FINAL COMMISSION REPORT

Alaska Climate Impact Assessment Commission

Alaska State Legislature
March 17, 2008

FINAL COMMISSION REPORT

Alaska Climate Impact Assessment Commission

Alaska State Legislature
March 17, 2008

Representative Ralph Samuels, Chairman
Representative Reggie Joule, Vice-Chairman
State Capitol Building
Juneau, Alaska 99801-1182

(907) 465-2095

http://www.housemajority.org/coms/cli/cli_final report_20080301.pdf

TABLE OF CONTENTS

AK Climate Impact Assessment Commission

Rp. Ralph Samuels, Chairman / Rp. Reggie Joule, V-Chairman

State Capitol #204, Juneau, AK 99801-1182 / (907) 465-3727 / fax - (907) 465-3810

FINAL REPORT TO THE LEGISLATURE

March 17, 2008

COMMISSION OVERVIEW:

AUTHORITY:

Legislative Resolve 49 from 2006, Attachment (A), established the Alaska Climate Impact Assessment Commission and charged it with assessing such effects under climate change, as would affect the citizens, resources, economy, and assets of the State of Alaska. The Commission was composed of two state House members, two state Senators, and seven public members appointed to specifically-defined seats. A roster of the members can be found at Attachment (B). The public seats focused on climatology/oceanography, communities/public health, tourism, resource development, the economy, engineering/construction/ maintenance, and fish/ wildlife/land management issues. The Commission was also charged with holding public hearings around the state. Existing legislative staff provided support work.

SCOPE OF ACTIVITY:

The Commission took both invited professional testimony and extensive public testimony at each of its hearings. In addition, we left our hearing record open to those who chose to write, fax, or email commentary, right up to the preparation of this final report. Beyond its organizing meeting, the Commission held six public hearings throughout Alaska, and one site inspection visit. The public hearings were in Fairbanks, Anchorage (two), Juneau, Kotzebue, and Barrow. The site inspection was to Kivalina. The Commission was weathered out of Shishmaref, another intended site visit. A total of 210 persons appeared and/or presented public testimony at our field hearings. Another 85 responded by email, letter, or email. A preliminary report to the Legislature was submitted on March 1, 2007, Attachment (C). A final report was due to the legislature by January 10, 2008, but because of the loss of time due to special legislative sessions in 2006 and 2007, an extension was granted.

The Fairbanks hearing was held on the campus of the University of Alaska,

and emphasized a scientific overview of the major climate change issues affecting Alaska. The Juneau public hearing emphasized the role of state government in addressing climate change, as well as learning about operational changes already being experienced, such as fire suppression activities. The two Anchorage hearings took testimony from municipal, business, research, federal, and village interests, as well as considerable anecdotal information from the public.

In Kotzebue, the Commission recorded insights into coastal erosion in the region, village relocation issues at Kivalina and Shishmaref, unstable ice conditions, a decrease in subsistence activities, and local success with wind energy generation. During hearings in Barrow, the Commission was made aware of the challenges of an ice-free Arctic Ocean, retreating coastlines, and a loss of some subsistence opportunities due to drying tundra, low river levels, poor snow and ice conditions, and tundra fires. The North Slope Science Initiative, the Barrow Arctic Research Center, and the Ilisagvik College each showed the community to be engaged at the forefront of research, monitoring activities, and education efforts to address the challenges of a warming Arctic.

At each public hearing, the Commission heard from local public officials and tribal leaders, including the mayors of eight different municipalities. The Commission took testimony on local efforts to better identify and respond to potential climate warming impacts, and noted the varying emphases of concern, generally differing between urban and rural communities. The greater concern of many urban communities was related more to greenhouse gas issues, while with rural communities, the prevailing concerns were more terrestrial; erosion, flooding, subsistence, and permafrost issues.

Commission members appeared as speakers upon request, and routinely participated in other climate change forums, including those organized by the Alaska Federation of Natives, the Alaska Center for Climate Assessment and Policy, the Department of Engineering at the University of Alaska (Anchorage), the Anchorage Business Roundtable and Resource Development Council, the 7th International Conference on Climate Change at the University of Alaska (Fairbanks), the Society of American Military Engineers and the Warming Oceans Forum, the federal Climate Change Roundtable, Coastal Erosion Strategies for Alaska (UAF), the Arctic Research Commission, the Kivalina Relocation Group, the Alaska Water Resources Association, and the Administration's Sub-Cabinet for Climate Change. A Commission member was appointed to the Immediate Action Working Group of the Sub-Cabinet.

TASK DESCRIPTION:

As stated in the Arctic Climate Impact Assessment, “The science suggests that responding to this challenge will require two sets of actions: one, *mitigation*, to

slow the speed and amount of future climate change by reducing greenhouse gas emissions; and the other, *adaptation*, to attempt to limit adverse impacts by becoming more resilient to the climate changes that will occur while society pursues the first set of actions," (ACIA, 2004). It is also important to note that mitigation in the context of the Alaska Department of Military & Veterans' Affairs and FEMA, is consistent with adaptation in improving infrastructure to minimize damage from natural disaster events.

The Commission acknowledged these definitions, and in shaping an approach to its charge under Legislative Resolve 49, prioritized its time, energy, and resources more toward adaptation issues. This emphasis on adaptation issues, it was felt, was more responsive to the immediate threats and concerns facing Alaska, and the need to orient state government toward new responsibilities. This emphasis was judged more the purview of the legislative and administrative functions.

Perhaps the most striking impacts in all of Alaska for mitigation and adaptation strategies to be developed and applied are with the village relocation issue in Western Alaska. The convergence of immediate threats, substantial human need, and prohibitive costs presents decision-makers at all levels of government with daunting challenges.

"There is little doubt that Alaskans are feeling the effects of climate change more than anyone else in our nation. Regardless of whether these changes are caused solely by human activity, we must take steps to protect people in the Arctic."
~ Senator Ted Stevens, July 11, 2007

The Commission found that climate change presents unavoidable challenges to the citizens of Alaska. There will be new responsibilities for the State of Alaska and public entities, and there will be responsibilities for private interests which individuals must accept. Certainly the economics are a key factor in these challenges. Successful adaptation strategies that recognize the environmental, cultural, and economic factors will be the keys to reducing the adversity of climate change.

The effects have been clearly stated in the stories and anecdotes of the Native people who have spoken before the Commission. These statements have stressed the need for help in adapting to an environment that has changed within a generation, when the culture and subsistence ways were dependent on traditional knowledge and wisdom built over many generations. Now, the "world" is different as changes are occurring at a more rapid pace.

SUMMARY OF CONCLUSIONS:

As has been often repeated, the State of Alaska is at the leading edge of impacts resulting from a warming climate. The Commission has recognized many

negative and expensive effects of anticipated climate change. There are potential, positive eventualities, as well. The Commission's concern over a reduction in federal spending implies an increased level of state spending may be in demand.

We considered the most potentially impacted state agencies as being the Department of Commerce, Community, and Economic Development, the Departments of Environmental Conservation, Natural Resources, Transportation and Public Facilities, Fish and Game, Health and Social Services, and the Department of Military & Veterans Affairs (Division of Homeland Security and Emergency Management). In other agencies, there may be budgetary and regulatory impacts, as well as contraction and/or expansion of some programs. The Commission concluded that informed decision-making will need objective, reliable data, continued monitoring activities in the field and at sea, and the most up-to-date research we can acquire.

The potential for commercial shipping expansion in the high Arctic and its related support services may be the most significant new economic development activity on the climate change horizon. Access to Northern Europe via the Northern Sea Route, and to the Eastern United States via the Northwest Passage, are vital to commercial shipping interests. Increased state revenues would be tempered by increased state investments and expenses. Expanded federal and international interagency relationships, regulatory activity, public safety, and other state responsibilities will grow in response. Implications exist for new workforce development and education strategies.

The Commission considers that longer and warmer Arctic summers will help increase the number of tourists coming to Alaska, especially by cruise ship. This would include more tourism in the far north, where currently, there is relatively little marine-based tourism. Shore-based businesses may extend their operating seasons in support of a longer tourism window. The perception of industry trends is considerably more favorable for enhanced tourism under a warming scenario.

Other major economic enhancements will draw from research activities. While other states have long-established records of various impacts upon their lands and their people, Alaska, in many cases, is in its infancy in terms of the historical record, data collection, and monitoring programs. Research of all types in Alaska is a $300 million per year proposition, and a growth sector, in large measure because of climate change research. Half of that activity is directed by the University of Alaska. As one of Alaska's recognized strengths, the research community within the state positions us well to take advantage of expanding initiatives in support of understanding, diversifying, and managing, our economy.

With an economy based primarily on resource extraction and government spending, the Commission also recognized traditional economies as significant forces in sustaining rural life in the Arctic. Impacts on Alaska's fish and game assets are

one of the most disconcerting signs of climate warming. Migratory patterns of birds, terrestrial mammals, and fish stocks are changing, and marine mammals are being greatly impacted, all to the detriment of wildlife viewers, subsistence and sport users. Boreal forests are in a pattern of range diminishment, and a variety of natural vegetative stocks necessary to sustain terrestrial mammals, is in flux. Testimony to the Commission indicated that many subsistence users have to range farther from home now in pursuit of game species, especially in Western, North-western, and Arctic Alaska.

MOVING FORWARD:

In our view, extending the Alaska Climate Impact Assessment Commission with the same approximate objectives and responsibilities will not generate a justifiable, incremental level of basic knowledge beyond that available in the Arctic Climate Impact Assessment and subsequent documents offered by public and private researchers, Non-Governmental Organizations, and contractors to the Alaska Department of Environmental Conservation.

The Commission concluded that continued identification of potential challenges, threats, and planned responses needs to occur within the Administration. It was also felt that this will enhance the development of policy, prioritization of responses, and in turn, lead to development of funding priorities, program management, and inter-agency collaboration, especially with federal agencies. Our primary responsibility was one of assessment. The Commission recognizes and supports the organizational, professional, and tenured capabilities of the Sub-Cabinet for Climate Change as the entity to develop Alaska's overall implementation plan.

ECONOMIC IMPACTS:

Discussion of the Alaska economy and economic development relating to climate change touches all issues from resource development, fisheries, and subsistence, to the health and welfare of the citizens. As a state with an economy fueled by resource development, Alaskans by necessity must adapt to changes in climate. In fact climatic changes have been a part of human adaptation in Alaska going back over 10,000 years.

In any natural system there will be change, whether we are in a warming trend or a cooling trend often depends upon the timeframe (years to decades to centuries). While some studies such as the 2007 UAA-ISER report suggest increased costs to the State of Alaska for public infrastructure, there are also offsetting savings in heating costs, less cold weather degradation of infrastructure, as well as changes such as potential lower transportation costs due to an ice-free Arctic Ocean. In early 2008, the U.S. Coast Guard (USCG) began working with the cities of Nome and Barrow in anticipation of increasing its presence in those areas.

Certainly there are specific issues such as threatened villages which must be addressed. Recent climatic shifts have accentuated erosion problems, however, the problems have always been there, to one degree or another. Thus looking ahead, the state needs to be proactive in strategic planning for impacts to infrastructure, taking into account the dynamic nature of a changing environment.

Fishing, mining, timber, and other resource extraction industry operations are energy-intensive, and therefore, sensitive to fuel cost escalations. This fossil-fuel dependence and a lack of alternatives has the potential of decreasing the market value of our resources. A variety of alternative energy and renewable energy projects have been and are being considered for Alaska. Those with successful development potential include wind and solar power, wave action/stream-flow technology, bio-fuels, hydro, geothermal, methane, and heat recovery/reuse applications. Feasibility, efficiency, cost effectiveness, and sustainability should remain the guiding principles, as location and funding issues are addressed.

Perhaps one of the greatest benefits of the heightened awareness of climate change to economic development is that policymakers and citizens are now fully aware that we live in a dynamic natural environment, and we always have. Thus adaptation will be required, as it always has been, even if not always recognized.

Specific recommendations to help address future economic impacts to the state from climate change, as well as to capitalize on what these changes could bring as opportunities for Alaska, include:

- Support monitoring systems integrated with state and federal agencies and the University of Alaska, to collect or update pertinent baseline data on physical, biological, and cultural factors.

- Support the state Division of Geological & Geophysical Surveys (DGGS), or other appropriate entity, for the identification and mapping of permafrost, landslides, riverine / coastal erosion, and soil type for engineering studies and community planning.

- Support to ensure decisions are based on science and engineering analysis well documented with recent data and future monitoring programs.

- Education and public awareness on the fact that Alaskans live in a dynamic natural environment, and that adaptation is nothing new, despite what is sometimes said.

- Plan for infrastructure development along the Northwest Arctic and Arctic coasts for maritime industries and offshore resource development.

- Support federal funding for two new ice breakers for the U.S. Coast Guard and new UNOLS ARRV to collect offshore physical, chemical, and biological data throughout the seasons.

Based on these conclusions and the breadth of adaptation needs facing Alaska, the state should have a designated liaison to work with industry (oil and gas, minerals, fisheries, transportation) and federal agencies that will be more involved in the Arctic (e.g. the U.S. Coast Guard, Department of Defense, NOAA, U.S. Fish and Wildlife Service, etc.).

FISHING / HUNTING / SUBSISTENCE:

The Commission took testimony describing projected changes in the movement of commercial fish stocks, especially the potential for salmon species intent on migrating north to follow favorable cooler water temperatures. King salmon were reported being caught with greater frequency in Norton Sound, for example. Other observers described catching unrecognizable fish species in Southeast Alaska, species likely on the move from the mid-Pacific Ocean. Several shark species unseen until recent times in Alaskan waters, have also made appearances in such numbers that sport anglers pursue them as new game fish. Marine species migrations also bring parasites, other elements of more southerly food chains, and unknown impacts to our waters.

The North Pacific Fisheries Management Council (NPFMC) has initiated a process to develop a fisheries plan for the Northern Bering Sea and the Arctic Ocean which will require additional research and fish stock monitoring. The Commission supports this effort as part of an expansion of commercial fisheries opportunities in the far north.

The changing migratory patterns of terrestrial mammals in the state, some species more pronounced than others and some areas of the state more affected than others, are being documented. Some of this is due directly to warming, but also indirectly, due changing distributions of wild plants upon which they feed. Caribou appear the most sensitive to changes in their environment. The Commission concluded that impacts on subsistence hunting and fishing activities may be substantial over time. State game management must address the changing migratory patterns of wildlife by providing current resource data with subsistence users in mind. Real time information is important for the successful hunting and gathering of subsistence resources by rural Alaskan residents.

Changes in animal migration patterns and movement of fishery stocks portray that state and federal agencies charged with management, face new regulatory challenges, for example, with seasonal and harvest limits. These new animal and fish dynamics will need continuing research and monitoring activities.

FEDERAL SPENDING:

Generally, the Commission was not encouraged that federal spending in Alaska will increase over time to meet the overall challenges of climate change, particularly in support of mitigation actions. The exceptions may be federal spending for research, homeland security (a predominantly emergency response-type function), and military spending.

INSURANCE INDUSTRY:

According to the National Association of Insurance Commissioners (NAIC), the insurance regulators will begin to review *"all aspects of insurance regulation with a view to making significant changes that will be necessary as a result of this challenge."* The NAIC has established a Climate Change and Global Warming Task Force, charged with assessing climate change insurance-impacts on consumers, insurers, and insurance regulators. Since 2006, their focus has narrowed on impacts to regulators. We have discovered no corresponding task force or other entity at a statewide level in Alaska.

NAIC findings highlight insurer solvency issues of concern to regulators nationally, their investment practices where assets in coastal areas may face greater threats, and differing potential market impacts for the different lines of insurance protection offered to customers.

Of more local concern in Alaska is affordability, and long term availability of coverage for municipalities, the private sector, and other entities in regions threatened with permafrost degradation, flooding, and erosion.

Insurability of Alaskan communities, especially those with recurring disasters, is a challenge that will require improved data and detailed risk assessments. Presently, risk assessments can only build upon recurrence of natural disasters associated with storm surge and erosion, flooding, ice damage, fires, and thawing permafrost. With federal agencies identifying over 160 communities potentially at risk (USACE, 2006 and 2007), the amount of data required to support adaptation for these communities, while providing sustainability and insurability, is significant. The Commission supports federal efforts to interview and prioritize each community as to the level of risk and potential for recurring natural disasters. This information can help to support cost-effective insurance for public and private community assets.

The Commission recognizes the value of access to the National Flood Insurance Program (NFIP). However, insurance under this program requires communities, boroughs, or counties to be incorporated, and may be considerably more expensive than residents of remote communities can afford. The State of Alaska, together with the Alaska Municipal League's insurance arm, should explore cost-effective means of insuring communities against loss due to climate change.

Ultimately, though, the impacts of climate change on insurers will be borne by those insured.

MARINE TRANSPORT:

Assuming current warming trends continue or accelerate, it should be considered fact that the high Arctic will become increasingly more accessible in the next decade. Couple this with projections that the Arctic will continue to grow as a major energy development arena and that it will offer new, long-sought commercial shipping routes. Given these developments, it can be seen that new demands for financing, shore-based infrastructure, new resource extraction, a variety of regulatory regimes, environmental protection, military and homeland security, international cooperation, cultural integrity, research strategies, and more, will all be at hand. New challenges, opportunities, and responsibilities will confront the State of Alaska.

The Arctic Council (www.pame.is) is the official circumpolar agency which manages a strategic plan for the high Arctic. The Council is comprised of the five Arctic Ocean nations (U.S., Canada, Denmark/Greenland, Russia, and Norway), plus Finland, Iceland, Sweden, representatives of several affected indigenous groups, and a corps of observer entities.

The Arctic Marine Shipping Assessment (AMSA) is a project of the Arctic Council. The AMSA has been underway since 2005, and a final report will be issued later this year. The initial task has been to conduct a marine activity data survey with two major components. One is to establish a baseline of current Arctic marine shipping activity and assess its environmental, social, and economic impacts. The second component of this undertaking is to project levels of Arctic shipping activity out to 2050, and assess related environmental, social, and economic impacts for that period. This component will also generate recommendations for the final report.

The U. S. Arctic Research Commission (www.arctic.gov), established in 1984 by Congress, develops and implements national policy priorities for basic and applied scientific research in the Arctic. Among other things, ARC is engaged with the Arctic Council in evaluating the potential for commercial shipping expansion in the Arctic under climate warming conditions. The ARC stressed to the Commission, the need for environmental monitoring, and voiced support for the work of the Global Earth Observing System (GEOS), the Arctic Observing System (AON), and the Alaska Oceans Observing System (AOOS). The ARC also recommended that the State of Alaska support the Arctic shipping regime currently in the President's draft of the White House Policy On The Arctic.

Shipping routes through the Arctic Ocean between the Pacific Ocean / Bering Sea and the North Atlantic are so attractive that the five nations in the core region

are boosting military capacity in order to assert territorial claims. Chinese interest is significant. Their large container ships could reduce the run from Shanghai to Rotterdam by nearly one-thousand miles using the Northern Sea Route (above Russia). Other opportunities are just as appealing via the Northwest Passage (above Canada). The Commission recognized a potential need for a Vessel Traffic System (VTS), such as is now in place in Prince William Sound, but not in the Aleutians nor in the Bering Strait. Alternatively, the U.S. Coast Guard (USCG) may consider vessel routes or designated shipping lanes within which ships would be obliged to confine their movement.

Infrastructure requirements for Alaska's Arctic coastal seas include charting & hydrography, improved sea ice monitoring & forecasting, enhanced search & rescue, ports & harbors of refuge, communications & navigational aids, oil spill & vessel incident response capacity, marine traffic monitoring, and additional icebreakers. The State of Alaska may need to participate financially in these needs.

USCG officials have called for a national dialogue on American security interests in the Arctic. Today, the USCG is developing plans for a greater presence in the Bering Sea and Arctic Ocean, as new commercial shipping activity becomes more apparent. Presently, there is little or no consistent vessel patrolling in these northern waters, and only one Coast Guard patrol aircraft flies, mainly to monitor activity on the commercial fishing ground.

The USCG now possesses a total of three icebreakers for the entire nation, two of which are at the end of their service lives. Without completely overhauling these or acquiring new ships, we will not be ready for the growth of this new frontier. In addition to keeping shipping lanes open, these vessels are designated research ships, and as such, work extensively for the National Science Foundation, which pays a majority of their operating expenses.

