification of continuing gaps, and development of a plan for providing essential information.

Research and Data Needs:

1. Research what other countries, U.S. federal agencies and other states are doing to incorporate climate change considerations into commercial fishing policies and management. Assess what is appropriate to Alaska and North Pacific conditions. Identify inconsistencies and/or gaps in regulations, statutes and policies that affect our ability to effectively address and manage climate change impacts on natural resources. Assess policies for prioritizing survey work, and include climate change impacts as a consideration. **High Priority for near-term.**
2. Develop a comprehensive long-term monitoring program, building upon existing federal and state agency programs, and including physical and biological components, to inform the fishing community about ecosystem changes. See details under Option Design #2, above. **High Priority.**
3. Research potential impacts/ramifications of climate changes to ocean, coastal, cryosphere (sea ice and glaciers), estuarine, and freshwater ecosystems, the ecosystem services that they provide, and the wildlife, fisheries, and societal impacts of these changes. Consider developing a set of reliable physical and biological indicators of climate change and related community impacts to identify the most effective ways to implement short-, mid-, and long-term status and trend monitoring across broad areas and multiple land management units. Consider low-tech monitoring techniques to cover broad geographic regions. **Medium priority**
4. Synthesize current information about climate change impacts on fisheries and assess its reliability and degree of uncertainty. Understand how productivity of coastal and estuarine systems may change. **Lower priority.**
5. Possible research is needed on new infrastructure to meeting engineering requirements of a changing climate. **Lower priority for commercial fishing sector.**

Implementation Mechanisms

1. The review of existing statutes, regulations, and policies could be done either by existing state staff, or by establishing an independent expert panel. Proposed changes could require legislative or regulatory changes.
2. Ensuring a robust research and monitoring program cannot be accomplished with state funds alone, and requires significant federal, university, non-governmental organizations (NGO) and

other sources of funding. The state should work with these entities to develop a long-term funding approach that makes use of multiple funding sources.

Related Policies/Programs and Resources

Related Policies/Programs/Actions: Related programs include those of federal agencies such as NOAA, U.S. Geological Survey (USGS), US Fish and Wildlife Service (USFWS), National Park Service, Environmental Protection Agency (EPA), and National Science Foundation (NSF). A state-federal integrative initiative – the Alaska Ocean Observing System (AOOS) – is working with stakeholder groups to assess existing monitoring needs and develop an overall approach for filling in observing gaps.

Key stakeholders include the various commercial fishing industry sectors (fishers, processing, value-added, vessel support such as harbors and pilots, etc.), coastal communities that rely on commercial fishing, relevant state and federal agencies, and others.

Available Resources: Resources currently exist, but funding is not sufficient to implement the four components of this recommendation. A new funding mechanism, such as an Ocean Trust Fund, if implemented at the federal level could be used to fund these efforts.

Feasibility

Feasibility and Constraints: The State could realistically implement these actions, although funding for a robust monitoring program would require substantial federal funding. The AOOS provides a mechanism for coordinating the various monitoring efforts.

A review of existing statutes, regulations and policies is feasible. The end result may be that existing institutions have sufficient flexibility to consider climate change impacts. However, if changes are recommended, adding the additional uncertainties of climate change could add new constraints to decision-making and raise concerns about more decisions ending up in the court system.

Adaptation Benefits and Costs

Significant documentation exists in the peer-reviewed literature to show that increased monitoring of fish and wildlife populations and habitat (including ocean conditions) leads to improved resource management. With less precise forecasts and trends, fisheries resources are either over- or under-harvested, both resulting in significant economic losses.

The Alaska Fisheries Science Center budget for federal research in Alaska is about \$40 million a year. The ADF&G's commercial fisheries budget for 2009 is about \$80 million from state, federal and other funds. Given Alaska's huge geographic scope, remoteness, and logistical challenges, these budgets could easily double in order to provide for a more robust research and monitoring program. However, given their value, in the billions, and their job creation, this investment could have huge payoffs.

Status of Group Approval

Approved unanimously, with no objections.

NS-2 Review and Modify Alaska's Wildland Fire Policies and Programs

Recommended Adaptation Option

The State will thoroughly review and modify as appropriate, Alaska's wildland fire policy and programs to address potential climate-induced increases in wildland fire frequency, size and geographic location.

Option Description

Wildland fires occur commonly throughout much of Alaska and have a wide range of effects on social, health, economic and biological conditions. Historically, about 96% of all acreage burned in Alaska occurs in the Interior portions of the state and thus most of the greenhouse gas (GHG) emissions associated with wildland fire also occur in this region (Kasischke et al. 2002). However, in recent years fire agencies have observed the occurrence of lightning caused fires in Southcentral Alaska, a relatively rare ignition source for this region, and in 2007 one of the largest fires on record in the far north occurred in the tundra region. While this is just anecdotal information, monitoring of these phenomena should occur to identify trends in location, cause and burn intensity.

This option would address these concerns through a variety of actions including changes to current policy, increased planning and education at the community and individual homeowner levels, increased active management of high-risk fuel types, and increased active management of wildland fires.

This option addresses several goals:

- Maintain a healthy ecosystem that provides habitat for a variety of species, many of which are important to subsistence life styles.
- Reduce risks to human health (respiratory) and to human improvements.
- Utilize woody material removed from fuels management activities in bioenergy applications to offset fossil fuel used in home and community heating applications.
- Minimize the emissions of GHGs in tundra ecosystems by managing the extent of severe wildland fires to retain the large stores of organic material and extensive lichen cover (food for caribou) characteristic of this ecosystem.
- Engage local communities in planning and implementation of fire management in the lands that directly affect them.

These goals will be addressed by actively managing high-risk fuel types through fuel-reduction programs for individual homes and communities, proactive management of wildland fires on adjacent lands and increased education and planning efforts. These plans are called Community Wildfire Protection Plans (CWPP), while the individual outreach would be via an education program called Firewise. The interagency community that provides wildfire protection and education services in Alaska already uses these tools, but the programs would be expanded and updated to address changing conditions, perhaps in collaboration with the proposed *Alaska Climate Change Knowledge Network*.

Additionally, the Wildland Fire Management Options that were selected for the North Slope portions of the state under the Alaska Interagency Wildland Fire Management Plan (AIWFMP) will be reviewed in the context of a policy discussion on the changing role of fire in tundra ecosystems. Currently and historically, tundra fires are relatively rare events and most tundra regions are planned for a "limited" response. In layman's terms, this means no initial attack on fire starts except in very specific circumstances. Some call this the "let burn" policy, but this terminology over-simplifies the option. The interagency community that manages wildland fires in Alaska uses this tool to respond to changing conditions and needs of the ecosystem and the wildlife and humans that depend on it. However, there is a need for greater involvement by the public in these basic decisions.

Option Design

Sub-Option 1: Community Wildfire Protection Plans

Structure/design: Increase the capacity of communities to initiate, complete and implement a CWPP. This program is already well established and has a template for developing a planning effort. Communities will need technical assistance in developing plans and maps that show fuel types and community improvements. This could be accomplished through close collaboration with the proposed *Alaska Climate Change Knowledge Network*. Once risk maps are completed, projects for treating hazard fuels can be designed and ranked.

Targets/goals:

- Complete five new CWPPs each year for the next ten years.
- Keep all current plans updated.
- Establish a statewide CWPP coordinator as part of the Division of Forestry or the Alaska Wildland Fire Coordinating Group (AWFCG).

Timing:

- Can begin immediately, but need to increase the number of plans being prepared or updated.
- Within ten years complete 50 new plans and within 20 years have plans completed for all communities with fire risk.
- Benefits will accrue indefinitely into the future so long as plans are updated and implemented.

Participants/Parties involved: Numerous individual communities and federal and state agencies involved in wildland fire management activities and national, state and local governments. Specific agencies would include: State of Alaska, DNR, Division of Forestry, ADF&G, Wildlife Conservation, Habitat Divisions, Bureau of Land Management, Alaska Fire Service (AFS), U.S. Fish and Wildlife Service, Bureau of Indian Affairs, National Park Service, and the proposed *Alaska Climate Change Knowledge Network*.

Evaluation: Periodic review of the CWPPs would be required to determine if community goals and projects are being implemented on the ground. Reviews should be made at the community level annually and a more comprehensive update made every five years if conditions warrant.

Research and Data Needs: There are no specific research needs for this sub-option but, as noted in the design section, there would be needs for data in the form of vegetation (fuel) maps that are usually compiled from satellite imagery. Ortho rectified imagery would show human improvements and culturally important areas. A vegetation base map is needed for the state. Currently this information is available for only portions of the state. In addition, fine-scale projections of future fire regime, prepared by Scenarios Network for Alaska Planning (SNAP) at the University of Alaska (UA), would benefit communities in preparing their Community Wildfire Protection Plans.

Sub-Option 2: Policy Change (Review) to Wildland Fire Management Options Identified for Tundra Regions in the Alaska Interagency Wildland Fire Management Plan

Structure/design: Reviews of the selected wildland fire management options are part of the current process provided for in the AIWFMP and occur on an annual basis. The interagency community that oversees the plan would need to engage communities, landowners, and managers in a formal review process of the fire management options for the lands they manage. A discussion of the merits of higher fire protection for tundra areas would be undertaken as part of the annual review. It may be necessary to update sections of the plan to better reflect climate-change issues and concerns as they relate to wildland fire and its management in the state.

Targets/goals:

- Complete a review of the selected wildland fire management options for tundra lands within two years to identify resources at risk (including air quality in communities) and appropriate management responses for future wildland fires.
- Identify components of a CWPP (see sub-option 1) appropriate to communities in tundra-dominated regions.

- Update plan to reflect climate-change issues and strategies as they relate to management of wildland fires.
- Reduce or avoid GHG emissions from tundra fires by setting prescriptions and carefully monitoring environmental conditions to pre-empt extreme tundra fire events, such as occurred in 2007. Plan and document these effects in ways that allow the State to claim carbon credits in the context of whatever national carbon-trading legislation is developed.

Timing:

- Begin review in 2010 and have any adjusted protection levels in place for the 2012 fire season.
- Results will accrue over time, depending on the level of success of the increased protection policy.

Participants/Parties involved: Individual land owners and managers on the North Slope of Alaska, North Slope Borough fire department and science staff, Nuniamuit corporation, possibly leaseholders such as BP and Conoco/Phillips, other native corporations and the fire management agencies, mainly the AFS and the Division of Forestry. In addition, local government and researchers at the UA and other institutions and agencies should be involved in discussing the nature and feasibility of potential policy changes.

Evaluation: There should be monitoring of fire occurrence and burn intensity to calculate CO₂ emissions', on an as-needed basis, to determine if objectives and goals of the policy change are being met. Agency or university researchers could do this monitoring. Concurrent monitoring of lightning strikes and climate trends would allow inference on whether there is an increasing trend in potential area burned in tundra on the North Slope.

Research and Data Needs:

- Further work on burn severity mapping and quantification of GHG emissions from recent fires should be continued to complete work that has been initiated. Studies should look at both the long- and short-term emissions from fire in tundra and changes in the dynamics of permafrost response in boreal forest and tundra. Research on the relative contribution of GHG emissions from tundra ecosystems that are independent of fire is also needed to put fire release of GHGs in context (e.g., release of methane CH₄ from melting permafrost; it has >20 times the effect on climate warming than release of CO₂).
- Evaluate mitigation strategies for communities in tundra-dominated ecosystems to create fuel breaks at the wildland interface (e.g., gravel perimeter road around community) to reduce risk of wildland fire spreading among structures, as well as spread of fire from communities into wildlands (e.g., escaped trash fires at dumps).
- Additional research should be conducted on the impacts of fire on winter caribou range and changes in vegetation patterns and succession caused by fire.
- Modeling work to help quantify what would happen under an increased fire-protection strategy scenario and the current management action. (This could help quantify the third goal bullet above). Modeling is also needed to assess future fire dynamics under a suite of potential future climate scenarios. SNAP at UA has these modeling capabilities.

Sub-Option 3: Develop a comprehensive fuels management program to treat high-risk areas to minimize negative impacts of wildland fire on humans and to increase beneficial aspects, especially wildlife habitat.

Structure/design: Examine ways to use wildland fire and mechanical fuel treatments to break up extensive areas of fire-prone black spruce forests, in part by creating fuel breaks of less flammable early successional post-fire vegetation that connect to other natural fuel breaks such as wetlands.

Targets/goals:

- Work in conjunction with CWPPs at the community level to identify fuel-reduction projects.
- Reduce GHG emissions and lessen health impacts from wildland fire events.

- In fire-dependent ecosystems, allow wildland fire to continue to play an important role in maintaining healthy ecosystems, while meeting the needs of communities that utilize these ecosystems.
- Find opportunities to actively manage wildland fires to break up and reduce high-risk forest fuels.
- Utilize woody fuels from hazard fuel treatment, if feasible, in wood biomass applications.

Timing:

- Fund and implement fuel reduction projects identified in current CWPPs from 2010 forward.
- Take advantage of wildland fire starts to remove hazard fuels during late fire season or during other strategic times during the fire season. The time frame will be variable, depending on fire season activity, but wildland fire use strategies should be considered during each fire season. Use of aerial ignition can help direct burning to the locations where fuels management is most needed, at times appropriate for the conditions.¹

Participants/Parties involved: Primarily the wildland fire management agencies in the state: Division of Forestry, AFS and the U.S. Forest Service. These agencies would need to work with communities, land managers, Alaska Native Corporations and other entities to fully implement this option.

Evaluation: Utilize a statewide Fire Plan Coordinator to develop metrics to track and monitor the accomplishments of the stated strategies. Acres treated by both fire use and mechanical methods on an annual basis could be one metric. Acres of fuel types in a condition class² above normal to gauge level of risk and thus risk reduction by these treatments.

Establish baseline conditions across geographic regions and track via modeling expected outcomes under different treatment scenarios.

Research and Data Needs:

- Determine if mechanical fuel treatments are achieving the desired condition class change in the fuel type.

Implementation Mechanisms

Sub-Option 1: Provide funding for a statewide CWPP coordinator as part of the Division of Forestry or the AWFCG and annual funding to complete the number of plans identified in the target and goal sections of the Option Design, above.

The CWPP coordinator would interface with communities and the interagency community to access technical and professional assistance to develop and complete new plans, maintain a database of current plans and status, assist with updates of current plans and provide overall leadership on a statewide basis to ensure the program is coordinated between agencies. No new authorities would be required. The key implementation item is funding. Without additional funds a low level program will continue where individual agencies work in a relatively uncoordinated manner with communities that fall within their jurisdictions. Plans may not follow a standard format and will be completed in an ad hoc manner based on agency funding levels and support for this program.

Sub-Option 2: Task the AFS and Division of Forestry (DOF) with a comprehensive review of the current fire management options in the AIWFMP. Ensure that monitoring and research is taking place to help identify changing conditions and trends and work with UAF and other research institutions to address items identified in the research needs section of this paper. This initial review entails no additional costs.

If a more aggressive fire management option is adopted, there will be additional costs incurred for the pre-suppression budget for the AFS and DOF.

¹ Note: If prescribed fire is used in permafrost areas, it should be scheduled for the spring season to provide maximum protection for the permafrost layer.

² There is a formal definition of "Condition Class" and its components. <http://www.nwcg.gov/teams/wfewt/message/FrccDefinitions.pdf>

Sub-Option 3: Much of this option can be implemented by ongoing work in several agencies, notably the DOF and several Department of Interior agencies. While the state has no dedicated general fund monies directed at fuels management, funding from the federal government, mainly via the U.S. Forest Service (USFS), State & Private Forestry program has allowed communities and the DOF to undertake a number of fuel mitigation projects across the state. Funding under the American Recovery and Reinvestment Act (ARRA) of 2009 may enable additional projects to be initiated and the DOF has submitted a number of projects for consideration in the USFS competitive ARRA process. (Note, most ARRA funding is formula driven, but a competitive process allocates USFS funds.)

The U.S. Fish and Wildlife Service, Bureau of Indian Affairs, and the National Park Service have all provided some funding toward agency specific fuel mitigation projects in the past and are likely to continue this effort.

Increasingly, fire managers are moving toward a “fire is fire” concept. Management actions on a wildland fire to purposely manipulate forest fuels can reduce future protection expenditures. Directing a wildland fire with aerial ignition to achieve a fuels management objective can be a cost-effective use of resources already assigned to the fire, under the right conditions, and should not be considered an inappropriate use of suppression funds.

Projects to demonstrate the costs and potential to utilize woody biomass generated from these fuel mitigation projects are also underway, most notably in the community of Tok where a wood biomass facility will make use of material from a fuels treatment project.

Related Policies/Programs and Resources

The proposed changes are relatively modest changes that can be implemented by the Alaska Division of Forestry through its participation with the AFS in the AWFCG. These options would build on the basic programs and policies that are currently in place in the interagency fire management community; although sub-option 2 would require a review of current policy in regard to fire management levels in the northern portions of the state (tundra regions).

Active management of wildland fires to modify forest fuels may require discussion and agreement among agency heads that fire management is more than suppression. Managers would need to become more proactive on wildland fires and use fire resources in new roles if they are to meet the protection needs of communities in a safe and cost effective manner.

CWPP and the Firewise education and homeowner assistance program are well established, but not always well-funded programs.

There is work occurring on the statewide base map and National Land Cover Classification System (NLCCS) land cover mapping is available statewide at 30 meter resolution and can be accessed via mapping utility at AFS website. LANDFIRE should provide a value-added enhancement of this with finer vegetation classes and cross-walked fuel types within the year. Most of the layers are now done and being reviewed and the next version/update of the NLCCS are in progress from 2007 satellite data. Additionally, DNR and the UA are considering investment in 2.5-meter statewide satellite coverage via the Statewide Digital Mapping Initiative (SDMI). This would provide a good base map for fuels mapping and other resource management activities.

At the national level, the development of a comprehensive cap and trade policy on CO₂ could provide opportunities to market carbon credits. Revenue from these sales could offset or cover a portion of the expense associated with the implementation of sub-option 2 should a more aggressive initial attack strategy be adopted for the northern portion of the state.

Feasibility

This policy recommendation with its three sub-options is quite feasible to implement because most of the policy components are already in place. There is a need for establishment of a CWPP coordinator position and funding to ramp up completion of new CWPPs.

If a more aggressive approach is recommended for tundra fires, the methodology to provide a higher protection level is very feasible, but also dependent on funding. A more aggressive response for initial attack of fire starts would rely on aviation assets and an upgrade of the current CL-215 water scooper air tankers to CL-415 tankers. These aircraft are faster and could cover the longer distances between current home bases and fires on the North Slope. The current smoke jumper program would provide the needed ground presence to mop-up and fully contain a fire and can be expanded as needed based on fire activity via the normal resource ordering system in place nationally.

Adaptation Benefits and Costs

Benefits: There are large benefits to reducing the risk of increasing wildfire extent expected with climate warming. Increased public safety and ecological resilience are direct positive outcomes from the suite of options presented. Wildland fire is a natural process that managers can utilize as one of several strategies for reducing or minimizing CO₂ emissions by managing fuel loading, ignition timing and location of fire events.

Sub-option 2 examines the potential for preventing large releases of CO₂ in a region of the state that historically has not been prone to wildland fire occurrence. This option may be viewed as a strategic short-term (20 years) approach to preventing emissions in order to “buy time” for other adaptation or mitigation programs to mature and stabilize or reduce CO₂ levels. Over time if the fire regime is changing, it will become more difficult to minimize the impact of fire in this region. At some future point a large catastrophic event will occur similar to the 2004 and 2005 fire seasons. The challenge will be to manage fire to meet the objectives of this option while allowing the evolutionary process of the system to proceed.

Ancillary Benefits:

- Communities will have a more robust and proactive approach to fire management. Much of what we see today is reactive and can result in an inefficient use of resources
- Wildlife habitat and a variety of subsistence activities will continue to be important beneficiaries of these policies
- Potential to sell carbon credits for carbon stored in place as opposed to emitted for tundra regions
- Job training and employment for fuel mitigation crews (Type II village crews) which will enhance their employment opportunities during the regular fire season

Costs:

Sub-Option 1: Annual costs of \$100,000 per year for coordinator position and \$125,000 per year to prepare five new CWPPs per year, for the next ten years.³

Sub-Option 2: The initial policy review entails no additional costs. If a more aggressive approach is adopted for initial attack on tundra fires, the cost would range from \$650,000 to \$2.0 million a year. The AFS currently pays \$7,800/day and \$5,000/flight hour for their CL-215 and they anticipate that their costs would double for a CL-415 platform. The first option would be to upgrade the current 90-day contract for two CL-215 aircraft to two CL-415 aircraft. (Cost of \$650,000 per year with \$50,000 of this cost being for extra general support costs.)

The second option would add two 90-day contracted CL-415 aircraft to the current fleet mix, thus having two CL-215 and two CL-415 aircraft in the AFS pool. (Cost of \$2.0 million per year with \$50,000 going to general support costs.) This would ensure availability of aircraft even during a busy fire season for use in implementing this option.⁴

Additional work on the cost effectiveness of sub-option 2 should be completed. Work on quantifying the carbon emissions from the Anaktuvuk Pass fire are in progress and it would be a straight forward process to calculate the value of CO₂ emitted and compare this figure to the prevention cost. While this would be

³ Personal communication with Division of Forestry (DOF) staff and costs for individual CWPP plans from the Alaska Wildland Fire Coordination Group (AWFCG) database.

⁴ Personal communication with the Alaska Fire Service (AFS), Chip Houde, Aviation Manager.

only a snapshot of one incident, it could serve to illustrate some of the fiscal considerations and the magnitude of the monetary costs and benefits for changing response to fires in tundra regions.

Sub-Option 3: Depending on the fuel type, location and treatment method, the costs of fuel mitigation projects can vary widely. In general, the least expensive treatments use wildland fire or prescribed fire to treat large acreages, while more expensive methods involve mechanical treatments and hand crews. This last option is usually the most expensive method of treating fuels. A paper entitled "*Development of Wood Residue Markets From Fire Hazard Mitigation Projects and Analysis of Wood Residue Volume Available for Market Development*" (Lee 2008) and the companion document "*Summary of Cache Creek Hazardous Fuel Treatment Project*" (Lee 2008) outlines several common treatment scenarios and the associated costs. The costs discussed in these papers range from \$4,830 per acre to \$550,000 per acre.

Individual projects recommended by a community CWPP will vary significantly in cost because of the unique situations of each treatment, thus it is difficult to discuss specific project costs for sub-option 3.

Status of Group Approval

Approved unanimously, with no objections.

DRAFT

NS-3 Address the Effects of Climate Change on Alaska's Freshwater Resources through Adaptive Management Supported by Improved Hydrologic Data

Recommended Adaptation Option

The State of Alaska will improve the capacity of its freshwater management program to adapt to the impact of climate change to meet the diverse needs for freshwater in Alaska, through: (1) advocating for and coordinating with the federal government and others to fill the substantial need for essential data on stream flow and groundwater hydrology, (2) improved coordination among water resource agencies and the public, (3) reservations of water in rivers and lakes to protect fish and wildlife habitat, and (4) adjusting laws, policies and practices as necessary. Beneficial uses of water in Alaska include those of communities, industries, transportation/utility systems, and natural ecosystems and the fish and wildlife that depend on those ecosystems. It is critical that the State's water managers have scientifically sound water information in order to apply effective water management strategies in what could be a significantly altered future environment.

Option Description

This option is designed to ensure effective adaptive management of freshwater for users in Alaska, including, but not limited to, communities, industries, transportation/utility systems (including hydroelectric/hydrokinetic projects) and ecosystems (for fish, wildlife, recreation, aesthetics and other values), in the face of changing climatic and hydrologic conditions.

Future Trends: Climate change projections suggest that surface water abundance in Alaska could become more variable and might become seasonally limiting in more areas across the state. Changes in surface water hydrology will vary by region, but substantial changes in precipitation, water storage in the soil, surface water base and peak flow rates, and runoff timing are expected to occur. As permafrost degrades in Alaska's interior and northern regions, increasingly permeable soil could cause perched lakes and other surface water sources to disappear for much of the year. Surface water quality may also be impacted, with increases in water temperature, changes in precipitation, increased runoff and erosion contributing additional sedimentation and pollutants, and potential concentration of pollutants if there are decreases in water supply. Changes in groundwater quantity and quality must also be expected.

These and other changes will pose significant challenges to Alaska's ecosystems, as well as to communities and other users who may not find suitable alternate water sources. In addition to expected changes in water quantity and quality for human use, declines in stream flow, warmer water temperatures and degradation of water quality would threaten fish and wildlife habitat, and changes in surface water flow would affect navigability of watercourses essential for rural transportation.

Issues of Concern:

- 1) Lack of Basic Hydrologic Data:** Water resource managers must have scientifically sound hydrologic data (both surface and groundwater) to use for modeling and to make informed decisions. Collection of hydrologic data, predominantly a federal government function, has been historically under-funded in Alaska. In most parts of Alaska data are insufficient to adequately describe seasonal or long-term hydrologic characteristics or support modeling of future conditions without a large range of uncertainty.

Stream gaging of surface water flow in Alaska is woefully inadequate. Fifty or more years ago, the federal USGS established networks of stream gages throughout the western United States; they have never provided comparable coverage in Alaska, even in the most developed regions of the state. In the western Lower 48 states, there is approximately one stream gage for every 400 square miles and the density in eastern states is even higher. In Alaska, there is approximately one USGS stream gage for every 7,500 square miles.⁵ Less than one percent of Alaska's rivers or lakes have historic

⁵ The best surface water hydrology data available in the State is from a gaging network on the North Slope, maintained by the University of Alaska. However, this data is not transferable to other regions.

flow or water-level data. Without adequate data, there can be little confidence in the hydrologic models upon which managers rely.

While in the past the USGS matched State funding 1:1 to install and operate stream gages, the agency has now significantly reduced these federal fund contributions. Data from stream gages is essential for many uses including modeling, permitting, planning, engineering designs, flood prediction and control, and water appropriations. The existing stream gaging network must be maintained and additional gages with expanded data collection capabilities (including water quality parameters) established in strategic locations, to provide Alaska with the information needed to effectively manage its water resources under changing climatic conditions.