American polar icebreakers are key instruments of U.S. maritime policy and security. It is critical that America’s polar icebreakers be operated by the USCG, and not be outsourced to foreign powers, so that such responsibilities as search and rescue, law enforcement, icebreaking, and scientific research (including surveying the outer continental shelves), can be effectively conducted off Alaska. The Commission recommends replacement of the two aging icebreakers in the American fleet as soon as feasible.

ECONOMIC VALUE OF RESEARCH:

The research factor throughout the array of climate change issues, has great and positive implications for Alaska. Research activity and the funding it brings into the state are of considerable significance to the University of Alaska (UA) and other entities, and therefore, the economy in general. Total research value in Alaska is worth about $300 million per year, with about half under the auspices of UA.

Climate change research is a major share of that activity, and growing. UA refers to research as the "silent giant," which provides nearly 2,400 jobs and a $92 million payroll. Active UA research exceeded $151 million in value in 2006, nearly all of which is new money into the economy. Other, indirect benefits of research activity appear beyond the academic community, as well.

TOURISM:

Climate change presents both opportunities and challenges for the tourism industry. The vast majority of visitors to Alaska come in the summer time. About one million of the state's 1.8 million or so visitors come by cruise ship and over the last decade, ships have started coming earlier in May and leaving later in September.

Thus, it can be argued that longer and warmer summers help increase the number of tourists and the amount of money they spend. Also, there is some evidence that people visiting Alaska tend to spend more on some activities on warm sunny days that they do on cooler wetter days. Also, some activities such as flight-seeing sometimes are canceled on stormy days, thus decreasing revenue for Alaskan businesses and reducing the visitor experience. The unusually warm summer weather that occurred in Southeast Alaska in 2004 had a definite and positive economic impact from the point of view of the cruise industry.

If winter continues to leave earlier and start later, it is likely that some businesses which close down for the cold months, will stay open longer. Thus, it is possible that both Alaskans (who can be tourists in their home state) and visitors from outside, will provide an increased source of revenue for these businesses. It might even be argued that shorter and less severe winters have a positive effect on wildlife and their ability to survive. If this is so, wildlife viewing, a major activity for tourists, may well be enhanced.

Another potentially positive economic impact of climate change is the opening of the Arctic Ocean to tour ships. Some small tour ships already offer tours as far north as Barrow, but the receding ice pack in the summer may well increase these opportunities and offer some economic benefits to some of our northern communities.

However, the entire picture in not positive. As Alaska seeks to expand its winter tourism appeal, the unpredictable nature of recent winter weather becomes a problem. We have seen dog sled races, skiing events, and other winter activities cancelled or moved to new locations.

Warm hot summers have brought us record-breaking forest fires both in Alaska and in the Yukon Territory. The smoke from these fires has covered Southeast, South Central and interior parts of the state from time to time. This

smoke has definitely reduced the visitor experience and has caused some ground tours to be canceled or rerouted, often at considerable expense to the tour company.

Receding glaciers may be another negative aspect of climate change. Glaciers are another item on most visitors' “to-do list.” The change in glaciers can have a major impact on visitor activities. For instance, Portage Glacier used to be the most visited location in Alaska. However, as the glacier has receded from view, the area has become less of a tourist attraction.

In summary, the fact that the Arctic in general and Alaska in particular experience some of the most dramatic effects of climate change, this may in itself attract more visitors. However, those visitors may experience a different Alaska than if they had made their trip a decade ago.

ALASKA'S COMMUNITIES:

LAND USE ISSUES:

The Commission supports the obvious, that many land use regulations, regional codes, ordinances, and professional practices need to be reviewed for potential climate change impacts. The history of construction in known flood plains, erosion-prone areas, vulnerable coastal locations, and permafrost-degraded regions of the state bares the costly lessons we must avoid in the future.

As a step forward, the Commission recommends issuance of an Administrative Order regarding the siting and building of state-owned and financed construction projects. It's in the state's best interest to protect capital investment by reducing potential impacts from erosion and flooding. Construction standards found in federal regulations under 44 CFR Part 60 of the FEMA National Flood Insurance Program (NFIP) should be mandated for all state agencies with construction authority.

TECHNICAL MAPPING UPDATES:

The Commission took testimony regarding the inadequate state of the technical maps inventory available to researchers, planners, engineers, construction firms, emergency preparedness personnel, and others. These maps chart soils, erosion, flood plain features, surface water, stream and river course changes, and permafrost conditions, all referred to as the vertical datum. Some maps have not been updated in decades, especially in Western and Northern Alaska. This deficiency only serves to increase the level of professional guesswork on various projects.

Updating technical maps to address the problems mentioned above will require a comprehensive effort to establish an accurate vertical datum for Alaska, especially the coastal zone of the Bering Sea from Bristol Bay north to the Chukchi and Beaufort Seas. The vertical datum would establish the orthometric heights relative to the ellipsoid height measured by Global Positioning System (GPS). In conjunction with accurate horizontal datum as established by GPS, this would allow for accurate determination of shoreline and determine direction of water flow and potential flood risk.

To complete this, coastal mapping in Alaska needs also to be expanded. A proposal to map the gravity field of Alaska's Littoral Regions (excluding the Aleutians) with airborne gravity sensors and topographic lidar is in draft by NOAA's National Geodetic Survey (NGS). This effort will produce an accurate shoreline that can be monitored automatically with GPS technology. The statewide digital ortho-image program offers a mechanism for developing the technical maps. The Commission recommends that the state, in conjunction with federal agencies, prioritize mapping upgrades especially for coastal erosion-prone areas. We also recommend that the state encourage NOAA to seek funding for this project so that decisions affecting communities are clear as to the orthometric heights, risks of flooding, and rates of coastal erosion.

In addition to pursuing the digital ortho-image mapping of Alaska, specific communities are in need of more detailed geologic and hydrologic mapping, including geophysical hazard mapping, in order to define the adequacy of the local terrain for adapting to coastal and riverine erosion and permafrost thawing. Specifically, the state should provide adequate resources to the Division of Geologic and Geophysical Surveys (DGGS) in the Department of Natural Resources, to coordinate state-federal engineer-ing surveys of potential evacuation routes, village relocation sites, and material sources, including gravel and armor rock. This coordinated effort will insure that sites will prove sustainable and can optimize local resources in a cost effective manner.

Efforts by NOAA's Center for Ocean Observations and Prediction have enabled National Water Level Observation Network (NWLON) stations (tide stations) to be increased in Western Alaska, with recent stations established at the Red Dog dock (Kotzebue-Kivalina area), Village Cove on St. Paul Island (Pribilof Islands), and Port Moller (Alaska Peninsula), support an understanding of sea levels associated with meteorological and oceanographic conditions in near real time. Such efforts are valuable in understanding changing sea levels and coastal inundation. Additional stations are proposed between Nome and Port Moller for Western Alaska and Bristol Bay, and at the Red Dog dock and Prudhoe Bay for Chukchi and Beaufort Sea measurements. These, though, are not now at a priority that will allow installation consistent with future Arctic

shipping interests or the needs for predictive tools in planning for coastal flooding and erosion.

THREATENED COMMUNITIES:

The Commission took a considerable amount of testimony from residents of small communities, including villages under threat of damage or demise due to storm surge, river flooding, and severe erosion. We also made site visits in Barrow, Kotzebue, and Kivalina. Some communities have been working on village relocation for nearly twenty years.

In the Commission's view, perhaps the largest impediments in all of this appear to be lack of a unified vision toward goal achievement, little confidence that substantial funding will materialize, and concern for the ability to assist all similarly impacted villages to the extent that the first few might be helped. These lead to other problems evident in many relocation circumstances, including inadequate planning, differentiated authorities in decision-making among agencies, uncertain "first step" funding, and an inability to overcome certain regulatory conflicts in support of community relocation actions. These problems are most acute where relocation sites have not been agreed to, and impasses continue between residents and agencies. The Commission also recognized a concern for the use of funds needed to secure present village sites for public safety reasons, versus the lost opportunity of applying those funds to a new community site. Estimates for stabilizing or securing existing village sites ranges from to several to tens of millions of dollars per year without addressing the long term sustainability of each community.

In Kivalina, a community inspected by the Commission, the assessment of safety preparedness and successful adaptive measures in place for residents and village infrastructure, was not encouraging. Both immediate and long term planning are inadequate although improving, but decision-making among the action entities, including residents, are not coalescing adequately for the ultimate protection and relocation of this community.

Presentations by Newtok showed how the community has maximized the community planning process to identify a new village site and work with state and federal agencies to transfer ownership, characterize the site, develop an infrastructure plan, and begin limited relocating of village assets. Funding of the relocation remains a major challenge as the weakening of the permafrost and subsidence of the Newtok village site makes the relocation inevitable.

Presentations by other communities, including Shishmaref and Koyukuk, show progress on providing protection against coastal erosion and flooding while developing evacuation and relocation routes. In the case of Shishmaref, experimental shoreline protection using armor rock is being evaluated by the

U.S. Army Corps of Engineers (COE) while the relocation to Tin Creek, including gravel source and relocation route, is developed.

As many as twenty other Alaskan villages may suffer from similar strategic short-comings. The Commission recommends exploring the large mine decision-making process used in the Department of Natural Resources as a structure for advancing the goals for successful village relocation projects. Another recommended model may be that of the former Alaska Land Use Council under ANILCA.

Given the breadth of impacts and the unique ownership status of Alaska, these are Federal-State-Native cross-cutting issues. Alaska has employed the Alaska Land Use Council in the past. The State of Alaska has the capability, partially established in the Denali Commission, partially with the COE, and partially within the U.S. Departments of Interior and Transportation. The Commission recommends that appropriate Memorandums of Agreement be developed to establish a point of leadership on behalf of village relocation projects in the state.

NATURAL RESOURCES:

RESOURCE DEVELOPMENT IMPACTS:

Natural resource development in the oil & gas and mining sectors remains an important part of Alaska's economy. Oil and gas development in Alaska has already been impacted by climate change. As the Alaska Department of Natural Resources (DNR) presented to the Commission, the number of days exploration can be carried out on the North Slope, the tundra travel season, steadily declined from near 200 days per year in the early 1970's to around 100 days per year in the early 2000's.

DNR's Division of Mining, Land, and Water, in conjunction with the U.S. Department of Energy, initiated the Tundra Travel Modeling Project which, with scientifically valid, peer-reviewed research, found ways to extend the season without compromising the environment. The success of that project, and continued research by the division and private sector explorers, will be crucial to continued oil & gas and mining developments in the Arctic.

In the broader context, changes in climate which impact natural resource development operations could manifest in several different ways:

- Changes in Soils (permafrost, active layer depth, slope stability)
- Changes in Sea Temperature (ice thickness, timing, and distribution)
- Changes in Weather patterns and severity (snow depth)

Changes in these physical parameters have the potential to result in changes, both positive and negative, in existing and proposed natural resource operations:

- Unexpected settlement damage to existing production facilities (-)
- Shorter operating windows for seasonal ice roads (-)
- Lower design ice loads for offshore and shore structures (+)
- Changes in fresh water availability (+ / -)
- Reduced ice gouge risks for offshore pipelines (+)

Private sector companies operating on the North Slope have already begun assessing the potential impacts of climate change on their operations and developing strategies to adapt their operations to a warmer climate. In addition to researching revised design specifications for future facilities, consideration is being given to potential modification of existing facilities to guard against premature settlement or erosion.

On the positive side, increased transportation opportunities in the Arctic, over the long term, may enhance the economics of resource development. Relatively cheaper water borne transportation, available on a more regular basis, could reduce the costs of delivering resources to market.

At this point, no near term changes to statute or regulations have been identified as crucial for adaptation measures in oil & gas and mining development in the state. In the longer term, as the natural resource extraction industries identify trends requiring adaptive measures, state agencies should remain flexible in their approach to regulation of the industry.

Climate changes in Southwestern, South Central, and Southeast Alaska are not outside the long term variability in the climate fluctuation. Each region will need additional research to identify trends and assess opportunities. Consideration for sustaining natural resources while maintaining resource development opportunities will need positive interpretation of existing data, and a strategy for future data collection.

Whether considering offshore development in the north Aleutian Basin, mines in the mineral-rich districts of the state, or pursuing forest resources in South Central and Southeast Alaska, providing the state with access to the best data will benefit resource managers and developers in finding solutions consistent with the approach to balancing the regulation of developers and the sustainability of the communities and resources involved.

FISHERY IMPACTS:

Commercial and recreational fishing are cornerstones of the Alaskan economy and the Alaskan mystique. The stocks are sustainable because of scientific study, and management regimes that insure responsible recruitment to the fishery, and appropriate escapement for replenishing the populations. Access is insured by the Alaska Constitution and includes a regulatory structure that is of the people and for the people.

These factors recognize the value of healthy habitat, variability in fish populations, changes in the efficiency of the harvest, and competition for the resource. Climate change is being documented as a factor in changing distribution patterns and ranges, in periods of the runs, and in the species mix harvested as catch and bycatch. To address these, the State of Alaska should continue on its present course of action with strong interagency and state-federal management, while interjecting a precautionary approach that reflects the current stock assessments and trends. In this precautionary approach, however, data will be essential to:

- Manage boundaries and seasons opened and closed to fisheries to optimize the catch and minimize risks to stocks and fishermen.

- Show that stream flows, water quality, ocean currents, and ice cover are changing the habitats and directly affect the fish and fishery, whether in our marine fisheries or our anadromous fisheries.

- Optimize economics of the fishery over the long term and allow for a flexible management regime to sustain the fishery while yielding revenue to the fishermen and taxes to the state and federal governments.

- Address species and ecosystem shifts where increases in predatory fish may be lowering harvest levels of preferred finfish and shellfish.

- Understand the near term and long term ramifications of ocean acidification on predator/prey relationships and particularly the survival of calcium dependent shellfish and zooplankton.

- Document the distribution and growth of invasive species in Alaskan waters, either as predators in bio-fouling or niche replacement, or as pathogens affecting the lifecycle of the species or the public health aspects of consuming seafood.

In this light, public education and outreach will need to be an integral part of communicating risks and opportunities with climate change in Alaska. Addressing the climate change impacts on our fisheries will take monitoring and assessment programs, and funding as new questions arise.

An excellent example of addressing the changes can be found in the fishery management policy process in the northerly range extension of salmon into the Arctic, and the northerly extension of walleye pollock to the northern Bering Sea. Recognizing the trends in 2004-2005, the North Pacific Fishery Management Council has begun to develop an Arctic Fishery Management Plan that will provide a framework for future commercial fishing in the Chukchi Sea. Presently, the precautionary approach keeps the fishery closed while scientific data can be collected and assessed. Through the fishery management policy process, a rational public process will lead to decisions that will sustain the fishery and the industry, and allow for optimal use of the resource within federal and state mandates.

FORESTRY and WILDFIRE IMPACTS:

The mean annual surface temperatures in Alaska are increasing, most notably on the Alaskan North Slope. With rising temperatures, changes in precipitation and increased evapo-transporation are to be expected, as well as continuing permafrost degradation. This results in reduced water availability, such as a net decrease in stream discharge, and a dryer environment with long-term drought potential. These conditions have already been observed as impacting the northern birch and spruce forests, and yellow cedar in the Southeast. Under climate warming assumptions, boreal forests may be expected to see decreased tree growth because of warmer temperatures and reduced water consumption. With probable continuation of these conditions, tree mortality would spread, and conversion to non-forest ecosystems would eventuate.

Climate scientists and other professionals have indicated that the increased frequency, intensity, and scope of suppression activity for wildland fires in Alaska is associated with climate warming. In the past five years, Alaska has experienced record-setting fire seasons, with considerable increases in agency expenses. In 2004 and 2005, the total spent was $95 million, far over budget.

Indirect impacts and expenses occur when smoke from wildfires pervades urban and rural areas alike. Respiratory illnesses increase, and the public health community becomes more involved. Also, a combination of wildfire events in concert with a greater number of homes and infrastructure built in wooded and rural areas, raise costs to citizens and the private sector. These conditions, likely to increase, necessitate a review at the community and borough levels for zoning and land use changes. Consideration must be given to the prospects that eventually, not all structures and properties may be protected by wildfire suppression services.

EROSION, FLOODING, ENGINEERING:

Erosion and flooding are fundamental issues that impact as many as 162 communities in Alaska (USACE, 2007). Technical evaluations have identified nine communities as Coastal Erosion Communities and ten communities identified for Comprehensive Assessment. An additional 143 communities are identified for interviews for Erosion Assessment. This effort will provide a basis upon which additional decisions can be made under the guidelines provided in the Alaska Village Erosion Technical Assistance Study (USACE, 2006).

These interviews are ongoing, with 20 additional communities to be interviewed in 2008. Given the importance of understanding the potential damage to Alaskan communities, the completion of these interviews should remain a priority, with state participation in the review of findings to assess risks and determine the priority of mitigation needs and adaptation options. To accomplish this, the State of Alaska should join in a timetable with a commitment of staff and resources that will allow effective assessment and planning for meeting adaptation and mitigation measures so as to reduce emergency expenditures.

Determining the risks to communities and infrastructure depends on having accurate environmental models that build upon the changes in climate and ocean conditions. A significant data source for determining risks for engineering in flood plains is the *Precipitation Frequency Estimates* (PFE) of the National Weather Service (NWS). In Alaska, the data is no more current than the 1963 and 1965 NWS Technical Papers 47 & 52, and does not reflect present conditions or observations from the last decade. This is a particular shortcoming relative to the seasonal flooding events in South Central and Interior Alaska, and the significant drying of tundra on the North Slope.

It would benefit the State of Alaska and the 162 communities being assessed for potential risk of flooding, to have updated PFE's for assessing the risks to communities and infrastructure. To accomplish this, the state should endorse efforts by the NWS (Alaska Region), in securing funding for a 2008 update for Alaska.

The melting of the Arctic ice cap and late freeze up of coastal ice are two of the most significant indicators of the impact of global warming on Alaska. The trends have been well presented in the Arctic Climate Impact Assessment (2005), State of the Arctic Report (2006) and the Arctic Report Card (2007). With decreased coastal protection from ice, coastal erosion in the Bering, Chukchi, and Beaufort Sea communities has increased, and the loss during specific incidents is well documented. Storm frequency and wave energy models are being developed through the University of Alaska, Fairbanks

to support engineering decisions (Atkinson, 2007). Research efforts by the U.S. Army Corps of Engineers, NOAA's PMEL, the Arctic Research Commission, and the University of Alaska should continue to be supported so that the rate of change can be monitored and included in models, forecasts, and engineering studies. To accomplish this, the State of Alaska should endorse efforts by federal agencies to continue research into changes in the Bering, Chukchi, and Beaufort Seas' oceanographic and sea ice conditions, and to have the information made available for forecasts and risk assessments.

Comparably, establishing an accurate vertical datum for Alaska, particularly the coastal zone of the Bering Sea from Bristol Bay north, and the Chukchi and Beaufort Seas, would provide a coastal datum reference for determining shoreline change. The vertical datum would establish the orthometric heights relative to the ellipsoid height measured by GPS. In conjunction with the accurate horizontal datum as established by GPS, this would allow accurate determination of the shoreline and determine direction of water flow and potential risk of flooding from GPS-controlled topography and bathymetric mapping.

To complete this, coastal mapping in Alaska needs to be expanded. A proposal to map the gravity field of Alaska's Littoral Regions (excluding the Aleutians) with airborne gravity sensors and topographic lidar is in draft by NOAA's National Geodetic Survey. This effort will produce an accurate shoreline that can be monitored with GPS technology.

To accomplish this, the State of Alaska should prioritize mapping in coastal erosion-prone areas and guide the NOAA NGS on project planning for combined gravity measurements and lidar topographic mapping. The State of Alaska should encourage NOAA to direct funding to this project in order that decisions affecting communities can be made with a clear understanding of the orthometric heights and risks of flooding and rates of coastal erosion.

Recent efforts by NOAA's Center for Ocean Observations and Prediction have enabled National Water Level Observation Network (NWLON) Stations, tide stations, to be increased in Western Alaska, with recent stations established at the Red Dog Mine dock (Kivalina area), Village Cove on St. Paul Island (Pribilof Islands), and Port Moller (Alaska Peninsula). These support an understanding of sea levels associated with meteorological and oceanographic conditions in near real time. Such efforts promote safe navigation, understanding storm surge, and coastal inundation. Additional stations are proposed between Nome and Port Moller, and between the Red Dog Mine dock and Prudhoe Bay for Chukchi and Beaufort Sea measurements.

However, these are not consistent with anticipated Arctic shipping interests or the need for predictive tools in planning for coastal flooding and erosion with storms and storm surge. To accomplish this, the State of Alaska should identify the transportation and public safety needs in terms of a complete NWLON station network that supports the coastal Bering Sea communities between Port Moller and the Beaufort Sea. The State of Alaska should encourage NOAA to establish a timetable to install the NWLON stations consistent with the transportation and public safety needs.

In the Aleutians East Borough, a region where we did not hold public hearings, residents in Nelson Lagoon observe that erosion has increased noticeably in the last six to eight years. According to the borough manager, this is due to later and lighter freeze-up activity, which has historically served as a buffer to fall and winter storm-related tidal encroachment. This is not unique or unprecedented as all areas on the north side of the Alaska Peninsula are susceptible to erosion and coastal flooding associated with strong winds and lack of sea ice protection.

However, as with other areas better documented, the dependence on anecdotal data and lack of physical measurements make the estimates of impact and coastal change marginally accurate at best. This is particularly true if few state or federal disasters have been declared in the area. And without impacts to physical structures or limitations to navigation, the impacts to the environment and ecology can not be assessed. The State of Alaska should encourage community involvement in coastal management plans to develop a pictorial history and anecdotal data base of environ-mental and ecological changes that support local concerns, including subsistence and sustainability.

ENGINEERING FOR ADAPTATION:

Alaska is a land of extremes, and successful engineering solutions must address these extremes, often without the benefit of refined regional codes of practice and extensive data common to areas with longer histories. Alaskan tides vary from one to forty feet, and the presence of ice and/or permafrost is common. Waves, currents, variable soils, and other terrain features offer complex combinations in the tidal and riverine zones. A tour down the Trans-Alaska Pipeline System corridor crosses every kind of climate variation, terrain feature, and complex engineering challenge Alaska has to offer.

According to the Institute of Social and Economic Research at the University of Alaska, Anchorage (UAA-ISER, Larson et al 2007), both temperature and precipitation will continue to increase in Alaska. Adverse climate change conditions could make the cost of building and maintaining public infrastructure 10% more expensive, or greater, by the year 2030. Public infrastructure includes federal, state, and local facilities which serve society:

Bridges, roads, buildings, schools, airports, harbors, docks, sanitation systems, power generation & transmission facilities, fuel tank farms, post offices, the Alaska Railroad, and the like. Private facilities are likewise vulnerable to significant climate change. With well over 300 communities in Alaska, UAA-ISER has identified 16,000 separate elements of public infrastructure that are affected by changes in climate.

Unusual warming conditions will affect our infrastructure situated in places where flooding, erosion, and permafrost damage are most acute. According to UAA-ISER, this will mean accelerated degradation of roads, runways, and water-sewer systems, which are particularly vulnerable to these adverse conditions. There may be some offsetting benefits as warming trends might lessen the eventual damage to facilities designed and engineered for the change, however, in the near term, damage to older infrastructure designed for colder conditions, will be more substantial. As sea ice recedes and marine transportation routes open up, the cost of building materials in Western and Arctic Alaska will be reduced.

Improved engineering strategies and techniques are vital adaptation responses to this increasing challenge. Competitive and dynamic engineering practices have the potential to reduce incremental cost estimates associated with climate warming in the Arctic. The success of engineering projects is not strictly related to project costs. Expensive engineering structures have failed considerably sooner than the expected service life of the project in question. The Commission took testimony and inspected sites, notably at Kivalina, where failed design and construction strategies cost millions, failed to protect citizens, and perpetuated threats to other village infrastructure.

By taking action to find the best new techniques, aggressively engaging in research and development, and by establishing a peer-review process, the state can have a strategy to develop hazard-resilient public infrastructure, and reduce financial loss due to premature failure. The Commission supports development of engineering standards that reflect this strategy. Standards should be developed in conjunction with other public and private entities engaged in Arctic engineering to assure use of the best available design, material, and engineering applications.

"Best practices" must be reflected in all requests for engineering proposals submitted to the state. The state may then institute an oversight peer-review panel to ensure best practices applications. Greater emphasis must be placed on suitable Arctic or Sub-Arctic professional experience. The Commission also recognizes the need to expand the network of monitoring stations throughout Alaska, both terrestrial and marine observing stations. Engineers here work under conditions of relatively severe climate change

impacts, yet have a much less substantial system of monitoring stations than any other state. An improved knowledge base reduces risky guesswork in the design process, and reduces project costs.

Alaska enjoys a wealth of cold regions expertise in engineering and research. Engineering challenges in a time of climate warming call for many more engineering graduates from our university system than can presently be managed, including those in graduate programs. The University of Alaska should be encouraged to continue expansion of its existing programs to meet this demand. Among those institutions at the forefront of Arctic engineering in Alaska (in addition to the University of Alaska), are the Cold Regions Research and Engineering Lab and the Cold Climate Housing Research Center. The Commission supports the work of these, and public research entities such as UAA-ISER, and the U.S. Arctic Research Commission.

STATE and OTHER AGENCY CONSIDERATIONS:

SUB-CABINET FOR CLIMATE CHANGE:

Recognizing the threats climate warming brings upon Alaska, the Governor issued Administrative Order 238 in September of 2007, establishing the Alaska Sub-Cabinet for Climate Change. Its chief purpose is to advise the Governor on the preparation and implementation of an Alaska climate change strategy. It currently has five working subcommittees, and will soon form advisory and technical working groups. Chairman of the Sub-Cabinet is the Commissioner of the Department of Environmental Conservation. Sharing inherent responsibilities for the State of Alaska from the perspectives of two branches of government, the Sub-Cabinet and the Commission have worked closely together to develop a state strategy to best address responses.

STATE AGENCY IMPACTS:

The Commission approached seven departments of the state government to ascertain their perceptions and identifiable experiences of impacts under climate warming conditions. A few state officials had testified to the Commission in 2007. Those state departments considered most likely impacted by climate change are the Alaska Departments of Commerce, Community, and Economic Development, Environmental Conservation, Fish and Game, Health and Social Services, Military and Veterans' Affairs, Natural Resources, and the Department of Transportation and Public Facilities.

Generally, the Commission feels that we are early in the period of climate change understanding when it comes to determining precise budget impacts and service delivery changes by state government. State agencies were mostly speculative or suggestive in describing budget impacts, but with

the elevation of climate change awareness and impacts now reaching program management levels, the Commission is confident that the Sub-Cabinet for Climate Change can pursue an agenda for long term action. As has been noted throughout this report, this recognition underscores the need for data collection and monitoring activities. Highlights of the affected state agencies' responses follow, and complete responses may be found at Attachment F.

COMMERCE, COMMUNITY, and ECONOMIC DEVELOPMENT:

DCCED leads the effort on behalf of communities most immediately threatened by flooding, erosion, and storm surge - Kivalina, Newtok, Shaktoolik, Shismaref, and Unalakleet. Other villages are in varying degrees of less-threatening circumstances. State funding is considered essential to attract meaningful federal funding for helping these villages. The agency specifically recommends a statewide comprehensive management plan for a framework of response to climate change threats.

A host of other departmental responsibilities are seen for small communities, certain types of infrastructure, subsistence resources, commercial fishery financing and permit values, investment portfolio collateral, and certain insurance issues, including the National Flood Insurance Program (NFIP). DCCED contains the Division of Insurance, the Alaska Industrial Development and Export Authority, the Alaska Energy Authority, the Office of Economic Development, the Division of Community Advocacy, and the Division of Community and Regional Affairs.

ENVIRONMENTAL CONSERVATION:

In addition to providing leadership and staff support to the Sub-Cabinet for Climate Change, DEC has direct responsibility for a host of climate change impacts, including flooding and erosion threats to community infrastructure such as water and sewer systems, marine spill prevention and containment, air quality issues related to wildfires, newly anticipated food-borne pathogens, fuel delivery, storage, and power generation facilities threatened by erosion and flooding, water quality standards for warming estuaries and fresh water habitat which support fisheries, and more. DEC is also the state's action agency for anticipated carbon-reduction mandates from the federal government.

In the longer term, the department perceives greater incidents of exposure of old military, community, and industrial landfill sites due to permafrost degradation, encroachment of surface waters, and manmade system failures, as well as with increased risks of oil spills and marine vessel accidents in the Beaufort Sea / Arctic Ocean. DEC also speculates that certain Congressional actions could positively affect market demands for Alaska natural gas, clean fuels from coal, and may enhance the attractiveness of renewable energy alternatives.

FISH and GAME:

The department carries substantial responsibility for commercial and sport fisheries, subsistence activities, sport hunting, a wide-ranging regulatory program, wildlife conservation, and manages considerable research and monitoring activity.

F&G perceives threats to commercial, recreational, and personal use fisheries under climate warming assumptions. A host of new regulatory provisions may be needed to address migrating fish stocks, harvest limits, commercial entry, ocean acidification, loss of stock due to increasing natural predation, and parasites. Under some assumptions, fish tax revenues, for both the state and local communities, may see reductions.

F&G also recognizes impacts to Alaska's wildlife and bird populations. Changes in species distribution and behaviors would necessitate changes in management plans and harvest limits. Habitat may likely be threatened by invasive plant and animal species, increased wildfires, flooding, changing weather patterns, and erosion. As with fisheries impacts, increased monitoring and research strategies would be vital in support of management needs.

HEALTH and SOCIAL SERVICES:

Identified areas of significant impact within the Health and Social Services Department focus on respiratory illnesses, air/food/water-borne diseases, adverse dietary changes due to a reduction in subsistence provisions, increased participation and costs associated with food assistance programs, and accidents due to negotiating changing weather and ice conditions. Rural water and sewer systems, vulnerable to permafrost melt, increased flooding and erosion, imply greater demands on outbreak response and mitigation activity. Several agencies within the department would have responsibility to address impacts brought about by climate change activity.

MILITARY and VETERANS' AFFAIRS:

The Division of Homeland Security and Emergency Management (DHS&EM) is the primary agency within the Department of Military and Veterans' Affairs which confronts perceived impacts from climate warming. Since 1978, the division has experienced 226 declared disasters, costing $378 million in state and federal funds. The division has observed an increase in community fuel shortage incidents, due to barge delivery impediments from weather-related activity. Fuel shortages potentially threaten life, public safety, and damage to public facilities. For riverine communities, successful fuel delivery is affected by water level, sand, and siltation matters. For coastal and island communities, the challenge is delivery in the fall prior to the storm

season. In any case, air delivery of fuel is considerably more expensive, less efficient, and impacts budgets at several levels.

Over the past sixteen years, the division has observed trends showing greatly increased costs for disaster response, coupled with a rising number of repair projects. Disasters occur due to erosion, often exacerbated by a lack of shore ice, storm surge, ivu (ice encroachment onshore), flooding, severe wind and rain, permafrost deterioration, and wildfires. All adversely impact Alaska's citizens, natural resources, public health, and the economy.

DHS&EM works extensively with the Federal Emergency Management Agency (FEMA), and has developed formal hazard mitigation plans with participating Alaskan communities. These agreements qualify as locally adopted FEMA plans, which will avail the local community of federal hazard mitigation funds. To date, Alaska has twenty-four approved plans, and fifty under development. DHS&EM is itself prevented from engaging directly in pre-disaster mitigation activity, due to the federal Stafford Act.

NATURAL RESOURCES:

Climate change impacts pervade most operations of the Department of Natural Resources (DNR). In the near term, DNR identifies a greater need for essential data to identify and monitor changes. LIDAR imagery and satellite data will identify trends in erosion, vegetation, and other surface changes in the geomorphology. Hazards mapping needs to be enhanced to track permafrost conditions, wildfire fuel sources, and other conditions which influence permitting and development actions in and near communities.

The department also identifies potential changes in its permitting and regulatory scheme, affecting energy exploration and other extraction development. A tundra travel season which continues to shrink has significant implications for industry, and the state. In the mining industry, tailings dams will need to be engineered and monitored to recognize changes in permafrost, precipitation patterns, and other hazards. DNR also concerns itself with the stability of the Trans Alaska Pipeline (TAPS) in terms of its heat pipes and possible permafrost degradation below support structures.

Within the department's Division of Agriculture is recognized a potential for increased commercial production of food sources, such as grains and vegetables, under a climate warming assumption. However, with that would come increased invasive pests, weeds, and plant diseases, all of which would require control or containment measures.

TRANSPORTATION and PUBLIC FACILITIES:

Most activities within the Department of Transportation and Public Facilities (DOTPF) are or will be impacted by climate change, most notably planning, design, engineering, construction, and maintenance & operations activities. In the maintenance & operations area, the department has confronted changing permafrost conditions for decades under infrastructure throughout Southwest, Northern, and Interior Alaska. According to DOTPF, its maintenance & operations costs average $10 million annually to address the impacts of permafrost on the highway system, and does not adequately address the entire needs base.

The department has not systematically studied the need for, or implemented specific changes to policy or regulations relative to climate change, nor does it have pertinent data upon which to base such changes. DOTPF does not have a mechanism available to identify costs strictly assignable to climate change factors. It has, though, undertaken an assessment of the possible future effects of climate warming trends on its mission. Among their findings:

~ Longer seasonal transitions, fall to winter and winter to spring, may mean a more costly approach to snow and ice control, and lead to changes in roadway weight restriction policies.

~ Degrading permafrost may increase highway and runway integrity, and imply greater maintenance and capital expenditures.

~ Airports in Western, Northern, and Interior Alaska, built over permafrost, would need rehabilitation, reconstruction, and relocation at a greater rate.

~ State buildings in the same regions would be vulnerable to the same needs.

~ Increased avalanche, flooding, erosion, and debris flow would require a greater M & O response, and additional funding.

~ DOTPF assets and facilities in coastal areas prone to flooding and storm surge would need to eventually be relocated along with communities.

DOTPF is currently assisting several communities significantly impacted by conditions associated with climate warming. There are active projects currently in Kivalina, Newtok, Kotzebue, Nome, Unalakleet, Shishmaref, Noatak, Allakaket, and Alakanuk.

DOTPF sites the need for increased data collection for stream flow records, precipitation and other weather-related data, geotechnical and foundation data, hazards mapping updates, and other hydrologic data.

OTHER AGENCIES:

The Commission recognized a greater need for interagency action among state and federal agencies, almost exclusively where threatened communities are struggling with relocation issues. These problems, while recognized as serious, dwell somewhere between routine matters and pure emergencies. The Sub-Cabinet for Climate Change is reaching a level of activity to address the state element of this equation, being officially in existence for less than a year now. As the State of Alaska becomes more involved in relocation matters, it will join the U.S. Army Corps of Engineers (COE) and the Denali Commission, among others, in continuing to address these considerable challenges.

In the opinion of the Commission, major obstacles in this arena appear less a function of management intent and capability, than with various agency authorities and missions. While we heard frequently of a desire to establish a centralized, command-style dynamic for major decision-making, such does not appear possible without changes in various federal charters, and of course, the funding to accommodate new responsibilities.

The Denali Commission, a federal-state partnership designed to provide critical utilities, infrastructure, and support for economic development, delivers federal services throughout the state. Congress mandated that new and innovative solutions be found to address these unique challenges, and that includes consideration for the impacts of climate change. While the Denali Commission does not have a direct mission in coastal and river flooding and erosion, it does have a mission to protect infrastructure, and it has been participatory. In its estimation, responding to broader threats to vulnerable communities will require alignment of state and federal policies.

The Commission found that state agencies are dependent on federal services and data bases. These services, including weather, engineering, census, resource assessment, fire suppression, and insurance, have not had adequate funds to fully meet federal mandates, particularly in their base programs. The Commission recommends the state work with federal agencies to ensure that adequate funding is available to provide services in Alaska consistent with services in the other states. This would include updating networks for data collection so that they provide adequate information to understand potential climate change impacts. Planning the appropriate adaptation strategy for areas at risk, e.g. Western Alaska and the North Slope, would then follow.

RESEARCH and MONITORING:

OVERVIEW:

The research factor throughout the array of climate change issues, has positive implications for Alaska. Research activity and the funding it brings to the state are of considerable significance to the University of Alaska (UA), other entities, and therefore, the economy in general. UA refers to research as the "silent giant," which provides nearly 2,400 jobs and a $92 million payroll. Active UA research exceeded $151 million in value in 2006, nearly all of which is new money into the economy. The Commission perceives a healthy continuation, even expansion of research activity throughout the state and its proximity, as a direct result of a warming Arctic climate. Other indirect benefits of research activity will continue beyond the academic community, as well.

The Commission has identified a need to better communicate, manage, coordinate, and disseminate the aggregation of research projects among institutions in Alaska. A central project and/or data inventory source would be beneficial to effective and efficient research planning. The Alaska State Research Committee should be supported in pursuit of this undertaking.

Global climate models have projected that the Arctic is an area where changes to the climate may be the largest in the world. The models predict a greater warming for the Arctic than the rest of the world. Alaska, as part of the Arctic, is already experiencing dramatic climate change. Observed data indicate that over the last 50 years, mean annual surface temperatures have increased 3-5 ˚C with some of the largest increases occurring along the Alaska North Slope. The extent of Arctic sea ice reached an all time low in September 2007, shattering the previous record in 2005 by 23 percent. It was also 39 percent below the long-term average from 1979 to 2000.

Additionally, winter freeze up and spring melt conditions are now arriving more than three weeks later and earlier, respectively. The waters around Alaska are showing an increase in sea level. On land, an increased seasonal thaw depth of the active layer is causing accelerated permafrost thaw. There is increasing evidence of changes in storm frequency, intensity and shift in storm track. These observations all point to climate change occurring now and that change is affecting weather patterns. There is a greater incidence of aviation icing conditions especially along the coasts of the Bering and Chukchi Seas. There are more frequent high amplitude weather episodes such as mid-winter “break ups”; heavy precipitation causing local flooding; low water events affecting river transportation and subsistence; episodic high wind events; more variable weather affecting moisture conditions resulting in the greatest wildfire season (6.5 million acres) ever, in 2004. Alaskan coastal ecosystems also continue to be threatened by natural and manmade coastal hazards, including

tsunamis, earthquakes, volcanic eruptions, severe (including hurricane force) storms, harmful algal blooms, invasive species (including pathogens) and oil spills, among others.

Temperature and precipitation trends are two essential climate variables that most directly influence the Arctic region and impact a wide range of societal and environmental factors. Significant physical characteristics readily measureable and monitored are sea ice, sea surface temperature, sea level change, and the thawing of the permafrost and melting of glaciers. Changes in these characteristics present opportunities and challenges to people and ecosystems.

Less sea ice will cause shifts in the migration patterns of marine mammals, as well as the productivity of fish stocks and other levels in the marine food chain. Open coastal waters already have resulted in extensive and rapid coastal erosion as experienced at Shishmaref, and threaten other coastal Alaskan villages. In the past twelve months an area of the Alaska North Slope experienced as much as 100 meters retreat of the coastline due to wind driven wave erosion. Storm surge, and to a lesser extent sea level rise, increase the extent of coastal inundation and threatens coastal ecosystems and infrastructures.

Permafrost thaw has affected terrestrial and coastal marine environments and threatens overland transportation routes through the collapse of the ground surface, draining of lakes and wetlands, toppling of trees, collapse of structures in susceptible areas, and accelerated coastal erosion in certain locations.

The Alaska Ocean Observing System (AOOS) provides a template for maximizing the data collection among various ocean-oriented federal and state agencies. To improve access to the monitoring data, the State of Alaska should work with federal agencies to insure the AOOS program is fully supported with instruments and deployment plans appropriate for the remote locations particularly in the northern Bering Sea, and the Chukchi and Beaufort Seas. Given the above observations, especially in the marine environment, the Commission recognizes the following research and monitoring priority needs:

<u>COORDINATION AND COLLABORATION:</u>

Many agencies, universities and individuals are currently conducting research or monitoring activities relevant to climate change and its impacts in Alaska. A number of coordinating forums currently exist whose mission is to share current and planned projects relating to climate change: the Alaska Marine Ecosystem Forum, the State-Federal Climate Change Roundtable, the Alaska Ocean Observing System, and the Governor's Sub-Cabinet on Climate

Change. The Commission recommends that the State of Alaska review these initiatives and consider how to better coordinate state, local, federal, university, and private activities in order to maximize the benefits of these efforts and minimize duplication.

DATA MANAGEMENT:

Many of the entities described above are currently conducting research or monitoring activities relevant to climate change and its impacts in Alaska. Yet we lack a comprehensive inventory of data management archive and access locations for observations, data, and information. We also lack a central web-based "gateway" to easily access Alaska/Arctic projects, data, and information. There are some initiatives currently underway such as the Alaska Marine Information System for ocean and coastal information, sponsored by the Alaska Ocean Observing System, the North Pacific Research Board, and the Geographic Information Network of Alaska. The Commission recommends that the primary state and federal data providers develop a consensus process and system for archiving and accessing climate change data in Alaska that is integrated and interoperable with other data across the nation and globe.