Groundwater hydrologic data is even sparser. The USGS has one groundwater monitoring well in the entire state, in Anchorage. The state is currently unable to determine how much groundwater is available, even in regions that are of key importance to communities and to industry; it is likely that groundwater is being "mined" in key areas (that is, more groundwater consumed than replenished) and climate change may worsen that situation.

- 2) **Need for Policy-Level Emphasis and Coordination:** The Alaska Water Resources Board (authorized in 1966 by AS 46.15.190-240) has been unfunded and inactive since 1994. Since that time, the State has lacked a forum for communication and coordination between State water management agencies, and between State managers, federal agencies that have a role in hydrologic data collection and management, and the public. It is essential to reestablish this agency/public body to advise the Governor on matters related to water management. The Board can help ensure that the State adapts its water resource programs to Alaska's changing climate and environmental needs, and can also help the state combine and leverage funds and other resources.
- 3) **Need to Increase Pace of Adjudications for Instream Flow Reservations:** Alaska's policy for freshwater management must ensure that water resources are adaptively managed to retain sufficient instream flow quantity and quality to meet fish and wildlife needs. The State DNR and ADF&G have been working collaboratively to secure water appropriations for instream flows for major fish streams in Alaska, for streams that have adequate gaging data (at least five years). As a near-term target for adaptive water management, it would be very beneficial to increase the pace at which adjudications are completed to provide protection on the numerous fish-bearing water bodies throughout Alaska⁶.
- 4) **Need to Review and Adapt Alaska's Water Management Laws, Policies and Practices:** The State of Alaska's Water Use Act (AS 46.15) and State Water Policy (Administrative Order No. 130) provide the structure for water appropriation and management in Alaska, following the prior appropriation doctrine (First in Time-First in Right). Alaska's water management statutes, regulations, policies and practices generally have the flexibility and adaptability to take into account potential impacts of a changing climate. However, as changes occur, it will be essential to review and adapt the administrative structure for water management to ensure it is responsive to changes in water resource availability, beneficial uses and demands. The Alaska Water Resources Board would serve as a coordinating body for this ongoing effort.

Recommendations to address these issues of concern are discussed in the Option Design section below.

Option Design

Structure/Design:

- 1) Obtain necessary data regarding surface and groundwater hydrology (through a strategic action plan that prioritizes needs) and its effect on surrounding ecosystems to improve the State's capacity to incorporate climate scenarios into its water management risk assessments, policies and decisions.

It is recommended that the State of Alaska advocate for the USGS to retain and strategically expand the stream gaging network that exists in the state to provide the data necessary to be able to confidently model and manage Alaska's water resources under changing climatic conditions. Ideally, effective coverage for Alaska would mean continuation of existing gaging stations, and installation

⁶ Conservatively, it has been estimated there are over 15,000 fish bearing streams and millions of fish bearing lakes in Alaska. Many water bodies have never been surveyed for fish so it is assumed that actual numbers are much higher.

and operation of approximately 400-500 additional stream gages with expanded data collection capabilities (including key water quality parameters). A network of 50-75 groundwater-monitoring wells should also be established in areas of the state where groundwater is heavily used (e.g., Anchorage, Mat Su Valley, portions of Fairbanks and Kenai).

Installation of stream gages and groundwater monitoring wells should be done strategically, with initial emphasis on areas where pressure on diminishing water resources would be felt first (e.g., population centers, areas where industrial uses are occurring or expected); secondly, in locations targeted for instream flow reservations and/or where changes in water volume and quality may be reaching minimum threshold levels for support of important fish and wildlife resources; and third, in consideration of improving USGS regional prediction models. Cost effectiveness and feasibility of installations must also be considered.

Implementation steps could include:

- Coordination of a round-table discussion with the many entities that have a role in water quantity and quality management, modeling and data in Alaska, including state agencies, federal agencies, the University and industry. The purpose of this discussion would be to identify existing sources of information and data gaps that should be addressed through strategic, coordinated efforts.
 - Specifically related to the stream gage network, DNR should work with the USGS, the University and other water management agencies to revisit and update the 1996 study, "Evaluation of the Streamflow-Gauging Network of Alaska in Providing Regional Streamflow Information" (USGS Water-Resources Investigations Report 96-4001). The review should also include a strategic evaluation of the need for water quality data that could be gathered at gaging locations. This would result in an updated strategic plan for allocation of financial resources to meet the most pressing surface water hydrology and water quality data needs.
 - For groundwater monitoring wells, DNR should coordinate with USGS, University and affected communities on development of a strategic plan for establishing a network of wells in areas where groundwater is, or is projected to be, heavily used.⁷
 - The State should work with Congress, the USGS and others to support and obtain additional federal funding for baseline hydrologic (including water quality) monitoring in Alaska. The State should also consider the need to increase State appropriations for cooperative funding for this essential hydrologic data collection.
- 2) Reestablish the Alaska Water Resources Board, to improve coordination regarding water management among state agencies, and between the state, other water management entities and the public. Reestablishment of the Alaska Water Resources Board would provide needed policy-level emphasis to water resource management issues and programs, including the potential need to adapt the water right adjudication process, and statutes and regulations related to the allocation of water and its uses.
- The Board includes representation from DNR, ADF&G and the Department of Environmental Conservation (DEC), as well as seven citizen representatives appointed by the Governor that represent non-government organizations, local and tribal governments, industry, and the public. The Board's duties are to inform and advise the Governor on all matters relating to the use and appropriation of water in the State of Alaska, including "... studies of the state's water supplies and plans for future requirements" (AS 46.15.210(4)), which is particularly relevant to meeting the challenge of adapting to climate change.
- 3) Increase State efforts to appropriate reservations of water for fish and wildlife habitat to provide protection for fish and wildlife resources.

⁷ Note that the Alaska Department of Environmental Conservation receives groundwater well logs that could possibly serve as a source of data for groundwater resources.

Alaska's freshwater resources should be managed adaptively to retain sufficient instream flow and water quality to meet fish and wildlife needs. DNR and ADF&G have been working collaboratively to secure appropriations for reservations of water for major fish-bearing streams in Alaska that have adequate gaging data (at least five years). As a specific near-term target, it would be highly beneficial to increase the pace at which adjudications are completed, particularly for the approximately 150 fish-bearing streams in Southcentral and Interior Alaska for which there are adequate data for assessment of instream flow needs and water right adjudication. There are also adjudications for instream flow for fish pending on federally managed lands in Alaska.

- 4) Continue to assess the water right adjudication process, and where necessary revise the statutes and regulations related to the allocation of water and its uses, to provide additional flexibility when needed to adapt to climate change.

DNR and the reestablished Alaska Water Resources Board should work together and with other entities to ensure that Alaska's water resource management laws, policies, and practices allow the State to adapt to the effects of climate change. Incorporating climate change considerations in water management is critical to the sustainability of Alaska's communities, industries and ecosystems. This may include using available data and assessment tools to identify areas where there is risk that future water needs will not be met, and development of long-term water management strategies for these regions, including strategies and assessments conducted at the watershed-level. (It is important, however, to note that confidence in the results of risk assessments is directly related to the availability of useful hydrologic data. For example, the Arctic Water Resources Vulnerability Index [AWRVI] is a promising tool for the North Slope of Alaska, where there is better data coverage; however, the lack of data in many other areas of Alaska would be a significant constraint to conducting risk assessments.)

Targets/goals and Timing: The goal is to provide more effective management of Alaska's water resources under changing conditions, through adaptive management supported by adequate hydrologic data and modeling.

Potential targets and timing include:

- Take immediate steps to coordinate among agencies to evaluate hydrologic data needs and gaps, and to increase the surface and groundwater hydrologic data available for Alaska, through the strategic expansion of data collection methods and sites. (Targets and accomplishments depend upon funding.)
- Reestablish the Alaska Water Resources Board within one year.
- Complete adjudication for the approximately 150 fish-bearing streams in Southcentral and Interior Alaska that have adequate flow records to reserve water for fish and wildlife, within five years of receipt of funding.
- When data permit, conduct vulnerability and risk assessments to determine areas of the State most at risk for not having water needs met (for communities, industry, transportation/utilities and/or ecosystem health).
- On-going adjustment of water management laws, policies and practices, as required to adapt to changing conditions.

Evaluation: Metrics could be established around accomplishment of specific targets, dependent on funding. DNR, in close coordination with the Alaska Water Resources Board, would be the appropriate lead for evaluation of progress.

Participants/Parties involved: DNR, ADF&G, DEC, UA, USGS, Alaska Water Resources Board, non-government organizations, local and tribal governments, industry, public

Research and Data Needs:

- As described in more detail above, gather data on hydrologic parameters (surface and ground water) throughout the state to establish baselines and support modeling, to better understand the broad range of impacts of climate change on freshwater in Alaska.
- Develop new tools to assist water managers in addressing climate change such the USGS's *StreamStats* application for assessing stream flow and basin characteristics in gaged and ungaged watersheds (see <http://water.usgs.gov/osw/streamstats/>).

Implementation Mechanisms

The primary need for implementation of these recommendations is Cabinet-level emphasis, intention, and strategic funding. No new legislative authority is required. Reestablishment of the Alaska Water Resources Board, which operated for 15 years but was disbanded in approximately 2001 due to budget considerations, is recommended. More specific implementation steps are provided in the Option Design section, above.

Related Policies/Programs and Resources

Related Policies and Programs: These recommendations build upon existing government structures for water resources management in the State of Alaska, as provided in Alaska Administrative Order No. 130 (dated July 1992), and applicable State statutes and regulations. The DNR, Division of Mining, Land and Water has the statutory responsibility, authority and expertise to manage Alaska's water resources (appropriation), in coordination with many other parties, including ADF&G, DEC, UA, USGS, Alaska Division of Ocean and Coastal Management, other federal agencies, local and tribal governments, and non-government organizations (e.g., watershed groups, conservation organizations). Alaska's Department of Environmental Conservation has responsibility for management of water quality. Federal agencies, the University and the private sector also collect hydrologic data (quantity and quality), develop and apply hydrologic models, and have other involvement in water management issues. State and federal management agencies and the University coordinate at the staff level through the Interagency Hydrology Committee for Alaska (IHCA); however, this group does not have authority to allocate resources (funding, staffing) or provide the policy-level commitment needed to implement these recommendations.

Available Resources: Funding is the key limitation to fulfilling these recommendations. Expanded collection of hydrologic data is very costly and substantial federal funding would be required. The State and the participants/parties listed above have the expertise and authority to implement the recommendations, provided funding is available for required staffing, equipment, logistics, and other costs.

Feasibility

As detailed above, the primary constraint or limiting factor to effective water management under changing conditions is the lack of sufficient surface and groundwater hydrologic data, and lack of a consistent identified federal funding source for a sufficient data collection program. There will also be a substantial delay between actions taken (establishment of a data collection network) and benefits realized (more accurate water resource modeling and more effective management), because of the time needed to accumulate a meaningful hydrologic database.

Adaptation Benefits and Costs

Benefits: The primary benefits of these recommendations will be improving the State's capacity to provide fresh water of sufficient quantity and quality for the wide range of beneficial uses, into the future. By closing existing substantial data gaps and strengthening the management structure, the State will be better prepared to develop a strategic approach to water management, assess risk of water shortage and the need for replacement sources within and between regions, avoid over-appropriation, and protect beneficial uses.

In the short-term, the State can realize benefits through increased coordination of water management issues at the policy level, coordination of effort and resources to identify and tackle data shortages and

address the highest priority data gaps, and completing reservation of water appropriations for key fish bearing water bodies.

However, gains in hydrologic data and data application will be long-term, due to the expense associated with establishing the monitoring network and obtaining a sufficient time series of data

Costs: Collecting additional hydrologic data and associated water quality data is very costly, due to the need to establish, maintain and monitor many surface water gages and groundwater monitoring sites in remote sites throughout Alaska.⁸ Substantial federal funding would be required and data collection would undoubtedly need to be prioritized. Federal funding sources might include ARRA funding or funds appropriated to the USGS for hydrologic work in Alaska. However, continuing to delay filling this essential data need will be costly to Alaska. Costs to establish the data collection network will increase, and Alaska will be faced with high costs in the future as conflicts over limited water increase, and resource value and economic growth is negatively impacted by lack of water, ongoing conflict over appropriations, or diminished water quality. Coordination of a round-table among the government agencies, University and other entities that collect and apply hydrologic and water quality data would be a feasible, affordable and important first step in developing a strategic plan to fill essential data gaps.

Less costly implementation steps would include reestablishing the Alaska Water Resources Board (estimated cost of \$50,000/year) and providing additional staffing in DNR and ADF&G to complete the reservation of water appropriations for fish bearing systems with adequate data for adjudication (estimated cost of \$500,000/year for the next five years.)

It is expected that the federal and State government would need to help bear the costs of implementation of these recommendations, with possible participation by the private sector.

Status of Group Approval

Approved unanimously, with no objections.

⁸ Each stream gage site is estimated to cost \$25,000-\$40,000 per year to set up and operate, with potential additional costs for measurement of water quality parameters. Installation of a groundwater well is estimated at \$9,000 per well, with additional annual staff costs to monitor the wells.

NS-4 Reduce Introduction and Spread of Invasive and Eruptive Species

Recommended Adaptation Option

The State of Alaska will expand efforts to become an active partner with all levels of government and other entities in addressing the problem of invasive species in the state, primarily through establishment of the Alaska Invasive Species Council and implementation of strategic actions to prevent and control invasive and eruptive species.

Option Description

More and more non-native species are turning up in Alaska, and lengthening growing seasons and less severe winters increase their likelihood of establishing and their rate of spread. These climatic changes have also been associated with outbreaks of insect pests and plant pathogens. The involvement of the State of Alaska is critical to controlling the introduction and spread of invasive species, yet to date the State's participation in efforts to prevent, control and respond to invasive species has been modest. Through establishment of the Alaska Invasive Species Council and implementation of a strategic invasive species program, the State will express its commitment to prevention and control of invasive and eruptive species and will join its efforts with work already underway by federal agencies and private entities.

The combination of changing climate and increasing globalization has dramatically increased the rate of introductions of non-native, invasive species to Alaska. Invasive species threaten every Alaskan ecosystem, from near-shore marine environments to arctic tundra. Invasions by non-native species have the potential to damage important economic sectors such as fisheries and forestry, as well as to alter fire cycles and subsistence opportunities. Longer growing seasons and less severe winters increase the opportunity for non-native species to become established and spread in Alaska (e.g. the recent dramatic spread of bird vetch (*Viciacracca*) in the Fairbanks area). Insects are expanding their ranges in the state, and in some cases exacerbating vector-borne diseases. In addition, shifts in climate have contributed to heretofore atypical but dramatic eruptions of some native species (e.g. spruce beetles in Southcentral Alaska and alder canker in Interior Alaska).

Alaska still has the opportunity to prevent the myriad problems that invasive species can provoke. If allowed to become widespread, invasive species can cause gradual and irreversible degradation of entire ecosystems, with substantial negative impact to local economies. Once invasive species become widespread, the possibility and economic feasibility of controlling them declines dramatically.

This option would take advantage of the opportunity that still exists to prevent the spread of invasive species to large areas of the state. Limited state funds would be far more effectively spent on prevention than on control.

Implementation of this option would include:

- **Creation of an Alaska Invasive Species Council**, through State support for House Bill 12 "Establishing the Alaska Council on Invasive Species," introduced January 9, 2009). State representatives to the Council will include the ADF&G, DNR, DEC, Transportation and Public Facilities (DOT&PF) and UA. The Council would include nine additional members appointed by the Commissioner of ADF&G. The primary purpose of the Council will be to coordinate the State's new and pro-active involvement in invasive species issues, and provide an effective forum for the State's coordination with local, federal and tribal governments and other entities. The Council will review the current funding mechanisms and levels for State agencies to manage noxious weeds and aquatic nuisance species on the lands and waters under their authority. The Council will establish criteria for the prioritization of invasive species response actions, and prepare an annual report to the governor and to the relevant policy committees of the Senate and House of Representatives.

Under the policy and strategic direction of the Alaska Invasive Species Council and the work of staff from represented agencies, additional actions would be implemented to address Alaska's most pressing invasive species challenges, including:

- **Develop modern and comprehensive noxious weed regulations.**
- **Encourage Alaskan agricultural producers, greenhouses and nurseries to enter the native-plants-as-revegetation-materials market.**
- **Work with Canada through appropriate diplomatic channels** to encourage the control and eradication of a variety of weeds, insects, aquatic nuisance species, and marine invasives (e.g. spotted knapweed, *Spartina*, green crab) in British Columbia, the Yukon, and NWT to reduce their spread towards Alaska.
- **Work with shellfish mariculture industry** on education and best management practices to prevent, identify and control non-native organisms that arrive with shellfish stock.
- **Evaluate ballast water treatment technologies now available.**
- **Evaluate the impact of hull fouling on the spread of invasive marine organisms to Alaskan waters.**

This option would contribute to and build on work underway by the statewide Alaska Committee on Noxious and Invasive Plant Management (CNIPM) and by the Alaska Invasive Species Working Group (AISWG).

Option Design

Structure/design: This option allows the State of Alaska to strengthen its commitment and organize its efforts through formation of the Alaska Invasive Species Council. Through the Council, the State can join forces with already-established federal efforts (US Forest Service, National Park Service, US Fish & Wildlife Service) and public sector programs (Cooperative Weed Management Areas, Watershed Partnerships, CNIPM, AISWG) to coordinate a cross-land-ownership program on invasive species in Alaska. This proposal includes tasks that can be implemented at both small and large scales. Examples of the types of actions that could be taken are provided in this section.

Currently, invasive plant propagules are being spread unintentionally in gravel and fill material used in construction projects statewide. Yet most of the state's material sales sites (gravel pits) remain, at this point, weed-free. A gravel pit certification program would be a simple means of documenting and maintaining weed-free status for state-owned pits. The next step would be to encourage that gravel used by Alaska DOT&PF and in other state construction projects come from certified pits only.

Routine road maintenance operations of the DOT&PF also spread invasive plant propagules, rapidly and unnecessarily increasing the distribution of those species. Simple changes in the timing, methods and equipment used in these activities would eliminate this acceleration of spread.

At present, the only plant/agricultural materials entering the state that are inspected in any way are potatoes and tomatoes. Nursery starts are being shipped into Alaska from outside the state with a wide variety of noxious weed contaminants. Western tent caterpillars are routinely found pupating on ornamental trees and shrubs brought to Alaska from the lower 48. In 2007, a 747-cargo plane of Christmas trees from Oregon was flown directly to Alaska after being rejected for off-loading in Honolulu by the Hawaii Division of Agriculture. The shipment was infested with a variety of species of insects and contaminated with soil, which was then distributed around Anchorage when the plane was off-loaded with no inspection whatsoever. As Alaska's climate warms, such introductions will increasingly lead to new established populations. For some species, the consequences for Alaskan ecosystems are potentially devastating. An inspection program is needed that would include all nursery materials and Christmas trees entering the state as well as wood shipping containers, pallets and wood products for exotic wood borers.

The University of Alaska Fairbanks (UAF) has begun to develop a management plan for the significant invasive plant infestations on the UAF campus. UAF facilities services and the UAF administration should be recognized for their commitment to this effort; it should be expanded to address similar issues at the Palmer Experiment Station. The next step would be to use these projects as a starting point from which to address and manage invasive plant infestations around all state-owned administrative sites, buildings, storage areas, parking lots and other public facilities.

Plant species now recognized as invasive are still being used for revegetation projects around the state, in part because commercial sources of native plant seed or starts are extremely limited. Demand for native plant revegetation materials far outstrips supply. The state could initiate a small-grants program to encourage Alaskan agricultural producers, greenhouses and nurseries to enter the native-plants-as-revegetation-materials market. A next step would be to require that construction projects on state land revegetate with native species.

The State should work with and encourage the shipping industry to adopt any of the many treatment technologies now available to reduce the impact of ballast water in Alaska offshore environments. Ballast water coming into Alaska must be tested to gauge the range and types of organisms present. Ballast water may have the ability to transfer pathogens - such as a possible *Vibrio* outbreak, and may have implications to the health of the shellfish industry and human health. The state should consider regulation such as that for Washington and Oregon to protect Alaskan waters from ballast water release.

The State of Alaska should work to develop educational outreach materials and best management practices to prevent, identify and control non-native organisms that arrive with shellfish stock. Work with the shellfish mariculture industry to educate about and monitor for green crab occurrence in State.

The State should actively support the outcomes of a National Marine Fisheries Service (NMFS) -funded *Spartina* response plan.

The State should determine if action should be taken to address hull fouling as a vector to Alaska. This would involve evaluating the results of research funded by Prince William Sound Regional Citizen's Advisory Council (PWSRCAC) for possible follow up on additional research, education, or best management practices.

Targets/goals:

- Establish the Alaska Invasive Species Council. (State support for HB 12).
- Re-fill the integrated vegetation management position at the Alaska DOT&PF (position has been vacant since January 2008).
- Establish a dedicated plant/wood products quarantine inspector in the Division of Agriculture *with regulatory authority*.
- Implement actions identified as strategic priorities by the Council, such as the actions described in the Structure/Design section, above.

Timing: The groundwork for many of the targets/goals described above has already been laid. In some cases the only ingredient missing is committed State of Alaska involvement. Thus, many of these goals can be accomplished quickly, within two to five years.

Participants/Parties involved: There are a wide variety of entities that can participate in these efforts, including public and private organizations with broad expertise in the areas discussed. A partial list would include: DNR, DOT/PF, DEC, ADF&G, Alaska Committee for Noxious and Invasive Plant Management, Alaska Invasive Species Working Group, Alaska Cooperative Extension Service, Association of Alaska Conservation Districts, U.S. Forest Service, State and Private Forestry, National Oceanic and Atmospheric Administration, US Fish and Wildlife Service, US Department of the Interior (USDI) National Park Service, USDI Bureau of Land Management, US Department of Agriculture (USDA) Agricultural Research Service, Juneau Watershed Partnership, Anchorage Cooperative Weed Management Area, Alaska Center for Coastal Studies, and PWSRCAC.

Evaluation: The body charged with monitoring these efforts would be the newly formed Alaska Invasive Species Council.

Research and Data Needs: Research is needed on a variety of topics associated with invasive species in Alaska, including:

- Commercial production of native plant materials for revegetation projects,
- Appropriateness of existing ballast water technologies for Alaska,
- Spread and distribution of *Spartina*, green crab and tunicates in Alaskan coastal waters, and

- Effectiveness of new road maintenance equipment, schedules and methods in reducing the spread of invasive plant propagules.

Implementation Mechanisms

- Support the creation of the Alaska Invasive Species Council. Legislative authority for the Council is proposed in HB 12, a bill “Establishing the Alaska Council on Invasive Species,” introduced January 9, 2009.
- Through the policy and strategic direction of the Council and the work of agencies represented on the Council, implement actions targeted to address Alaska’s most pressing invasive species challenges (see Option Description, above).
- Fill necessary State agency positions to support the strategic work of the Council.

Related Policies/Programs and Resources

Several federal agencies have developed strong invasive species programs in Alaska, beginning in about 2000. Two ad-hoc groups (Alaska Committee for Noxious and Invasive Plant Management and Alaska Invasive Species Working Group) have made important advances in the development of a coordinated invasive species response system. Websites, publications, sub-committees, annual meetings, listservs, all are up and functioning well. Those groups are primarily composed of representatives of federal agencies, the UA, the Soil and Water Conservation Districts, and the Cooperative Weed Management Areas.

Involvement by representatives of the State of Alaska has been modest, perhaps with the exception of ADF&G. Because invasive species don’t respect land ownership boundaries, the State’s DOT&PF, DEC, and DNR needs to become fully involved.

Seventeen states have established invasive species councils. It has been their experience that resources are effectively combined and leveraged when decision makers come together in these councils, so much more is accomplished at less cost. The existing Alaska Invasive Species Working Group has worked hard and accomplished a lot over the past three years, but sees the establishment of a Council as essential to provide a group that can make policy decisions and more effectively involve the State agencies. This is especially important given the growing concern with invasive species in light of the changing climate in Alaska.

Feasibility

All of the proposed actions are feasible. None are very expensive. Alaska is isolated from most of the worst invasive species problems in North America. Compared to the lower 48, the Yukon and northern British Columbia are very clean. We have few points of entry; few ports and very few roads coming into the state.

Adaptation Benefits and Costs

Benefits: Alaska’s intact ecosystems are its most fundamental asset. The benefits to be gained by protecting those ecosystems from invasive species cannot be overstated. In Alaska, the subsistence lifestyle, our sport and commercial fisheries, hunting, trapping, wildlife viewing, the timber industry, and much of the tourism industry are directly connected to and fully reliant upon the functioning and intact ecosystems in our state.

The advancement of invasive species into intact ecosystems can be likened to the spread of an irreversible cancer. Sometimes it happens slowly, sometimes it happens very fast. The effects are difficult to predict, but invasive and eruptive species that threaten Alaskan ecosystems are directly aided and propelled by the changing climate.⁹

⁹ Alaska must learn from the consequences of inaction or insufficient action in other systems: kudzu and cogongrass in the American southeast, gypsy moths across the northeast, zebra mussels in the Great Lakes (and now spreading across the west), Chinese carp in the Mississippi watershed, tamarisk along water systems throughout in the southwest, leafy spurge and spotted

Success in this program would have several components, all of them feasible, none of them complex or especially costly. Establishment of the Alaska Invasive Species Council would provide immediate benefit, through coordinated policy and strategic direction, and coordination and leveraging of state resources. The DNR Division of Agriculture would develop an inspection program for untreated wood products and agricultural/horticultural products entering the state. This program would have regulatory authority. State employees in a wide variety of agencies would be trained to recognize and report non-native species. State agencies would participate in coordinated planning with federal partners on rapid-response plans to non-native insect and pathogen outbreaks. State agencies would review their own operations and modify or eliminate activities that contribute to introductions and spread.

The timeframe for realizing benefits is both short- and long-term. Alaskans would realize the ultimate benefits through the continued functioning of our ecosystems: producing fish, timber, and wildlife. Key uncertainties center on predicting the impacts of, and prioritizing responses to, a wide variety of potential invaders or eruptive species. However, a sophisticated system for ranking the invasiveness of plants in Alaska has been developed and is already being widely used:

(<http://www.fs.fed.us/r10/spf/fhp/invasive/invasiveness%20ranking%20report.pdf>). Similar systems are being discussed for insects, pathogens, and marine organisms.