IMPROVED OBSERVATIONS OF WEATHER AND OCEAN CONDITIONS:

Over half of the coastline of the U.S. is in Alaska. Within this challenging environment, the Alaska marine transportation system continues to grow and expand. Receding sea ice has begun to open up these waters to commercial and recreational interests. New sea routes, development of oil and gas resources, and increased tourism will all require an increase in the need for the best weather and ocean information available.

Existing coastal observations in Alaska are inadequate to support existing and future local, state and federal agency resource management, marine transportation, emergency response, and public health responsibilities. These include observations of basic physical and biological parameters such as winds, waves, currents, temperature, salinity, nutrients, acidification, contaminants, and invasive species. Research scientists require adequate quality and number of observations to monitor the present rate of change. Applied scientists need access to more observations and improved models to assist in the daily operational monitoring and generation of forecasts for use by the public.

Recent real world observed changes in the Arctic region indicate the projections of current models are in some cases not adequately forecasting the recently documented rate and extent of change. Typical historical observations and conditions are no longer proving to be a solid basis for plausible future projections and predictions. The Commission recommends that the state work with federal agencies to inventory current observing systems that can

contribute to measuring and monitoring climate change trends across Alaska and the adjacent marine environment. Also, we would support developing a plan to close the critical observational and modeling gaps to improve monitoring of change across Alaska through timely analysis of new observations linked to the historical observational records.

In particular, we recommend that the state work to increase the number of weather buoys and stations, climate reference network stations, tide and river gauges, sea ice radars, high frequency radar, and other ocean observing platforms. We need to develop forecast models (weather, wind, wave, and ocean circulation) to better support Alaska's communities and commercial operations.

IMPROVING SEA ICE FORECASTS:

Recent events have highlighted the importance of accurate sea ice forecasts. Improving these forecasts requires two major research components. First, since existing forecast models use multiyear sea ice concentration as a proxy for ice thickness, a comprehensive program of airborne measurements of sea ice thickness to integrate into forecast models would significantly increase the accuracy of these models. Increased precision measurement of sea ice thickness is viewed as one of the top priorities of the sea ice research community. Monitoring the Freezing Index, which is important to the engineering community among others, is also a necessary component of improving sea ice forecasts.

The second component is creation of a sea ice climatology database, or atlas, which would provide a complete and accurate historical record, essential in making timely and accurate decisions, and forecasts of Arctic sea ice. Such an atlas would integrate knowledge from the indigenous people, empirical observations, human analyses, as well as remote sensing tools.

A need exists to develop and implement a data mining application to sift through large amounts of data to produce data content relationships, and extract hidden patterns in the Arctic seas database. Then, developing a scalable, interactive Decision Support System (DSS) that integrates all Arctic sea ice-related resources in a systematic fashion would be necessary. No DSS exists to assist those with Arctic interests, to make consistent, informed decisions that affect safety of navigation, the economy, resource management, and ecosystem protection. Without a comprehensive sea ice database, atmospheric, oceanographic, ocean circulation, and ice model forecasts cannot be validated properly. Such a database would allow the U.S. to implement a methodology to categorize ice regimes in a consistent manner such as the method used by the Canadian Coast Guard for decisions on passage of ships of a certain ice class.

We encourage the State of Alaska to work with the appropriate federal agencies and research entities to implement a sea ice thickness measurement program and to develop an Arctic sea ice atlas that would establish Arctic sea ice trend analyses for the Bering, Chukchi and Beaufort Seas. This would also provide a baseline for understanding climate change and its potential impact on the Arctic ecosystem and Arctic commerce to include data and information prior to the advent of satellite imagery. The Commission supports ensuring Synthetic Aperture Radar image availability in order to continue monitoring sea ice extent.

IMPROVED AVIATION WEATHER OBSERVATIONS:

While pilot fatality rates in Alaska have decreased 51% during the period 2000-06, they remain well above the national average. The old weather paradigms that guided much of Alaska's air traffic are no longer reliable. The need exists to continue the reduction in the number of fatal aircraft accidents in Alaska through 2015 by providing more accurate forecasts and warnings delivered to aviators in a format which best meets their needs. Specifically, we should pursue the acquisition of additional weather data, to include additional weather radars, meteorological satellite information, expansion of Tropospheric Airborne Meteorological Data Reporting (TAMDAR) systems, and support of the Arctic Observing Network (AON) projects.

TECHNOLOGY (UAS, GLIDERS, AUV, AIS, HF RADAR, SATELLITE SERVICES):

Routine monitoring of key atmospheric, ice, and ecosystems conditions is very difficult in the Arctic. Frequent cloudiness, long intervals without daylight, extreme temperatures, and weather conditions – these are all part of Alaska's conditions. Current observation systems are not adequate to detect the full suite of changes that are underway. For that reason we recommend that 21st Century science and observations be applied to address these changes. The Commission recommends that the University of Alaska develop a plan to test and implement in the Arctic, new technology that is being developed elsewhere, including unmanned aircraft systems (UAS), gliders and remotely operated vehicles for underwater research, automated information systems and high frequency radars. In addition, we recommend that a program be implemented to test the potential of ocean and tidal energy in Alaska.

COMMERCIAL FISHERIES RESEARCH:

Robust and sustainable fisheries are critical to Alaska's commercial and subsistence economies. Projected warming of the marine waters off Alaska, particularly in the eastern Bering Sea shelf region, could profoundly alter ecosystem structure by changing energy pathways and the spatial distribution and species composition of fish, seabird, and marine mammal communities. Climate-ocean conditions could impact the abundance and distribution of

commercial and subsistence fisheries and influence how fisheries are conducted and their economic viability. With potential impacts due to climate change, these questions arise:

a. For commercial fishermen, will these changes lead to: (1) a change in home ports and distribution of fishing vessel rents, (2) vessels traveling further, incurring greater fuel costs and peril at sea, and (3) greater burden on smaller vessels?

b. For subsistence users, will these changes lead to: (1) greater reliance on owners of larger vessels that can travel farther to harvest and distribute subsistence goods, (2) decreased consumption of species with decreased local abundance, and (3) adoption of new species into the diet as these species colonize local areas?

Will changes be needed in current management strategies for fish, seabirds, and marine mammals to accommodate changes in population

c. abundance and range? What will be the impacts on endangered and threatened species?

d. Will pollock and other fish stocks move northward and thus closer to the US-Russia boundary and lead to more transboundary fishery management issues?

e. How will increased presence of Sub-Arctic species, particularly salmon, in the Chukchi and Beaufort shelf region impact oil and gas development?

Research is needed in the following areas:

a. <u>Basic Food Web Research</u>

Earlier ice retreat could result in later spring phytoplankton blooms and more energy flow through the pelagic ecosystem, and less to the benthic system. These climate-induced changes could modify the availability and partitioning of food for all trophic levels, thus impacting juvenile fish production and over-wintering conditions.

b. <u>Distribution of Species</u>

Fish reproduction, survival, and distribution all are influenced by climate and ocean conditions that impact water temperatures and circulation patterns, and in turn, the domain boundaries for various species.

c. Fronts and Other Prey-Concentrating Mechanisms

Climate and ocean conditions influence circulation patterns and domain boundaries that in turn affect the distribution, frequency, and persistence of fronts and other prey-concentrating features that act together to determine the foraging success of marine birds and mammals.

There presently exists very little information of fish species distribution, abundance, or habitat north of the Bering Straits. Biomass surveys must be undertaken to assess current fish and marine mammal species, their relative abundance, and their likelihood to change. Change agents include a loss of sea ice, increased water temperature, changes to upwelling and currents, and increased fishing activity.

Ship surveys must continue in the Bering Sea and Aleutian Islands regions to monitor shifts in migratory patterns of fish and marine mammal species. Researchers must produce products and services that can be used by managers and the industry to define the environmental baseline in these regions. The state should work with NOAA to start planning for scientific research in the Chukchi and Beaufort Seas. This includes establishing a network with coastal residents for purposes of collecting data and sponsoring joint US-Russia scientific projects.

NOAA Fisheries is planning a Beaufort Sea Marine Fish Survey for August, 2008 through collaboration with the Alaska Fisheries Science Center, the Universities of Alaska and Washington, and the Minerals Management Service. We should support the establishment of a regulatory regime (a Fishery Management Plan) that will prevent unrestricted exploration and exploitation of marine species until sufficient research has been conducted.

ECOSYSTEM EFFECTS:

Alaskan coastal ecosystems, include human communities, are experiencing changes associated with accelerating climate change and increasing coastal development, including offshore oil and gas activities, large-scale mines, and increased population. These ecosystems also continue to be threatened by natural and manmade coastal hazards, including tsunamis, earthquakes, volcanic eruptions, severe (including hurricane force) storms, coastal erosion, harmful algal blooms, and oil spills, among others.

Alaska's coastal managers need science-based information and decision support tools that are integrated across multiple disciplines. Little coastal ecosystem forecast capability exists in Alaska. Models need to be developed that help coastal managers better assess the risk of action or inaction on their part. Operational ecosystem modeling will ultimately require investments in

human and facility infrastructure to develop and run the models, as well as provide output products and services.

OCEAN ACIDIFICATION:

Approximately 30-50% of global anthropogenic CO_2 emissions are absorbed by the world's oceans. Increased CO_2 uptake by the oceans is expected to reduce surface ocean pH by 0.3-0.5 units over the next century, which would be the largest change in pH to occur in the last 20-200 million years. Ocean acidification reduces the calcium carbonate ($CaCO_3$) saturation point. Dramatic reductions in calcium carbonate saturation have been observed in the North Pacific since the industrial revolution, but the concern is that with warmer oceans, increased absorption of CO2 likely will impact the ability of marine calcifiers, such as corals and mollusks such as mussels, crabs, oysters, and clams, to make shells and skeletons from calcium carbonate. We recommend that the state support federal funding for an ocean acidification research and monitoring plan. This plan should include:

- Monitoring ocean pH using ships, moorings, fisheries and marine mammal surveys;

- Understanding processes of how high carbon dioxide levels affect calcification, respiration, reproduction, settlement, and re-mineralization in order to develop models to forecast the impacts of ocean acidification in Alaskan waters;

- Understanding whether/how well marine calcifying organisms can acclimatize to ocean acidification effects;

- Understanding how our important species (important for economic, social, and biological reasons) are likely to adapt to life in water that is more acidic than recent historic states; and

- Developing adaptive management techniques to mitigate impacts of Alaskan ocean acidification scenarios.

COASTAL INUNDATION, EROSION, TSUNAMIS:

Increased coastal erosion and inundation is related to the changing sea ice conditions resulting in later freeze-ups, earlier break-ups, and less multi-year ice, as well as possible increases in "storminess" (frequency and strength). Unlike the occurrence of many other weather hazards, each coastal erosion event creates a more serious situation for the next event that may come along, be it a day later or a year later.

NOAA operates 17 long-term continuously operating tide stations in the state of Alaska which provide data and information, relative sea level trends, and are capable of producing real-time data for tsunami and storm surge warnings. The Commission recommends development of coastal hazard assessments for coastal villages, as well as improved coastal flood warnings and high surf advisories. These would require accurate coastline maps, additional weather and ocean monitoring instruments (including tide gauges), more precise models to improve forecasts, and use of modern technology (Aerial Analysis, Lidar, GIS, modeling of storm surge and wave height, etc.), melded with routine village contact and ground-truth measurements.

PRECIPITATION FREQUENCY, RIVER FLOODING, FRESHWATER FLOW:

Alaska has 3000+ river systems, with over 90% of those currently unmonitored. All Alaskans rely on inland and coastal waterways in one or more ways, including but not limited to industry, transportation, food, potable water, energy, and culture. River systems provide important habitat for species important to subsistence and commercial interests. Moreover, coastal freshwater discharge plays an extremely important role in the marine ecosystems surrounding Alaska. Precipitation frequency and distribution is required for design and construction of infrastructure.

Presently, engineers are using an outdated precipitation frequency estimate for design of new structures. The Commission recommends increasing the number of rivers that are monitored or modeled to forecast water quantity. We also recommend using Geographic Information Systems, precipitation and flood frequency studies, new hydrologic and hydraulic models, and advanced remote sensing tools to develop new forms of gridded forecasts as tools for non-gauged areas. We need better research to understand how freshwater input influences ocean currents and properties and how these characteristics and interactions may be expected to change with various potential climate scenarios.

We recommend updating the presently outdated precipitation frequency estimate and using it as a baseline for monitoring climate change. The State of Alaska should meet with federal agencies to design appropriate regional climate service products for Alaska. Increased knowledge of this nature will provide the state and coastal villages with information necessary for village relocation projects due to hydrologic, glacial, or sea level threats.

The Alaska Department of Transportation and Public Facilities, boroughs, and municipalities benefit from long-term hydrologic monitoring by using these data to properly construct bridges, culverts, storm water collection and treatment systems, and other roadside drainage features. Undersized bridges

and culverts are prone to damage or destruction in floods thus requiring costly repairs. Undersized storm sewer systems can lead to unsafe driving conditions and ineffective storm water management. Oversized bridges, culverts, and other drainage structures have unnecessarily high construction costs. Furthermore, this same information can benefit zoning decisions, thus saving life and property by ensuring Alaskans are not building in a previously-unrecognized floodplain. Finally, a better understanding of Alaska's hydrologic processes will affect both freshwater and marine fisheries management.

PRECIPITATION, DROUGHT, WILDFIRE:

Observed data over the last 30 years show increases in annual surface temperatures, with some of the largest increases occurring on the Alaskan North Slope. As temperatures continue to rise, changes in precipitation and an increase in evapo-transporation are also expected and permafrost will continue to thaw. This may result in an overall net decrease in stream discharge and a net dryer environment with long-term drought issues which could influence the ability of barges to deliver supplies to those villages located on rivers.

On the flip side, headwater glacier areas are expected to see an increase in stream discharge particularly during the spring and fall months. This increase in temperature may also bring about longer, more severe and more widespread fire seasons in Alaska. Based on annual precipitation much of interior and northern Alaska can be classified as a desert, however due to the approximately six months of freezing temperatures that precipitation is only used by vegetation for the other half of the year. With an extended warm season, the water needs of the vegetation will expand as well and the available moisture may be insufficient.

The Alaska Department of Natural Resources has shown that they can mount a successful initial attack on a small fire with an average cost of $5,000 dollars per incident, whereas the cost to suppress a well-developed fire in Alaska generally ranges between $3 million and $30 million. We recommend research to develop better understanding and forecasts of hydrologic changes in Alaska and how these changes (such as the thawing of permafrost and extended warm seasons) impact such diverse areas as wild fire activity, industrial transport on water and ice, subsistence travel and harvest, and habitat and migration of wildlife.

The Commission further recommends that gridded hydrologic modeling be developed for Alaska, and the tools needed for near and long term drought forecasting be developed. We recommend integrating regional climate information and permafrost hydrology to produce hydrologic response scenarios, as well as improving weather and soil moisture forecasts. Precipitation frequency estimates (PFE) are a climate-related precipitation tool.

The PFE data are commonly used to reduce the risk of runoff-related loss of life and property, and to prevent pollution. They provide rainfall related criteria used extensively by the engineering and environmental communities for the design of structures such as sewers and drainage systems, for environmental studies and design, and for sediment control.

The criteria are used by the FEMA to update National Flood Insurance rate maps and by the Environmental Protection Agency's National Pollution Discharge Elimination System Program to regulate pollution control in streams. The statewide PFE data currently available for Alaska is contained in two reports by the Department of Commerce called Technical Papers 47 and 52, last revised in 1963 and 1965, respectively. NOAA's NWS recent updated analyses in the Lower 48 indicated differences up to 30% between the old and new estimates. The Commission recommends updating these estimates.

PERMAFROST THAW:

Transportation and infrastructure could significantly be impacted by permafrost thaw and glacial melt. Supply routes to remote inland towns are threatened where there are no roads for use in the summer, such as places dependent on ice roads and/or river-based resupply routes (too little precipitation or too much glacial melt). Roads already built might begin to deteriorate beyond use and lakes that supply water to create the "ice roads" may no longer be available, not to mention structural failure of buildings, etc. We recommend improving our monitoring and forecasting of permafrost thaw: where, how much, rate, etc. and rate of glacial melt. This would require expanding existing permafrost and river level/flow observing systems across Alaska and improved permafrost and hydraulic forecast models.

MAPPING:

Accurate shoreline maps are essential in order to develop accurate coastal erosion and storm surge forecasts. Accurate bathymetric (ocean bottom) maps are essential for mapping essential fish habitat, and developing more precise ocean circulation and wave models. We recommend that the federal government increase its program to conduct hydrographic surveys in Alaska to develop accurate bathymetric maps, and that the state and federal agencies develop a plan for a comprehensive shoreline map in Alaska.

FISHERIES RESEARCH PRIORITIES RELATIVE TO CLIMATE CHANGE:

a. Will earlier sea ice retreat result in a later spring phytoplankton bloom, increased coupling with zooplankton and greater pelagic production, and decreased benthic production?

b. Will reduced frequency and intensity of summer storms reduce surface mixing, increase stratification, and lead to nutrient depletion and less

phytoplankton production? Will this diminish zooplankton production and thus reduce juvenile fish production and survival?

c. Will an earlier spring transition change the flow along the Alaska Peninsula and thus transport larvae away from offshore piscivores?

d. Will increases in piscivorous fish species for forage species lead to a decline in fur seals, murres, and kittiwakes?

e. How will the food web be affected by increasing populations of humpback and fin whales that both consume and compete with forage fish for zooplankton?

f. Will Sub-Arctic species expand northward and occupy areas formerly occupied by Arctic species?

g. Will changes in the cold pool on the Bering Sea shelf remove the barrier to northward migration of various fish species, thus increasing the overlap of inner domain forage fish and outer domain piscivores?

h. How will potential changes in fish distribution, especially forage populations, impact other fish, seabirds, and marine mammals?

i. Will expected decreased benthic productivity negatively affect feeding and survival of small flatfish and crab and even bottom-feeding marine mammals such as walrus?

j. Will there be an increase in certain predatory fish such as arrowtooth flounders that have no value to the commercial fisheries? How will they impact the commercial stocks?

k. Will certain predictable foraging hotspots change location, thus favoring or disadvantaging various seabird and marine mammal foragers?

l. Will these marine mammal (e.g. fur seals) and seabird populations then change in abundance or location, possibly exposing them to added predation by apex predators (e.g. killer whales)?

NEXT STEPS:

The following recommendations represent the next steps which the Alaska State Legislature may wish to pursue to further the ability of the State of Alaska and the residents of the many cities and villages throughout the state to better prepare for changing climate conditions. Recommendations are made as a function of testimony received or information gleaned from others in the pursuit of Commission responsibilities. The Commission has not limited its recommendations on the basis of any potential need for either state or federal funding, but has left that prioritization to the public processes involved with appropriation matters.

1. NEED A COORDINATED PROCESS FOR VILLAGE RELOCATION EFFORT

The Alaska State legislature should work with the state administration, the Denali Commission, and the U.S. Army Corps of Engineers (COE) to develop criteria by which a community is identified as “at risk” and in need of relocation due to erosion or other potential damage as a result of climate change. These same parties should identify an appropriate entity to coordinate village relocation efforts. The criteria should also allow identification of other communities where the need does not rise to the level of relocation but does require funding for "mitigation/protection" efforts to protect the existing community. Once a community is identified as “at risk” or in need of mitigation/protection efforts, a central coordinating body needs work with the affected community to identify potential funding sources and navigate the maze of documentation requirements for financial assistance.

Once the coordinating body has been identified, and the criteria determining “at risk” and in need of “mitigation/protection” has been established, a statutory change may be needed to clearly identify the duties and responsibilities of the agency so designated as the coordinating body for this purpose. As part of the same legislation, the review process should be clearly delineated. The coordinating agency should be directed to provide a report to the legislature identifying the outcome of the review process with a prioritized request for funding needs that cannot be met through existing state and federal resources, on an annual basis.

Federal funds available for community assistance will likely require a local match. Most of the affected communities do not have the resources to match federal funding. Therefore, a funding mechanism that is reliable must be developed for rural communities in peril from coastal erosion to provide the needed local match funding. This could take the direction of multi-year block grant program to award matching funds to rural communities recognized by the COE as in need of structural and non-structural projects for storm damage prevention and reduction, coastal erosion, and ice and glacial damage in

Alaska. This would include the relocation of affected communities and construction of replacement facilities.

2. CAPITAL PROJECT PLANNING

The Alaska State Legislature should review existing capital planning statutes to determine if amendments are necessary to assure that infra-structure planning, mediation, and replacement all take into account the potential future impacts as a result of climate change. Engineering designs must incorporate best available and proven practices in the Arctic, and project specifications must reflect that requirement for purposes of selecting contractors for state projects. Standards should be developed in conjunction with other public and private entities engaged in engineering in the Arctic to assure that best practices are reflected. In prioritization of major maintenance needs, climate change mitigation should receive consideration in determining a project's placement on the priority list.

3. FEDERAL EFFORTS

The warming of the Arctic is creating an increase in traffic as sea ice retreats for longer periods of time each year. This increase in traffic creates possible public safety concerns that are more appropriately the concern of the federal government. The Alaska State Legislature may wish to develop resolutions demonstrating support for the following federal efforts:

a. COASTAL MAPPING needs to be expanded. A proposal to produce an accurate shoreline that can be monitored with GPS technology has been developed by NOAA's National Geodetic Survey. However, no funding has yet been identified.

b. TIDE STATIONS. NOAA's Center for Ocean Observations and Prediction has tide stations in Western Alaska and north on the Bering Sea Coast as far as the Red Dog Mine dock near Kotzebue. Proposals have been developed to create additional tide stations between Nome and Port Moller for Western Alaska and Bristol Bay, and the Red Dog Dock and Prudhoe Bay for Chukchi and Beaufort Sea measurements. Stations are also needed between Barrow and Kaktovik.

c. U.S. COAST GUARD PRESENCE. The USGC has identified the need for a presence, at least in the warmer months, in both Nome and Barrow. USCG operations are needed to assure the safety of commercial fishing operations in the Bering Strait, where foreign fleets operate in close proximity to American vessels. Also, commercial traffic increases throughout the Arctic will likely

result in increased Homeland Security concerns as well as increase the potential for search and rescue activities. Increased funding for USCG operations in Alaska to enable the conduct of these activities, should be supported.

d. ICEBREAKERS. The United States has three icebreakers. Two of the three are approaching the end of their useful life. The ice-breakers are the only vessels capable of traversing the Northern Bering Sea and the Arctic Ocean during much of the year. These vessels are also utilized for Arctic research by the National Science Foundation. Replacement of the older vessels has been authorized by Congress but no funding for replacement has been appropriated for that purpose.

4. PUBLIC INFRASTRUCTURE

The Alaska State Legislature should identify the necessary funds to do an assessment of public infrastructure needs for protection against possible loss due to erosion and the loss of permafrost. It is possible that with identification, infrastructure can be retrofitted to continue to safely function even under changing climate conditions. Priority should be given to assessment of schools, bulk fuel storage facilities, and transportation infrastructure (highways and aviation). Funding for remediation of existing facilities should be given priority in future capital planning.

Failing water and sewage systems could create significant public health hazards. It may be more difficult to identify where systems are at risk of failure than with other public infrastructure. However, the state must be positioned to address such failure immediately to avoid public health threats to small rural communities. This may require an emergency fund be established and funded specifically designed for such a purpose.

5. RESIDENTIAL NEEDS

The Alaska State Legislature should work with the Alaska Housing Finance Corporation to modify existing and/or develop a new low interest loan program (and identify funding needs) to allow loans to home and business owners to make necessary modifications to protect structures from the loss of permafrost and other conditions exacerbated by warming conditions. Loan limits need to be realistically designed to address retrofit of existing structures.

6. RESEARCH

The Alaska State Legislature should support continued research efforts for the study of the Arctic and the effects of climate change. It is important that research efforts be coordinated between state, federal, university, and

private activities in order to maximize the benefits of these efforts and minimize duplication. Research efforts must be catalogued and easily accessible by all interested parties. Research funds provided the University of Alaska specifically for Arctic Climate research should be targeted to research establishing baseline data and address gaps in knowledge regarding Alaska and climate change impacts.

7. CONTINUATION OF CLIMATE CHANGE EFFORTS

The Alaska Climate Impact Assessment Commission concluded that continued identification of potential challenges, threats, and planned responses needs to occur with the Administration. It is felt that this will enhance the development of policy, prioritization of responses, and, in turn, lead to development of funding priorities, program management, and inter-agency collaboration, especially with federal agencies. The Commission supports the organizational, professional and tenured capabilities of the Sub-Cabinet for Climate Change created by the current administration. However, sub-cabinets have no guaranteed existence beyond the administration establishing them. Therefore, the Alaska State Legislature should work with the current administration to create legislation establishing the sub-cabinet approach as a recognized state council, with organization, duties, and responsibilities mirroring the current sub-cabinet structure and activities.

ATTACHMENT A

S T A T E O F A L A S K A
THE LEGISLATURE
2006

Legislative Resolve No. 49
Source: SCS CSHCR 30(FIN)

Creating an Alaska Climate Impact Assessment Commission.

BE IT RESOLVED BY THE LEGISLATURE OF THE STATE OF ALASKA:

WHEREAS recent weather patterns have created warming trends that have jeopardized the health and well-being of residents of communities and the natural resources on which they rely; and

WHEREAS flooding and erosion negatively affect coastal and river communities in both rural and urban areas of the state; and

WHEREAS coastal communities are negatively affected by flooding and erosion because of delayed formation of protective shore ice in the fall; and

WHEREAS communities along riverbanks or in river deltas are more susceptible to flooding and erosion caused by ice jams, snow and glacial melts, rising sea levels, changing river patterns, and heavier rainfall; and

WHEREAS permafrost is found beneath approximately 80 percent of the state; and

WHEREAS, in recent years, there has been widespread thawing of permafrost in some areas, causing land to slump and erode, which in turn has caused serious damage to roads, buildings, and other infrastructure; and

WHEREAS the thawing of the permafrost is likely to continue, which will have a continuing negative effect on future structures and development; and

WHEREAS fish and wildlife habitats are changing, affecting the accessibility and viability of certain species; and

WHEREAS resource development and the revenue it generates are potentially negatively affected by the effects of climate change; and

WHEREAS the rapidly retreating sea ice affects polar route navigation and has raised security concerns; and

WHEREAS the state has only one employee working on these issues; and

WHEREAS, although the Arctic Climate Impact Assessment provides the necessary scientific foundation to assess current effects of climate change in the Arctic, it does not address the economic effects of climate change on the State of Alaska; and

WHEREAS a comprehensive plan to address these issues, prevent or mitigate negative effects of climate change, and address economic effects on the state will help save lives, protect public health, preserve economic and resource development, and protect valuable infrastructure;

BE IT RESOLVED by the Alaska State Legislature that there is created an Alaska Climate Impact Assessment Commission; and be it

FURTHER RESOLVED that the commission shall consist of 11 members as follows:

(1) two senators appointed by the president of the senate;

(2) two representatives appointed by the speaker of the house of representatives; and

(3) seven public members appointed jointly by the president of the senate and the speaker of the house of representatives consisting of

(A) one member with expertise in climatology or knowledgeable in the area of oceanography;

(B) one member who is knowledgeable about Alaska's economy;

(C) one member who is knowledgeable in the area of land management or restoration of wildlife and natural resources;

(D) one member experienced in arctic and sub-arctic engineering

requirements for public highway and facility construction and maintenance;

(E) a recognized local expert representing affected Alaska communities;

(F) one member who represents affected resource development industries;

(G) one member who represents the affected tourism industries; and be it

FURTHER RESOLVED that the task force shall select a chairperson from among members of the legislature; and be it

FURTHER RESOLVED that the public members of the commission may receive compensation for per diem or reimbursement for travel or other expenses incurred in serving on the commission; and be it

FURTHER RESOLVED that the commission may meet during and between legislative sessions; and be it

FURTHER RESOLVED that the House and Senate Resources Committees may assign committee staff to provide support services for the commission; and be it

FURTHER RESOLVED that the duties of the commission include the following:

(1) assess the current and potential effects of climate warming trends on the citizens, natural resources, public health, and economy of the state, in particular the adverse effects on natural resource development, forest safety, fish and game utilization, transportation, community, and resource development infrastructures;

(2) estimate costs to the state and its citizens of adverse effects associated with climate change;

(3) identify specific circumstances of flooding and erosion that have affected life, property, and economic and resource development in the state;

(4) examine alternative measures to prevent and mitigate the effects of flooding and erosion;

(5) develop policies to guide infrastructure investments in Alaska villages, cities, and boroughs that are most affected by flooding and erosion;

(6) recommend land use regulations, including area standards for designation of land prone to flooding and erosion;

(7) investigate and assess issues involving permafrost and damage caused by permafrost;

(8) recommend policies to decrease the negative effects of climate change; and

(9) identify and coordinate efforts of mutual concern with federal, state, and local agencies; and be it

FURTHER RESOLVED that the commission shall offer recommendations and provide possible solutions and preventative measures that can be implemented by Alaska communities and by the state and federal governments; and be it

FURTHER RESOLVED that the commission shall conduct eight hearings throughout the state to fulfill its purpose; and be it

FURTHER RESOLVED that the commission shall deliver a preliminary report of its findings to the legislature on March 1, 2007, and make a final report to the legislature on January 10, 2008, together with legislative proposals for consideration; and be it

FURTHER RESOLVED that the commission shall be available for legislative hearing on its final report and recommendations; and be it

FURTHER RESOLVED that the continuation or termination of the commission shall be reevaluated at the Second Regular Session of the Twenty-Fifth Alaska State Legislature.

ATTACHMENT B

ALASKA CLIMATE IMPACT ASSESSMENT COMMISSION

STAFF: Tim Benintendi, (907) 465-2095 / tim_benintendi@legis.state.ak.us

COMMISSION MEMBERS

Rep. Ralph Samuels, Chairman, **(907) 465-2095**
representative_ralph_samuels@legis.state.ak.us
State Capitol #204, Juneau, AK 99801-1182
Fax - 465-3810 / STAFF: Tim Benintendi

Rep. Reggie Joule, Vice-Chairman, **(907)465-4833**
representative_reggie_joule@legis.state.ak.us
State Capitol #421, Juneau, AK 99801-1182
Fax - 465-4586 / STAFF: Alison Elgee

Senator Gary Stevens, **(907) 465-4925**
senator_gary_stevens@legis.state.ak.us
State Capitol #103, Juneau, AK 99801-1182
Fax - 465-3517 / STAFF: Doug Letch

Senator Gene Therriault, **(907) 465-4797**
senator_gene_therriault@legis.state.ak.us
State Capitol #427, Juneau, AK 99801-1182
Fax - 465-3884 / STAFF: Ernest Prax

Captain Bob Pawlowski, **(907) 276-7315**
(CLIMATOLOGY / OCEANOGRAPHY) / rpawlowski@afdf.org
Executive Director, Alaska Fisheries Development Foundation
431 W. 7th Ave. #201, Anchorage, AK 99501 / Fax - 276-7311

Dr. Lance D. Miller, **cell - (907) 321-4470**
(ALASKAN ECONOMY) / lancemiller@gci.net
4470 N. Douglas Rd., Juneau, AK 99801

Ms. Stephanie Madsen, **(907) 523-0970**
(LAND MANAGEMENT, WILDLIFE, NATURAL RESOURCES) / smadsen@atsea.org
Box 32817, Juneau, AK 99803-2817 / Fax - 523-0789

Mr. Dennis Nottingham, **(907) 561-1011**
(ENGINEERING, CONSTRUCTION, MAINTENANCE) / dnottingham@pnd-anc.com
President, PND Engineers, Inc.
1506 W. 36th Ave., Anchorage, AK 99503 / Fax - 563-4220

Mr. Caleb Pungowiyi, **cell - (907) 360-4710**
(AFFECTED COMMUNITIES) / cpungowiyi@oceana.org
1676 N. Lacy Loop, Wasilla, AK 99654

Mr. Michael Hurley, **(907) 265-6313**, michael.j.hurley@conocophillips.com
(AFFECTED RESOURCE DEVELOPMENT INDUSTRIES)
Director, State Government Relations, Conoco-Phillips AK, Inc.
PO Box 100360, Anchorage, AK 99510-0360 / Fax - 265-1502

Mr. John Shively, **(907) 264-2127**
(AFFECTED TOURISM INDUSTRIES) / jshively@hollandamerica.com
Vice President, Holland-America Line
745 W. 4th Ave.#304, Anchorage, AK 99501 / Fax - 264-2162

ATTACHMENT C

AK Climate Impact Assessment Commission

Rp. Ralph Samuels, Chairman / Rp. Reggie Joule, V-Chairman

State Capitol #204, Juneau, AK 99801-1182 / (907) 465-3727 / fax - (907) 465-3810

PRELIMINARY REPORT TO THE LEGISLATURE

March 1, 2007

SUMMARY:

HCR 30 (Legislative Resolve 49 / 2006) established the Alaska Climate Impact Assessment Commission and charged it with assessing such effects under climate change in the Arctic, as would affect the citizens, resources, economy, and assets of the State of Alaska. The Commission is composed of two state House members, two state Senators, and seven public members appointed to specifically-defined seats, focusing on climatology/oceanography, communities, tourism, resource development, the economy, engineering/construction/ maintenance, and fish/wildlife/land management issues. Existing legislative staff has been tasked with supporting the work of the Commission. Authorized expenses include travel, per diem, and supplies.

The Commission is to hold at least eight public hearings throughout Alaska, and issue a report of its findings to the Legislature on January 10, 2008. To date, the Commission has held an organizing meeting, and two public hearings. The two public hearings, one each in Fairbanks and Juneau, were composed of invited professional testimony and open public testimony.

The Fairbanks hearing was held on the campus of the University of Alaska, and emphasized a scientific overview of the major climate change issues affecting Alaska. The Juneau public hearing emphasized state agency perceptions of state responsibilities, and in some cases, operational changes which are already underway due to climate warming in the Arctic. An Anchorage public hearing is scheduled for April, and the Commission will soon plan hearings to be held in rural Alaskan communities over the course of the summer and autumn.

The Commission considers existing evidence for Arctic warming trends sufficient to pursue its charge under HCR 30. Current science and climatology indicate that Alaska is a bellwether for climate change in the United States. Commission activities to date have focused on gathering and exchanging information, including anecdotal information, and evaluating it in terms of the Commission's responsibilities. The Commission will necessarily limit the scope of its investigation to provisions in HCR 30; it is not equipped to engage in major academic discourse on many of the unresolved issues within the climate change arena. Along with evaluating public testimony, the Commission has already begun discussing the framework of its final report due next year.

Commission members have participated in other climate change forums, including those organized by the Alaska Federation of Natives, the Alaska Center for Climate Assessment and Policy and the Department of Engineering at the University of Alaska (Anchorage), the Anchorage Business Roundtable and Resource Development Council, the 7th International Conference on Climate Change at the University of Alaska (Fairbanks), and upcoming, the Society of American Military Engineers and the Warming Oceans Forum to be held during the ComFish Alaska exposition in Kodiak. Other opportunities are anticipated throughout 2007.

SCOPE OF RESPONSIBILITIES:

Under HCR 30, the Commission will assess the effects of warming trends on the citizens, natural resources, public health, economy, natural resource development, forest safety, fish and game utilization, transportation, communities, and resource development infrastructures. It is to estimate the costs of adverse climate change to our citizens and the state, recommend policy and regulatory changes, and identify and coordinate efforts of mutual concern with federal, state, and local entities.

In addition, the Commission will more specifically assess problems caused by flooding, erosion, and permafrost melt. To this end, it will identify specific circumstances of flooding and erosion where these affect life, property, economies, and resource development. The Commission is also obliged to examine prevention and mitigation measures for flooding and erosion problems. It may also recommend land use regulations, including standards for the designation of land prone to erosion and flooding.

DRAFT ACTION PLAN:

Over the remainder of 2007, the Commission will continue gathering and prioritizing information, participating in other public climate change forums, and preparing information for its final report. The Commission is already evaluating reporting formats from other governmental bodies and other relevant entities. The Commission's responsibilities will be viewed in the following major interest areas (not prioritized):

1) public health and communities (health, municipal impacts)
2) fish and game impacts (commercial, sport, subsistence)
3) forest impacts (state and federal assets, wildfire suppression, related economic issues)
4) economic impacts (tourism, construction, transportation, insurance, federal spending, agriculture, and flooding/erosion/permafrost damage)
5) resource development (oil and gas, mining, support industries)
6) policy and regulatory aspects (land use, alternative energy, other legislation / regulation changes)
7) state assets at risk (harbors, bridges, roadways, airports, parks)

OBSERVATIONS FROM ALASKANS:

A sampling of observations by Alaskans thus far conveys the diversity of impacts being felt by citizens and communities: Unusual, double-crops of blueberries in the Interior; salmon stocks and other species moving northward; waning birch forests in the Interior and declining yellow cedar stocks in the Southeast; increased frequency and intensity of wildfires; negative implications for continued insurance protection for coastal and riverine communities affected by storm surge, flooding, and erosion; a lack of adequate federal, state, or local data for mapping Alaska's areas at risk; emerging impact costs for state infrastructure; and the need for interagency coordination between local, state, and federal officials, including specially chartered entities such as the Denali Commission. These are but a few of the manifestations of climate change which have come forward.

LOOKING AHEAD:

It is expected that the Anchorage public hearing will offer insight from resource extraction industries, construction and engineering interests, research entities, and federal agencies, to name a few.

As the Commission anticipates public hearings in rural areas, particularly in coastal areas, it expects to concentrate in some detail, on flooding and erosion issues, impacts on the subsistence lifestyle, threats to small communities, and fish and game resources.

Ultimately, the biggest challenge facing the Commission will be to focus on and prioritize those issues within the scope of Arctic climate change, which most substantially impact the state, its people, and its economy. Consolidating the panel's findings into useful, relevant information will remain our objective. The potential exists for some measure of positive economic change due to Arctic climate warming. Although speculative, benefits may be seen in Alaska's fisheries, agriculture, and academic research fields, among others.