Costs: Implementation of this option would not be high cost. Costs would be contained by: (1) acting early to prevent and control invasive and eruptive species, (2) building on existing State of Alaska staffing and programs, and (3) coordinating and leveraging resources among state agencies, federal agencies and other partners. Depending upon the exact actions taken, costs could be associated with the following elements of this recommendation:

- The ADF&G has submitted a fiscal note for \$190K to the state legislature for costs associated with establishing the Alaska Invasive Species Council. It includes salary for an Executive Director and part-time administrative assistant.
- Limited staff increases, especially a plant/wood products quarantine inspector in DNR Division of Agriculture and re-fill of the vegetation management position in DOT&PF. It is estimated that a full-time inspector position and two seasonal positions would cost approximately \$150K per year.
- Support needed research efforts to support development of policies and best management practices.
- Development and implementation of regulations and best management practices.
- Possible small-grant program to encourage development of native-plants-as-revegetation-materials market.

The Council would determine the appropriate scale of the program, in keeping with the resources available.

The critical factor that will determine the likelihood of success and the cost of effective implementation is timing. Prevention is much more cost-effective and feasible than control. Alaska is in an enviable condition right now, with respect to invasive species. Compared with other states, there are relatively few non-native or erupted species in Alaska and they are not yet widespread. However, more and more non-native species are turning up each year, and it is expected the changing climate will exacerbate their spread. It would be fiscally prudent to implement these actions proactively rather than reactively.

Status of Group Approval

Approved unanimously, with no objections.

knapweed in western rangelands, purple loosestrife in wetlands across the lower 48, the brown tree snake on Guam, the Emerald Ash Borer in the upper Midwest, rats and foxes in seabird colonies on islands in the Aleutian chain. Asian long-horned beetles, found for the first time in Worcester, Massachusetts in August, 2008, now threaten the maple trees of New England and eastern Canada.

NS-5 Provide for Adaptive Management of Fish and Wildlife

Recommended Adaptation Option

The State of Alaska will improve its capability to adaptively manage fish and wildlife species harvested in Alaska to assure sustainable management of these important resources under conditions of rapid and substantial climatic change. Two specific actions are proposed to achieve this end:

- Sub-Option 1: Develop and adopt a more timely regulatory process for the harvest of game, in order to adapt and respond to short- and long-term changes in climate that can decrease harvest success under a static harvest season.
- Sub-Option 2: Develop a coordinated framework for monitoring the abundance and distribution of fish and wildlife in Alaska, to facilitate adaptation of resource development, harvesting systems, and conservation of biological diversity in response to changes caused directly or indirectly by climate change; including a system for coordinating the management, sharing and dissemination of monitoring data.

Sub-Option 1: Adopt a More Adaptive Regulatory Process for Wildlife Harvest

Option Description

This sub-option describes the need for a timely regulatory process for the harvest of wildlife in Alaska, in response to short- and long-term changes in climate that can decrease harvest success under a static harvest season. Developing an option for in-season game harvest management is described below, along with challenges for its implementation. (Note that this recommendation focuses on management of wildlife harvest, as fisheries management already provides for adaptive in-season management.)

The rate of climate change in recent years is perceived to be disrupting historic patterns of movement and behavior by game animals (e.g., large forest fires, warm periods during rut) and transportation options for hunters during hunting seasons (e.g., low water depth in rivers, formation of ice that is inadequate for safe travel). There is concern by some hunters that the regulatory process for changing hunting seasons is too slow for timely adaptation to changing conditions, resulting in lower hunting success (proportion of people who harvest an animal compared to the number who attempt to harvest an animal).

The goal of this sub-option is to conduct a comprehensive review of laws, regulations, and policies on sustainable harvest of wildlife in Alaska and recommend changes that allow for more timely, coordinated, and effective adjustment of state and federal hunting regulations to allow hunters to adapt to effects of climate change. The current process of inseason management of commercial and subsistence salmon fisheries may provide a model for how this could be accomplished. A system of robust and timely stock assessments is essential to inform inseason management actions.

Hunting seasons restricted to inopportune periods may hinder harvest success of wild game as a food source, complicate care of meat in the field, force unsafe travel, or encourage illegal hunting during closed periods, especially where subsistence harvest is critical in remote communities. Requests to shift hunting seasons are occurring more frequently in certain regions (e.g., September moose hunts in western Interior), which increases workload and decreases efficiency for regulatory authorities and local advisory groups. Some rural residents perceive a lack of concern by management agencies and regulatory authorities, which hinders the cooperation necessary for effective harvest management and wildlife conservation in remote areas.

Option Design

Structure/design: Unlike some commercial and subsistence fisheries, presently it is not possible for local wildlife managers to extend hunts in-season or increase bag limits of game where appropriate. Emergency season closures do occur on some registration hunts when a general harvest quota is reached; but encourages strong competition to hunt early, when meat care may be difficult.

This sub-option recommends that a working group focused on a community or small region (as a test case) develop a proposal to the Board of Game for an in-season management option that would allow managers to avoid a hunting season in warm weather. The charge would be to design a hunting season and harvest quota system that is flexible and informed by knowledge of local conditions to allow a season extension for local and non-local hunters if short-term weather hindered harvest during a general season and the harvest quota for the community/region is not met. Communication and close cooperation between managers and hunters to ensure timely harvest reporting would be critical for low abundance animal populations to avoid overharvest with this approach.

Targets/goals: One goal would be a reduction in the number of proposals to the Board of Game and Federal Subsistence Board that request shifting hunting season dates later because of trends in warmer conditions during fall and early winter hunts. A second goal would be to allow hunting at times when travel is safe and meat can be preserved in good condition.

Timing: A working group could provide input through the local Fish and Game Advisory Committee (state) and Regional Advisory Council (federal) for development of a test proposal for a community or small region. Initial recommendations for changes in regulations could be completed within one year. The Alaska Board of Game and Federal Subsistence Board each convene annually but address regional issues (e.g., Southeast, Southcentral, Interior, Western/Arctic in state system) for wildlife on a two-year cycle. Thus, the entire process to put a new (flexible) regulation in place in a particular region may take up to three years.

Participants/Parties involved: Hunters, state and federal wildlife managers, Alaska Board of Game/Local Advisory Committees, Federal Subsistence Board/Regional Advisory Councils, and tribal organizations (e.g., Association of Village Council Presidents).

Evaluation: Effectiveness would be gauged as fewer proposals to shift seasons or create additional hunting seasons, community harvest needs being met (subsistence harvest monitoring), and a sustainable harvest that does not cause wildlife population declines (population monitoring, harvest reporting).

Research and Data Needs: The most common request for harvest regulation adaptation to date has been to shift moose hunting seasons later in autumn when weather is cooler (change to warmer weather in early September for parts of the Interior was documented by National Weather Service on request of Alaska Department of Fish and Game in 2008). Managers are concerned that shifting a hunt into the rut period (when bulls are preoccupied with breeding) can increase hunting success, which could be a problem in low-density populations or those with a low bull:cow ratio. Research on rutting behavior would require long-term observational studies, which would be challenging in boreal forest. A literature review about the effects of temperature on rut timing and the potential effect of allowing moose hunting during the rut on productivity of moose is warranted. It would also be instructive to understand the effect of temperature and rainfall patterns on river level for motorboat access in autumn and the effect of temperature patterns on ice formation for winter travel on both freshwater ice and sea ice. The travel relationships are complex, encompassing both natural sciences (climate, hydrology) and human behavior.

Implementation Mechanisms

Progress would occur by choosing a test case area of state where weather during hunting season has been a problem, asking for participants for a working group (one representative from each group noted in previous section), setting goals and a timeline for developing a regulatory proposal, and providing the group with the resources for meetings to occur. A local test case in the Bush where good cooperation already exists is advisable before attempting a more complex process on the road system or a process that is regional or statewide in scope. These types of collaborative efforts to resolve hunting issues or conflicts have occurred in Alaska in the past. This test case would demonstrate the feasibility and effectiveness of providing for this type of timely and adaptive game harvest management more broadly in Alaska.

No new legislative authority would be needed to implement this option. The Alaska Board of Game sets hunting regulations for all lands statewide, and these regulations apply for all hunts on state and private lands (including Alaska Native allotments and Native corporation lands). The Federal Subsistence Board may separately set hunting regulations on some federal lands to ensure subsistence needs of federally-

qualified rural residents are met, which may result in a priority for rural residents at times when sustainable harvest is less than demand by all hunters.

There would need to be a mechanism for resolution of state and federal harvest management in times of perceived game shortage in rural areas, when a subsistence priority could be given to rural residents on federal lands (see Feasibility section below).

Related Policies/Programs/Actions: There are good examples of consensus-based stakeholder groups to address hunting issues (Western Arctic Caribou Working Group) and fishing issues (Yukon River Drainage Fisheries Association) in Alaska.

Available Resources: Travel funding would be required for a working group to convene two to three times over several months to one year to draft a proposal (federal partners may be able to assist with funding). Depending on the schedule, additional travel funding may be needed for the rural Fish and Game Advisory Committee because some committees have funding only for one meeting per year. The working group would submit a proposal to the Board of Game at the next available cycle.

If the Board of Game adopted a quota system, it may require extra resources for ADF&G staff to travel to communities that do not have a license vendor so hunting licenses and harvest reporting information can be issued to hunters. Timely reporting would require hunters to provide ADF&G with harvest data by phone or email within a short period after harvest (e.g., three days) so a manager could estimate if a season extension is advisable.

Feasibility

The Alaska National Interest Lands Conservation Act of 1980 (ANILCA) required a subsistence hunting and fishing preference for rural residents of Alaska on federal lands, which compose 60% of the state. In the 1989 McDowell decision, the Alaska Supreme Court upheld the common use clause in the Alaska Constitution that provides for access to game by all Alaska residents. Since 1990, dual regulations for hunting and fishing have existed on most federal lands in Alaska (determined by Title VIII of ANILCA). While amending ANILCA or the State Constitution is problematic, it would be feasible to adopt a State regulation allowing manager discretion to extend season length for harvest up to a sustainable quota that meets subsistence harvest needs for a rural community or communities; this would eliminate the need for additional hunts on federal lands. Regulations that are simpler, apply to all land ownership, and are consistent over time are more likely to be understood and embraced.

Participating hunters will have to be convinced of the value of harvest reporting as a benefit to meeting their subsistence needs, because law enforcement alone is unlikely to be an effective means of change. Some people prefer cow moose (often more fat than bulls) or hunting in winter (additional season), when options exist for overland travel by snow machine and easier meat care. Some requests to adjust timing of harvest seasons may occur in areas where harvest is already managed to the sustainable limit (e.g., harvest in warm weather is more difficult but the quota is already being met). In that instance, shifting a State moose-hunting season open to all residents and possibly even non-residents from early September to late September or early October (during the active rut, when bull moose are more vulnerable) may increase harvest success to beyond sustainable yield. Allowing a winter hunt for bulls on federal lands (particularly after bulls have begun to drop their antlers) may increase the harvest of cows. This is a particular problem in low-density moose populations, which are common in predation-limited systems of the boreal forest in rural Alaska. Coordination of state seasons and federal subsistence seasons is critical to prevent overharvest, particularly of cow moose during winter hunts.

Adaptation Benefits and Costs

Regulatory proposals to state and federal boards for fish and game management often create substantial workload for agency staff and boards, so success would be commonplace options for in-season management that would reduce the number of regulatory proposals. Better coordination of state and federal regulatory processes for fish and game management should also reduce duplication of efforts. An ancillary benefit may be to reduce the tendency for conflict between user groups and management agencies that having dual regulations for federal lands or waters can bring. The need for coordination is not unique to climate-driven issues, but concerns over climate change may serve as the catalyst for innovation, particularly in game management. The time frame for local case studies (if successful) to

spread to larger regions or statewide is unknown because of the increasing complexity of dealing with resource allocation closer to the road system (high access potential for harvesters). Whether this approach could be applied successfully statewide is unknown.

Data collection to assess fish stocks or game populations in the short term is on going, regardless of climate change. The travel and staffing costs to implement a local case study over one year with a working group in a rural area (outlined above) would be small in comparison to the public process for a complex issue that includes a large number of stakeholders from a much larger geographic region. A large or complex process would also likely require additional planning and support staff in agencies.

Sub-Option 2: Develop a Coordinated Monitoring Framework for Fish and Wildlife to Facilitate Adaptive Management

Option Description

Changing climate is expected to continue influencing the distribution and possibly the quality of habitat for fish and wildlife in Alaska, which may cause declines in some native species and increases in other species. Important distributional changes in populations may occur for terrestrial, freshwater, and marine species.

The goal of this sub-option is to coordinate efforts to monitor fish and wildlife species or stock abundance changes, evaluate the risk of species loss or decreased genetic diversity, and ensure that information and tools are in place for adaptive management to be implemented where feasible and warranted. Developing and using a coordinated system for managing, sharing and disseminating monitoring data is a key part of this recommendation. Through coordination, agencies could combine efforts and leverage funding to document changes sooner and make adaptive management possible. Adaptive management could include changing harvest patterns or taking steps to restore populations if adequate habitat remains. Note that under the Waxman-Markey bill pending in the U.S. Congress, it may be necessary for the state to revise its *Alaska Wildlife Comprehensive Conservation Strategy* to include adaptation measures for climate change.

A decline or change in distribution of harvested species or stocks could have important economic impacts on local communities that rely heavily on commercial fishing. These changes may also have implications for food supplies, particularly for remote communities as the cost of transportation fuel increases. Climate change may also threaten populations of non-game species, leading to potential biodiversity loss or restrictions on uses of lands for some purposes. Indirectly, change in location of major vegetation types has implications for wildland fire regimes, which is the primary agent of habitat enhancement for game in boreal forest. Climatic changes may also accelerate loss or fragmentation of rare habitats (e.g., alpine in Yukon Tanana uplands) important to some endemic species (e.g., Alaska marmot). Changes in near-shore marine circulation patterns may alter food webs or migratory pathways for fish, and changes in freshwater flow and temperature regimes may impact salmon spawning habitat and juvenile survival.

Option Design

This sub-option recommends that the agencies and other entities that monitor fish and wildlife species abundance and distribution in Alaska develop a coordinated framework that documents existing monitoring efforts, identifies priorities for monitoring in the context of climate change, and identifies gaps and potential for collaboration. The option would also include development and use of a common structure for cataloging and disseminating monitoring information, perhaps through collaboration with the proposed *Alaska Climate Change Knowledge Network* (See additional detail in Implementation Mechanisms, below.) This sub-option extends the monitoring program described in NS-1 to non-commercial marine species and to harvested and non-harvested freshwater and terrestrial species.

Targets/goals: The initial target would be completing a coordinated framework for monitoring efforts for fish and wildlife, including non-game species. Quantitative targets or goals would need to be developed by participants once a review of the existing efforts is assembled in a single framework. Existing escapement goals for salmon species and stocks can be used to evaluate potential impacts of climate change on abundance, productivity, and distribution.

Timing: Various levels of collaboration on monitoring biological diversity for scientific and conservation purposes has occurred in the past. It should not be a lengthy process for a comprehensive participant group to meet to develop a monitoring framework and protocols for coordination and sharing of monitoring data.

Participants/Parties involved: State and federal management agencies, UA, tribal organizations, non-government organizations, citizen science efforts, and private business (e.g., oil companies).

Evaluation: Increased efficiency in obtaining fish and wildlife monitoring information at a single source, particularly as large development projects are undertaken (oil or gas pipelines, railroads, roads for resource extraction) that require comprehensive environmental studies.

Research and Data Needs: Once a review of the existing efforts has occurred, participants could identify gaps in knowledge, prioritize inventory and monitoring needs, and suggest protocols.

Implementation Mechanisms

Sub-option 2 would initially be implemented through meeting(s) of State and federal agencies, the University and other entities involved in fish and wildlife monitoring, to catalog monitoring efforts across fish and wildlife species, aquatic and terrestrial ecosystems, regions and jurisdictions to develop a monitoring framework that catalogs existing monitoring efforts, identifies priorities for monitoring in the context of climate change, and identifies gaps and potential for collaboration. Meeting participants would also discuss and develop protocols for improving coordination of monitoring data, so it can be more readily accessed and shared across organizations, possibly through collaboration with the proposed *Alaska Climate Change Knowledge Network*.

A data coordinator position would be required to link extant monitoring programs into an archival network for data exchange. The coordinator could be housed in a government agency that already has a substantial data archive. Alternatively, it could be located in a neutral organization such as the UA that has secure base funding (office space, internet data server, and technical specialists) and seeks operational/maintenance funding from conservation foundations and various agency members that contribute data on species status. A membership charter for the network to document responsibility of contributors (free access to data, providing metadata on sources of information, funding for upkeep of host website, etc.) would be needed. Several efforts to coordinate monitoring have already occurred in the last few years (see Related Policies/Programs/Actions below). No new authorization would be needed to implement this recommendation.

Related Policies/Programs and Resources

Related Policies/Programs/Actions: Efforts to inventory and monitor the status of species and their environments already exist in many forms and organizations. Harvested species are monitored by ADF&G. Non-game vertebrates, invertebrate animals, and plants are monitored through several groups or efforts, such as the High Latitude Ecological Observatory (part of national non-government organization), regional inventory and monitoring networks (National Park Service), the Comprehensive Wildlife Conservation Strategy (ADF&G), and the Alaska Natural Heritage Program (UA-Anchorage). Efforts are presently underway with respect to forecasting the effects of climate change on terrestrial, marine and freshwater species and ecosystems. (See Section I of the Natural Systems Technical Work Group Catalog or Adaptations and Policy Options, December 2008, which provides an overview of changes to Alaska's habitats and dependent species due to climate change, and future trends.)

Available Resources: State and federal agencies have numerous monitoring programs in place already. Results of gap analysis can identify the need for new monitoring efforts. Indigenous knowledge may be highly useful to sampling design. Potential for citizen science involvement is high for some monitoring tasks and would leverage labor across our vast geography, although training and testing of observers will be necessary for some species or purposes.

Feasibility

ADF&G and UA can play lead roles for the State in coordinating development of a fish and wildlife monitoring framework and for coordination of fish and wildlife monitoring data. The financial resources

required to host and maintain a coordinated internet database could be estimated during the review of existing data sets and where gaps in data exist.

There would be a start-up period of perhaps one to two years before all the various entities and information sources are coordinated to fully identify data gaps and make existing data available in a consistent structure. Some data may be proprietary (e.g., private industry reports), and some will require filtering for posting on a public database (e.g., reduced geographic resolution for species listed as threatened or endangered). The funding required for sampling of data gaps would likely be substantial, and the time delay until a “useful” product exists depends on the desired resolution or intended uses of the data.

Adaptation Benefits and Costs

Development of a coordinated fish and wildlife monitoring framework would help ensure that the coverage and products of existing monitoring programs are well understood by all monitoring entities, that opportunities for collaboration and leveraging of effort are identified (and can be pursued), and that monitoring gaps are identified for species, ecosystems, or regions that should be addressed due to the potential for substantial change in fish and wildlife abundance and distribution due to climate change.

Benefits of a common structure for cataloging and disseminating monitoring information on species status and distribution would be better access to information for managers and harvesters of exploited stocks or populations, as well as information about those non-game species whose abundance or distribution have been altered by climate change. As the speed and success of adaptation by harvesters increases through information and technology, respectively, timely information on status of exploited populations would benefit in-season management decisions. This would be especially important as species ranges change and harvest systems may develop in new areas, thus lack the benefit of historic management experience in a particular area.

The cost of collaboration to develop a monitoring strategy and identify and consolidate sources of monitoring data is not expected to be large. However, there will be a long-term cost of staff (technical specialists and administrators) and computer hardware and software to update and maintain a database with strict protocols for data quality and to ensure its security on an internet server. Data collection costs would continue to be borne by the various contributors or end users.

Status of Group Approval

Approved unanimously, with no objections.

NS-6 Support Local Sustainable Agriculture in Alaska

Recommended Adaptation Option

The State of Alaska will develop a program to support sustainable agriculture in Alaska that will improve, secure and sustain the supply of quality, affordable food for all Alaskans, to respond to new challenges and opportunities presented by a changing climate and other future challenges (e.g., increasing food transportation costs to and within Alaska).

Option Description

The goal of Option NS-6 is to develop a program to improve, secure, and sustain the supply of quality, affordable food for Alaskans by expanding and enhancing food production in rural and urban Alaska and improving marketing of Alaska-grown products.

Option NS-6 will be incorporated into the Alaska Division of Agriculture's (ADOA) strategic planning process with the purpose of complementing ADOA efforts to expand community-based agriculture across Alaska. (See Objective 3.2 of ADOA's strategic plan, *Challenges and Opportunities for the Future - While Meeting the Needs of Today*, 2009, which calls for addressing climate change effects on the agriculture sector.)

To achieve this goal, one has to look not only at what agricultural products Alaska can grow, but also infrastructure/processing capabilities, marketing, and other considerations. One of the largest hurdles to truly sustainable agriculture in Alaska is the seasonality of our production combined with the lack of infrastructure/processing capabilities and limited marketing. For instance, Alaska is probably capable of producing more vegetables, but only so many of them can be consumed while still 'fresh'. The market for unprocessed vegetables (such as potatoes, which can be stored year round) is also limited. The amount of cold storage available in the state may also be another limiting factor.

Anecdotal observations indicate that well over 98% of Alaska's total food supply is imported. With the current uncertainty in the national and global economies, the security of that food supply is at risk. The impacts of climate change on the food producing capabilities of the state are unknown but can be expected to provide both opportunity and the need for adaptive change. The state has a history of food production including agriculture, commercial seafood harvesting, and fishing and wildlife hunting for personal and community use. There is both an opportunity and a need to build on our history to create a new system of food production that can maximize the potential of the state to feed itself.

Option Design

Structure/design: Four initiatives or tasks are needed to improve, secure and sustain the Alaskan food supply for the future:

- 1) Encourage community-based agriculture and practices that optimize the use of the land and resources available
- 2) Research the magnitude and composition of food consumption in the state.
- 3) Research the sources of food supply and the risk associated with high reliance on imported foods.
- 4) Develop in cooperation with the University a strategic Alaska food policy to increase reliance on locally produced food sources through agriculture, seafood harvesting, and subsistence activities, including enhanced marketing of Alaska-grown products.

Targets/goals:

- ADOA will provide the leadership to create an Alaska Food Coalition of producers, providers, and consumers.

- ADOA will work to support the expansion of locally produced food through farmers markets and community-based agriculture initiatives.
- ADOA will partner with the University of Alaska to design and conduct the research identified above.
- ADOA will facilitate the development of a draft Alaska Food Policy by the Alaska Food Coalition.

Timing:

- Year One: begin and complete task 1 above and begin work on task 2.
- Year Two: Continue support for task 2 above and work on tasks 1 & 3 by facilitating the development of research initiatives in collaboration with the Alaska Food Coalition and the University of Alaska.
- Year Three: Continue work on task 2 and support for research initiatives including funding and information.
- Year Four: Begin facilitating the development of an Alaska Food Policy with the Alaska Food Coalition based on new research findings.

Participants/Parties involved: The Alaska Division of Agriculture will serve as lead for implementation of NS-6. The UAF Cooperative Extension Service, the UAF School of Natural Resources and Agricultural Sciences, and others will assist ADOA.

The first task of NS-6 will be to organize the Alaska Food Coalition to include representatives of producers, consumers, processors and providers.

Evaluation: Create a data collection system to record production and consumption progress related to the goal of creating a secure and sustainable food system in Alaska.

Continue work with the Alaska Food Coalition to evaluate how programs and policies are meeting the needs identified by the coalition.

Research and Data Needs: The research need associated with NS-6 is to conduct an analysis of the demand and supply for food in Alaska, including an analysis of how this demand is currently met. The findings of this research would inform development of a strategic Alaska Food Policy and serve as a baseline to measure future progress of this option. Following the accomplishment of this task, the ADOA strategic plan will be reviewed to see how much of Alaska's supply of food could be provided by local growers in the various communities (i.e., examine potential for import substitution opportunities).

This research is a HIGH priority for implementation of NS-6. The Alaska Food Coalition would have an important role in coordination to accomplish this research.

Implementation Mechanisms

First: Need to prepare an **analysis of Alaska's DEMAND for food** -- this is for ALL types of food (not just agriculture sector – Note: Need to analyze by sub regions, since there are great differences in different geographic regions and differences rural / urban, etc.):

- What is Alaska's food need?
- To what extent are our current needs met?
- What needs are not met (i.e., current hunger)?
- What are the sources of our food supply?
- What is the risk to our food supply, under different potential change scenarios?

Second: Research findings regarding Alaska's food supply and demand would be incorporated into the ADOA Strategic Planning Process and used to develop a strategic Alaska Food Policy addressing the following questions:

- What is the capacity of Alaska to be self-sufficient in food production?
- How can agriculture contribute to the food needs of Alaskans?
- How can the seafood industry contribute to the food needs of Alaskans?
- How can subsistence and personal use activities contribute to the food needs of Alaskans?
- How can a marketing and distribution system be created to deliver Alaska produced food to Alaskans?

The Alaska Food Policy "Findings" will also identify the need for any legislative action.

The ADOA is well placed to provide leadership for this effort. Implementation of NS-6 will require the creation of a new stakeholder group (the Alaska Food Coalition) to coordinate the activities of agencies and industry involved in food production, processing, and marketing. ADOA will need an increase of professional staffing (2.0 FTE at a minimum) to support this effort.

Related Policies/Programs and Resources

Related Policies/Programs/Actions: There are many state and federal programs with (potential) food related responsibilities that will need to be consulted and/or included in the Food Coalition as stakeholders. (See the ADOA Economic Development Resource Guide at <http://www.commerce.state.ak.us/dcra/edrg/EDRG.htm>)

Available Resources: The ADOA is well placed to provide leadership to implement NS-6, but will need an increase of professional staffing (2.0 FTE at a minimum) to support this effort.

Feasibility

It is very feasible and realistic for the State to implement this option through the leadership of ADOA. However, ADOA has limited resources to take on this additional and important task, and would require a minimum of 2.0 FTE additional professional staff. Additional resources would also be needed to support the Alaska Food Coalition process and research. (See Costs section, below).