ATTACHMENT D

Alaska Climate Impact Assessment Commission

INVITED SPEAKER CONTACT INFORMATION

FAIRBANKS PROGRAM (December 7 & 8, 2006)

Dr. Steve Jones, Chancellor
University of Alaska Fairbanks
P.O. Box 757500
Fairbanks, Alaska 99775
Phone: 474-7112
Fax: 474-6725
E-mail: chancellor@uaf.edu

Dr. Buck Sharpton, Vice Chancellor for Research
University of Alaska Fairbanks
Center for Research Services
909 Koyukuk Drive
West Ridge Research Building, Suite 212
P.O. Box 757270
Fairbanks, AK 99775-7270
Phone: 474-5837
Fax: 474-5444
E-mail: buck.sharpton@alaska.edu

Dr. Glenn Juday, Professor of Forest Ecology
School of Natural Resources and Agricultural Sciences
University of Alaska Fairbanks
P.O. Box 757200
Fairbanks, AK 99775-7200
Phone: 474-6717
Fax: 474-7439
E-mail: g.juday@uaf.edu

Dr. Larry Hinzman, Deputy Director
International Arctic Research Center
930 Koyukuk Drive
PO Box 757340, Room 203F
Fairbanks, AK 99775-7340
Phone: 474-7331
Fax: 474-1578
E-mail: lhinzman@iarc.uaf.edu
Website: www.iarc.uaf.edu

Dr. Brian Barnes, Director
Institute of Arctic Biology
University of Alaska Fairbanks
902 North Koyukuk Drive
PO Box 757000
Fairbanks, AK 99775-7000
Phone: 474-7649
Fax: 474-6967
E-mail: brian.barnes@uaf.edu
Website: www.iab.uaf.edu

Dr. Dan White, Director
Institute of Northern Engineering
University of Alaska Fairbanks
525 Duckering Building
PO Box 755910
Fairbanks, AK 99775-5910
Phone: 474-6222
Fax: 474-7041
E-mail: ffdmw@uaf.edu

Dr. Hajo Eicken, Associate Professor of Geophysics
Snow, Ice and Permafrost Group
Geophysical Institute
University of Alaska Fairbanks
903 Koyukuk Drive
PO Box 757320
Fairbanks, AK 99775-7320
Phone: 474-7280
Fax: 474-7290
E-mail: hajo.eicken@gi.alaska.edu

Dr. Brenda Norcross, Professor of Fisheries Oceanography
Institute of Marine Science
University of Alaska Fairbanks
PO Box 757220
Fairbanks, AK 99775-7220
Phone: 474-7990
Fax: 474-7204
E-mail: norcross@ims.uaf.edu

Ms. Karen Perdue, Associate Vice President for Health
University of Alaska
Suite 202 Butrovich Building, Fairbanks, AK 99775-5320
Phone: 450-8017 / Fax: 450-8002
E-mail: karen.perdue@alaska.edu

Alaska Climate Impact Assessment Commission

INVITED SPEAKER CONTACT INFORMATION

JUNEAU PROGRAM (January 24, 2007)

Mr. George Cannelos, Federal Co-Chairman
Denali Commission
510 L Street, Suite 410
Anchorage, AK 99501
Phone: 271-1414
Fax: 271-1415
E-mail: gcannelos@denali.gov

Mr. Bob Swenson, State Geologist
Division of Geological & Geophysical Survey
Department of Natural Resources
3354 College Road
Fairbanks, AK 99709-3707
Phone: 748-8905
Fax: 451-5223
E-mail: rfs@dnr.state.ak.us

Mr. Marc Lee, Fairbanks Area Forester
Division of Forestry
Department of Natural Resources
3700 Airport Way
Fairbanks, AK 99709
Phone: 451-2601
Fax: 451-2690
E-mail: marcl@dnr.state.ak.us

Mr. Tom Chapple, Director
Division of Air Quality
Department of Environmental Conservation
555 Cordova Street
Anchorage, AK 99501-2617
Phone: 269-7634
Fax: 269-3098
E-mail: Tom_Chapple@dec.state.ak.us
Website: http://www.dec.state.ak.us/air/cc.htm

Dr. Rick Steiner, Professor and Conservation Specialist
Marine Advisory Program
University of Alaska Anchorage
2221 E. Northern Lights Blvd., Suite 118, Anchorage, AK 99508
Phone: 786-4156 / Fax: 786-6312
E-mail: afrgs@uaa.alaska.edu

Mr. Mike Black, Director
Division of Community Advocacy
Department of Commerce, Community and Economic Development
550 W. 7th Avenue, Suite 1770
Anchorage, AK 99501-3510
Phone: 269-4580 / Fax: 269-4539
E-Mail: Michael_Black@commerce.state.ak.us

Dr. Peter Larsen, Resource Economist
Institute of Social and Economic Research
University of Alaska Anchorage
3211 Providence Drive, Anchorage, AK 99508
Phone: 786-5449 / Fax: 786-7739
E-mail: anphl@uaa.alaska.edu

Ms. Kate Troll, Executive Director
Alaska Conservation Alliance
PO Box 100660
Anchorage, Alaska 99510
Phone: 258-6171 / Fax: 258-6177
E-mail: kate@akvoice.org

Mr. Chris Mello, Project Manager
Alaska Energy Authority
813 West Northern Lights Blvd.
Anchorage, AK 99503
Phone: 269-4649 / Fax: 269-3044
E-mail: cmello@aidea.org

Dr. Dave Bernard, Retired RTS Fisheries Scientist
6801 Sky Circle
Anchorage, AK 99502
Phone: 334-9005
E-mail: drbernardconsulting@gci.net

Alaska Climate Impact Assessment Commission

INVITED SPEAKER CONTACT INFORMATION

ANCHORAGE PROGRAM (April 12 & 13, 2007)

Mr. Larry Hartig, Commissioner
Department of Environmental Conservation
P.O. Box 111800
Juneau, AK 99811-1800
Phone: 465-5066
Fax: 465-5070
E-mail: larry_hartig@dec.state.ak.us

Mr. Wyn Menefee, Chief of Operations
Division of Mining, Land & Water
Department of Natural Resources
550 W 7th Ave Ste 1070
Anchorage, AK 99501-3579
Phone: 269-8501
Fax: 269-8913
E-mail: wyn_menefee@dnr.state.ak.us

Mr. Gary Schultz, Natural Resource Manager
Division of Mining, Land & Water
Department of Natural Resources
3700 Airport Way
Fairbanks, AK 99709-4699
Phone: 451-2732
Fax: 451-2751
E-mail: gary_schultz@dnr.state.ak.us

Dr. Orson Smith, Professor of Arctic Engineering
University of Alaska Anchorage
3211 Providence Drive, ENGR 201
Anchorage, AK 99508
Phone: 786-1910
Fax: 786-1079
E-mail: afops@uaa.alaska.edu

Dr. Stephen Sparrow, Associate Dean & Professor of Agronomy
University of Alaska Fairbanks
P.O. Box 757140
Fairbanks, AK 99775
Phone: 474-7620
Fax: 474-6184
E-mail: ffmps@uaf.edu

Dr. James Partain, Chief of Environment & Scientific Services Division
NOAA/National Weather Service
222 W. 7th Avenue, Suite 23
Anchorage, AK 99513-7575
Phone: 271-5131
Fax: 271-3711
E-mail: James.Partain@noaa.gov

Dr. Mike Sigler, Fishery Assessment Scientist
NOAA/National Marine Fisheries Service
Ted Stevens Marine Research Institute
17109 Lena Point Loop Road
Juneau, AK 99801
Phone: 789-6000
Fax: 789-6094
E-mail: Mike.Sigler@noaa.gov

Dr. Gerhard Kramm, Atmospheric Scientist
UAF Geophysical Institute
903 Koyukuk Drive
P.O. Box 757320
Fairbanks, AK 99775-7320
Phone: 474 5992
E-mail: kramm@gi.alaska.edu

Mr. Mead Treadwell, Chairman
U.S. Arctic Research Commission
420 L Street, Suite 315
Anchorage, AK 99501
Phone: 271-4577
Fax: 271-4578
E-mail: usarc@acsalaska.net

Dr. Patricia Reynolds, Arctic Refuge Ecologist
U.S. Fish & Wildlife Service
101 12th Avenue, Room 236
Fairbanks, Alaska 99701
Phone: 456-0250
Fax: 456-0428
E-mail: patricia_reynolds@fws.gov

Mr. Julian Fischer, Wildlife Biologist
Migratory Bird Management
1011 East Tudor Road
Anchorage, Alaska 99503
Phone: 786-3644
Fax: 786-3641
E-mail: julian_fischer@fws.gov

Mr. Tony Barter, Retired DOT Construction Engineer
Home phone: 346-1170

Alaska Climate Impact Assessment Commission

INVITED SPEAKER CONTACT INFORMATION

KOTZEBUE PROGRAM (June 28, 2007)

Ms. Martha Whiting, Mayor
Northwest Arctic Borough
POB 1110, Kotzebue, AK 995752-1110
Phone: 442-2500 / Fax: 442-2930
E-mail: mwhiting@nwabor.org

Mr. Jim Dau, Regional Wildlife Biologist
Alaska Department of Fish & Game
POB 689, Kotzebue, AK 99752-0689
Phone: 442-3420 / Fax: 442-2420
E-mail: jim_dau@fishgame.state.ak.us

Mr. Alex Whiting, Environmental Specialist
Native Village of Kotzebue
POB 296, Kotzebue, AK 99752-0296
Phone: 442-5303 / Fax: 442-2162
E-mail: sheep@otz.net

Mr. Brad Reeve, General Manager
Kotzebue Electric Association
POB 44, Kotzebue, AK 99752-0044
Phone: 442-3491 / Fax: 442-2482
E-mail: kea_gm@otz.net

Mr. Stanley Tom, Administrator
Village of Newtok
POB 5546, Newtok, AK 99559
Phone: 237-2316 / Fax: 237-2321
E-mail: stanley_tom2003@yahoo.com

Ms. Colleen Swan, Elder
Village of Kivalina
POB 51, Kivalina, AK 99750-0051
Phone: 645-2153 / Fax: 645-2250
E-mail: colleen.swan@kivalinaig.org

Mr. Enoch Adams, Jr., Elder
Village of Kivalina
POB 70, Kivalina, AK 99750-0070
Phone: 645-2244 / Fax: 645-2246
E-mail: eadamsnab@yahoo.com

Ms. Emma Ramoth, Regional Elders' Council

Mr. Tony Weyiouanna, Sr.
Shishmaref Relocation Council
POB 100, /Shishmaref, AK 99772-0100
Phone: 649-2289 / Fax: 649-4461
E-mail: tony@kawerak.org / www.kawerak.org

Ms. Linda Joule, Chairman
Native Village of Kotzebue
POB 673, Kotzebue, AK 99752-0673
Phone: 442-3467 / Fax: 442-3452
E-mail: linda.joule@gira.org

Press: Stefan Milkowski - Fairbanks Daily News-Miner
Phone: 459-7577
E-mail: smilkowski@newsminer.com

Press: Tamar Ben-Yosef - Arctic Sounder
Phone: 348-2419 or (800) 770-9830, ext. 419
E-mail: tbenyosef@alaskanewspapers.com

Alaska Climate Impact Assessment Commission

INVITED SPEAKER CONTACT INFORMATION

BARROW PROGRAM (September 27, 2007)

Mr. Edward Itta, Mayor
North Slope Borough
POB 69, Barrow, AK 99723-0069
Phone: 852-0200 / Fax: 852-0337
E-mail: sheila.burke@north-slope.org

Mr. Nate Olemaun, Mayor
City of Barrow
POB 629, Barrow, AK 99723-0629
Phone: 852-5211 / Fax: 852-5871
E-mail: cityclerk@cityofbarrow.org

Mr. Kenneth Toovak, Ph. D, Elder
Phone: 852-6335

Mr. Arne Fuglvog, Congressional Staff
Senator Lisa Murkowski (DC office)
709 Hart Building, Washington, DC 20510-0202
Phone: (202) 224-6665 / Fax: (202) 224-5301
E-mail: arne_fuglvog@murkowski.senate.gov

Mr. Eugene Brower, President
Barrow Whaling Captains' Association
POB 492, Barrow, AK 99723-0492
Phone: 852-3601 / Fax: 852-
E-mail: cebrower@ak.net

Ms. Anne Jensen, Senior Scientist
Ukpeagvik Inupiat Corporation
POB 577, Barrow, AK 99723-0577
Phone: 852-3050 / Fax: 852-2632
E-mail: anne.jensen@uicscience.org

Mr. Dan Endres, NOAA Global Monitoring Program
National Oceanographic & Atmospheric Administration
POB 888, Barrow, AK 99723-0888
Phone: 852-6500 / Fax: 852-4622
E-mail: dan.endres@noaa.gov

Mr. Greg George, Manager, Department of Wildlife
North Slope Borough
POB 69, Barrow, AK 99723-0069
Phone: 852-0350 / Fax: 852-0351
E-mail: greg.george@north-slope.org

Radio: KBRW - 852-6811

Press: Stefan Milkowski - Fairbanks Daily News-Miner
Phone: 459-7577
E-mail: smilkowski@newsminer.com

Press: Tamar Ben-Yosef - Arctic Sounder
Phone: 348-2419 or (800) 770-9830, ext. 419
E-mail: tbenyosef@alaskanewspapers.com

Alaska Climate Impact Assessment Commission

INVITED SPEAKER CONTACT INFORMATION

ANCHORAGE PROGRAM (October 10, 2007)

Mr. Dennis Nottingham, Principal
PND Engineers, Inc.
1506 W. 36th Ave., Anchorage, AK 99503
Phone: 561-101 / Fax - 563-4220
E-mail: imartin@pnd-anc.com (Staff: Ingrid Martin)

Mr. George Cannelos, Federal Co-Chairman
Denali Commission
510 L Street, Suite 410, Anchorage, AK 99501
Phone: 271-1414
Fax: 271-1415
E-mail: gcannelos@denali.gov

Senator Ted Stevens
222 W. 7th #2, Anchorage, AK 99513-7569
Phone: 271-5915 / Fax: 258-9305

522 Hart Building, Washington, DC 20510-0201
Phone: (202) 224-3004 / Fax: (202) 224-2354
Webpage: http://stevens.senate.gov

Dr. Lawson Brigham, Director
Arctic Research Commission
420 L Street #315, Anchorage, AK 99501
Phone: 271-4577 / Fax: 271-4578
E-mail: usarc@acsalaska.net / lwb48@aol.com

Mr. Joseph David, Sr., Elder
Nunivak Island
Contact through Kate Troll, kate@akvoice.org

Ms. Sue Mauger, Stream Ecologist
Cook Inletkeepers
Box 3269, Homer, AK 99603-3269
Phone: 235-4068 / Fax:
E-mail: sue@inletkeeper.org

U. S. Army Corps. of Engineers, Alaska District
Ms. Patricia Opheen, PE, Chief of Engineering (presentation team leader)
Box 060898, Anchorage, AK 99506-0898
patricia.s.opheen@poa02.usace.army.mil
Phone: 753-2662 / Fax: 753-2661

Dr. Jon Zufelt, PE / jon.e.zufelt@erdc.usace.army.mil
USARAK Science Advisor
Box 050646, Ft. Richardson, AK 99505-0646
Phone: 384-0511 / Fax: 384-0519

Mr. Mike Rabbe / mike.rabbe@poa02.usace.army.mil
Chief, Regulatory Division, Corps. of Engineers AK
Box 060898, Anchorage, AK 99506-0898
Phone: 753-2782 / Fax: 753-5567

Mr. Ken Eisses, PE / kenneth.j.eisses@usace.army.mil
Chief, Hydraulics and Hydrology Section
Box 060898, Anchorage, AK 99506-0898
Phone: 753-2742 / Fax: 753-2625

ATTACHMENT E

CLIMATE IMPACT ASSESSMENT COMMISSION

Public Hearing Information Sites

http://www.housemajority.org/coms/cli/cli_readingfile.php is the site to access documents, resolutions, reports, a copy of HCR 30, a list of commissioners, and the preliminary report.

http://www.housemajority.org/coms/cli/cli_fairbanks.php has the power point presentations from the Fairbanks public hearing.

http://www.housemajority.org/coms/cli/cli_juneau.php has the power point presentations from the Juneau public hearing.

http://www.housemajority.org/coms/cli/cli_anchorage_01.php has the power point presentations from the Anchorage public hearing of April 12 & 13.

http://www.housemajority.org/coms/cli/cli_kotzebue.php has the power point presentations from the Kotzebue public hearing, and an audio record of the hearing.

http://www.housemajority.org/coms/cli/cli_barrow.php has information from the Barrow public hearing (contains only one power point presentation).

http://www.housemajority.org/coms/cli/cli_anchorage_02.php has the power points and other information from the final public hearing, held in Anchorage on October 10.

AUDIO RECORDINGS OF ALL BUT THE KOTZE-BUE PUBLIC HEARING MAY BE FOUND AT:

http://old-mp.legis.state.ak.us/

ATTACHMENT F

STATE OF ALASKA

DEPT. OF ENVIRONMENTAL CONSERVATION
OFFICE OF THE COMMISSIONER

SARAH PALIN, GOVERNOR
410 Willoughby Ave., Ste 303
Post Office Box 111800
Juneau, AK 99811-1800
PHONE: (907) 465-5066
FAX: (907) 465-5070
http://www.dec.state.ak.us

February 15, 2008

The Honorable Ralph Samuels
Chair, Alaska Climate Impact Assessment Commission
Alaska State Capitol, Room 204
Juneau, AK 99801-1182

Dear Representative Samuels:

Please find enclosed the responses prepared by the following state agencies to your questions regarding the possible impacts of climate change:

Department of Natural Resources (DNR)
Department of Environmental Conservation (DEC)
Department of Health and Social Services
Department of Fish & Game (DFG)
Department of Commerce Community & Economic Development (DCCED)
Department of Transportation & Public Facilities (DOT/PF)
Department of Military & Veteran Affairs (DMVA)

Each agency prepared its own response. If you have any questions concerning a response, please contact the agency who prepared it. Please call me if you have any questions regarding the work of the Governor's Alaska Climate Change Sub-Cabinet.

As you know, in September 2007, Governor Palin signed Administrative Order 238 establishing the Alaska Climate Change Sub-cabinet. The Sub-cabinet is comprised of the commissioners of DNR, DEC, DFG, DCCED and DOT/PF. Liaisons from the Governor's office and the University of Alaska participate in Sub-cabinet meetings. DEC chairs the Sub-cabinet.

The Sub-cabinet is charged with making recommendations to Governor Palin on an Alaska Climate Change Strategy. This strategy is to include measures the state can take to: 1) build its knowledge regarding climate change; 2) avoid or adapt to the predicted effects of climate change; and, 3) mitigate the causes of climate change, through energy conservation and the use of alternative and renewable energy sources. The Sub-cabinet is to also to make recommendations to the Governor on new economic opportunities associated with addressing climate change. This includes commercialization of North Slope natural gas as a low-carbon energy source.

The Sub-cabinet is to give priority to developing a strategy for addressing the needs of Alaska's most at-risk communities. To this end, the Sub-cabinet formed the "Immediate Action Work Group" consisting of senior management from federal and state agencies with expertise and experience regarding capital projects in rural Alaska. This work group will be issuing a report in the next few weeks addressing the erosion and flooding risks threatening the villages of Newtok, Shismaref, Kivalina, Shaktoolik and Unalakleet. It may include other, more general recommendations, such as ways of lowering both capital and operating costs for public infrastructure in these and other similarly situated villages.

DCCED is the state agency taking the lead on working with the affected villages. They are establishing points of contact in these villages and designating a single point of contact at DCCED. The Governor has included a budget request of $1,100,000 for DCCED to be used in providing planning assistance to these villages. This planning assistance will include helping villages that may be threatened in the near-term to define their needs and communicate with the agencies that might help them address their needs. The list of villages needing both short-term and long-term assistance will certainly expand beyond the five communities named above. Meetings of the Sub-cabinet and workgroups (described below) help assure coordination among the agencies providing services to the at-risk villages.

There may be some actions necessary to address imminent life, health and safety risks. We anticipate most, if not all, capital budget requests coming from the agencies relating to short-term needs will start to appear in the FY 2010 budget. This will allow some needed time for planning and prioritizing projects.

At a November 2007 "roundtable" meeting of federal and state agencies with representatives from communities threatened by coastal erosion and flooding, Senator Ted Stevens stressed the need for the agencies to work together to timely meet the needs of the at-risk villages. He noted that it would take a federal/state partnership. We have also heard Senator Stevens and representatives from federal agencies say it is more likely federal money will be obtained for projects in Alaska if there is state or local matching money for these projects.

The Sub-cabinet will first be looking to existing programs and budgets to see what can be directed to addressing the needs of at-risk communities. For instance, DEC's Village Safe Water (VSW) program uses state and federal funds (typically 75% federal and 25% state) to provide drinking water and sanitation to rural communities. Funds from this program could be available to assist with the relocation of Newtok, a village that very likely has no other choice but to move. However, the VSW funds could only be used for water and sewer projects. Other sources of funds would have to be found for other infrastructure and housing. Additionally, planning money would be needed to coordinate all of the contributions of the various federal and state agencies. The various federal and state programs that might provide resources are not currently structured to work neatly together to construct a new community. This will be a challenge. In some instances it may be necessary to look at regulatory or statutory changes to make these programs more responsive to the needs of the at-risk communities.

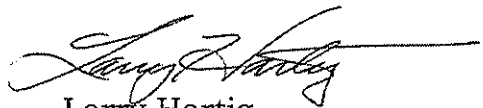
The Sub-cabinet is also creating advisory and technical work groups to provide public and expert input to the Sub-cabinet on climate change issues. An "Adaptation Advisory Group" comprised of 20-25 members from federal, state and local agencies, Tribes and individual citizens will identify and evaluate measures the state might take to better prepare for a warming environment. A "Mitigation Advisory Group" of similar size and composition, will make recommendations to the Sub-cabinet on ways the state, industry and individuals might lower greenhouse gas emissions. Again, this will include looking at energy conservation, and the use of alternative and renewable energy. It is a goal of the Sub-cabinet to find "win-win" situations, where the cost of energy is lowered along with the emissions of greenhouse gases. The Sub-cabinet looks forward to coordinate its efforts with those of the Governor's new energy coordinator.

The Adaptation and Mitigation Advisory Groups will be supported by and receive recommendations from Technical Work Groups. There will be approximately five Technical Work Groups under each Advisory Group. The Technical Work Groups will be comprised of persons with expertise and experience in particular areas relevant to the work of the Advisory Groups. The Advisory and Technical Work Groups will be provided logistical and technical support through the agencies, the University of Alaska, several outside non-profits and a local facilitator. The work groups will be start meeting in March 2008 with the goal of having their recommendations to the Sub-cabinet within one year. These recommendations will be considered by the Sub-cabinet in making its recommendations to the Governor. Prior to making its recommendations to the Governor, the Sub-cabinet plans to hold public meetings to review and take input on its draft recommendations. To support the work group process, the Governor has requested $230,000 for DEC in the supplemental budget. It should be noted additional funding for this effort is being provided by outside foundations and in-kind contributions from the University of Alaska.