Adaptation Benefits and Costs

Benefits: The long-term benefit is to reduce the food supply risks for Alaskans, in light of changing climatic conditions in Alaska and other future challenges (e.g., increased costs for food transportation to and within Alaska.) The short-term benefits will be the development of information, a coordinating body, and a strategic plan to accomplish the long-term benefits to include:

- A comprehensive analysis and assessment of Alaska's food needs and vulnerabilities -- important to determining how critical it might be for Alaska to have a policy and subsequent actions promoting local sustainable food sources.
- Vital information for identifying market opportunities for locally produced agriculture and other locally produced foods (e.g., seafood).
- Increased economic opportunity for Alaska businesses.
- Improved nutrition, particularly in rural communities (= health benefits). Reduced hunger (by meeting more of Alaska's food need).

Costs: Cost of these implementation steps will include:

- Funding for new positions and related support for the ADOA (a minimum of 2 FTE is anticipated).
- Funding for research identified in tasks above (estimated \$100,000) – estimate based on consultation with Dr. Bret Luick, University of Alaska Fairbanks, Cooperative Extension Service regarding implementation of the on-going Alaska Food Cost Survey (See <http://www.uaf.edu/ces/fcs/2008q1data.pdf>)

- Funding to support meetings and work of the Alaska Food Coalition (e.g., travel, staff support, meeting expenses).

Data sources used for the estimates provided in this section and additional references related to Alaska's agricultural sector include the following (to be inserted in the final draft).

Status of Group Approval

Approved unanimously, with no objections.

DRAFT

**Appendix G. Other Economic Activities Technical Work Group
Recommended Adaptation Options**

Option #	Option Title	Page
EA-1	Evaluate capability needs for potential expansion of arctic economic activities.	2
EA-2	Develop and evaluate future scenarios for the Alaska economy.	6
EA-3	Improve availability of mapping, surveying, charting, and imagery data.	11

DRAFT

EA-1. Evaluate Capability Needs for Potential Expansion of Arctic Economic Activities

Recommended Adaptation Option

Alaska must recognize and address the potential needs that increased Arctic economic activities may create. These needs are likely to include requirements for presence and capacity at all levels (federal, state, local, Non-Governmental Organizations-NGOs) to ensure adequate protection for the environment and human health and safety, while supporting economic growth in Arctic coastal waters. This recommendation proposes addressing these needs through planning among various agencies and authorization and implementation of a Capital Improvement Project (CIP) to identify the infrastructure and capabilities needed to provide means to comply with state, federal, and international regulations while supporting the expansion of economic activity in the region as climate changes.

Option Description

Melting sea ice in the Arctic Ocean could result in increased ship presence and infrastructure requirements to support environmental and safety protections. Potential gaps may exist in emergency response and regulatory oversight capabilities. This option recommends recognition that the potential for increased Arctic economic activities may result in a need to address potential gaps in infrastructure and the ability of agencies at multiple levels (federal, state, local, NGOs) to protect the environment, human health, and safety.

This option recommends coordination and planning among Alaska State Agencies such as the Department of Commerce, Community and Economic Development (ADCCED); Department of Environmental Conservation (ADEC); Department of Natural Resources (ADNR); and Department of Transportation (DOT); federal agencies such as the U.S. Coast Guard and Environmental Protection Agency (EPA), and local and tribal entities to explore response and regulatory needs for environmental and health and safety support in the Arctic. The recommendation is for authorization for a CIP, most likely to be managed by DOT, with involvement of federal, state, and other agencies and stakeholders to collaboratively identify the infrastructure and capabilities to address response and regulatory needs specifically concerning the Arctic maritime industry as climate change drives the expansion of economic activity. For the purposes of this recommended option, the Arctic Ocean area encompasses all U.S. waters north of and including Norton Sound.

Overview

Many scientific models predict that Arctic sea ice will continue to retreat, creating longer ice-free summers along the Alaska Arctic coast. This will result in growth of maritime economic activities in this region such as shipping, mining, fishing, tourism, and oil & gas exploration. The oil & gas industry is estimated to have the greatest potential for substantial economic growth in the Arctic. To a small extent, this is already happening today. To support increased economic activity, ports, infrastructure, and other facilities are expected to follow as warming temperatures result in longer seasonal access. This will bring increased ship traffic and a greater human presence, not only creating job and business opportunities, but also requiring investments to ensure essential government functions such as safety, security, and environmental protection are provided.

This option recommends that Alaska recognize and address the potential for increased Arctic economic activities and identify the gaps in government capabilities (federal, state, local, NGOs) to provide an adequate presence in the Arctic coastal region. For example, the state and federal agencies must be prepared to conduct emergency response operations (search and rescue, pollution remediation), regulate industry (tourism, oil & gas, and fishing) and protect U.S. sovereignty. In essence, most state and federal government agencies with regulatory responsibilities in Alaska will realize a need to expand their presence to the Arctic region commensurate with the growth in economic activity.

Alaska has a vital interest ensuring the future success of its Arctic maritime community and the ongoing responsible development of the region's natural resources. In today's economy, shipping and maritime infrastructure are essential elements of the marketplace. To be prepared for the future, a strategy is needed in the State that maximizes capabilities to sustain a productive Arctic maritime infrastructure and economy. Capabilities refer to the infrastructure and resources needed to regulate, prepare, protect, prevent, and respond as needed to maintain a viable maritime economy.

As an example of the need, there is a possibility that ten years from now a robust commercial fishing industry will exist in the Arctic Ocean. What services will be needed to support this industry? For example, is there a need for the state to expand Arctic towns/ports to fully support means to address safety and environmental concerns associated with increased commercial fishing activity? What buildings, stores, utilities, roads, communications, docks, etc are needed? Are there inland inter-modal (rail, road, barge, air) transportation systems needed to connect the Arctic fishing industry to other areas of Alaska? What job training opportunities for local residents might develop?

Implementing this option will provide the State with the information for planning to ensure capabilities for future economic growth are in place, and will put the State in a better position to compete for federal funding to meet the demands of the future. Moreover, extending government programs into the Arctic is resource intensive. There could be tremendous opportunities to share costs, facilities, equipment, and responsibilities among agencies at varying levels of government, thus increasing efficiency and strengthening interagency partnerships. For example, the U.S. Coast Guard shares common responsibilities with ADEC and the Alaska Departments of Fish & Game (ADF&G) and Military & Veterans Affairs (ADMVA)/Homeland Security.

Developing future scenarios as recommended in EA-2: "Develop and Evaluate Future Scenarios for the Alaska Economy and Consider Potential Investments" and implementation of this recommended option will allow the State to address issues such as the possibility of controlling/limiting Arctic industry operations until further studies and/or preparations are conducted. This course of action is the one taken by the North Pacific Fishery Management Council, preventing the expansion of commercial fishing in the Arctic. Although, this option does not specifically address natural systems, the results of completing this recommended project will also provide valuable information addressing Arctic subsistence issues.

If this recommendation is not implemented, Alaska will lack needed understanding of what capabilities are required to meet expanding economic growth, miss opportunities for efficiencies with other agencies, and be less competitive in an austere Federal budget climate.

Option Design

Structure/design

The primary component of this option is overseeing a study to be conducted through an Arctic infrastructure CIP, managed by the Alaska Department of Transportation (AK-DOT) with participation from other state departments represented on the Climate Change Sub-Cabinet, as well as federal agencies. AKDOT would contract a firm with relevant Alaska and Arctic experience to identify the capabilities required to address response and regulatory needs in the Arctic region if climate change drives the expansion of economic activity. This effort will compile information on real and potential industry growth in the Arctic coastal region, determine areas for government services expansion and infrastructure needs. It would provide recommendations on approaches to foster cooperation for expansion under various scenarios of industry growth.

Targets/Goals

The overarching objective is to develop an understanding of the requirements and strategies for organizations (federal, state, local, NGOs) to expand capabilities in the Arctic, and to recommend a schedule of that expansion focused on immediate needs, potential needs in 5-10 years, and longer term needs that are 10+ years in the future. The end goal is creation of a document to identify capabilities gaps, recommended improvements, primary agency responsibilities, and an action/implementation plan.

The State will have immediate benefits of information available to strategically plan and prioritize projects to appropriately address environmental and human health and safety needs as the economy adapts to growing opportunities in the Arctic.

Timing

A key first step in the success of this recommendation is the completion of the EA-2 - to develop an understanding of potential economic activity scenarios to serve as the base data supporting the determination of future infrastructure and capability expansion. Identification of a firm with relevant Alaska and Arctic experience to be contracted under the CIP would need to be done as soon as practicable thereafter. Arctic maritime industry is already starting to expand. There is presently a lack of capabilities for current conditions; any expansion would increase risk and exasperate the need for increased presence. .

Parties involved

This option recommends that the Governor's Office task AK-DOT to implement a CIP to begin the process of forward planning for the Arctic capabilities/requirements assessment. This would likely occur after development of economic scenarios addressed in EA-2. If a new state climate change task force or council is established to manage several new projects, this group could also manage the CIP.

Evaluation

The firm contracted under the CIP should be given a period of time to review and understand the goals of this option, create a two year work plan identifying key milestones, and submit periodic progress reports. AK-DOT will review and approve the work plan and monitor progress. Correction/changes can be made upon review of the quarterly reports.

Research and Data Needs

Data identifying climate models and their predicted impact on Arctic economic growth; data developed through the completion of economic scenarios under EA-2.

Implementation Mechanisms

Implementation of this option requires state approval and funding of a new Arctic CIP. To proceed with this option, the Governor's Office will need to assign AK-DOT (primary manager) authority to plan with other state and federal agencies the implementation of the CIP and commit funds to contract a firm to carry out the CIP. Assistance from federal, state, academic, and industry participation will be solicited similar to the process used with the Climate Change Advisory Groups, including assistance from both the North Slope Borough and NW Arctic Borough. DOT should involve each agency with responsibility in the Arctic.

Related Policies/Programs and Resources

Related Policies and Programs

- U.S. Coast Guard District 17 (Alaska) is conducting an Arctic capabilities analysis.
- U.S. Arctic Research Commission has conducted an Arctic Marine Shipping Assessment.
- The Institute of the North is coordinating several programs relating to current and future Arctic industry.
- Alaska's FY2010 funding proposal has \$0.5 million to be matched by the Denali Commission for a long term harbor study.

Available Resources

Available resources are unknown at this time. This option will require commitment of state funding.

Feasibility

This proposed option is primarily within the authority of the State with assistance from federal agencies and industry. Representatives from various federal agencies should be engaged and their timing/availability could be a constraining factor. Strategic partnerships with all affected agencies is required to ensure overall agreement on recommendations of future capability needs for Alaska to move forward in synch with industry growth – all agencies would retain authorities. A limiting factor is funding to manage the project. The key unknowns affecting the success of this recommendation are the uncertainty of future trends in climate change and economic feasibility of industry to expand industrial operations in the Arctic.

Adaptation Benefits and Costs

The first step preparing for the future and one of the most significant aspects of appropriately adapting is evaluating information to predict future needs and requirements. Economic development due to climate change will center on the Arctic Region transportation system, natural resources industry, and tourism industry. This information can be applied as major, uncertain changes occur to identify capabilities required to ensure an orderly economic expansion into the Arctic, increased safety for citizens, environmental protection, and reduced expenditures through cost sharing. The benefits of identifying capability needs and gaps also include exposing potential blind spots that might otherwise be overlooked, increasing ability to quickly and appropriately recognize and adapt to a scenario in its early stages, and providing decision makers with time to work out approaches as needs and gaps are identified.

Successful implementation of this recommendation will generate a strategic document assessing current infrastructure and capabilities and determining the level of increase needed for various economic scenarios. This information will give the State the foundation to allocate resources to establish an appropriate level of infrastructure and presence in a timely manner as economic activities change. The benefits of completing this option will remain effective indefinitely. Even with scenarios, regulatory requirements, and industry changes from current forecasting analysis, the information from this recommendation will need updating. The bulk of the work to establish the initial baseline data would be completed, making any future updates quicker and less costly.

The State will need to commit resources for AK-DOT to develop and implement a CIP, including identifying the costs to contract a firm with relevant Alaska and Arctic experience to conduct the assessment and committing the funds to proceed with the project. The costs to complete this option range greatly depending on the breadth and scope of the analysis required. The costs can range from \$300,000 to \$3,000,000 based on the level of detail at which this analysis is conducted. While no comparable or similar project exists to better define the cost, an example of a defined cost estimate to conduct a risk assessment project within the state of Alaska is the Risk of Vessel Accidents and Spills in the Aleutian Islands. After the M/V Seledang Ayu was involved in a marine casualty near the Aleutian Islands, the vessel representatives were required to pay \$3,000,000 to the National Fish and Wildlife Foundation for the purpose of conducting an Aleutian Islands risk assessment of the shipping hazards.

Status of Group Approval

Approved unanimously, with no objection.

EA-2: Develop and Evaluate Future Scenarios for the Alaska Economy

Recommended Adaptation Option

Alaska should provide funding to conduct a project that develops and evaluates possible scenarios examining the next 40 years of the economy in Alaska based on potential effects from climate change. This project would then identify opportunities and challenges for existing and potential future sectors of a sustainable, robust Alaskan economy that provides a high-quality of life for Alaskans.

Option Description

Components of the Alaska economy could experience varying impacts due to potential effects of climate change. Impacts could occur in areas such as energy and food supply, affecting the lives of all Alaskans. An assessment of economic strengths, weaknesses, opportunities and threats ("SWOT analysis") by sector is needed to both better understand current components of the economy and potential future components. This understanding will aid state agencies and other stakeholders in identifying and acting on optimum adaptive strategies and policies to help address future conditions. It is not possible to quantify the extent of economic impacts due to climate change or to develop appropriate strategies for addressing them without more accurately defining the conditions of the operating environment. This option recommends that Alaska provide initial funding to conduct and manage a project to develop and evaluate economic scenarios for Alaska, based on potential climate change effects. A component of these scenarios will be examination of issues and opportunities in current and potential future sectors to maintain a robust Alaskan economy.

Overview

This option recommends a series of steps leading to an understanding of potential future (within next 40 years) economic conditions for Alaska and potential options to influence those economic conditions to maintain a robust economy for the State. Climate modeling data about future conditions (e.g., temperature changes, precipitation, and snow and ice cover, sea level rise, and ground subsidence) will be integrated with socio-economic data such as population migrations, changing energy demands, cultural developments, and policies at the state or national levels to examine possible economic futures. The current state of the economy will be outlined in detail to understand the contributions of various sectors. Scenarios will be developed that take current variables and conditions as a starting point and examine the effects of various future conditions such as changes in land use, energy use, water and food availability, infrastructure development, regulations, demographics. Future economic scenarios will examine challenges in terms of possible job losses in current sectors and opportunities that may result in both existing and new sectors. The scenarios developed will provide potential ways to consider the future of the Alaskan economy and aid planning and investment decisions.

The current economy of Alaska is dependent on the responsible development of its natural resources. Specifically, the oil and gas industry generates more than 80% of the revenue that funds State government. Commercial fishing, mining, tourism, and forestry also currently contribute to the State coffers. It is critical to the future of Alaska that the responsible development of these natural resources be managed effectively and be encouraged to provide ongoing state revenue. The unique Alaskan environment and experiences of the state in dealing with climate impacts may potentially result in gains or losses of existing jobs, and also may provide opportunities for new and as yet unforeseen economic activities. Based on the scenarios that are to be investigated, the need for adjustments and investments in existing sectors as well as potential opportunities for exploring jobs in new sectors will be identified. Potential sources of appropriate funding will be examined and considered to support job growth to help sustain the Alaska economy.

Potential new sectors could include greenhouse gas management, renewable energy (e.g., tidal, wind, hydroelectric, solar, biomass), energy efficiency, sustainable infrastructure development, and increased and sustainable agriculture development. Although there is some potential to develop new "green"

economic sectors for Alaska, it is highly unlikely that the level of activity generated in these sectors could replace the current natural resource based economy, which is dependent on a robust oil and gas industry. It will be imperative to address issues such as the natural gas pipeline, new resource developments in the oil and gas sector, potential infrastructure for increased agriculture, as well as other natural resource developments to maintain a sound economy. A warming climate could significantly contribute to enhanced access to natural resources, as well as longer growing seasons and with opportunities for more locally produced and marketed food supplies.

Economic assessments and exploration of job losses and potential job creation must include consideration of credible climate change models, assumptions, expectations and planning scenarios that make use of reliable scientific methods and that are within statistical confidence limits to be determined by the State. If the range of potential changes can be defined over target time frames, then actual challenges and opportunities can be anticipated and plans and funding developed to help anticipate or influence future conditions.

Better understanding of the potential range of economic impacts due to the range of possible climate changes is needed to anticipate challenges and opportunities. Having a better understanding of the potential economic scenarios, Alaskans will improve their ability to predict future conditions and to develop and implement adaptive strategies to try to ensure robust economic conditions for the state. Response actions will be implemented by various state agencies and private entities, as appropriate. Efforts will need to be extended for coordination with various legislative actions to coordinate priorities and expenditures.

Option Design

Structure/design

Phase 1: Develop Scenarios

1. Identify appropriate funding and contracting mechanism for developing and evaluating potential economic scenarios.
2. Establish project organization, and schedule. Prepare option plan document, including scope, objectives, resources, performance measures and feedback mechanisms.
3. Establish climate change assumptions, expectations, and uncertainties, using and building on the work completed by University of Alaska Fairbanks (UAF) Scenarios Network for Alaska Planning (SNAP), the U.N. Intergovernmental Panel on Climate Change (IPCC), and other models as they become available. Develop climate change planning scenarios for appropriate climate parameters (temperature, precipitation, snow and ice cover etc) and federal, State and regional climate policy regimes.
4. Based on input from numerous experts, identify significant existing economic sectors of the Alaska economy, such as fisheries, oil and gas, mining, and shipping, and potential new economic sectors, including renewable energy, energy efficiency, adaptive technologies and sustainable development. Identify key expertise with Alaska experience in these areas to understand their current role in the Alaskan economy and the potential roles going forward.
5. Outline critical variables that have an impact on the economy, including federal and State policies and regulations, funding, employment demographics, cultural expectations, land use regulations, etc.
6. Develop scenarios about the potential future options for the Alaskan economy based on a 40 year timeframe. Prepare economic segment SWOT analysis.
7. Prepare draft and final reports, soliciting public and expert comments as appropriate.
8. Establish climate change economic review board or panel to consider the economic scenarios and outline needed actions to help address possible future conditions.
9. Implement ongoing monitoring of actual climate changes to apply to climate modeling efforts to assess actual changes to the climate for ongoing efforts to identify new opportunities and minimize risks.

Phase 2: Based on the evaluation of scenario results, explore needs and options for economic development

1. Using guidance provided by the climate change economic review panel (Phase 1, Step 8), identify specific areas requiring attention for future economic conditions. This may include addressing and investing in existing economic sectors or new sectors. This may also entail promoting or exporting scientific innovation and engaging strategically on national and regional climate change policies.
2. Explore and engage in (as appropriate) national/regional climate change legislation that addresses the following:
 - Receive equitable share of federal nature-based and physical infrastructure adaptation funding for Alaska;
 - Identify financial incentives for developing low carbon-equivalent fuels (e.g. natural gas pipeline);
 - Identify financial incentives for geologic and forest carbon sequestration activities (e.g., carbon credits for controlling forest fires, replanting);
 - Identify options for exploiting opportunities for developing local-based sustainable food supplies;
 - Continue to receive substantial Research and Development (R&D) funding for Alaska-based research institutions
 - Continue appropriate levels of funding for federal/State/local agencies operating within Alaska.
3. Consider use of possible funding from potential national/regional climate carbon markets to foster innovation, including:
 - Provide appropriate financial incentives to promote affordable renewable energy and efficiency efforts across Alaska;
 - Encourage Alaska Industrial Development and Export Authority (AIDEA) or another state clearinghouse to create loans to assist sustainable businesses and communities;
 - Enhance the Alaska Energy Authority's role in developing affordable renewable energy;
 - Provide tax incentives to sustainable businesses and communities;
 - Build out infrastructure to support (inter-tie expansion, communications, ports, roads, etc.);
 - Consider the cost-effectiveness of nature-based adaptation strategies versus new infrastructure development (e.g., in some places it may be less expensive to protect a coastal wetland than build a seawall to reduce community risk from coastal erosion/inundation);
 - Develop complete net metering regulations;
 - Develop and enforce standards for collecting community-level business and economics data over time;
 - Develop research and development export clearinghouse to market ideas and innovation outside of Alaska to new marketplaces; and
 - Evaluate existing job training and education programs and identify possible adjustments to develop a workforce that meets future community and statewide economic needs.

Targets/Goals

The overarching goal of this option is to prepare the state of Alaska and its residents for potential future economic opportunities and challenges associated with climate change. This also includes positioning the state to seek and receive appropriate levels of funding that may be available from numerous sources, including possible markets that may regulate greenhouse gases (GHGs). Alaska must seek to maintain a robust natural resource based economy as well as address potential job losses, innovate for new job markets, and position itself manage any economic changes. The time frame for this strategy is within the next 40 years.

Timing

- Phase 1: Complete final report on evaluation of potential scenarios for the Alaskan economy prior to the end of 2009.
- Phase 2: Initiate work to identify potential areas of focus and/or for investments by early to mid-2010. Assess potential appropriate funding sources and begin seeking funding by mid-late 2010.

Parties involved

- Appropriate oversight from Governor's office or appropriate State agencies (see below)
 - Department of Commerce, Community & Economic Development (ADCCED)
 - Department of Environmental Conservation (ADEC)
 - Department of Natural Resources (ADNR)
 - Department of Revenue
- The Institute of Social and Economic Research (ISER), the University of Alaska, the Alaska Center for Climate Assessment and Policy, a program funded by the National Oceanic and Atmospheric Administration (NOAA) at UA-Anchorage and UAF, or other suitable economic or scientific academic entity could lead the overall effort
- UAF Institute of Northern Engineering and/or International Arctic Research Center would assemble a panel of scientific and engineering authorities (e.g., industry and regulatory agencies) to establish climate change assumptions, expectations and uncertainties
- An entity, such as UAF SNAP, would prepare climate change scenarios following the climate change panel assumptions
- The AIDEA, which provides means of financing to promote economic growth and diversification in Alaska, may provide an opportunity for partnership/coordination to foster green innovation and economic development.
- The following should be involved as stakeholders and partners in this effort:
 - Alaska Energy Authority
 - AK Oil and Gas Conservation Commission
 - US Arctic Research Commission
 - Cold Climate Housing Research Center
 - Native Corporations
 - Sustainable business owners and operators
 - Industries developing low carbon-equivalent resources (Natural Gas, Renewables, etc.)
 - Universities
 - Other relevant non-governmental organizations
 - Other local/State/federal agencies operating in Alaska
 - Other identified stakeholders

Evaluation

Assign project scoping and management accountability to a suitable State of Alaska economic or scientific academic entity (to be named by Sub-Cabinet). Assign oversight accountability to a lead agency (to be named by Sub-Cabinet). Effectiveness measures and performance indicators will be proposed by the project management entity and evaluated by the oversight agency. A formal comprehensive independent audit or assessment should be conducted prior to implementation and then perhaps every other year to validate and revise both climate change and economic scenario assumptions as needed.

Research and Data Needs

Research will be needed to:

1. Identify scenario building and evaluation method and climate modeling method most appropriate for north circumpolar regions
2. Establish climate change assumptions, expectations, and uncertainties for Alaska, including development of a list of suitable climate parameters for use in climate and economic modeling with described statistical confidence limits.
3. Identify and obtain data to characterize current components of the Alaska economy
4. Assess economic response to climate change scenarios for each segment of the Alaskan economy

Implementation Mechanisms

Action and funding by the Sub-Cabinet to authorize a study to develop and evaluate scenarios is needed. This could be performed under the authority of ADEC or other appropriate agencies. Development of panels of experts may require additional state action such as Executive Order or legislation. Solicitation and distribution of funding, should it occur will require state authorization.

Related Policies/Programs and Resources

Related Policies and Programs

The UAF SNAP (<http://www.snap.uaf.edu/>) program is tasked with developing high quality predictions for Alaskan climate; however, they are funded to produce climate scenarios of air temperature and precipitation only. This information is certainly essential, but not all that is needed to best understand the economic implications of climate change.

Available Resources

This information is required for planning by multiple State and federal agencies operating in Alaska. It is anticipated that costs could be distributed among multiple beneficiaries of such an effort.

Feasibility

The proposed action would need to be supported by available technical and budgetary resources, though the exact needed resources are currently uncertain. The project should be coordinated with other federal, State, and private entities (such as the American Society of Civil Engineers) with interest and expertise in climate change issues and the economic implications. Public and interagency involvement will be needed to conduct economic assessment, and to prepare and review and comment on draft and final report documents.

Adaptation Benefits and Costs

Costs would need to be evaluated by the State. Benefits can be expected in the form of public policy adjustments resulting from improved knowledge of the requirements to minimize the potential negative impacts to economic activity, and possibly grow some sectors of the economy, more cost effectively compared with the no action alternative. There may be some substantial up-front costs from administering the option, and it will need to be demonstrated that the long-run benefits from this process will offset the early costs. Generally, it has been shown in economics literature that making early investments in workforce development are worthwhile.

Based on similar assessment activities that are underway with the Heinz Center, NOAA and International Arctic Research Center (IARC), rough estimated costs for the option follow. These are only estimates.

- Organize current data, facilitation, development of variables: \$100,000
- Develop uncertainty and related analyses and data configuration: \$100,000
- Collaborate with economists to facilitate their analyses and write reports: \$75,000

Status of Group Approval

Approved unanimously, with no objection.

EA-3. Improve Availability of Mapping, Surveying, Charting, and Imagery Data

Recommended Adaptation Option

The Climate Change Sub-Cabinet should direct Alaska to invest in an accurate and high-resolution statewide digital base map that includes a DEM and an acquisition system for imagery and encourage the involvement of other stakeholders. This option should ensure that the base map and associated data are available to all users, with a first priority on mapping coastal areas and floodplains.

Option Description

Accurate, timely information about the distribution and magnitude of changes is needed to better address economic challenges and opportunities. To assess change, a good baseline of existing conditions is needed. This baseline includes map imagery, elevation data, bathymetric data, and habitat, landcover, and soils information. Changing boundaries, especially shorelines, potentially have large ownership and regulatory implications. High resolution imagery and elevation mapping are required to properly assess changes in permafrost degradation and thermokarst development, glacier melting, streambed changes, coastal erosion and many other dynamic geomorphic processes that will have real economic impacts on Alaska. A precise definition of the height of the mean sea level surface throughout the state is needed. Accurate bathymetric mapping will also improve the quality of navigational charts, leading to safer passage through new northern sea routes.

Overview

This option will improve the availability of real-time mapping, surveying, charting, digital elevation models (DEM), and imagery data to provide means to better track and understand economic impacts of and opportunities to address climate change. Additionally, it provides support for ongoing management and distribution of this spatial information through a geographic information system and open standards web services. Development of these spatial data sets will contribute to a more robust information infrastructure to plan and adapt to climate change. Coordination with UA Research Centers, the U.S. Coast Guard, and NOAA is a recommended approach for this option. This option will make data available in near real time, with a first priority on coastal areas and floodplains, as they will be changing the most with warming temperatures and changing climate, sea ice, and storm patterns. Changing shorelines in and around communities and other infrastructure can lead to significant costs for relocation or protection. Near real time imagery data is also extensively used by wildfire fighters; wildfire incidence is anticipated to grow in coming years due to the changing climate. Imagery and elevation information is needed and utilized by all state agencies and private entities engaged in land management, monitoring, planning, or development. Bathymetric data are needed by all vessels (including the U.S. Coast Guard), as well as those entities addressing habitat and economic development activities in the Arctic.

The state is creating a digital basemap through the [Statewide Digital Mapping Initiative](#) (SDMI) program, and this climate change adaptation option should use the SDMI as a vehicle for implementation. The SDMI and Geographic Information Network of Alaska (GINA) have developed an effective and widely used data archive, distribution, and web services system that can be used to manage data for this initiative. Consideration should be given to establishing means to integrate bathymetry data as well. This existing infrastructure can be used to save cost and produce immediate results.

Option Design

Structure/design

There are two major components to this option: a DEM and imagery.

- 1) Alaska lacks an accurate statewide DEM. The current base DEM for Alaska is the National Elevation Dataset (NED), which is maintained by the U.S. Geological Service (USGS) and is

based on Alaska's 50-year-old USGS topographic maps. The NED DEM has widespread inaccuracies, making it unusable for many applications. Alaska needs an accurate base DEM at a reasonable resolution and accuracy that serves a broad range of applications. For areas that need higher accuracy and resolution, such as floodplains and coastal areas, improved products can be acquired to meet project requirements.

2) The second component is the need for a statewide system for acquiring real-time accurate imagery. One option would be to acquire a satellite ground station that would enable agencies to capture real-time imagery from satellites. This real time data would serve two purposes: a) provide real time monitoring and emergency response needs, and b) build a consistent, accurate, statewide base map image layer. SDMI is also researching other imagery options, and will be summarizing those in a white paper to be published in the spring of 2009.

Targets/Goals

- 1) Develop an accurate DEM for the entire state, with a priority on coastal areas and floodplains, as they will change the most under climate change.
- 2) Develop a system for acquiring imagery for Alaska and making the real time and archived imagery easily available to the public, agencies, and academia.

Timing

The timing is dependent upon the availability of funding. In the short-term, high-accuracy airborne Light Detection and Radiation (LiDAR) surveys could also be flown to create DEMs for areas of critical interest, such as flood plains or eroding shorelines. A parallel effort is underway to develop the specifications for an imagery acquisition system, and should be complete in spring of 2009. One option has been identified, and could provide real time, high-resolution imagery in the short term. This is establishment of a satellite ground receiving station that could be operating within a few months of approval by leveraging existing capabilities at GINA, SDMI, and NOAA satellite reception facilities in Fairbanks. No comparable initiative has been proposed at this time for bathymetric mapping and a subsea DEM.

Parties involved

Currently, the SDMI effort is being led by ADNR, ADMVA, and UA. Federal mapping leadership is also being provided by the USGS, the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS). This mapping information will be utilized by a wide array of users and stakeholders. Stakeholder involvement has already been engaged through SDMI-sponsored surveys, workshops, and planning efforts. In addition, NOAA's National Environmental Satellite, Data and Information Service (NESDIS) has a Fairbanks Command and Data Acquisition Station has committed to provide satellite reception antennas, equipment, and operations staff to support ground receiving operations.

All state, federal, and local resource agencies will benefit from this mapping effort, and should contribute. Academia, emergency and disaster management agencies, and the aviation and transportation agencies and industry will also benefit greatly. Coordination with UA-associated research centers is needed, as well as U.S., Canadian, and international researchers. The federal government is engaging mapping issues through the National Digital Orthoimagery Program, National Digital Elevation Program, and the Imagery for the Nation initiative—representatives of which have met in or visited Alaska within the past year. The SDMI intends to expand its State agency membership beyond ADNR, ADMVA, and UA to include AK-DOT (already participating), ADCCED, ADEC and the Alaska Department of Public Safety.

Evaluation

With mapping projects, concrete evaluation criteria are possible; some suggested metrics are:

- Total area with new base map imagery produced (square kilometers)
- Total area with new DEMs produced
 - Statewide: mid-accuracy and resolution (square kilometers)
 - Critical project areas: high-accuracy and resolution (square kilometers)
- Length of shoreline mapped (kilometers)
- Area of habit, landcover, or soils mapped (square kilometers)

Economic and public welfare evaluation criteria include:

- Effectiveness and timeliness of emergency response
- Cost avoidance for emergency response due to better informed decisions
- Cost avoidance for land management monitoring; i.e. fewer field inspection trips can be made if near real time satellite data is available
- Increased public safety through well-informed response or evacuation
- Increased efficiency of routine mapping performed by Geographic Information System (GIS) professionals
- Improved aviation safety
- Faster, more accurate NEPA studies
- Improved transportation planning
- New mineral resources identified through better DEMs and imagery
- Improved and better informed erosion mitigation efforts such as revetments

Research and Data Needs

As explained above, the initial research and development work for this option is nearly complete. Planning reports and whitepapers are available. The last of a series of SDMI-funded, formal planning documents will be published by June 30, 2009 and can be found at the SDMI Web site: <http://www.alaskamapped.org/>.

Implementation Mechanisms

The implementation mechanism for onshore mapping, SDMI, is already in place. SDMI is willing to serve as a governing body, or can be used as a template if a broader representation is required.

Related Policies/Programs and Resources

Related Policies and Programs

Many agencies and private interests are acquiring DEM and imagery data to support their Alaska projects and resource management responsibilities. The goal of this effort is to continue to coordinate existing mapping efforts within the community, to address the broader statewide needs that do not fall under a specific project or resource management imperative, and to establish statewide baseline imagery and elevation data sets against which future changes can be measured. Mapping efforts are currently ad-hoc and agency or entity mission driven; the gap is a broad, consistent, refreshed statewide coverage.

NOAA has a related program important for elevation mapping in Alaska. The Gravity for the Re-definition of the American Vertical Datum (GRAV-D) program is an airborne gravity survey to improve the accuracy of the vertical datum, by mapping the geoid (or mean sea level elevation), which, for Alaska, can be several meters off. This is an approved NOAA project and Alaska is the top priority to be mapped, but it will need federal funding. On behalf of Alaska, the SDMI has supported federal efforts to allocate funding for the program. This program is expected to cost approximately \$6.4 million.

Feasibility

The technology to perform these tasks exists and is available off the shelf. The expertise to implement the program to create, maintain, and distribute these improved statewide imagery and elevation data already exists within SDMI, GINA, NOAA, USGS, and other state and federal partners. The SDMI has spent more than a year performing extensive surveys, hosting workshops, writing whitepapers, and publishing planning documents. The requirements, uses cases, and business drivers are well understood and documented. Parts of the program—imagery reception, processing, and distribution and high-accuracy elevation mapping—are ready and could move forward almost immediately. The statewide mid-accuracy DEM acquisition will use mature, reliable technology and could be initiated rapidly, however, significant funding will have to be secured.

Adaptation Benefits and Costs

There is an ongoing cost of continuing to operate with outdated and inaccurate imagery and elevation data. Resource management, science, engineering, and policy decisions are often made based on imagery and elevation data that were collected 30 to 50 years ago under conditions that made production of highly accurate products impossible. This program will reduce those costs by providing a consistent, accurate, current, baseline framework for decision-making and planning.

SDMI has received state funding for \$6 million. Using this funding, the most comprehensive archive of Alaska imagery and elevation data has been assembled and these data are available for download and through open standards web services. The existing Web site has served thousands of users and many terabytes of data in 2008. Usage is on track to at least triple in 2009. These data, however, are not always current, nor of high-enough resolution to be useful in addressing climate change effects within Alaska.

Additional resources are needed as previously described – with specific state responsibilities falling into two areas: (1) digital elevation data and (2) the acquisition of satellite imagery for monitoring and assessing changes. An interagency effort has already identified the specifications for a statewide DEM, and an implementation plan is currently being developed which will identify a strategy for acquiring the funding. The following table depicts potential costs for these efforts, as well as other data needs currently being discussed or potentially funded by other agencies. As noted, some of these costs are estimated or unknown at this time.

Estimated Summary of Costs for Data Acquisition			
Data	Potential Funding Entity	Annual Funding	5 Year Total
DEM: High accuracy LiDAR for critical areas	State of Alaska	??\$1,000,000	??\$5,000,000
High-accuracy orthoimage map production	???	??\$300,000	??\$1,500,000
Real-time monitoring and data distribution	???	??500,000	??\$2,500,000
GRAV-D: fix gravity model for Alaska	NOAA, State of Alaska		\$6,400,000
DEM: Statewide Airborne IfSAR (20-foot contour accuracy)	USGS, BLM, State of Alaska		??\$80,000,000
Imagery: Satellite Ground Receiving Station	???	??\$1,200,000	??\$6,000,000

Higher resolution DEM data (based on Interferometric Synthetic Aperture Radar [IfSAR] data acquisition and processing for a 20 foot contour interval) is estimated to cost between \$50-100 million.

UAF and the NOAA NESDIS Fairbanks Command and Data Acquisition Station have extensive, existing satellite ground receiving and processing facilities, storage capabilities and tools and personnel developed for distribution of large geospatial datasets. The estimated funding necessary for a satellite ground station is between \$6 and \$10 million.

SDMI's goal is to produce a digital basemap that is accessible by the general public. Licensing data for general public use comes at a higher cost, and decisions will have to be made if some data should have a more limited license, at least initially, to enable agencies to use it in the immediate term.

Status of Group Approval

Approved unanimously, with no objection.

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Appendix H. Health and Culture Technical Work Group Recommended Adaptation Options

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HC-1 Surveillance and Control

This option will enhance current state programs and activities, as well as enhance partnerships with the public and private sectors, to protect the health of humans and animals from projected increases in the geographic range and incidence of climate-sensitive infectious diseases. Monitoring and evaluation are recommended to ensure the programs continue to be required and, if so, to identify changes to increase their efficiency and effectiveness.

Option Description

The Issue: Climate change is contributing to increases in the geographic range and incidence of climate-sensitive infectious and non-infectious diseases in Alaska, new problems in sanitation and solid waste management, and contaminant exposures.

Overview: This option addresses the observed and projected increase in infectious diseases in Alaska due to global climate change. Current programs are insufficient to identify and control changes in the distribution of climate-sensitive infectious diseases, thus increasing the risk of outbreaks in humans and animals. Existing infrastructure needs to be augmented to address these emerging concerns to develop new methods for surveillance, reporting, and control of human and animal disease.

Objective: The objective of this option is to protect the health of humans and animals, both domestic and wild, through surveillance and control from increased infectious disease risks due to climate change. Public health surveillance is the ongoing, systematic collection, analysis, and interpretation of data essential to the planning, implementation, and evaluation of public health practice. Improving surveillance will allow more robust tracking and identification of trends in order to expeditiously and effectively respond to and control emerging threats to humans and animals.

The Need: There is a scientific consensus that climate change has affected the distribution, including incidence and geographic range, of infectious and non-infectious diseases globally. Surveillance and control are necessary because they are the mechanisms by which public health practitioners prevent, prepare for, and respond to disease threats. Examples of human diseases that have already been or might soon be linked to climate change in Alaska include asthma, botulism, echinococcosis, giardiasis, paralytic shellfish poisoning, rabies, tick-borne encephalitis, venomous insect events, *Vibrio parahaemolyticus* gastroenteritis, and West Nile virus infection. Examples of animal diseases that have already been or might soon be linked to climate change in Alaska include leptospirosis; parasitic infestations in caribou, muskoxen and moose; toxoplasmosis in sea otters; tularemia; and winter tick infestation in moose.

Option Design

Structure: The state of Alaska agencies currently tasked with the responsibility for surveillance and control for human and animal diseases are the Alaska Department of Health and Social Services (DHSS), the Alaska Department of Environmental Conservation (DEC), and the Alaska Department of Fish and Game (ADF&G). The recommendations presented in this option will require augmentation of existing surveillance and control efforts performed by programs within these agencies. Implementation of the option recommendations will require increased human and material resources, including methods and tools within existing programs, as well as new and augmented partnerships with the public and private sectors, including memoranda of understanding to collect the necessary data.

Targets:

1. Improve surveillance for vectors and vectorborne diseases in vectors
 - a. Expand wild/domestic animal sampling (e.g. equine, rodent, ruminants, beavers, hares)
 - i. Sampling costs--\$20k/yr
 - b. Expand vectorborne disease vector surveillance
 - i. Hire 1.0 Full Time Equivalent (FTE) entomologist--\$150k/yr
 - ii. Hire 0.5 FTE administrative clerk--\$50k/yr
 - iii. Hire 1.0 FTE technical assistant--\$85k/yr
 - iv. Monetary support for travel, lease space costs, and supplies (e.g. traps, microscopes, preservatives and containers, sampling kits, IT resources, postage and shipping costs, etc)--\$75k
2. Expand and improve DHSS's hospital discharge and emergency room databases to improve detection of climate change-related diseases
 - a. 0.5 FTE data analyst--\$60k/yr
 - b. 0.5 FTE project manager--\$65k/yr
 - c. Contractual services for data clearinghouse work--\$80k/yr
3. Improve health care provider education around infectious disease reporting--\$15k/yr
 - a. Health aide conference lectures
 - b. Public health nursing conference lectures
 - c. Grand rounds in hospitals
 - d. Zoonotic disease lectures at Veterinary Association meetings
 - e. Develop a web-based medium for distribution of climate change-related information
4. Create a reporting system for sanitation/wastewater integrity disruptions within DEC
 - a. Create a reporting system database
 - i. 0.25 FTE data analyst--\$30k/yr
 - b. Educate around reporting requirements
 - c. Create a community-based monitoring and reporting program in rural and subsistence communities
5. Improve interagency notification of drinking water and wastewater violations between Municipality of Anchorage (MOA), DHSS, DEC
 - a. Establish a notification Memorandum of Understanding (MOU) between agencies
6. Increase monitoring in humans and animals for contaminants that are potentially related to climate change (e.g. mercury and persistent organic pollutants) that adversely impact human and animal health.
 - a. 1.0 FTE Public Health Specialist I--\$90k/yr
 - b. Laboratory analysis costs for human biomonitoring--\$150k/yr
 - c. Laboratory analysis costs for animal biomonitoring--\$100k/yr

- d. Establish an MOU whereby federal agencies would agree to collaborate with state and local government officials in the collection and analysis of contaminant/irritant samples.
7. Provide surveillance and control program updates to stakeholders through a variety of means
 - a. Epidemiology Bulletins
 - b. Alaska Forum on the Environment talks
 - c. Office of the State Veterinarian Quarterly Newsletter
 - d. Other

Timing: It is recommended that each target be implemented as soon as possible to establish baseline data, and that the target activities be discontinued only if it is determined that the solution is no longer necessary during the evaluation process.

Participants/Parties Involved: DHSS, DEC, ADF&G, Alaska Department of Natural Resources (DNR), MOA, Alaska Native Tribal Health Consortium (ANTHC), Alaska Municipal League (AML), Alaska Hospitals and Emergency Departments, U.S. Department of Agriculture (USDA), Centers for Disease Control (CDC), Department of the Interior (DOI), National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA)

Evaluation: Ongoing monitoring and evaluation is recommended for each solution, with annual assessments regarding the need to continue the effort. A variety of evaluation mechanisms could be used, including the distribution of periodic survey forms to stakeholder agencies, including communities participating in surveillance efforts. Finally, the efforts could undergo evaluation by an outside consultant to enable continuous improvement.

Research and Data Needs: Sufficient evidence exists that implementation of this policy option will provide the intended benefits—namely, surveillance data for detection of disease and sanitation/wastewater violations. This information is critical for determining targeted public health control needs.

Implementation Mechanisms

See prior sections. Hardware, software, and personnel needs, as discussed above, are minimal but essential for implementation and management of the presented targets.

Related Policies and Programs

1. Center for Climate and Health, ANTHC
2. Environmental Public Health Program, DHSS
3. Infectious Disease Program, DHSS
4. Office of the State Veterinarian Program, DEC
5. Drinking Water Program, DEC
6. Wastewater Program, DEC
7. Solid Waste Program, DEC
8. Wildlife Conservation Program, DF&G
9. Reportable conditions policies, DHSS, DEC

Available Resources:

1. Existing public health and animal health infrastructure
2. Other resources, as discussed above

Feasibility

Feasibility: Each solution is highly feasible as no new legislative authority is needed and the basic governmental structure already exists for implementation with minimal cost in terms of capital infrastructure and personnel services support.

Constraints: Need for long-term funding.

Adaptation Benefits and Costs

- Estimates of the proposed surveillance and control financial costs are indicated in the Target section above.
- Health benefits include
 - Identification and prevention of climate change-related infectious and non-infectious diseases among humans and animals, and
 - Prevention of health consequences associated with contaminant exposures and water/sanitation disruptions
- Financial benefits include
 - Averted costs of human and animal health care associated with climate change-related diseases
 - Averted costs to state government for human and animal outbreak response
 - Outbreak response can be very costly in terms of personnel time, travel, laboratory resources, supplies, etc.
 - Averted costs to industry from aftermath of outbreaks
 - e.g. the outbreak of *Vibrio parahaemolyticus* gastroenteritis in Alaska in 2004 severely threatened the oyster industry in Alaska; a similar incident could involve other fish species (salmon), or mammal such as moose or reindeer.

Status of Group Approval

Approved unanimously, with no objections.

HC-2 Community Health Impact Evaluation Initiative

Actions taken to mitigate greenhouse gas emissions or to adapt to the current and projected impacts of climate change also may benefit or harm human health. This option proposes a Community Health Impact Evaluation (CHIE) initiative to rapidly and efficiently screen proposed mitigation and adaptation activities to determine whether there may be associated health benefits or harms and to identify additional actions to maximize the benefits and reduce potential adverse impacts.

Option Description

The Issue: Mitigation and adaptation activities implemented in a wide variety of sectors can affect human health, from building new physical infrastructure, such as protective seawalls, to a review of historical burial site records. These auxiliary health effects are generally unintended and can range from none to highly significant. At present, there is no established mechanism for a brief, structured, and rapid professional evaluation of a proposed mitigation or adaptation measure to identify potential adverse or positive influences on health. This option would create such a mechanism to identify where health effects were unlikely, minor, few, or more significant. Such an evaluation would facilitate the design and implementation of necessary additional measures, including monitoring, to maximize benefits and to reduce potential likely and significant adverse effects.

Objective: The objective of this policy is to create a CHIE initiative to rapidly and efficiently screen proposed mitigation and adaptation measures to identify health benefits and harms, and to identify activities to maximize the benefits and reduce potential harms.

Option Design

Structure/design: The CHIE would require a designated Project Review Committee (PRC) with primary responsibility for examination and evaluation of each mitigation and adaptation measure recommended for implementation. To optimize efficiency and ensure rapid response, the PRC would have a core team that includes the State Department of Public Health, representatives from relevant State agencies, and public health professionals from other organizations. Implementing this option would not require the hiring of new professional staff, but would need part-time staff support.

The PRC would follow these steps:

1. The State agency responsible for proposing the mitigation or adaptation measure would forward a request to the PRC chair for an evaluation, along with a full description of the measure.
2. The PRC Chair would convene the core PRC members, with at least one representative from the responsible State agency. The proposed measure would be reviewed by the PRC to determine the possible need for an in-depth review. A detailed evaluation would be recommended if (1) multiple likely mechanisms for adverse health effects were identified, (2) one mechanism was identified with a high likelihood of adverse effect, or (3) the initial evaluation suggested that there was likely to be a public perception of possible adverse effects.
3. If the PRC evaluation concluded that there was a negligible likelihood for any adverse health effect, a report from the PRC would be issued to the responsible State agency. TARGET—one working week.

4. If the PRC decided an in-depth evaluation was advisable, an appropriate group of additional consultants, agency personnel, and citizen members would be convened, and the following steps taken:
 - a. The PRC Chair would send an interim report to the responsible State agency recommending an in-depth evaluation and listing the reasons that justify the recommendation. TARGET - 2 working weeks.
 - b. The PRC Chair would convene the expanded committee and:
 - i. Ascertain the possible pathways or mechanisms of potential adverse effects or benefits.
 - ii. Ensure all needed additional State, federal, municipal and other citizen groups possibly affected by the identified mechanisms were represented. This group would identify all aspects of effect mechanisms, positive and adverse, and suggest measures to mitigate adverse effects and maximize benefits.
 - iii. Align measures designed to minimize adverse impacts, and measures designed to maximize benefits, with outcome monitoring indicators to create the most efficient monitoring strategy.
 - iv. Submit a final report to the requesting State agency. TARGET--4-6 working weeks.

Timing: Implementation of the CHIE option would require authorizing legislation or regulations before the first mitigation and adaptation option is implemented.

Participants/Parties involved: The PRC should be the responsibility of the State Department of Public Health, with participation from community and environmental health professionals from other agencies and organizations. The expanded PRC required for an in-depth review would reflect the needs of the specific mitigation or adaptation option.

Evaluation: A variety of mechanisms for PRC evaluation could be used. The simplest could consist of regular feed back forms used by the PRC Chair to elicit evaluation comments from the participants and agencies involved in each review. In addition, regular feedback and critique could be solicited from involved agencies over the life of a mitigation or adaptation project, as well as residents potentially affected by the option. Monitoring reports should be maintained over the life of the project to fine-tune the option as needed, and to provide information to affected communities that might be useful for planning additional adaptation/mitigation strategies. Periodically, the PRC should undergo evaluation by an outside consultant to enable continuous improvement. Ideally, the reports, and monitoring reports, as well as all evaluation reports should be available to the public on a user-friendly website.

Research and Data Needs: The CHIE Option is based on existing models of assessing the impacts of policies and measures on community health, including those used by the Centers for Disease Control and Prevention, and does not require further research. It is a well-established, widely used public health protection mechanism.

Implementation Mechanisms

The CHIE Option would require at least authorizing regulations. Existing personnel in the Department of Public Health could probably meet the professional needs, but part-time support staff would be needed. It is anticipated that the number of mitigation and adaptation options selected by the State will not be large enough at any one time to make additional full-time professional staff a requirement.

Related Policies/Programs and Resources

Related Policies and Programs: No programs currently address the issue with the recommended specificity and process taking climate change into consideration.

Available Resources: Expertise within the DHSS, DEC, and other relevant agencies.

Feasibility

Feasibility: The proposed process for evaluating mitigation and adaptation options for potential adverse impacts on health is well established and widely used worldwide, with descriptions of the process published by the CDC and the World Health Organization, among others. Implementing this option in Alaska is feasible and consistent with established best practice.

Constraints: The primary constraint for ongoing effectiveness of a CHIE is the need to rapidly engage relevant agencies and stakeholders over short time periods with limited notice, when this activity would be in addition to current responsibilities. Ensuring high-level support for the option would help address this potential problem.

Adaptation Benefits and Costs

There is growing concern with the potential for mitigation and adaptation options to have adverse impacts on human health. In general, the public is skeptical that the agencies or departments proposing an option have carefully considered and addressed potential adverse consequences. An independent review by the Department of Public Health and others would provide a rapid, independent, and thorough evaluation of the possible benefits and harms of a proposed mitigation or adaptation option, and would identify additional actions to recommend when harmful impacts could arise.

The costs would be minimal as all that would be required would be some staff support.

Status of Group Approval

Approved by supermajority, with one objection. One AAG member objected to creation of a system because it would add an unnecessary layer of oversight. Additional costs in time and resources should be estimated and compared to that which is presently directed to assist communities in adapting their public health and water and sanitation infrastructure to warming.

HC-3 Sanitation

Climate change is altering the effectiveness of current sanitation and solid waste management infrastructure and practices to prevent the outbreak of water- and vectorborne diseases. This option would build on current programs and activities to maintain and improve the control of infectious diseases associated with sanitation and solid waste management.

Option Description

The Issue: Increases in global temperatures have led to new and exacerbated existing problems in sanitation and solid waste management that are anticipated to negatively impact the health of communities.

Overview: Sanitation and solid waste management are intended to prevent the outbreak of waterborne, vector-borne, and hygienic diseases, limit environmental toxic exposure to humans and wildlife, and improve quality-of-life. Facility and program performance design is based on historical environmental factors. However, these design factors are shifting due to climate change. This option is intended to adapt program and facility design so that public health continues to be adequately addressed in the face of current and anticipated environmental changes. Current rural sanitation policies are insufficient to address these changes and need to be modified.

Objective: The objective of this option is to protect the health of humans and wildlife from the effect of climate change in Alaska by improving the capacity of the rural sanitation and solid waste management systems to respond to and/or control anticipated new and exacerbated disease and toxic exposures. The goal is to prevent or at least ameliorate acute and chronic health problems in the population.