It is important to recognize there is a considerable amount of work that is being done around the state by government, Tribal organizations, non-profits, industry and individuals that is already addressing climate change. The Alaska Climate Change Strategy will support and build on the beneficial work that is already being done.

On behalf of the Sub-cabinet, I would like to express our appreciation of the work of the Alaska Climate Impact Assessment Commission. We look forward to receiving your report. Please let me know if there is any additional information the Sub-cabinet can provide that might be helpful to the Commission in finalizing its report.

Sincerely,



Larry Hartig
Commissioner & Chair of the Governor's
Climate Change Sub-cabinet

cc: The Honorable Sarah Palin, Governor
Mike Tibbles, Chief of Staff, Office of the Governor
Mike Nizich, Deputy Chief of Staff, Office of the Governor
Karen Rehfeld, Director, Office of Management & Budget
John Katz, Director, State Federal Relations, Office of the Governor
Buck Sharpton, Vice Chancellor for Research, University of Alaska Fairbanks
Members of the Sub-cabinet

STATE OF ALASKA
DEPARTMENT OF
COMMERCE
COMMUNITY AND
ECONOMIC DEVELOPMENT
Office of the Commissioner

Sarah Palin, Governor
Emil Notti, Commissioner

February 8, 2008

The Honorable Ralph Samuels, Chairman
Alaska Climate Impact Assessment Commission
State Capitol, Room 204
Juneau, AK 99801-1182

Dear Representative Samuels:

In response to your letter dated December 14, 2007, the Department of Commerce, Community and Economic Development (DCCED) has compiled a list of perceived budgetary impacts, rural municipal impacts, and policy and regulatory recommendations relevant to erosion, flooding, and thawing permafrost.

DCCED's mission is to promote a healthy economy and strong communities. The Department is keenly aware of the importance and challenge of this mission in light of the work that the Department is engaged in with Alaska's rural communities. Many communities in the state are currently being impacted by erosion, flooding, and melting permafrost. Perhaps the most severely impacted communities are those located on Alaska's western coast, although riverine communities have been affected by erosion and flooding, and thawing permafrost is impacting communities in Interior Alaska as well. The number of communities impacted by these events is expected to increase in the future.

DCCED Division representatives met recently to discuss the impacts of erosion, flooding, and melting permafrost on the Departments programs and the public we serve. The single broad recommendation that was articulated at this meeting was the need for a statewide comprehensive management plan that provides a framework for the direction the State must take to respond to the climate change related issues of Alaska's communities.

DCCED's response to the budgetary impacts, rural municipal impacts, and policy and regulatory recommendations relevant to erosion, flooding and thawing permafrost, are summarized on the attached pages.

550 W. 7th Avenue, Suite 1770, Anchorage, Alaska 99501-3510
Telephone: (907) 269-8100 Fax: (907) 269-8125 Text Telephone: (907) 465-5437
Website: http://www.commerce.state.ak.us/

Thank you for giving the Department the opportunity to make recommendations to the Alaska Climate Impact Assessment Commission.

Sincerely,

Emil Notti
Commissioner

Attachment

BUDGETARY IMPACTS, RURAL MUNICIPAL IMPACTS, AND POLICY AND REGULATORY RECOMMENDATIONS RELEVANT TO EROSION, FLOODING AND THAWING PERMAFROST

IMPACTS ON INFRASTRUCTURE AND BUILDINGS

Thawing of permafrost can lead to ground subsidence, reduced slope stability, increased erosion, landslides, and flooding, all of which can lead to the following impacts to buildings and infrastructure:

- Structural failure in buildings due to thawing of permafrost and melting of ice-covered regions
- Sinking and tilting pilings due to thawing of permafrost and melting of ice-covered regions
- Road damage resulting increased road maintenance costs and major landscape changes from accelerated thawing of permafrost.
- Broken pipelines due to thawing and melting of permafrost and ice-covered regions. For example, as warming continues, the Trans-Alaska Pipeline's support structures, anchored in permafrost and designed for specific temperature ranges, would be affected, costing up to $800 million to repair.

Many of these issues are already impacting the operations of the Alaska Energy Authority in rural Alaska, necessitating the design of special foundations for new facilities and retrofitting existing facilities to address subsidence issues.

The anticipated budgetary impacts include:

- A need for increased departmental staffing, particularly in the Division of Community and Regional Affairs, to address increased community assistance requests
- Subsequent need for budget increases to address increased community assistance requests
- Increased insurance claims

Anticipated rural community impacts include:

- Deterioration or loss of buildings and critical infrastructure
- Reduced quality of life
- Increased public health problems due to failing water, sewer or fuel facilities.
- Threatened life and property

Policy and regulatory recommendations:

- Encourage incorporated municipalities to utilize land use regulation measures to discourage development in unsuitable areas
- Establish best practices for new development in areas underlain by permafrost

Mitigation Measures:

- Use of special foundations for development in areas underlain by permafrost
- Provide outreach and education to communities regarding best practices

IMPACTS ON COASTAL COMMUNITIES

Sea-level rise is attributed to melting of the arctic ice sheets. Some of the expected impacts of sea-level rise to coastal residents include:

- Increased flooding of low-lying property
- Increasing frequency and severity of storm surges exacerbated by the loss of coastal sea ice.
- Loss of coastal wetlands due to increased beach erosion
- Damage to or loss of infrastructure in coastal areas impacted by erosion and flooding
- Saltwater contamination of drinking water
- Increased need to relocate coastal villages

Several coastal communities are currently experiencing these effects, and the number of villages threatened by severe erosion, storm surge and flooding is expected to increase in the future.

The anticipated budgetary impacts include:

- Need for increased departmental staffing, particularly in the Division of Community and Regional Affairs, to address increased community assistance requests
- Subsequent need for budget increases to address increased community assistance requests, including funding for planning and feasibility studies
- Increased insurance claims

Anticipated rural community impacts include:

- Loss of critical infrastructure
- Impaired delivery of fuel and other critical supplies as critical infrastructure, such as barge landings, is lost
- Increasing costs to community to pay for more expensive delivery of fuels and critical supplies
- Deteriorating infrastructure due to funding agency constraints to invest in threatened villages
- Reduced quality of life
- Increased public health problems due to failing infrastructure, impaired water supplies and poor sanitation, particularly in communities without water/sewer infrastructure

Policy and regulatory recommendations:

- Encourage incorporated municipalities to utilize land use regulation measures to discourage development in the floodplain and areas susceptible to erosion
- Establish best practices for new development in vulnerable areas
- Modify current investment policies to allow for funding infrastructure repairs (or alternative strategies) in threatened communities to maintain acceptable quality of life, while actions (relocation, shoreline protection) are being taken to address threats

Mitigation Measures:

- Elevation of structures built in the floodplain
- Construction of shoreline protection structures (sea walls, gabions, etc) along coastlines susceptible to erosion and storm surge
- Use of each beach nourishment measures when feasible
- Relocation of structures built in areas susceptible to erosion
- Provide outreach and education to communities regarding best practices

IMPACTS ON SUBSISTENCE RESOURCES

Continued thawing of permafrost, and the retreat and thinning of sea ice is likely to cause widespread alterations to the lifecycles, habitats and health of ecosystems of subsistence resources. As habitats change, these populations are likely to undergo dramatic shifts in range and abundance, which in turn will affect communities that are dependant upon subsistence resources.

The anticipated budgetary impacts include:

- Need for increased departmental staffing, especially in the Division of Community and Regional Affairs, to address increased community assistance requests
- Subsequent need for budget increases to address increased community assistance requests

Anticipated rural community impacts include:

- Impaired dietary and economic well-being of subsistence based way of life.
- Loss of traditional meat ice cellars in several northern villages to thaw, making them useless.
- Reduced quality of life

Policy and regulatory recommendations:

- Establish policies to address how the needs of communities with subsistence-based economies will be met

Mitigation Measures:

- Provide technical assistance to communities to develop strategies for dealing with a reduction in subsistence resources
- Build capacity in subsistence-based communities to facilitate economic development in other areas

IMPACTS ON COMMERCIAL FISHERIES

Erosion and melting permafrost could have significant effects on Alaska's lake and riverine fish habitat, which in turn would impact communities and individuals who rely on fisheries resources. Increased stream bank erosion and sedimentation of rivers and streams could alter lake and wetland ecosystems. Additionally, changes in permafrost could alter the lake and wetland ecosystems maintained above the impermeable frost layer.

The stability of many communities and the health of an important sector of the state economy as well as regional and local economies all depend on healthy fish populations and robust commercial fisheries. The seafood industry has billions of dollars of investment riding on healthy commercial fisheries. Specific to DCCED, if fish populations and returns are impacted due to these changes, it could reduce the ability of commercial fisherman to make their fishing loan payments to the Department's fishing loan funds.

Anticipated budgetary impacts include:

- Reduction in the Department's Commercial Fishing Relief income and the earnings of that fund to the General fund.
- Reduction in Fisheries Enhancement Relief income and the earnings of that fund to the General fund

- Reduction in the value of fishing permits and other assets that are held as security for Commercial Fishing Relief and Fisheries Enhancement Relief loans
- Reduced federal funding for Alaska Seafood Marketing promotional efforts

The following rural municipal impacts could result:

- Communities that collect fish taxes would be impacted by decline in gross fishing incomes of fisherman
- Communities with fish processors would be impacted with fewer jobs available for local residents and decreased income for fisherman
- Loss of income in communities who have developed tourism connected with sport fishing

Policy and regulatory recommendations:

- Because the impact to the state's commercial fisheries is a far-reaching issue, policy and regulatory recommendations should be established in a statewide comprehensive management plan

Mitigation Measures:

- Mitigation measures to address climate change related issues should be established in a statewide comprehensive management plan

STATE OF ALASKA
DEPT. OF HEALTH AND SOCIAL SERVICES
OFFICE OF THE COMMISSIONER

SARAH PALIN, GOVERNOR

P.O. BOX 110601
JUNEAU, ALASKA 99811-0601
PHONE: (907) 465-3030
FAX: (907) 465-3068

January 31, 2008

The Honorable Ralph Samuels
Alaska House of Representatives
Alaska State Capitol #204
Juneau, AK 99801-1182

Dear Representative Samuels,

Thank you for your interest in the impact of climate change on the Department of Health and Social Services (DHSS) and Alaska's population as a whole. I am submitting this letter to be included with the Administration's overall response to your panel – as coordinated by Department of Environmental Conservation Commissioner Larry Hartig, who chairs the Governor's sub-cabinet on climate change.

While it is impossible to predict the extent to which global climate change will affect the public's health in the future, there is considerable evidence to date of adverse health outcomes that have already occurred on both a national and a global scale, as demonstrated in the table below obtained from the CDC's *Climate Change and Public Health* website (available at http://www.cdc.gov/nceh/climatechange/).

Weather Event	Health Effects	Populations Most Affected
Heat waves	Heat stress	Extremes of age, athletes, people with respiratory disease
Extreme weather events,(rain, hurricane, tornado, flooding)	Injuries, drowning	Coastal, low-lying land dwellers, low Socioeconomic status (SES)
Droughts, floods, increased mean temperature	Vector-, food- and water-borne diseases	Multiple populations at risk
Sea-level rise	Injuries, drowning, water and soil salinization, ecosystem and economic disruption	Coastal, low SES
Drought, ecosystem migration	Food and water shortages, malnutrition	Low SES, elderly, children
Extreme weather events, drought	Mass population movement, international conflict	General population

Increases in ground-level ozone, airborne allergens, and other pollutants	Respiratory disease exacerbations (Chronic obstructive pulmonary disease (COPD), asthma, allergic rhinitis, bronchitis)	Elderly, children, those with respiratory disease
Climate change generally; extreme events	Mental health	Young, displaced, agricultural sector, low SES

DHSS utilized the Arctic Climate Impact Assessment (available at http://www.acia.uaf.edu/pages/scientific.html) to assist with the selection of six adverse health outcomes of greatest potential concern to the health of Alaskans as a result of climate change, listed below.

- Changes in animal and plant distribution and accessibility are predicted to affect food availability resulting in an increase in the number of recipients relaying on the Food Stamp Program and Women, Infants and Children Program. Currently, 10% of the Alaskan population is food insecure. An increase in the number of recipients would increase the costs of the food assistance programs.

- An increase in the prevalence of chronic health conditions due to a shift from a traditional diet (due to changes in animal and plant distribution and accessibility) to a more "western" diet. Increased prevalence of chronic diseases may result in increase utilization and cost to the state's health care system.

- An increase in zoonotic and vector-borne disease outbreaks.

In 2004, Alaska experienced the first documented outbreak of *Vibrio parahaemolyticus* gastroenteritis that was attributed to consumption of oysters grown in Alaskan waters, which have shown a consistent warming trend for decades. Record warm water temperatures during 2004 appeared to be associated with the outbreak by promoting bacterial proliferation in water, and subsequent accumulation in oysters. This outbreak expanded the range of epidemiologically confirmed *Vibrio parahaemolyticus* illness to above latitude 60 degrees–more than 1,000 kilometers north of British Columbia, the previously northernmost area of reported illness. Other infectious diseases whose incidence might increase in Alaska as a result of climate change include botulism, paralytic shellfish poisoning, echinococcosis, giardiasis, respiratory infections, bacterial skin infections, and arthropod-borne infections such as California encephalitis virus and Northway virus.

Unpredictable ice and weather conditions may increase the number of accidents associated with traveling in these conditions and also threaten winter subsistence activities. It is difficult to predict the costs to Alaskans due to increased utilization of Alaska's emergency response system and need to increase injury prevention education.

An increase in waterborne, skin, respiratory, and other illnesses resulting from the collapse of sanitation infrastructure and changes in access to quality drinking water due to melting permafrost melts, eroding shorelines, changing waterways and disappearing watersheds. These changes in rural Alaskan villages could result in the loss of the most basic public health service, quality drinking water. Response to disease outbreaks in these areas poses serious financial implications in the form of epidemiologic surveillance, provision of medical treatment, and implementation of prevention strategies.

Increased mental illness (e.g., depression, anxiety) and social stress due to changes in the physical environment and lifestyles.

All of these changes will require increased DHSS staff time and resources for surveillance, outbreak response, and public education efforts. At this time, DHSS does not have financial information on current or potential public health impacts due to climate change.

Please don't hesitate to contact me if you would like additional information regarding this issue.

Sincerely,

Karleen K. Jackson, Ph.D.
Commissioner

cc: Jay Butler, M.D., Chief Medical Officer,
Beverly Wooley, Director, Division of Public Health
Joe McLaughlin, M.D., Chief, Section of Epidemiology

STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF FISH AND GAME

OFFICE OF THE COMMISSIONER

P.O. BOX 115526
JUNEAU, AK 99811-5526
PHONE: (907) 465-4100
FAX: (907) 465-2332

February 14, 2008

The Honorable Ralph Samuels, Chairman
Alaska Climate Impact Assessment Commission
Alaska House of Representatives
Alaska State Capitol, Room 204
Juneau, AK 99801-1182

Dear Representative Samuels:

As requested in your letter dated December 5, 2007 the Alaska Department of Fish and Game (ADF&G) has identified potential impacts on fish and wildlife populations and their uses due to climate change. Climate change has the potential to positively or negatively impact species, their habitats and/or their food webs, and users of these resources. As a result, we believe management of targeted species may need to become more precautionary because of accelerated changes and increased variability in abundance (i.e., stable ecosystems require the least precaution). Specific impacts we have identified to date are summarized below.

We are currently in the process of prioritizing these impacts and developing budgets to address identified priorities. Unfortunately, we have not progressed sufficiently in this process to report on potential costs. It is our plan to submit needed budget increments to the legislature as part the ADF&G normal budget cycle of future years department budget requests.

Likely Impacts to Commercial, Recreational, and Personal Use Fisheries

- Geographic boundaries of areas opened or closed to fishing may need to be revised as stocks shift in distribution (e.g., northward movement of stocks into the northern Bering Sea and southern Chukchi Sea).
- Extended economic losses are possible as traditional target stocks change in relative abundance and location (e.g., northwestward movement of Bering Sea pollock). This could result in a drop in fish tax revenues, as well as income to fishers and CDQ groups. Economic opportunities may arise, but there may be a time lag prior to capitalizing on these.
- Increases in predatory fish (e.g., arrowtooth flounder, mackerels) may lead to lower guideline harvests for targeted fish (other groundfish and salmon).
- Ocean acidification due to CO_2 buildup may seriously disrupt shell formation in crab, shrimp, and other shellfish, potentially leading to collapse of shellfish fisheries in the long-term. Acidification could also impact zooplankton development, thereby affecting fish survival of species (e.g., sockeye salmon) dependent upon zooplankton.
- The potential for decreased production of some recreationally targeted fish stocks and increases in others may necessitate geographic realignment of fisheries and adjustment of management plans.
- Changes in stream flows and water quality may alter fish species distribution and composition. It could also alter the type and quantity of fish habitat that could impact ecosystem

productivity. Instream flow needs for fish and wildlife and their uses will also need to be reevaluated.

- Access by anglers to waterbodies may improve, degrade, or change significantly as climate changes the extent of wetlands drainage basins. Managers will need to anticipate and mitigate for these changes.
- Fishery managers will need to increase efforts for prevention, monitoring, and control/eradication of invasive species that will be expanding their ranges or those newly arriving.
- Fishery regulations will need to adapt to a longer open water season, allowing for potentially higher harvest rates on some recreational fish stocks.
- Requests for stocking of non-native fishes that are better adapted to warmer water temperatures (e.g., walleye) will need to be considered and policy decisions made regarding these requests.
- New assessments of fish habitat (e.g., anadromous waters or fish community data) will need to be prioritized and implemented to meet our statutory and regulatory responsibilities.
- Adjustments to outreach, education, and involvement programs will need to be made to inform and educate the public about changes in fish and fisheries (both good and bad) due to climate change.

Likely Impacts to Wildlife

- Changes in species distribution and behavior may necessitate adjustments of management plans and harvest regulations.
- New population survey and monitoring strategies may need to be developed; this may require research into new techniques.
- The effect of climate on wildfires is of great interest and concern, since over much of Alaska fire is the predominant habitat change agent and since our main big game species are fire-adapted in different ways. Similarly, we may see a trend where the boreal forest will transition toward grasslands, which would favor a different species mix.
- In the last couple of years the Board of Game has been faced with unusual regulatory requests for extended or extra late hunting seasons to compensate for people's observations that animals' (generally moose) movement timing and pattern have changed. This type of input from villages is anecdotal, and there is no way to know if it has been influenced by the increasing worldwide coverage of climate issues. However, DWC staff have agreed that in several cases, the weather patterns and seasonal temperatures have been unusual (late and warm) and would conceivably affect wildlife movements in the way described by the proponents of the late seasons. This could necessitate changing or adjustment of management plans.
- Changes in sea level and increases in storms and erosion could result in multiple effects:
    1. Coastal dependent species could lose low-lying habitats that are critical to their productivity and welfare. These include Pacific brant (Y-K breeding colonies, North Slope molting areas, critical Izembek fall staging), emperor geese (Y-K breeding, molting), cackling Canada geese (Y-K breeding/molting), spectacled eiders (Y-K breeding).
    2. Low-lying coastal staging areas that support millions of shorebirds, geese and ducks during spring and fall staging could degrade. Key examples: Stikine Delta; Copper River Delta and barrier islands; Cook Inlet marshes; Alaska Peninsula flats at Pilot Point, Nelson Lagoon, Izembek Lagoon; Y-K Delta coastal flats and marshes; Safety Lagoon near Nome; Kotzebue Sound lowlands; North Slope salt marshes and onnected lakes from Elson Lagoon, Teshekpuk Lake, Colville Delta, Sagavanirktok Delta, Canning Delta, and low barrier islands.