The Need: There is a growing scientific consensus that climate change has affected the distribution, including incidence and geographic range, of infectious and non-infectious diseases that sanitation systems are intended to minimize. Additionally, changes in water quality, such as acidification and temperature that can affect human and wildlife toxic exposures are occurring in Alaska. Changes in drinking water supply (both quality and quantity) and location may occur with the changing hydrology regime. Permafrost, utilized in some cases as a waste liner for sewage lagoons and solid waste facilities, and riverbanks that support treatment cells and infrastructure are eroding. Additionally, permafrost lader soils, in some cases, serve as structural elements in the foundation of water storage tanks, buildings that are part of the community sanitation infrastructure and/or earthen berms that may contain fresh water for drinking or coral effluent from a sewage collection system. These phenomena are a concern as rural sanitation differs from urban and semi-rural facilities in that:

- 1) Solid waste and wastewater treatment and retention largely relies on earthen structures, unlined natural land cells, simpler water supply and treatment systems, and inadequate logistical opportunity for waste compaction, cover, and consolidation that make toxin and pathogen removal/barrier performance susceptible to physical environmental changes.
- 2) A high proximity of facilities to housing, drinking water sources, and a local diet of aquatic species is creating conditions amenable to water, vector, and hygienic disease spread, and
- 3) Economies-of-scale present extreme Operation and Maintenance (O&M) costs so that impacts from climate change threaten to exceed the tipping point of community's ability to pay.

Option Design

Structure: The agencies currently tasked with the responsibility for rural sanitation and solid waste management include the DEC, the Alaska Native Tribal Health Consortium, Regional Tribal Health Organizations, local Environmental Programs, USDA, and U.S. EPA. Alaska Department of Health and Human Services, ADF&G, U.S. Fish and Wildlife are indirectly involved in identification and control for human and aquatic life negative health outcomes that may emanate from inadequate system performance.

The recommendations presented in this option will require augmentation of existing sanitation and waste management or human and aquatic life health efforts performed by programs within these agencies. Implementation of the option recommendations will require increased human and material resources, including methods and tools, within existing programs, as well as new and augmented partnerships with the public and private sectors. Additionally, these recommendations will require an update of existing environmental data sets (temperature and climate projections) in order that facilities can be constructed and/or renovated to meet future changed environmental conditions.

Targets:

1. Provide a portion of distressed community O&M costs in order to adequately protect system investment, via an annuity or other mechanism. Non-traditional approaches such as the Alaska Rural Utilities Collaborative may be considered for more wide spread utilization.
2. Collaborate with statewide sanitation and environmental health entities currently conducting infrastructure inspections to design inspection/evaluation protocols addressing severity, nature, and timing of climate change impacts.
3. Review existing Class III solid waste management guidelines (for rural and remote, non-hub communities) to adapt the regulations, recommendations, and community outreach to anticipate continued climate change impacts. For example:
 - a. Design allowances such as permafrost loss and inability to rely on permafrost as a satisfactory liner
 - b. Identify alternative or supplemental systems such as composting, hazardous waste storage facilities
 - c. System design or operations for erosion, or flooding – such as leachate retention ponds
 - d. Ensure designs are amenable to anticipated relocation (move back from eroding river or move community) such as sack-fill/road mat system that may be used to move entire landfill using local resources
 - e. Identify minimum distances to housing and drinking water sources to allow for increased rodent, insect disease vector populations at disposal site
 - f. Encourage open burning in covered containers to keep out increased precipitation, decreasing smoke toxicity
4. Review the State of Alaska Capital Improvement Project (CIP) list for solid waste projects and priority classifications in relation to substantial and relevant climate change issues
5. Make available financial resources or incentives for development of more efficient and lower-cost systems (e.g. Alaska-based manufacturing of road mats, modular treatment systems)
6. Establish an MOU between agencies with related responsibilities

- 7 Assure to the extent possible that existing sanitation facilities are protected against system failure due to climatic events such as flooding, wind, erosion, permafrost melt, etc.
- 8 Include the potential for climate change in plans and designs for new sanitation facilities, to account changes that could damage or destroy these facilities

Timing: It is recommended that each target be implemented as soon as possible to establish protection-adaptive systems in the communities where resources are being allocated in the near-term. Without timely implementation, wastage of capital resources is at risk as system lifespan horizons are designed for 20 -40 years. Human and aquatic life health may suffer both acute and chronic effects as well as reduced quality of life.

Participants/Parties Involved: DEC, ANTHC, USDA, EPA, AML, Regional Tribal Health Organizations

Evaluation: Annual assessments are recommended for each solution with respect to the need to continue or modify the effort.

Research and Data Needs: Sufficient evidence exists that implementation of this policy option will provide the intended benefits—namely, modification of rural sanitation and waste management to meet health and quality-of-life performance goals in the face of anticipated environmental impacts will meet the intent of public health infrastructure in rural communities.

Helpful research needs for implementation:

- Use of Geo-tubes for waste or wastewater cells
- Economics of Supersack and road mat manufacture in Alaska
- Increased acidification in streams – increased mobilization and bioavailability of toxics impact on the National Pollutant Discharge Elimination System, ash settlement of open burning, leachate
- Engineering design parameters based on anticipated climate changes including temperature, precipitation, wind, sea level rise, etc.

Implementation Mechanisms

Key agencies and entities form a task force to identify and implement responsibilities and activities

Related Policies/Programs and Resources

Related Policies and Programs: ANTHC and Village Safe Water Project (VSW) sanitation programs, Regional Tribal Health Organizations environmental health programs

Available Resources: There are some resources available for sanitation infrastructure projects, but those resources have been on the decline. There is a very real possibility that new financial resources will be necessary, although much of the substantive expertise already exists to address sanitation infrastructure issues.

Feasibility

Feasibility: Each solution is highly feasible as no new legislative authority is needed and the basic governmental structure already exists for implementation. If systems are adapted to climate change, capital costs are not likely to increase dramatically.

Constraints: If systems need to be retrofitted or repaired due to climate change, the economic impact could be substantial. Some cost increases may be anticipated in communities where systems must be located further from towns, for systems with no alternative than supporting a higher protective level (e.g. a treatment cell liner), or for alternative systems (e.g. increased filter efficiencies, reverse osmosis, road mats in place of gravel roads). However, an initial increase in costs in switching to targeted adaptive policies will decrease over time as these methods become conventional and design and production costs lower.

Adaptation Benefits and Costs

Benefits (positive or beneficial effects)

This priority of this option is high as failure of sanitation systems is potentially catastrophic to public health, as well as being resource-intensive and often logistically complex to address after the fact. Addressing these risks in a timely proactive manner will be protective of health and require significantly less resources.

Benefits produced/metrics: Number of homes with adequate and protected drinking water, number of homes with indoor plumbing, number of communities meeting National Safe Drinking Water Act, number of communities meeting National Resource Conservation and Recovery Act, number of cases of communicable diseases, and number of potentially emerging vector infestations (e.g. Norway Rat).

Program Success: Program success would be defined as no catastrophic system failures, disease outbreaks, or negative health outcomes due to inadequate protective resulting from climate change impacts.

Time frame over which the option will produce benefits: Benefits continue over decades.

Considerations in producing benefits: Adequate and timely funding for effective systems, incorporation of operation and maintenance needs, and community buy-in may all lead to improved public health.

Unknowns: Unknowns include the number of communities affected and what each community might require, and optimal system treatment for changed water quality and/or quantity.

Costs (financial requirements or negative effects)

Overall Cost: This option carries a relatively small cost compared to the cost of pursuing a “no action” alternative. The provision of adequate supplies of water for drinking and hygienic practices has been shown to reduce health care costs.

Actions/activities associated with costs: Reviewing regulations, legislation, assessment, building, and training.

Programmatic costs involved: Capital costs, O&M costs, labor, equipment, fuel, technology, and design and manufacturing incentive programs.

Cost components of other activities: Overall Low. Assessment of this option can largely be performed with existing resources and entities. System feasibility studies are already performed and only incremental costs would be associated with adding climate change considerations. Costs for new and innovative approaches or locating an in-state manufacturer can largely be borne by the private sector with sufficient promises of use and/or an incentive program.

Cost components of taking adaptive action: Upgrading/adapting/relocating infrastructure, and identifying best system options.

Financed by: Financing would primarily come from the state and federal sector, and projects would be carried out by ANTHC, VSW or private contractors. Secondly, the private sector may incur some or all costs associated with research and development of improvements and innovations with market potential. If this option is implemented with foresight and adequate funding, any additional costs incurred above current infrastructure funding are anticipated to be

primarily temporary, with the exception of an anticipated need for permanent sources of funding for distressed communities to cover a portion of O&M costs.

Factors/circumstances affecting costs: Costs would be affected by the number of communities affected and what each community might require.

Unknowns: Unknowns include the number of communities affected and what each community might require, and optimal system treatment for changed water quality or quantity.

Ancillary Benefits and Costs

This option will protect community drinking water, supply some communities with improved drinking water quality, increase substantially the number of communities with safe solid waste systems, protect source water for drinking and subsistence uses, protect aquatic species of commercial, subsistence, and conservation interest, reduce substantially exposures to toxic contaminants, increase urban-based jobs via potential for local manufacturing of adaptive system components and/or incremental increased resources required for option implementation, and increase in rural-based jobs via subsidy of O&M.

Data Sources

- U.S. Army Corps of Engineers (USACE) Village Erosion Report
- USACE Evaluation of Supersacks for Erosion Control
- Department of Transportation evaluation report on road mats
- Community case studies using supersacks for waste disposal and road mats for roads/landfill roads
- ANTHC and VSW data and studies on existing systems (can be cross-indexed with USACE erosion study)
- Regional health corporation inspection reports
- ANTHC and VSW design and construction estimates

Status of Group Approval

Approved unanimously, with no objections.

HC-4 Effects on Archaeological, Historical, and Cemetery Sites

The State, in partnership with tribes and other stakeholders and through augmentation of existing infrastructure, should coordinate the inventory, assessment and prioritization of cemetery, archaeological, and historic sites to develop mitigation strategies for threats due to climate change.

Option Description

The Issue: Alaska's gravesites, archaeological sites, and historic sites are becoming increasingly exposed and impacted through anthropogenic and natural processes, including global climate change. Coastal sites are particularly vulnerable. The sea level rise projected to occur over the next few decades will alter the shape of coastline and speed erosion, submerging or destroying many graves and cultural sites. Inland, warming temperatures have led to the melting of ice fields thousands of years old, exposing organic artifacts such as arrows to the elements. Warming temperatures are also causing lake and stream levels to become higher or lower than normal, exposing or inundating sites. In some areas, the onslaught of the bark beetle has had an effect on sites and structures.

Overview: This option addresses the observed and projected increase in the destruction of gravesites, archaeological sites, and historic sites due to the effects of global climate change. Programs within the state have the authorities, infrastructure, and expertise to coordinate identification, assessment and mitigation of adverse effects to these resources, but do not have adequate staff or funding to perform the duties. Appropriate responses to these challenges require augmentation to existing infrastructure.

Objective: The objective of this option is to identify, assess, prioritize, and mitigate adverse effects of climate change on gravesites, archaeological sites, and historic sites through the development of dedicated program areas within existing state authorities. This will provide for the coordination of efforts to identify, assess, prioritize, and develop mitigation plans to address the effects of climate change, and will enable the State to rapidly respond to threats as necessary.

The Need: There is strong scientific support for a relationship between global climate change and the environmental changes that are causing the destruction of gravesites, archaeological sites, and historic sites. The collection of baseline data and monitoring efforts are required to identify, assess and prioritize threatened sites, and develop plans for mitigating these threats. Examples of cemeteries and cultural sites that have been wholly or partially destroyed by changing weather patterns are widespread throughout Alaska.

Option Design

Structure: The state agency tasked with preservation and protection of archaeological and historical sites on state lands, including tidelands and submerged lands, is the Office of History and Archaeology (OHA). Housed within the Alaska DNR, Division of Parks and Outdoor Recreation, OHA carries out the policy of the state to "preserve and protect the historic, prehistoric, and archeological resources of Alaska from loss, desecration, and destruction so that the scientific, historic, and cultural heritage embodied in these resources may pass undiminished to future generations..." (AS 41.35.10). OHA also fulfills the responsibilities of the State Historic Preservation Office, a federally funded program that carries out the mandates of the National Historic Preservation Act of 1966 (16 U.S.C. 470) for a wide range of historic preservation activities, including maintenance of the official restricted-access statewide inventory of archaeological and historic sites. With regard to gravesites and human remains, OHA has provided forensic anthropology consultation to the State Medical Examiner under reimbursable

services agreements since 1988. In 2004, OHA initiated a Memorandum of Understanding with the State Medical Examiner and Alaska State Troopers that provides interagency guidance on the discovery and treatment of human remains.

With the ability to work across agency lines, staff expertise in the related fields, and a history of collaborations with tribes and other organizations, OHA is the best candidate for coordinating and facilitating the activities described under this option. While OHA has the authorities and infrastructure to begin assessing the effects of climate on the state's archaeological and historic sites, including gravesites, it does not currently have the staff or funding to carry out these duties. Implementation of this option will require increased human and material resources within this existing program, as well as new and augmented partnerships with other agencies, local governments, tribes, and organizations such as historical societies.

Targets:

1. Establish a new program area within OHA, with a dedicated archaeologist / anthropologist position and funding for travel and equipment to coordinate and facilitate cemetery issues. Duties would include coordination of studies to assess the effects of climate change and providing technical advice. Modeled somewhat after a successful program in Wisconsin, the proposed "Alaska Burial Sites Preservation Program" would coordinate closely with the Alaska State Troopers, the Alaska State Medical Examiners Office, tribes, and other stakeholders. The position should be supplemented as necessary to carry out specific program activities through the use of paid college interns or non-permanent state positions. The position would serve as OHA liaison with law enforcement agencies, the State Medical Examiner's Office, and the Bureau of Vital Statistics (for burial transit permits and disinterment / re-interment permits). The position would also facilitate communication with tribal representatives on matters involving human remains. As a part of program development, the position would:
 - a. Help to establish the "Alaska Burial Sites Preservation Advisory Board" comprised of the State Archaeologist (nonvoting facilitator), program archaeologist, tribal members, scientists, university faculty, and other stakeholders. The Board will provide guidance and oversight to the "Alaska Burial Sites Preservation Program."
 - b. Coordinate and facilitate field surveys, interviews, and records searches to identify, inventory, and determine the condition of cemetery and gravesites. Assess threats by erosion and quantify changes by measuring rates of erosion through time.
 - c. Develop a dedicated restricted-access database for reported cemetery / gravesites and discovered human remains. This can best be accomplished by designing a supplemental Geographic Information Systems (GIS)-compatible module to the AHRS database, which is under ongoing development by the state's DNR Land Resources Information Service (LRIS)/GIS Section. The cemetery database would be the primary tool for identifying, managing and monitoring changes to gravesites. By implementing a map interface, it would also serve as an important tool for law enforcement agencies and the State Medical Examiner's Office by allowing a visual comparison between human remains discovery sites and known grave locations.
 - d. In consultation with the "Alaska Burial Sites Preservation Advisory Board" and landowners, prioritize cemetery / gravesites based on level of threat, feasibility to relocate or mitigate, and importance to stakeholders such as tribes and local organizations.
 - e. Help develop mitigation plans (such as relocation); seek supplemental funding opportunities and partnerships with tribes, other agencies, universities, non-profits, and other stakeholders for survey or to carry out mitigation projects;
 - f. Coordinate with other OHA program areas to develop a public education program with site stewardship and monitoring components. This should be done in collaboration with

- other organizations when possible. This will give local community members an active role in monitoring sites for changes due to climate or disturbance, and will provide baseline information to the state.
2. Establish a new program area within OHA, with a dedicated archaeologist position and funding for travel and equipment, to coordinate and facilitate studies for addressing the effects of climate change on Alaska's archaeological and historic sites.
 - a. In collaboration with tribes, other agencies, and local organizations, this position will help to coordinate and facilitate field surveys, interviews, and records searches to identify and inventory threatened cultural resource sites. The position should be supplemented as necessary to carry out program activities through the use of paid college interns or non-permanent state positions.
 - b. Enter or update site records in the Alaska Heritage Resources Survey (AHRs) database, the state's official statewide inventory of archaeological and historic sites. The AHRs is the primary management tool for preservation planning under state and federal laws. Data fields in the AHRs record observations on current condition and provides baseline information for assessing changes to sites through time.
 - c. Prioritize sites based on level of threat, feasibility to mitigate, and importance to stakeholders such as tribes and local organizations.
 - d. Help develop mitigation plans (such as data recovery) for threatened sites; seek supplemental funding opportunities and partnerships with tribes, other agencies, universities, non-profits, and other stakeholders for survey and mitigation efforts.
 - e. Carry out a public education program with site stewardship and monitoring components. This should be done in collaboration with other organizations when possible. This will give local community members an active role in monitoring sites for changes due to climate or disturbance, and will help provide baseline information on changes for inclusion in the AHRs inventory.
 3. Pursue funding to create a benefit for private landowners who actively protect listed cemeteries / gravesites and archaeological or historical sites on their land.

1. **Timing:**

Targets 1 and 2 (establishment of program areas within DNR/OHA) should be implemented as soon as possible. The intent of these targets is to identify and prioritize cemeteries and sites for mitigation, in consultation with tribes and other stakeholders, before the onset of crisis mode. The need already exists, as affirmed by increasing reports of damage from erosion and other effects of climate change. It is anticipated that after the "coordinating archaeologist" positions are filled, it will take around 6 months to create and appoint members to a burial sites advisory board, begin working with other agencies to develop agreement documents such as MOUs for interagency cooperation, begin meeting with key stakeholders in coastal areas, refine the framework for program areas, and establish a timeline for meeting specific goals. Within one year, it is expected that program infrastructures will be established and tested, and that the realization of direct benefits will have begun. Target 3, which would only help protect cemeteries/sites on private lands, is not as time critical. The Target 3 benefits would be long-term and cumulative, but less profound.

Participants/Parties Involved:

- ✓ DNR/Division of Parks and Outdoor Recreation (DPOR) OHA: OHA has state and federal authorities and infrastructure for addressing a broad range of cultural resource issues, and is the logical agency to incorporate the Target 1-2 program areas. OHA has the ability to work across agency lines, staff expertise in related fields, and a history of collaborations with tribes, agencies, and other organizations. OHA, along with the Alaska State Troopers and the

State Medical Examiner, has already signed a Memorandum of Understanding that establishes protocols for the treatment and investigation of ancient human remains.

- ✓ Tribal Organizations: Tribal organizations will be represented on the Alaska Burial Sites Preservation Advisory Board, and will be consulted during the identification, prioritization, and mitigation planning for eroding cemeteries and archaeological sites.
- ✓ DHHS / Public Health / Office of the State Medical Examiner (SME): The SME, with jurisdiction over human remains, will be consulted under Target 1 (cemetery issues) as appropriate. The DNR position created under Target 1 will serve as liaison with the SME.
- ✓ DHHS / Public Health / Bureau of Vital Statistics (BVS): BVS issues permits for the relocation of burials (i.e., Burial Transit Permits, Disinterment - Re-interment Permits). The BVS will be consulted under Target 1 (cemetery issues) as appropriate. The DNR position created under Target 1 will serve as liaison with the BVS.
- ✓ Department of Public Safety Alaska State Troopers (AST): The AST, with jurisdiction over criminal investigations, will be consulted under Target 1 (cemetery issues) as appropriate under the existing MOU. The DNR position created under Target 1 will serve as liaison with the AST, and will coordinate both with local posts and with the Alaska Bureau of Investigation (ABI) Missing Persons Bureau.
- ✓ University of Alaska: The various campuses of the University of Alaska support programs and expert staff that can enhance our abilities to understand and address climate change. For example, university programs include anthropologists, ocean scientists, earth scientists, climatologists, and experts in other related fields. The university also trains students who can be employed through internships to help with implementing the described tasks.
- ✓ Federal Agencies: The U.S. National Park Service (NPS) coordinates actions under the Native American Graves and Repatriation Act (NAGPRA) (43 CFR 10.2.f.1-2). NAGPRA applies to Native American remains located on federally owned, federally controlled, or tribal lands. In Alaska, federally controlled lands include more than 200,000,000 acres of federal lands, as well as federally restricted properties such as Native Allotments. Human remains in museums that are entirely or partially federally funded are also covered under sections of NAGPRA. NPS and federal land managers are potential consulting parties on NAGPRA issues, along with affected tribes. The DNR position created under Target 1 will serve as liaison with federal agencies on NAGPRA issues.
- ✓ Local Governments: Local governments, including law enforcement jurisdictions and historic preservation commissions, will be consulted as appropriate under Targets 1 and 2. The DNR position created under Target 1 will serve as liaison with local governments.
- ✓ Private Foundations: The DNR positions created under Targets 1-2 potentially will collaborate with tribes and other organizations to solicit grant funds for specific measures (such as cemetery re-location and archaeological data recovery) to mitigate the effects of climate change.
- ✓ Private Corporations: The DNR positions created under Targets 1-2 will coordinate with and solicit assistance from corporate landowners and regional managers to help identify and protect cemeteries and archaeological sites under their oversight (Tasks 1 and 2). Under Task 3 (tax incentive), private corporations potentially could benefit by protecting such sites.

Evaluation:

A measure of the success of Year 1 (implementation) includes the following hallmarks:

- ✓ Create and appoint members to an Alaska Burial Sites Preservation Advisory Board, establish a meeting schedule and operating procedures (Task 1);
- ✓ Develop, through meetings and teleconferences, a comprehensive list of contacts in affected communities, local governments, and partner agencies. Schedule meetings in key communities (Tasks 1-2);

- ✓ Initiation or modification of agreement documents (MOUs, MOAs, Cooperative Agreements, etc.) to enhance cooperation between OHA and other organizations (Tasks 1-2);
- ✓ Establish a database structure for recording baseline information on burial sites (cemeteries, graves, discovered human remains) and evaluating effects of climate change (Task 1);
- ✓ Incorporate the burial sites database structure into the OHA Integrated Business System as a component of the Alaska Heritage Resources Survey (AHRS). This is dependent on funding for DNR GIS programmers, and will probably extend into subsequent years (Task 1);
- ✓ Establish a database structure for evaluating the effects of climate change on archaeological and historical sites;
- ✓ Establish methods and protocols, in consultation with other scientists, for measuring the effects of climate change on cemeteries and archaeological / historical sites (i.e., cadastral surveys, photo stations, satellite data, NOAA studies, annual measurements of ice field boundaries, etc.) (Tasks 1-2);
A measure of the success of Year 2 and subsequent years includes the following quantitative data:
 - ✓ The number of burial sites and archaeological / historical sites added to appropriate modules in the AHRS inventory as a result of investigations under Tasks 1 and 2;
 - ✓ The number of updated records for burial sites and archaeological / historical sites in the AHRS inventory as a result of investigations under Tasks 1 and 2;
 - ✓ The number of burial sites and archaeological / historical sites evaluated for effects of climate change and prioritized for the development of mitigation plans (Tasks 1-2);
 - ✓ The number of burial sites and archaeological / historical sites for which mitigation plans were developed in partnership with other organizations (Tasks 1-2);
 - ✓ The number of burial sites and archaeological / historical sites for which mitigation measures were carried out with OHA assistance (i.e., relocation of burials or artifacts, shoreline stabilization, etc.) (Tasks 1-2);
 - ✓ The number of field investigations conducted by OHA under Tasks 1 or 2 with or without partners;
 - ✓ The number of grants or requests for assistance initiated and/or received for specific mitigation measures.
 - ✓ The measures of success should be evaluated within the same framework as other OHA program areas. Direct program oversight will be provided by the Chief of OHA (State Historic Preservation Officer) and State Archaeologist (Deputy State Historic Preservation Officer). In carrying out its duties, OHA is advised by the Alaska Historical Commission (AS 41.35.300-380), comprised of individuals appointed by the Governor and chaired by the Lt. Governor. Course corrections should be initiated if review determines that desired outcomes aren't being met.

Research and Data Needs:

1. In cooperation with appropriate entities, complete an assessment of archaeological sites most at risk, and develop a plan for their protection or recovery. 2. Complete a statewide assessment of and response to the gravesites most at risk. Improve understanding of the potential cultural impacts of climate change. Increased temperatures, changing precipitation patterns, flooding, melting permafrost, and other climate change-related risks will affect the stability of archeological sites and gravesites, requiring plans for protection or recovery

This adaptation options effectively presents a means for coordinating and gathering the data necessary to accomplish the objectives of this policy. No additional research or data needs are anticipated.

Related Policies/Programs and Resources

Related Policies and Programs: The State's OHA, located within DNR/DPOR, has the infrastructure, expertise, and authority (under AS 41.35) to carry out most of the suggested target activities, but does not have funding or positions for new program areas. Other state agencies with relevant authorities include the Alaska State Troopers (criminal / human remains investigations), the Alaska State Medical Examiner's Office (human remains investigations), the Bureau of Vital Statistics (burial transit and disinterment / re-interment permits), the DNR Division of Ocean and Coastal Management (coastal erosion), and the DNR Division of Mining, Land and Water (management of the state's coastal lands, including tidelands and submerged lands). Federal agencies have management authorities for archaeological resources (36 CFR 800, 16 U.S.Code 470aa-470mm, and others) and human remains (43 CFR 10.2.f.1-2) under their jurisdictions. Some of the major federal landowners include Bureau of Land Management, NPS, US Fish and Wildlife Service (USFWS), and USFS. The Bureau of Indian Affairs (BIA) has responsibility for carrying out agency responsibilities for Native trust lands. These agencies employ archaeologists to address site and historic cemetery issues on their lands. Some Native organizations (including regional corporations, village corporations, and heritage organizations) have undertaken intermittent efforts to protect cemeteries and sites on their lands. Most do not have the funds or professional expertise, however, for a formal program or sustained effort. Because the State owns the vast majority of tidelands and active river channels where erosion is most prevalent, State permits or partnerships will usually be necessary even if work occurs at the local level.

Available Resources: The State's OHA, located within DNR/DPOR, has the infrastructure, expertise, and authorities (under AS 41.35) to carry out most of the suggested target activities. There is no funding mechanism in place for the new program areas and added responsibilities. Conceptually, the two new positions, if implemented, would serve as liaisons with other organizations (tribes, federal agencies, state agencies, non-profits, universities, etc.) to develop plans and cooperative projects, as well as collaborate on grant proposals for specific activities. OHA has the ability to work across agency lines, staff expertise in the related fields, and a history of collaborations with tribes and other organizations.

Feasibility

Feasibility: The solutions listed are highly feasible and can be implemented under existing infrastructure. As the primary owner of tidelands and active river channels in Alaska, as well as other key landforms, the State should take the lead in managing cemeteries and archaeological sites threatened by climate change. This should be done through cooperation and collaboration with other stakeholders.

Constraints: Targets 1 and 2 will require funding for staff positions, travel, and emergency response actions to mitigate short-term effects of climate change (for example, deployment of staff to assist a local community with identifying and re-interring burials exposed by a storm). Travel to remote areas can be costly, but is important. Target 3 (property tax benefit) is conceptual, but has been implemented successfully in other states. This target, which will require legislative action, should be further defined in consultation with other state agencies and local governments.

Adaptation Benefits and Costs

The creation of two new program areas under Targets 1 and 2, each staffed by a single "coordinator" position assisted by college interns as needed, will produce cost effective benefits. Tasks 1 and 2 can be implemented with confidence that the intended benefits will be provided. Overall authorities and infrastructure already exist within State government. While Tasks 1 and 2 should be regarded as ongoing processes, tangible results are expected to begin accumulating

after approximately 6 months of implementation. Task 3 (tax incentive), which has precedent in other states, is expected to yield long-term benefits that may not be provided for several years.

Status of Group Approval

Approved unanimously, with no objections.

DRAFT

Appendix I. Common Themes Across Sectors

Recommended Adaptation Options

Option #	Option Title	Page
CT-1	Establish an Alaska Climate Change Knowledge Network (ACCKN).	2
CT-2	Coordinate implementation of Alaska's efforts to address climate change.	8
CT-3	Community climate impact assistance.	11
CT-4	Promote climate change science through K-12 education.	23

Common Theme #1: Establish an Alaska Climate Change Knowledge Network (ACCKN)

Recommended Option

Establish an Alaska Climate Change Knowledge Network (ACCKN) to foster coordination among the various entities with responsibilities for collecting, interpreting, and using climate change data in Alaska. The ACCKN will leverage current efforts to facilitate the following functions:

- Organize, archive when needed, and inventory data and other resources pertinent to understanding climate change and its effects in Alaska.
- Promote enhanced online access to the above data, information, and knowledge in ways that facilitate use.
- Identify and communicate (to data and information providers) the needs of communities for information to understand and plan for climate change.
- Share information on specific geographic areas of concern such as the Arctic and on specific thematic issues or trends of concern such as ocean acidification.
- Incorporate community and other entities' (e.g., the private sector, non-profit, and citizen science efforts) data, information, and knowledge about the effects of climate change and feedback on adaptation efforts.
- Integrate and analyze data and information for better understanding of climate change impacts and effects, including identifying gaps where additional data may be needed
- Provide a point of coordination with federal efforts in Alaska such as National Oceanic and Atmospheric Administration's (NOAA) activities to develop a Regional Climate Service partnership and U.S. Geological Survey (USGS) activities related to their Alaska Science Center.

Option Description

Issue

Numerous activities are underway to collect data relevant to climate change in Alaska, within state agencies, among Alaskan research institutes, in the private sector, at the federal level, within not-for-profit and international organizations, and within Alaskan communities. Some of the existing data are maintained in online archives, others are stored in file cabinets or boxes. There is no easy way to access and integrate these climate-change data sets, research, and project information. Additionally, numerous forums, meetings, and events take place that generate information, knowledge, and ideas among the participants. Significant knowledge exists in these contexts, but awareness of its existence is limited and accessing and using the information is challenging and does not facilitate use. Most Alaskan communities and businesses have very little understanding of the recent and projected environmental and ecological changes they are experiencing and the approaches needed to adapt. Further, most state and federal agencies responsible for planning and managing both natural resources and built/human capital are not sufficiently informed about climate-change research and predictions to make good decisions regarding strategies to adapt to climate change. Finally, the information available is often not in a user-friendly form that meets the planning needs of communities, agencies, businesses, Non-Governmental Organizations (NGOs) and other entities.

Overview

There is a need to promote more effective organization of climate-change data and information and means to use the information in Alaska. This requires technology and data management approaches, as well as coordination and collaboration among agencies, organizations, and entities with data collection and management responsibilities. Current entities with some component of climate-change data collection, data management, policy, and/or research responsibilities include:

- Alaska Marine Ecosystem Forum
- State-Federal Climate Change Executive Roundtable
- Alaska Ocean Observing System – AOOS (Alaska Marine Information System for Ocean and Coastal Information)
- Scenarios Network for Alaska Planning - SNAP
- Alaska Center for Climate Assessment and Policy - ACCAP
- Alaska Climate Research Center - ACRC
- Governor's Sub-Cabinet on Climate Change
- North Pacific Research Board - NPRB
- National Oceanic and Atmospheric Administration - NOAA
- USGS Alaska Science Center
- Alaska SeaLife Center
- Geographic Information Network of Alaska - GINA
- Office of the State Climatologist

The ACCKN will provide this needed coordination. It will be supported by a staff that organizes and coordinates access to existing archives of data on climate change, promotes sharing of data and knowledge among experts and those in need of information, provides means to link data, identifies gaps in data and information, improves access to data that are currently difficult to locate, and provides access to tools and models that support the use of data accessible through the ACCKN. The staff will bring expertise in both technology to support the infrastructure of the ACCKN and science to analyze and understand the content.

The ACCKN will support the online, distributed management of numerous information resources via a Web portal. Resources will include archived climate data, climate projections, maps of climate and Arctic conditions and changes, research on climate-change effects, data on current environmental conditions (including data for which archives may not currently exist), policies, forums, workshops, adaptation tools, technical assistance opportunities, community knowledge, etc. The ACCKN will not be responsible for new data collection, but will organize and facilitate access to data from existing sources and assist in identifying and prioritizing gaps in data and potential sources of funding to address those gaps.

Users of and participants in ACCKN will likely include scientists, federal, state, and local government agency representatives; the private sector; academics; community members; the media; and non-governmental organizations.

Option Design

Structure

Central to this option is the establishment of a focal point for organizing and disseminating information relative to the various state, national, and international entities and forums on climate change. It is expected that this focal point will consist of a staff that performs a coordination function among various data collection efforts and climate change events (e.g., maintain a directory of contacts and calendar) and that develops and maintains an on-line portal to facilitate knowledge sharing. This staff, which may be established at a state-university funded site, an NGO, within an existing agency, will also assist in the analysis and use of the data. The staff, on behalf of the ACCKN, will have several responsibilities including the following:

1. Maintain a comprehensive inventory of organizations and programs collecting data relevant to climate change in Alaska. Establish means to evolve the inventory to ensure currency and the ability to integrate new efforts.
2. Provide/encourage access to information about climate change and various geographic regions that exist in current programs, offices, and databases as identified on the first page. (This will be

- a distributed model, with data residing where they are collected or organized, with tools and standards to promote access.)
3. Provide access to research papers and references for better understanding impacts of and potential responses to climate change.
 4. Provide access to an inventory of successful Alaska-relevant climate-change adaptation programs as well as contact information for communities, agencies, NGOs, and businesses that developed these. This will enable stakeholder groups to learn quickly from others that have developed successful climate-change adaptation plans.
 5. Provide access to data about Arctic forums and individuals participating in them, results of discussions, and decisions. This will aid participants in understanding and tracking Alaska's views and positions on Arctic concerns. Similarly, support will be provided to address specific thematic issues or concern. (e.g., ocean acidification).
 6. Provide a forum to bring together various entities with responsibilities for climate-change data collection to support integration and analysis of data. This includes working with NOAA as they explore development of their regional climate partnerships and Climate Services Initiative.
 7. Establish means to address questions of users about climate change issues, including collecting questions and creating a Frequently Asked Questions (FAQ) and Answers file and establishing "chat" rooms/wikis for discussion.
 8. Identify gaps in data and information and explore and facilitate potential funding sources to address those gaps.
 9. Provide means for communities and individuals with knowledge of local conditions to contribute their data to the ACCKN.
 10. Identify areas with a high degree of interest or critical topics where information is lacking and promote means among ACCKN stakeholders to interact on these topics.

Targets/Goals

A primary goal of the option is to ensure that investments in Alaska in data and information relative to climate change be leveraged to ensure they serve the communities, businesses, and people of Alaska. This includes understanding existing efforts and providing access to the data they produce.

Targets are as follows:

- Secure funding to:
 - conduct a comprehensive inventory of existing efforts, including primary points of contact
 - develop a plan for an approach to organize and coordinate access to relevant climate change data.
- Based on the plan, establish dedicated staffing (based on additional funding) for the ACCKN, as well as commitments from existing centers and data repositories to provide resources to ensure adequate engagement for Network development. Identify and secure funding for staff to support both technical and scientific aspects of managing and promoting use of climate-change data. Staff and participants in the ACCKN will undertake the following:
 - Develop a prototype of a portal/center that will support improved access to the data identified above
 - Establish a portal/center for accessing climate change and Arctic data and research
 - Use the portal to analyze data and provide technical assistance and strategies that improve the ability to respond to a changing climate and address Arctic issues
 - Establish clear measures of performance (e.g., number of users, number of contributors, relevance of information) for the portal and adapt and improve in response to those measures and potentially changing needs

Timing

Year 1: Initiate planning and develop partnerships

- Explore potential options/relationships with NOAA in their consideration of a Regional Climate Center in AK. Consider how the ACCKN can support and leverage current NOAA climate efforts and define the regional component of the National Climate Service (NCS).

- Complete a comprehensive inventory of existing data collection and archival efforts related to climate change and Arctic issues and sources of potential funding and technical assistance for climate-change adaptation.
- Convene groups of interested parties to outline possible approaches and develop a formal plan, identifying needed funding, technical infrastructure requirements, analytical requirements, community support, staffing, and management

Year 2: Implement the plan

- Secure funding for staffing
- Develop a prototype for the ACCKN, including partnerships with selected communities, businesses, and NGOs as pilot tests of ACCKN
- Begin integration and provision of data

Year 3: Provide technical assistance in the integration and use of climate change data to a broad array of stakeholders

Years 4 and beyond: Continue to provide online access to and technical assistance in the use of data and information and identify data gaps and potential funding to address the gaps.

Parties Involved (in implementation of this option)

Representatives of the various centers at the University of Alaska, representatives from selected state agencies who are knowledgeable about agency needs and expertise related to climate change, federal agency representatives with responsibilities for collecting data relevant to climate change and Arctic issues (e.g., NOAA, USGS), private sector representatives addressing climate change and Arctic issues, community representatives with knowledge about community needs relative to climate change, and NGOs.

Evaluation

Metrics must be established that document effectiveness and utilization of the network; routine user surveys could be conducted.

Research and Data Needs

This option suggests a portal for information and knowledge sharing, so no additional research is anticipated before implementation. The operation of ACCKN will, however, identify research gaps in its efforts to provide climate-change information to stakeholders. These research needs will be communicated to research programs and state and federal agencies.

Implementation Mechanisms

This option can be initiated immediately through cooperative efforts among the stakeholders. Initial funding is needed for an inventory and detailed technical/institutional plan. Funding will support staff or contractor time to conduct the inventory and convene all interested parties. Funding will also support some travel costs for participants. Individuals involved in development of this option anticipate convening over the next several months to determine optimal approaches for management of initial funding (responsible entity and fund distribution). The plan developed as part of this initial phase will outline technical details and possible institutional arrangements to ensure success of the ACCKN. The plan will also identify additional staff and funding needed to support the ACCKN. A core staff of 3-5 people will likely be necessary to support ACCKN needs in the long term. Expanded functioning of the ACCKN would require additional funding support from potential stakeholders and partners, and federal agencies such as NOAA, Environmental Protection Agency (EPA), and the Departments of Energy and Interior; Federal grants, cost recovery (e.g. from industry groups wanting to know about climate factors in designing a new pipeline), and products generated (e.g. climate hazard maps for local governments). Other entities such as the Denali Commission and the North Slope Science Initiative may also play roles to support the AKCCN.

Related Policies/Programs and Resources

Related Policies and Programs

This program builds on and integrates the efforts of several entities that address climate change as noted in the Option Description.

Available Resources

Many entities already have some state funding in place (direct state funding for Subcabinet activities and university funding to SNAP, AOOS, GINA, ACRC, and ACCAP). There is additional federal funding provided by NOAA to AOOS and ACCAP. These funding mechanisms have enabled these entities to develop substantial capacity and expertise but not at a scale or level of coordination sufficient to implement the proposed ACCKN. Funding to launch ACCKN could come from the federal stimulus package to Alaska.

Feasibility

Feasibility

This program could be implemented immediately because existing entities have the technical expertise to develop the framework. The major hurdle will be institutional - having staff to help pull together existing entities and identifying who leads, how to coordinate, who participates, how information is managed, how decisions are made, etc. An unresolved issue is how to formalize the State-University-federal and within-University partnership in a way that makes it responsive to state needs but insulates it from short-term political crises and shifts in priorities. NOAA and other federal agencies, NGO, private sector, and community representatives should also be involved.

Constraints

The structure and function of the proposed NOAA NCS is not yet defined. ACCKN will be developing without a clear model for how it will integrate into the NCS as its Alaskan (and Arctic) regional component.

Adaptation Benefits and Costs

Benefits

This option provides numerous benefits for anyone dealing with climate change issues in AK. It will improve the availability of data for decision-making, will provide approaches to involve relevant stakeholders in discussions on data pertinent to climate change and Arctic issues, and could result in more fruitful and coordinated discussions occurring at the community, state, regional, and federal levels. It will also constitute the regional component of the NCS, giving the NCS an existing regional climate partnership to leverage.

Costs

Estimated costs¹:

1. Phase 1 (Inventory, Partnerships, Plan): \$150,000
2. Phase 2 (Initiate Plan Implementation): TBD based on Plan and federal agency activities (estimated \$300,000/year for state contribution to ACCKN)
3. Phase 3 (Ongoing Implementation): Estimated \$300,000/year (TBD – based on Plan)

¹ These are gross estimates based on discussions within the Theme Working Group. Costs beyond initial development of the inventory and plan will be determined based on the plan.

Status of Group Approval

Approved unanimously, with no objections.

DRAFT

Common Theme #2: Coordinate Implementation of Alaska's Efforts to Address Climate Change

This option was developed by the Cross-Cutting Technical Work Group of the Mitigation Advisory Group. The formatting and presentation are slightly different than Adaptation Advisory Group options.

Policy Description

Responding to climate change and reducing greenhouse gas (GHG) emissions will require a dedicated and coordinated effort. Better coordination can promote efficiencies and effectiveness in the following areas:

- Tracking climate change efforts across state agencies in Alaska;
- Communicating between Alaska's efforts and other efforts (e.g., federal activities);
- Proactively interacting with and responding to expected federal initiatives on climate change;
- Providing access to information and education resources; and
- Improving outreach to citizens and businesses on climate change.

To achieve the above, a coordinating entity is needed. This coordinating entity could be an Alaska Climate Change Coordinating Committee under the Sub-Cabinet or a designated person or office that brings together representatives of state agencies. It is recommended that the Sub-Cabinet ensure coordination of the work already started through the Advisory Committee process. If a committee or lead office is not identified, the Sub-Cabinet should authorize a task force to continue to identify ways to ensure coordination among state agencies, especially on policy and strategy coordination and responses to federal inquiries and reporting requirements. With a strong coordination effort, resources and funding can be identified, secured, and leveraged to further Alaska's climate change policies and goals.

Policy Design

Goals:

Provide focus to state agency efforts as recommendations of the Sub-Cabinet are implemented. Ensure the coordination of state agency development of position papers, guidance documents, policies, procedures, and standards to establish and implement federal and state climate change programs. Provide outreach and consistent information on climate change mitigation technology and regulatory guidance to industry and the public. Ensure the Sub-Cabinet's Climate Change Strategy efforts are coordinated with the Alaska Energy Plan (see CC-4), the Alaska Municipal League, industry, Western Climate Initiative (WCI), and advisory groups working on climate change efforts in Alaska. Provide a primary point of contact for federal agencies addressing climate change in Alaska.

Activities

Support a GHG emission reporting program and associated inventories (see CC-1) as mandated by federal or state policies. Develop state government partnerships with private citizens, businesses, and local governments. Promote actions for state agencies to take to address climate change (see CC-3). Provide outreach and access to information by continuing to support the Alaska Climate Change Strategy Web site. (Consider evolution to a portal to provide additional information and functionality as a clearinghouse of climate change information, resources, and education materials among state agencies.)

Timing: This coordination effort should be initiated as soon as possible after approval by the Climate Change Sub-Cabinet.

Parties Involved: Key to the success of the effort will be identifying and maximizing partnerships within state agencies, and with federal, private, and public programs. The Governor and the Governor's Office, the Office of Management and Budget (OMB), the Climate Change Sub-Cabinet, and representatives of key state departments, including the Alaska Department of Environmental Conservation (DEC), Alaska Department of Fish and Game (ADF&G), Alaska Department of Natural Resources (DNR), and Alaska Department of Commerce, Community, and Economic Development (DCCED) should be involved. In 2009, the Sub-Cabinet should assess current resources and identify lead staff. Resources and staff should be committed by the end of 2009 to address the coordination goals and activities listed above. Many groups will be partners and beneficiaries of this coordinating body, including the state legislature, Climate Change Sub-Cabinet, state and federal agencies, Alaska Municipal League, tribes, Alaska Energy Authority (AEA), University of Alaska (UA), state public elementary and secondary schools, communities and local government, and industry.

Implementation Mechanisms

To establish an Alaska Climate Change Coordinating Program, the Sub-Cabinet must provide authorization to an entity to lead the effort. Additionally, funding for activities may be required. The Sub-Cabinet should submit legislative or budget documentation necessary to procure the resources and authority to charter this coordination effort. DEC will continue to have responsibilities for permitting, database, and reporting tools for administering a GHG Reporting Program (see CC-1). Appropriate tools and skills must be put in place to support coordination and outreach efforts, including technology and training as necessary.

Related Programs/Policies in Place

Creating a coordinating function with the mission of tracking climate change and coordinating the state's response will help to ensure the success of the other policies in the Alaska Climate Change Strategy. Staff tasked with this effort can also serve as key liaisons and resources for the private sector if or when the state enacts regulations governing GHG emissions or reporting. A Web portal would serve as an information hub to provide outreach for preparing for and responding to climate change, and for efforts to monitor, measure, and research climate change.

Many state agencies already have existing staff who deal with climate change issues and outreach. This policy would not fund these positions or create new ones within these agencies; rather, it would serve to coordinate and complement these activities.

Key Uncertainties

Challenges include engaging all agencies with responsibilities for addressing climate change, establishing clear responsibilities for coordinating roles, identifying needed funding to carry out the coordination, organizing information to present to the public, and identifying processes to maintain and update a Web site.

Additional Benefits and Costs

Benefits

Creating a coordination function is essential to track and provide some cohesion to the state's response to the Sub-Cabinet recommendations. It will also facilitate state agencies' efforts to educate businesses, agencies, and individuals seeking knowledge about climate change programs and policies, thus improving overall understanding of climate change issues. Finally, it will provide a means for state agencies to share climate change information and coordinate interactions with the federal government.

Costs

Costs primarily entail resources for personnel to provide the point of coordination, including salaries and benefits, potentially contracting costs to develop materials and support a Web portal, and training costs to ensure staff have the skills needed to provide outreach and education.

Feasibility Issues

Key feasibility issues include identifying a funding source and appropriately coordinating across existing programs. In addition, the effort needs to be flexible and generate sufficient political will to be effective and sustained.

Status of Group Approval

Approved, by supermajority, with one objection. One AAG member voiced support for the option but felt it imperative that the State Coordination function expand beyond the coordination of internal state efforts to a more active and explicit role in providing communities with assistance. The suggestion was that CT-2 and CT-3 be combined, to avoid creating a new entity.

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Common Theme #3: Community Climate Impact Assistance

This option was imported from the Health and Culture Technical Work Group under the Adaptation Advisory Group (AAG) where it originated and was fully developed. The rationale of the AAG was due to the fact that a good portion of the Option is designed to provide assistance to communities affected by climate change in areas not directly related to individuals' health or culture but to the overall well-being of the community.

Recommended Option

This option recommends providing tools and assistance to help communities adapt to the changing climate and its impacts on community and individual health by establishing a coordinating entity among federal, state, local, and tribal entities. Coordination at the state level should take place to ensure state agency programs and budgets are aligned. Evaluation of existing services and identification of gaps would enable the state to operate as efficiently and effectively as possible. Likewise, inter-agency coordination among multiple state and federal agencies, local governments, NGOs, and others is considered essential in supporting vulnerable communities faced with the complex issues related to climate change. Such coordination was successfully demonstrated by the Immediate Action Work Group (IAWG).

This policy option is very similar to the IAWG recommendations offered in their March 2009 report. These options should not be treated separately, but should inform one another to create the most cost effective organization to address the problems identified both here and in the IAWG recommendation. Additionally, some services outlined in these options will be implemented by entities whose mission is geared toward delivery of outreach services.

Option Description

Issue

The traditional way of life in much of Alaska is at risk. Alaska Native villagers, rural Alaskans, and other vulnerable communities are undergoing a series of challenges due to climate change, deteriorating economic circumstances, and other factors. Climate change brings a multitude of physical impacts to villages, including erosion, subsidence, floods, and storm surges. In some cases, these impacts require significant emergency response efforts, massive investments in infrastructure, or full-scale community relocation. Other climatic changes include shifts and dislocations of subsistence species, which can adversely affect traditional ways of life and subsistence diet, leading to negative social, emotional and physical health impacts in some areas. As climate change progresses, these impacts are likely to affect Alaska's major urban centers in significant ways as well. In short, Alaska's citizens and infrastructure face immediate as well as future threats from climate change. These threats are most easily recognized at the community level where vulnerability and adaptive capacity can vary widely.

Overview

An array of state, federal and regional entities are responsible for delivering services to Alaskan villages, rural communities, and urban centers, but specific policies and regulatory constraints produce conflicting directives that prevent the coordinated delivery of vital services that will enable endangered villages, traditional culture, and vulnerable communities to adapt in the face of climate change. Therefore, there is a need to establish a coordinating entity with the ability to navigate these multiple bureaucracies and to leverage their resources to support vulnerable communities in emergency response, relocation, subsistence concerns, and other priorities.

Objective

The objective of this policy is to create an integrated and coherent process to enable state, federal, regional, and local entities to provide rapid, coordinated, and effective relief to communities facing (and experiencing) substantial cultural, health, economic, infrastructure, and subsistence impacts from climate change. Objectives of this proposed coordinating body are to navigate the complexities of requirements and mandates of multiple bureaucracies to address disaster planning and emergency response, community relocation, infrastructure development, health and cultural impacts, subsistence, and other issues. It should be noted that this policy option is very similar to the IAWG recommendations in their March 2009 report; with this option providing another perspective on the same issue. These options should not be treated separately, but should inform one another to create the most cost effective organization to address the problems identified both here and in the IAWG recommendation. Additionally, some services outlined in these options will be implemented by entities whose mission is geared toward delivery of outreach services.

Need

Marine and terrestrial ecosystems are changing substantially with complex feedbacks that alter habitat and the mix of fish, marine mammals, terrestrial mammals, and vegetation. Sea ice, the prime habitat of walrus and seals and the hunting grounds for many coastal villagers, is forming later and at differing rates in the winter and breaking up earlier in the spring. This combined with the overall dramatic rate of sea ice loss is impacting the people with loss of traditional knowledge and extended periods without access to traditional foods. Subsistence hunters in these areas must now travel increasingly large distances to hunt marine mammals that are experiencing sharply decreasing populations (e.g., ring seal have decreased 30% in the last three years). This hunting occurs in unsafe, frigid waters in boats for which gasoline costs more than \$9/gallon, a high price to pay in communities whose per capita income is one third that of urban Anchorage. Rural villagers also confront population shifts, declines, and loss of quality in other species traditionally used for food, including fish, moose, caribou, wild berries, and other native plants. Many aspects of the traditional ways of life are now more difficult, more dangerous, and more expensive. The cost of store bought foods, heating oil, and other daily living expenses interact with climate-related challenges to create circumstances that make survival in rural villages increasingly difficult. More than one in five individuals is below the poverty threshold, three times that of their urban counterparts. Stresses to traditional practices – including a way of life tied to being on the land and providing for one's community – is combining with rising cost of rural living to raise the potential of serious social impacts. Other outcomes can be subtler. For example, Alex Whiting from Northwest Alaska notes that the youth and elderly depend on strong ice in fall to ice fish for saffron cod and smelt. Late freeze up and a concomitant shorter ice-fishing season lessen the opportunity for elders to pass on traditional knowledge and values.

Beyond the social and cultural impacts of climate change, many villages are now facing erosion, flooding, engulfment, and disappearance of their community infrastructure. Shismaref, a community of 150 households on the northern Bering Sea, faces relocation at a cost of \$93 - \$179 million dollars. A 2003 General Accountability Office (GAO) report found 213 predominantly Native villages, historically situated along rivers and coasts, at risk, with potential relocation costs of \$34 billion (GAO 2003). Several existing communities have begun the relocation process and others are seriously evaluating the risk to their communities and may follow suit in the near future.

Stanley Tom of Newtok stated that one of the biggest obstacles that village faces in trying to relocate is the lack of a single agency or group in charge of planning and/or response. DOT can't build an airstrip unless there is a post office; there can't be a post office without a school; and the school has to have 25 students. But the structures needed to house 25 students can't be built without the airstrip. These and numerous other catch 22's impede an integrated, flexible, and timely response. In addition, obtaining funding for relocation has been difficult and frustrating.

Congressional hearings underscore the frustration that no single agency has been designated to take the lead on erosion and climate change issues. The Alaska Climate Impact Commission established by the

Alaska Legislature likewise acknowledged in its 2008 final report that there is “a greater need for interagency action among state and federal agencies, almost exclusively where threatened communities are struggling with relocation issues” (ACIC, 2008). A “key finding” from the Immediate Action Workgroup’s March 2009 report – *Recommendations to the Governor’s Subcabinet on Climate Change* – was “Replace the IAWG, which is an ad-hoc body, with a formal, standing committee or workgroup embedded in the State’s administrative operations. This will ensure continued success of leveraging the State’s resources through coordination and collaboration with other State and Federal agencies, and with regional and community organizations.” This Community Climate Impact Assistance option recognizes the same problem as the IAWG and provides the following recommendations to move toward a constructive solution.

Option Design

Structure

It is recommended that a permanent, high-level state coordinating body be established within Alaska. The specific form and organization of such a coordinating body is not recommended, as those decisions require a pragmatic political perspective to ensure that an effective coordinating body is created with the authority, expertise, and community trust necessary to tackle the difficult issues currently threatening Alaskan communities. The four primary functions this coordinating body will need to tackle are described below.

Function 1: Develop a Process for Prioritizing and Addressing Climate Challenged Communities.

A deliberative process is needed to systematically and fairly address the challenges of communities that are most at risk; many of the steps are derived from recommendations of the IAWG, which build upon the work of many others, including International Arctic Research Center (IARC), University of Alaska Fairbanks (UAF), and people within federal and state agencies.

- A.** Develop scenario analysis whereby potential future climate conditions are analyzed to quantify the community impacts that might result. Using these scenarios, identify communities at risk.
- B.** Conduct meetings with leaders in at-risk communities to develop an understanding of the risks and challenges from climate change. Focus on personal safety, infrastructure, health threats and population decline. Allow the process to be driven by community leaders and landholders, with significant support from agencies.
- C.** Prioritize at risk communities and the risks within each community. Develop clear and transparent criteria for prioritization, such as: timeframe of the impact, efficacy of the solution, magnitude of the impact, financial cost, etc. Under any conceivable set of criteria, there will inevitably be losers. The clarity of the criteria and the transparency of the prioritization process will be critical in justifying the inevitably difficult tradeoffs that must be made with limited resources.
- D.** Make recommendations for addressing specific risks within communities (so communities can work themselves to reduce their vulnerability) and make recommendations on which communities should receive state and federal assistance. Revisit these recommendations annually, and revise them subject to new information.
- E.** Create strategies and measures that are tailored to the needs of the community and develop alternatives for comparison, particularly when strengthening existing community infrastructure, undertaking relocation, or making changes to community development.
- E.** Work with communities to obtain funding for these adaptation measures. In many instances, where communities lack staff or expertise to apply for and administer funding from grants, programs, or agencies, assistance with these functions can empower communities with the financial and technical resources necessary to address their community concerns on their own.

For the communities that have been identified by the State as those most at risk (Newtok, Kivalina, Shismaref, Shaktoolik, Koyukuk, and Unalakleet), develop and implement:

1. Emergency response plans, including conducting training and drills
2. Community evacuation plans
3. Community wildfire management plans
4. Geologic mapping, hazard analysis and risk mitigation plans
5. Protection and/or relocation plans

Function 2: Help communities adapt to flooding, erosion, and other risks either by relocation or in-place protection.

- A.** Create a mandate for climate impact assistance (especially migration and relocation) within State and Federal entities.

Oftentimes, federal or state agencies have narrowly defined directives that prevent them from proactively addressing the impacts of climate change, especially migration and/or relocation efforts. For example, the Federal Emergency Management Agency (FEMA) has a mandate to replace what has been destroyed in situ, but does not have an obligation or directive (or resources) to rebuild infrastructure in a different location. Ensuring that agencies at all levels of government incorporate options for migration and relocation as a vital element of their mission would accomplish the responsibilities of this task. While additional funding for these efforts would make a significant difference to vulnerable communities, even simply establishing the consideration of a changing climate may have many beneficial effects by freeing up funding streams currently inaccessible for these purposes and for increasing the flexibility of state and federal agencies.

Lack of agency flexibility with existing mandates and funding exacerbates the on-the-ground difficulties for communities facing climate impacts, especially relocation. For example, Newtok is trying to transition to Mertarvik, a new community several miles south with an elevation of 400 ft. above the existing community. However, because no central fund (nor several pots of money that can be combined) currently exists for a relocation effort, the movement of the community will have to be accomplished in several incremental steps using available resources, cooperative approaches like the Innovative Readiness Training and clearly justified funding requests. The 'pioneer' community in Mertarvik is being constructed with an evolutionary and modular approach designed by the Cold Climate Housing Research Center. A community plan has been developed showing the way forward leading to a barge landing, airport design and initial road and material source work. A central hub at the site will initially house construction workers. As the community transitions, this hub will be converted to administrative offices with additional "spokes" radiating from this hub to house a clinic, post office, perhaps school, maintenance facilities, and so forth. Housing will be added in clusters during this transition. Unfortunately a serious drawback to this multi-staged approach is that while agencies at various levels may have mandates to provide services and help to existing communities few, if any, incorporate mandates to aid communities in migration from disaster prone areas or full relocation efforts. The inclusion of "relocation" mandates is an integral requirement to accomplish such an approach.

- B.** Designate lead agencies at the federal and state levels and outline an overall strategy for the relocation process.

Currently there is no designated lead agency at the state or federal level to coordinate the resources (personnel, technical and funding) between agencies that have independent responsibility for community infrastructure, e.g., housing, education, health, energy, and similar needs. In addition, because different components (e.g., housing, schools, health and energy) are the responsibility of different agencies with different funding cycles, priorities, and fiscal resources, any single component

of the process may be side tracked or delayed leading to significant costs overruns in other components, i.e., the communities' energy infrastructure must be in place before schools can be opened. Thirdly, a lack of a coherent and secure upfront planning/funding effort requires an enormously complicated project management approach. In fact the Division of Community and Regional Affairs using Coastal Impact Assistance monies has two grant programs offered through Department of Commerce, Community and Economic Development for two planning initiatives. One of these a Waterfront Management and All Hazards Plan (\$150k) that will result in a strategic management planning document that will provide criteria and guidelines for relocation and community/waterfront development at Mertarvik. The potential benefits of this planning process may be considered a model for future relocation of Alaskan villages affected by flooding and coastal erosion.

A coherent relocation planning strategy should include:

- Alternatives to a preferred relocation site.
 - Evaluation of the advantages and disadvantages of each alternative.
 - Local input on community values related to alternatives.
 - Evaluation of the environmental effects of each relocation plan.
 - Estimate of costs for implementing each alternative.
 - Life-cycle costs of not relocating the community. As part of this analysis, calculate the costs associated with various scenarios, such as relocating in ten years vs. relocating in 20 years.
 - Incorporate environmental, social, and economic sustainability into community relocation plans and designs.
 - An evaluation of cross agency budgeting and regulatory challenges.
 - Selection of the plan that provides the best overall balance to meet local needs and is cost effective, sustainable, sound from an engineering standpoint, and environmentally acceptable.
- C.** Create a dedicated funding source for community climate impact assistance to the extent consistent with Federal and State law.

While the agencies involved in the coordinating entity will provide direct assistance to communities in applying and administering agency specific grant and other funding, the coordinating entity should ultimately work to identify or initiate a dedicated funding source for adaptation efforts. Because cost-effectiveness will be so important, the coordinating body should:

- a) explore opportunities for greater federal funding through state co-sponsorship of projects to attract federal match dollars;
- b) cost share with local governments and communities, including, but not limited to in-kind services such as community planning and engineering design through native corporations;
- c) encourage the identification and development of local rock and other material sources; and
- d) coordinate construction projects with others to reduce mobilization costs.

Nevertheless, the existing “patchwork” funding approach needs to be rationalized on an inter-agency, multiple entity, and multi-year basis. The current funding process is time-consuming and almost impossible to coordinate.

D. Create a liquid funding source to provide immediate assistance.

In addition to the dedicated funding source for relocation efforts, there needs to be a readily accessible account that provides immediate cash flow and liquidity for private households, small businesses, and other entities (e.g., local IRA). This account will pay for immediate expenses as relocation efforts unfold. Division of Community and Regional Affairs (DCRA) stated in an October 2007 memorandum:

Communities such as Newtok are in need of “fast-tracked” funding to address critical infrastructure needs at the current village site, as well as emergency needs...at the new village site. There are few, if any, funding sources that provide for an expedited funding process. Communities experiencing erosion are not always eligible for imminent threat funding because erosion is not considered a single event disaster.

E. Provide assistance in compliance with the National Environmental Policy Act (NEPA) process.

Streamline the NEPA process as it applies to relocation and other climate adaptation projects by identifying a lead agency tasked with assisting community relocation efforts in compliance with the NEPA process by preparing programmatic NEPA documentation. Communities like Newtok lack the capacity, expertise, and resources to fully carry out the NEPA process, especially when they are dealing with myriad other demands, including planning for relocation, writing grants for various aspects of the relocation process, responding to inquires from numerous agencies requiring justification for their needs and at the same time trying to sustain themselves as individuals and families. Ideally, the U.S. Council on Environmental Quality (CEQ) would develop special procedures that tailor the NEPA process for relocation projects and to the scale of these communities. A permanent, high-level Alaskan government coordinating body would have the authority to bring this urgent need to CEQ’s attention.

Streamlining can include appropriation of boilerplate information from existing Environmental Impact Statements or a template broadly fitting the general circumstances of these riverine and coastal communities. The lead agency will require federally acknowledged leadership role in collaborating with and representing other federal agencies in the programmatic efforts in ultimately complying with the approved NEPA documentation.

Function 3: Develop a community-based, flexible, and responsive process to manage and promote traditional ways of life, including subsistence access under changing climatic conditions.

Climate change is clearly a factor that affects subsistence activities and traditional ways of life. Habitat, resource availability, and species composition are all changing. Many subsistence activities are more difficult, more dangerous, and/or more expensive. Factors that may restrict or impede the ability of an individual to harvest or access subsistence resources will have profound implications for the cultural fabric of rural Alaskan communities.

Typically in rural Alaska, subsistence resources provide much more than half of the local diet and in a number of places their replacement cost (at the inflated costs of local stores) can reach two thirds of a household’s disposable income. However, subsistence resources and the activities associated with the harvest of these resources provide more than food and nutrition. Participation in family and community subsistence activities, whether clamming, processing fish at a fish camp, or seal hunting with a father or brother, define and establish the sense of family and community. These activities teach how a resource can be identified, methods of harvest, efficient and non-wasteful processing of the resource, and preparation of the resource as a variety of food items. They also promote most basic ethical values in Native and rural culture – generosity, respect for the knowledge and guidance of elders, self-esteem for

the successful harvest of a resource, and family and public appreciation in the distribution of the harvest. No other set of activities provides a similar moral foundation for continuity between generations.

One of the impacts of climate change is that animal species that migrate into the region have been arriving up to three weeks earlier and in some cases also leaving three weeks later. These changes extend and expand the breeding season of migratory species. When coupled with other environmental factors, such as lack of snow cover, these changes affect traditional and seasonal harvest patterns. Even under conditions of profound uncertainty, there are pressing social reasons to sustain traditional subsistence practices.

To improve flexibility and dialogue, the coordinating entity should work to facilitate interactions between subsistence users and regulatory bodies (such as the Federal Subsistence Board, the Marine Mammal Commission, and the Alaska Department of Fish and Game-ADF&G), particularly where local observations may provide important data to managers on the health and quality of subsistence species. The aim of this policy is to support the ability of these bodies to adaptively and sustainably manage species from year to year in a changing climate/environment so that healthy populations are maintained in companionship with subsistence use.

Research should be conducted that identifies dependencies on traditional food sources and impacts and constraints on those sources due to climate change. The coordinating entity should consider an approach to allow rural communities to provide input through a citizen-based reporting system to document changes observed in rivers/lakes/aquifers, fish, bird, and animal numbers, locations, and conditions as well as berry and other gathered food conditions. This could be an on-line system. Likewise, in partnership with appropriate regional and local entities, surveillance programs may be established to identify changing range, densities, and health of traditional food species, and to increase existing monitoring of fish and animal health for emerging pathogens and introduction of new species to ensure food safety and sustainability.

Function 4: Develop principles to guide community climate impact assistance activities. These principles should include, but are not limited to:

- A.** Provide resources to ensure cross-cultural communication and understanding within traditional languages.

Many members of some tribal communities, especially those middle aged and older speak English as a second language or not at all. Consequently, care needs to be taken to reach out to these members of the community in a manner that they can understand. Furthermore, certain media are more effective than others for outreach and communication, especially in rural Alaska. In many places radio programs or community newsletters reach a broader audience than a website ever will. Finally, communication needs to go in both directions. There is a persistent need to translate the language and traditions of native peoples into terms that technical experts and policy makers can understand. For example, the social implications of traditional knowledge and the role of subsistence in traditional culture are not easily appreciated through the simple word 'subsistence.'

- B.** Reduce community burden during sensitive times.

The community climate impact assistance activities should seek ways to streamline communication, interaction, and burden on the community, perhaps using the Newtok experience to increase efficiency on various issues. At the least, meetings and communication can be scheduled to minimize the involvement community members during high subsistence harvest seasons.

- C.** Provide for local input and community involvement.

Providing mechanisms to ensure meaningful involvement of affected parties in all phases including planning, implementation, coordination, and communication.

Targets/Goals

- Create high-level, permanent government entity to coordinate community climate impact assistance. This entity will support coordination among federal, state, local, and tribal entities with responsibilities for addressing community needs.
- Other targets can be realistically identified only by the coordinating entity itself, but may include relocating communities, creating funding streams, integrating climate into agency mandates, etc.

Timing

2010:

- Create high-level, permanent government entity to coordinate community climate impact assistance.

Participants/Parties Involved: The partial list below represents parties that do or will play some role in adapting their culture to the impacts of climate change, including relocation efforts, emergency response, and traditional foods and traditional knowledge networks.

Protection, Migration or Relocation

Native Organizations:

- Native Village Traditional Councils
- ANCSA Regional and Village Native Corporations
- Other formal and informal village or Native networks

State of Alaska:

- Alaska Department of Commerce, Community, and Economic Development (DCCED), Division of Community & Regional Affairs (DCRA) – *group coordinator*
- Alaska Department of Environmental Conservation (DEC)/Village Safe Water Program (VSW)
- Alaska Department of Transportation and Public Facilities (DOT/PF)
- Alaska Department of Military and Veterans Affairs (DMVA)/Division of Homeland Security and Emergency Management (DHS&EM)
- Alaska Department of Natural Resources (DNR), Division of Coastal and Ocean Resources (DCOM)
- Alaska Department of Education and Early Development (DEED)
- Alaska Department of Health and Social Services (DHSS)
- Alaska Industrial Development and Export Authority (AIDEA)/Alaska Energy Authority (AEA)
- Alaska State Emergency Response Commission
- Alaska Municipal League
- Alaska Governor's Office

Federal:

- U.S. Army Corps of Engineers (USACE), Alaska District
- U.S. Department of Commerce, Economic Development Administration (EDA)
- U.S. Department of Agriculture, Rural Development (USDA-RD)
- U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)
- U.S. Department of Housing and Urban Development (HUD)
- U.S. Department of the Interior, Bureau of Indian Affairs (BIA) Indian Reservations Road Program
- U.S. Department of Transportation, Federal Aviation Administration (FAA).
- U.S. Environmental Protection Agency (EPA)
- Denali Commission
- Offices of Senators Lisa Murkowski and Mark Begich and Congressman Don Young

Regional Organizations:

- Association of Village Council Presidents Regional Housing Authority (AVCP)
- Coastal Villages Region Fund (CVRF) & Norton Sound Economic Development Corporation, Bristol Bay Economic Development Corporation, & Yukon Delta Fisheries Development Association
- Lower Kuskokwim School District (LKSD)
- Rural Alaska Community Action Program (RurAL CAP)
- Yukon-Kuskokwim Health Corporation (YKHC)
- Alaska Native Tribal Health Consortium

Emergency response

- DMVA, Division of Emergency Services
- DHS-FEMA
- DHS- U.S. Coast Guard Search and Rescue
- Local Emergency Planning Committees

Traditional foods and traditional knowledge networks

- U.S. Fish and Wildlife Federal Subsistence Management Program
- Federal Subsistence Board and Regional Advisory Councils
- Marine Mammal Commission
- International Whaling Commission?
- ADF&G Boards of Fish, Game, and the Division of Subsistence
- Alaska Native Science Commission
- Alaska Native Knowledge Network
- Alaska Native Tribal Health Consortium
- Eskimo Whaling Commission
- Aleut Marine Mammal Commission
- Alaska Native Harbor Seal Commission
- Yukon River Drainage Fisheries Association

Evaluation

Monitoring and evaluation of this alternative should be specific to each of the four functions identified above. While quantitative metrics may not always be available or may not tell a complete story, identification of specific objectives and progress made toward those objectives is relatively straightforward.

Research and Data Needs:

- Declines, increases or migratory shifts of major subsistence species and vegetation can significantly affect a wide range of cultural, community, and economic conditions. The effects of events must be assessed after an assessment is made of existing climate related socio-economic studies. Assess socio-economic impacts of existing and emergent climate change events on culture, community wellness, subsistence, and overall economics.
- Standardized ADF&G Harvest Surveys (which include considerable social, demographic, and economic information in addition to household harvest per species) need to be accomplished in each of the areas designated with emergency status.
- Standardized social network research needs to be accomplished in select communities to understand potential impacts of relocation on social, sharing, economic, and subsistence networks.
- Regional economic models to quantify climate change impacts on communities and provide input to the NEPA process.

- Regional assessments of existing social service infrastructure, staffing, budgets, and delivery need to be accomplished at regional levels as baseline to plan for increased demand.
- Social impact assessments need to be conducted at regional and community level to provide information for the NEPA process.
- Detailed interviews and oral histories need to be conducted to provide narrative information needed to assess the impacts of climate change and the potential impacts of different forms of relocation.

Implementation Mechanisms

Implementation requires approval by the AAG and analysis by the Subcabinet with respect to funding, possible legislation, and communication and coordination with federal entities.

Related Policies/Programs and Resources

Related Policies and Programs

The most pertinent related program to this option was the IAWG of the Governor's Subcabinet on Climate Change. The IAWG performed several of the functions suggested under this option but for a limited set of six communities and on a non-permanent basis. In fact, in its final report to the Governor, one of the IAWG's key findings was:

Replace the IAWG, which is an ad-hoc body, with a formal, standing committee or workgroup embedded in the State's administrative operations. This will ensure continued success of leveraging the State's resources through coordination and collaboration with other State and Federal agencies, and with regional and community organizations.

Available Resources

Although no dedicated funding exists to support these activities, a great deal of expertise has been developed by the IAWG in providing communities with climate impact assistance. Harvesting that experience can provide significant cost and time savings in developing an appropriate community climate impact assistance program. Furthermore, many of the most expensive elements of community climate impact assistance will require federal partnership. The experience of the IAWG indicates that there is a window of opportunity in the near term to garner significant federal support for assisting Alaskan communities, but that pool of money is likely to be spread thinner as more states begin to address adaptation needs.

Feasibility

Feasibility

The experience of the IAWG indicates that this option is quite feasible and that great advances can be made with even modest resource commitments.

Constraints

The most significant constraint to this option is the large number of communities affected and the necessity of prioritizing them in an equitable and transparent manner. Some functions in this option require the state to interact with federal authorities such as the Federal Subsistence Board or the USACE to address current policies and mandates that impede the progress needed to accommodate community climate impacts.

Adaptation Benefits and Costs

The coordinated delivery of services to rural communities supports every one of the TWG objectives. Currently an array of state, federal, and regional entities are responsible for delivering services to rural Alaskan villages, but specific program policies and regulatory constraints cause conflicting directives, resulting in bottlenecks in the ability to achieve a coordinated delivery of vital services and outcomes that will enable villages and traditional culture to adapt to climate change. The advent of a state coordination entity will help mitigate a number of health and cultural threats caused by climate change that are now being experienced by rural communities. For example, an integrated and coherent relocation process will:

- Decrease health risks from poor sanitation.
- Preserve community integrity and provide a basis for ongoing subsistence practices and traditional ways of knowing.
- Preserve existing cultural networks, to help communities adapt to substantial changes in wildlife and habitat.
- Lessen potentially adverse impacts on youth, by preserving opportunities to participate in traditional subsistence pursuits.
- Decrease the negative social, psychological and physical impacts associated with community dissolution.

Success in this policy option will be easily measured when a fully functioning Community Assistance Coordinating entity is up and running. Numerous benefits will accrue to agencies at the federal and state levels as they reduce their transaction costs (e.g., agency meetings) in attempting to deliver services and relief to impacted communities. A rationalized funding process will reduce cost overruns, minimize waste and duplication, and provide the community with a blue print of reasonable expectations. Processes of collaborative learning and adaptive management will allow for easy quantification of benefits over a period of decades.

Costs:

The costs of this proposal may be cut in many ways. Including community relocation costs will make the figure run into millions of dollars. However, getting started with an interagency coordinating entity could use existing personnel and existing budgets to make incremental changes with little to no additional funding. A more realistic scenario factors in some new personnel costs of several regional coordinators, dedicated support staff, travel, office space, equipment, and so forth. Savings may accrue depending upon the specific administrative and organizational form the coordinating entity takes (e.g., housed within an existing department, e.g., Division of Community & Regional Affairs, in a newly established division, or a new responsibility added to several high level agency officials).

Taking a broader view, the successful implementation of this entity is expected to result in significant avoided costs in the millions of dollars over the next 40-50 years, by facilitating cost-efficient community relocation and coordination of annual responses to floods and other impacts, rather than repeated short-term and temporary measures to shore up communities against erosion.

Ancillary Benefits and Costs:

Considerable ancillary benefits accrue across all functions of government as improved communication and coordination reduce transaction costs, improve reaction time, and streamline government response to issues and problems that may not be related to climate change. In addition, the same administrative structure put forth in this option can be utilized across a broad range of government mitigation initiatives including coordinating the many options for renewable energy, options that contain numerous costs and benefits, and options that require considerable coordination in the generation, storage, and transmission of this power.

Status of Group Approval

Approved unanimously, with no objections.

DRAFT

Common Theme #4: Promote Climate Change Science Through K-12 Education

This option was developed by the Natural Systems TWG under the AAG.

Recommended Adaptation Option

Despite the critical and growing importance of climate change to Alaska's residents, there is a generally a poor level of public understanding of the causes and consequences of climate change. For Alaska to adapt effectively to climate change in the future, improved public understanding of climate change is needed. To address this essential need, the State of Alaska will increase emphasis, curriculum and training for delivery of climate-change science content in grades K-12 and increase coordination among existing programs and entities that address climate-change education in Alaska's schools.

Option Description

The State of Alaska will implement steps to rapidly improve public understanding of the causes and consequences of climate change in Alaska through K-12 education programs, under the framework of the existing Alaska Science Standards. The State will provide training and curricula to teachers on climate change, provide an education specialist to focus on science and climate change education, and increase coordination among existing programs and entities that address climate-change education in Alaska's schools.

By emphasizing climate-change education, Alaska will provide adequate educational resources to its residents to enable them to make wise choices about how to minimize the costs and maximize the opportunities that result from climate change. In the absence of such education and outreach initiatives, K-12 teachers in schools will not be able to teach about climate change because of the time and subject-matter constraints in their existing curricula. Alaskans are unlikely to take climate change seriously and will not be prepared to adapt to the environmental and ecological changes that are occurring.

Option Design

Structure/design: Sub-option 1 has three major components:

- The State will provide funding to the University of Alaska or other appropriate entities to develop courses for K-12 teachers so these professionals have the training necessary to teach about climate change in Alaska. These courses will involve professionals in education and extension/outreach. It would be important to determine cost effective, yet successful methods for delivery of this training to Alaska's teachers, through distance delivery, training at district in-service sessions, etc.
- The State will establish and fund a new environmental/climate change science education specialist at the Department of Education and Early Development (DEED) to provide coordination among existing programs and entities that address climate-change education in Alaska's schools, and to coordinate development and dissemination of new curriculum, materials and teacher training. (At present, DEED does not have an environmental science education specialist.)
- The State will increase coordination with and utilization of existing programs that address climate change education for Alaska's school-age children. (See Related Programs, below)

Targets/goals

The goal of this sub-option is to include climate change as an integral component of public education in Alaska, so Alaska's youth are prepared to make wise choices about adapting to climate change. Targets will include completion of the tasks listed above.

Timing

Implementation for this policy can begin immediately and could be completed within three to four years.

Participants/Parties involved

DEED, U.S. Department of Education, University of Alaska, stakeholders, school districts, teachers, and entities listed in the Related Programs section, below.

Evaluation

Implementation of the adopted policy in classrooms can be monitored and evaluated through formative and summative assessments administered by classroom teachers and/or by DEED.

Research and Data Needs

- Research public education curricula and teacher training materials developed and implemented in other states (e.g., California).

Implementation Mechanisms

The primary need for implementation of these recommendations is Cabinet-level emphasis, intention, and limited strategic funding. Specific implementation steps are provided in the Option Design section, above.

Related Policies/Programs and Resources

Several organizations that have initiated efforts to integrate climate-change understanding into the educational program include the Center for Ocean Sciences Education, International Arctic Research Center, and the Alaska SeaLife Center. For example, the Alaska SeaLife Center in Seward is expanding its education program to include curriculum about the marine environment and climate change. This eight-unit Marine Ecosystems Curriculum will initially target students in grades 6-9 through Distance Learning. The curriculum will also form the basis for a summer camp program and can be modified for in-classroom use with grades 4-6.

The document on *Climate Literacy: Essential Principles of Climate Science* has been developed by federal science agencies including NOAA and National Science Foundation (NSF) in collaboration with many individuals and the following science and education partners: American Association for the Advancement of Science Project 2061, American Meteorological Society, Association of Science-Technology Centers, College of Exploration, Cooperative Institute for Research in Environmental Sciences, Federation of Earth Science Information Partners, Lawrence Hall of Science, University of California, Berkeley, National Environmental Education Foundation, National Geographic Education Programs, North American Association For Environmental Education, TERC, Inc., GLOBE Program, National Center for Atmospheric Research and University Corporation for Atmospheric Research. This Climate Science Literacy Guide includes science concepts aligned with the National Science Education Standards and the American Association for the Advancement of Science Benchmarks for Science, and provides a framework for understanding and communicating about climate change and climate science for individuals and communities.

Feasibility

These recommendations could be feasibly implemented within three to four years, if targeted funding is appropriated.

Adaptation Benefits and Costs

Benefits

The primary and essential benefits to this option will be improving the literacy of Alaska's youth (our future adults) in basic information about climate change, mitigation and adaptation, to inform their future decisions regarding their own actions and to ensure that Alaska's population understand the importance in future State decisions and actions.

Costs

This recommendation would involve the following general costs:

- A new statewide staff position (Education Specialist II: approximate cost \$83,000 per year, salary and benefits) to coordinate climate change education efforts for the DEED and to coordinate with other organizations involved in climate-change education.
- Development of climate change curriculum, teacher training materials and accomplishment of teacher training by the University would require contractual funding.

Status of Group Approval

Approved unanimously, with no objection.