3. There could be positive changes for dusky Canada geese if brackish/salt intrusion is restored to the Copper River Delta (reversion to graminoid sedge marsh from current shrub/forest succession).
4. Changes could occur in marine productivity (sea temps, nutrient distribution, forage fauna, benthic communities). This could affect food webs important to bird species. Examples include critical clam beds used in winter by the world population of spectacled eiders; impacts on Izembek Lagoon affecting eel grass for brant and fish, benthos for Steller's eiders; marine inverts for shorebirds; loss of productive coastal shoals used by 100,000s of sea ducks.
5. Very little information on trends in environmental variables is available, and we have no basis for projecting changes--or deciding whether they will be positive or negative. Changes can be modeled, but the availability of regional and local weather data is key. We need to support the efforts of other agencies (like the National Weather Service) to obtain better information.
6. Changes in climate could warm interior Alaska river basins. These basins are tremendously productive for ducks because of extensive wetland expanses in river valleys, and the dynamics of river flooding and periodic fire. Wetland diversity is changing as permafrost melts and shallow wetlands dry; if river flows are altered--especially seasonal flooding--low habitats could be lost and productivity could drop; increased fire frequency could affect (+/-) nutrient inputs to riparian systems.

- It will be important to monitor species expanding their ranges into Alaska that could impact hunted species and other wildlife with conservation concerns.
- Changes to general climate patterns and phenology of seasons could have major effects (+/-) over the long term. Breeding success of geese is mostly controlled by the timing of snow melt and mild weather. If spring storms or flooding make breeding more risky, production drops; conversely, far north species controlled by spring weather (early = boom; late = bust) could benefit--snow geese could increase rapidly, eiders could succeed more. In theory, dabbling and diving ducks usually centered in the prairies could increasingly succeed farther north; currently many (e.g., pintails) come to Alaska when prairies are bad, but do not produce much. The latitudinal range of productivity could shift north (not a bad thing), but although the weather may be better, environments would have to become more productive to provide food, brood-rearing conditions, and staging wetlands.
- Climate change outreach and education currently is underway, but may need to be expanded to include additional target audiences.
- Alaska's Comprehensive Wildlife Conservation Strategy was developed to assess species at risk throughout Alaska due to a variety of factors, including climate change. The Species Templates included in the strategy identify specific conservation actions relating to climate. A major contribution to the management of identified species of greatest conservation need would be to model potential impacts of climate change on the habitats that support these species.

Likely Impacts to Subsistence Users

- The degree of adaptation in subsistence practices and reliance may change over time due to climate change. To assess potential impacts it will be necessary to monitor economic parameters that characterize the mixed cash-subsistence economies of rural Alaskan communities. The degree of potential effects to rural economies, especially if salmon are adversely impacted, could mirror the economic disasters declared in the previous decade.
- Environmental monitoring will be needed to document the degree of changes in conditions that may affect populations of wildlife and stocks of fish upon which subsistence users have customarily relied. Some examples follow:

1. Changes in freshwater and near shore hydrological conditions may increasingly impact species, populations, and life cycles of fisheries and wildlife resources customarily harvested. Monitoring will be needed to assess changes in water volumes, water courses, currents, distribution and duration of winter ice, and other characteristics that influence abundance and availability of species important to subsistence harvests. Examples include traditional knowledge indicating changes such as lakes drying up, lakes draining, river flows significantly changing, and other dynamic variables such as water temperature that may affect spawning, migration, disease susceptibility, and other aspects of fisheries population biology and management for harvests. Subsistence uses of fish, large mammals and migratory birds may all be affected by such changes.
2. Various hydrological changes can significantly affect subsistence users' access to harvest of either fish or wildlife. Examples include recent incidence of historically low water in interior Alaskan locations such as McGrath. Such conditions may increase or recur more frequently if future years' conditions include less snow and melt water to replenish rivers and lakes to historic flows or levels. Changes in the seasonality of events such as river freeze up and break-up are having significant impacts on subsistence users' opportunities for customary and traditional uses of fish and wildlife.
3. Changes to terrestrial conditions also can be expected to influence availability of wildlife and fish species to harvest, as well as access to harvests. For example, if wildfires increase in frequency and extent, winter range for caribou and moose, as well as riparian buffer zones, may be adversely impacted over larger areas and result in longer recovery times than in the recent past.
4. Range extensions of more temperate plants and animals also may impact subsistence resources and resulting harvests. Monitoring and assessment of changing distribution patterns will be detected in community harvest surveys, as well as biological inventory and monitoring studies. For example, Chinook salmon are reportedly showing up in North Slope subsistence net fisheries, in which they damage the type of gear customarily used for the smaller fish historically present, but also may represent a developing fishery. We also have received reports of cutthroat trout being caught on the lower Kuskokwim River.

- Monitoring of subsistence harvests at the community level is needed to assess harvesting adaptations to changing conditions and flux in available fish and wildlife resources to harvest. Subsistence practices are fundamentally adaptive and need to be monitored to determine the variability and extent of adaptive uses of fish and wildlife resources. For example, hunting marine animals on sea ice has already been changing significantly in arctic regions where nearshore ice no longer persists for much of the traditional harvesting season.
- Evaluating the levels of confidence needed to detect and monitor change is a critical scientific need for any programmatic effort to assess biological or harvest-related changes associated with climate change.

If you have any questions regarding this information, please feel free to contact Mr. Ken Taylor at (907) 267-2228. Thank you.

Sincerely,

Denby S. Lloyd
Commissioner

STATE OF ALASKA

DEPT. OF TRANSPORTATION AND PUBLIC FACILITIES
OFFICE OF THE COMMISSIONER

SARAH PALIN, GOVERNOR

3132 Channel Drive
Post Office Box 112500
Juneau, Alaska 99811
Phone: 907-465-8365
Fax: 907-465-3900

February 13, 2008

The Honorable Ralph Samuels, Chairman
Alaska Climate Impact Assessment Commission
State Capitol, Room 204
Juneau, AK 99801-1182

Dear Representative Samuels:

This is in response to your December 14, 2007 letter requesting department input regarding budgetary impacts and engineering and construction considerations from perceived climate changes involving flooding, erosion, and permafrost degradation.

The Department of Transportation and Public Facilities (DOT&PF) manages the State's transportation infrastructure in a very challenging environment with many of the State transportation facilities in the Alaska's interior, northern, and southwest region's underlain by ice-rich permafrost. The department has been battling the effects of warming/melting permafrost for decades. Our Maintenance and Operations Divisions spend an average of $10 million annually to combat melting permafrost on our highway system. The $10 million annual figure realistically represents only a fraction of the actual need and therefore this cost may need to increase, perhaps dramatically, if the recent warming trend continues. However, at this point, the department does not have or collect the data necessary to accurately account for permafrost mitigation costs for our entire transportation infrastructure or predict supplemental costs associated with the future impacts of climate change. Doing so would require changing the department's current practices and a significant investment in additional resources. Damages to the public infrastructure could be large, but there is little reliable information detailing the degree and location of impacts.

As part of our mission to manage the State's transportation infrastructure, we have assessed the potential future effects of climate warming trends. Provided below is a list of potential impacts to department's transportation infrastructure and our operations if the climate warming trend continues.

- A longer seasonal transition period from Fall to Winter and Winter to Spring may require a different and potentially more costly approach to snow and ice control.
- The longer seasonal transition may lead to changes in weight restriction policies - both in terms of weights allowed and the length of time the restrictions will be in place.

- An increase in the rate of degrading permafrost is likely to increase highway and airport surface distress requiring an increase in both maintenance and capital expenditures to address the resulting safety problems. In some cases this may require the reevaluation of current design, construction and maintenance practices.

- The majority of roads in the interior, particularly around Fairbanks and north of Fairbanks, traverse areas underlain by ice-rich permafrost and will likely require substantial rehabilitation/ reconstruction and/or relocation if the warming trend continues.

- Increased Active Layer Detachments (slope sloughing and failures) on slopes adjacent to the highway system that result from the thawing of ice-rich surface layers. The thawing of these ice-rich slopes leads to a form of mass wasting. The potential for damage to the highway infrastructure is high and will require a pro-active geotechnical approach to prevent impacts to the transportation system. Even in less extreme instances, the mud-flow sloughing of cut banks fills ditches and plugs culverts, which will result in higher maintenance costs.

- A significant percentage of our airports in northern, western and interior Alaska are built over permafrost that will require significant rehabilitation/reconstruction and/or relocation if their foundations thaw.

- A number of our public buildings in northern, western and interior Alaska are built over permafrost that will require significant rehabilitation/reconstruction and/or relocation if their foundations thaw. These facilities include the majority of M&O maintenance stations.

- Embankments built over permafrost will need to be thicker to prevent the underlying ground from thawing. This will add to the cost of rehabilitation and reconstruction as more fill materials will be required.

- The continued warming trend will likely result in the increase in erosion of shorelines and riverbanks which will impact any facility constructed adjacent to the waterbody.

- Aufeis problems will likely increase as melt water flows out of warming zones of permafrost, requiring additional maintenance.

- Glacial fed rivers and streams will likely experience increased flows with the potential for flooding and the cutting of new, unanticipated stream channels. Highways such as the Copper River Highway and segments of the Richardson Highway may experience increased flooding requiring larger culverts and/or larger bridges.

- An increase in the frequency and severity of hot days could result in more highway and airport problems related to asphalt softening and traffic-related pavement damage and rutting.

- Milder winters, with more freeze-thaw cycles, would accelerate road deterioration and increase maintenance costs.

- If the timing, frequency, form and/or intensity of precipitation change in the future, then related natural processes, including debris flows, avalanches and floods, would likely increase with the resulting effect of increased repair costs.

- Coastal communities and their infrastructure are vulnerable to accelerated coastal erosion due to storm activity and wave action eroding shorelines once protected by shore-fast sea ice. As the climate continues to warm, coastal erosion will increase as sea ice retreats and coastal storms become more frequent.

- Coastal communities and their infrastructure are vulnerable to a rise in the sea level. A rise in the sea level could result in the required relocation on many public facilities as well as entire communities.

- As the Geophysical Institute has determined, warming temperatures are altering the blend of vegetative growth on the North Slope of Alaska. Extending this affect to all of Alaska leads to the conclusion that we may well face increased vegetation throughout our more northern areas, and face increasing demands for vegetation management that have never cropped up before.

- The slowly increasing temperatures being forecast by scientists will allow a variety of invasive plants to prosper in Alaska, which will pose new challenges and demands on our maintenance forces.

- The climatic warming trend, combined with an increase in transportation energy costs, will probably lead to alterations in the current vehicle "mix" (i.e., personal automobiles versus mass transit; buses and trains). Our transportation system is not well adapted to a dramatically different vehicle mix than has been experienced over the previous 50 years.

- The maintenance and operations fleet is totally dependent on the combustion of diesel - now shifting to ultra-low sulphur diesel. When viewing these vehicles in the sense of their carbon footprint, we are considering what tomorrow's fleet will be comprised of.

The department is currently assisting several communities that have already been affected by changing climate conditions. The department is actively involved in planning for designing and/or constructing shoreline protection, facility relocation, drainage improvements, and permafrost protection measures. We have active projects in Kivalina, Newtok, Kotzebue, Nome, Unalakleet, Shishmaref, Noatak, Allakaket, and Alakanuk.

To date, the department has not systematically studied the need for or implemented specific changes, policies or regulations to address the potential effects of climate change. At this point in time, we do not have the available data to accurately assess and determine required policy or procedural changes. As stated above, climate change can potentially impact the transportation infrastructure in a multitude of ways – melting/warming permafrost, sea level rise, increased river and shore erosion, increased scour of bridge foundations, increased storm frequency and

intensity, and increasing temperatures. We need to increase the collection and density of data ranging from stream flow records, precipitation and other weather related data records, geotechnical and foundation information, hazards mapping, and other hydrologic data. Our engineering staff needs the appropriate level of data to predict and determine more effective approaches for adapting to changes in climate. As an example, increased precipitation and runoff, storm intensities, and sea-ice conditions will potentially require new and/or revised hydrologic calculations for sizing culverts, designing bridges and their foundations, and erosion control structures. However, at this stage, we are lacking sufficient meteorological information to recommend changes in our planning and engineering processes.

The department will continue to address the impacts of climate change as they occur and will continue to investigate alternative design, construction, and maintenance techniques to address the changing environment that we work in. Right now we need accurate data to be able to design for future impacts to our transportation assets. By partnering with the University of Alaska and other State and Federal agencies we are addressing the most immediate needs for communities already being impacted and identifying the critical information we need to gather to be able to address future impacts of climate change.

Sincerely,

Leo von Scheben, P.E., L.S., M.B.A.
Commissioner

cc: Larry Hartig, Commissioner, Department of Environmental Conservation
Frank T. Richards, P.E., Deputy Commissioner of Highways & Public Facilities, DOT&PF
Mary Siroky, Legislative Liaison, DOT&PF

STATE OF ALASKA

DEPT. OF ENVIRONMENTAL CONSERVATION
OFFICE OF THE COMMISSIONER

SARAH PALIN, GOVERNOR
410 Willoughby Ave., Ste 303
Post Office Box 111800
Juneau, AK 99811-1800
PHONE: (907) 465-5066
FAX: (907) 465-5070
http://www.dec.state.ak.us

February 15, 2008

The Honorable Ralph Samuels
Chair, Alaska Climate Impact Assessment Commission
Alaska State Capitol, Room 204
Juneau, AK 99801-1182

Representative Samuels:

Your letter of December 20, 2007 is a welcomed opportunity for the Alaska Department of Environmental Conservation (DEC) to provide relevant information for consideration by the Climate Impact Assessment Commission. I appreciate this opportunity and offer any further assistance you believe might be helpful to the Commission in finalizing its report.

You may recall that various DEC directors testified before the Commission last January. We continue to progress in our understanding of climate change issues. The predictions presented in this letter capture our current assessment of potential near-term and potential long-term impacts. While today's communication goes beyond the issues we presented last January, the Commission may wish to refer to the January 2007 presentation for the additional value gained from its photos and charts.

In this letter we describe the possible impacts on DEC's environmental management duties and projects. We also note possible impacts on community and private sector interests. Identifying future costs associated with projected impacts is speculative, but we can confidently say there will be impacts. The data and models to project climate change and forecast its impacts in our geographically expansive and ecologically diverse state are quite immature. Undoubtedly, the scientific data and projections tools of the future will markedly improve our ability to understand and forecast the climatic changes and associated impacts in Alaska.

Key Near-Term Impacts for the Department of Environmental Conservation

- **Threats to community infrastructure.** Erosion and permafrost thawing / subsidence have and will continue to threaten state, community and private sector investments. For DEC, direct state investments are numerous public drinking water and sewer systems with piping and associated treatment facilities.

Private sector or community based investments include shore-line based fuel delivery, storage and electrical power generation.

DEC is addressing these threats through prevention and adaptation strategies. DEC has already assisted villages through feasibility studies and master plans that address the mitigating actions needed to prevent damage caused by climate change to their water and sewer systems. Also, DEC has started adapting to changes in climate by proposing alternative design approaches to reduce and eliminate risks to future facilities, such as the Buckland Piped Water and Sewer Project. As a point of reference, the community of Newtok (70 homes) is relocating to a new site of Martarvik. DEC's village safe water program estimates a new water and sewer infrastructure will cost $12 to 21 million depending upon the type of system and design details.

DEC's spill prevention and response workload is also increasing due to increased risk of fuel spills where erosion or thawing threatens the structural integrity of fuel storage tanks and piping systems. The most recent example was last fall in Kivalina when several fuel storage tanks had to be emptied and relocated inland at a cost of $575,000 to the Alaska Village Electric Cooperative.

- **Oil spill risks in new areas.** DEC and other agencies are witnessing increased marine vessel traffic in the Northern Bering Sea and the Chukchi Sea. Receding sea ice is opening the waters for greater use by the merchant marine trade. In a nutshell, the Bering and Chukchi seas are becoming active year-round marine waterways supported by the northern expansion of commercial fisheries, a strong interest in off-shore petroleum exploration and development, and a stronger reliance on merchant marine operators to support the industrial and community needs of northwest Alaska and Siberia. Many marine operators in these areas currently do not have the spill prevention and response plans. Moreover the region generally lacks the equipment resources and support services comparable to those in the Alaska gulf coast, Prince William Sound and Cook Inlet areas. We expect DEC's spill prevention and response workload to increase along with the need for private sector based supporting operations and facilities. In order to fully evaluate the risk posed by maritime transportation expansion in the arctic, a risk assessment similar to the one currently underway for the Aleutians may be necessary. The Aleutian risk assessment is estimated to cost $3.2 million dollars, which does not include costs for implementing risk mitigation measures.

- **Wildfires are increasing smoke pollution, changing the forest ecology and threatening safety of life and structures.** Major increases in the number, size and season for wildfires were documented in 2004 and 2005 as presented in DNR's response. For DEC, wildland fire smoke is now a far more frequent and serious public health threat for residents throughout Alaska. Smoke pollution conditions in the summer of 2004 were classified as "hazardous" in Fairbanks and other interior villages with pollution exposure far worse than most of the dirtiest cities in the U.S. Some people left town for short or seasonal respites from

the pollution. Since 2004, DEC has shifted 2 staff positions to fire support, hired new pollution forecasting expertise, purchased mobile air monitoring systems and now routinely engages in smoke pollution forecasting and portable monitoring during the fire season.

We are unable to quantify what the health costs are to Alaskans in the form of increased doctor visits, increased use of medication, new illnesses caused by this pollution or number of people experiencing respiratory incidents (i.e. asthma attacks) triggered by fire smoke. What we can say is that recent medical science shows far greater health impacts from fine particle pollution (the primary pollutant of concern in smoke) than previously thought. The medical research stimulated EPA to tighten, by approximately 50%, the national health standard for airborne fine particles in 2006.

Smoke pollution also impacts the state's tourist industry causing potential health risks to visitors, reducing vistas and visitor enjoyment of Alaska

- **New pathogens in animals, fish, wildlife, commercial foods and crops.** The combination of a global economy and a warming climate brings new species to our state, some of which directly affect the foods we consume and the food products we sell. New infectious diseases (viruses, bacteria, fungi) and parasites will find a naïve vulnerable population unable to defend itself against the invasion. Impacts to aquatic and terrestrial ecosystems will result in subsequent impacts to people, plants and animals. Some naturally occurring species, such as spruce bark beetles, can have a far greater consequential impact to the ecology when a warmer environment supports greater survivability and propagation. Colder temperatures were once protection from pathogens such as West Nile Virus (affecting birds, horses, and caribou), Blue tongue (virus affecting sheep, deer, caribou and cattle), Viral Hemorrhagic Septicemia Virus (viral disease of fish), Ichthyophonus Hoferi (parasite infecting salmon) and Cryptococcus Gatti (tropical fungus affecting both animals and humans, now found in the Pacific Northwest and Vancouver). We are now finding infections caused by these diseases in animals and people farther north than ever previously reported.

  DEC's environmental health laboratory is responsible for ensuring the safety of our food products. The state veterinarian, located at DEC, is responsible for the safety of domestic animals and advising and protecting the public from diseases carried by wild animals, fish and birds. As noted in the Health Department letter, the 2004 shellfish outbreak of *Vibrio parahaemolyticus* was linked to warmer ocean waters. Warmer temperatures are associated with an increase in the detection of saxotoxins, like paralytic shell fish poisoning, in Alaskan shellfish. These outbreaks cause significant economic harm to aquaculture and place an increased workload on DEC for laboratory testing of shellfish. DEC's work includes coordination with the Health department on numerous advisories to minimize public exposure to these threats. It is reasonable to expect that Alaska

will witness increasing incidences of other infectious diseases, such as West Nile virus, as the climate continues to warm.

- **Warmer freshwater systems and estuaries are threatening the health and productivity of our fisheries**. A changing climate is raising the water temperature of our lakes, streams, rivers and estuaries. DEC implements water quality standards by setting temperature limits to protect the spawning and rearing habitat of salmon and other fish.

  A decade long measurement program of Kenai Peninsula area streams and rivers shows rising temperatures during spawning season that approach and exceed the established standard. Part of the warming is due to a spruce forest die-off resulting in loss of shade over stretches of the waterway causing increased sun exposure and air temperatures. The spruce forest die-off caused by a bark beetle infestation has been linked to a warmer climate. Many silvaculture scientists believe our spruce forest is ecologically giving way to grasslands.

  The data collection is most robust for Kenai area waterbodies. Although DEC also has other stream temperature data (mostly in the Cook Inlet region), it is not sufficient to assess the overall state-wide trends for water temperature increases, or to assess the statewide threat for salmon habitat. Warmer waters in coastal Alaska may be one factor explaining the observed northern migration of some salmon and other fish species. DEC's Division of Water is working with DFG and DNR in the Alaska Clean Water Actions (ACWA) program to prioritize and establish long-term water monitoring efforts to track temperature changes over time. Through ACWA, DEC will develop strategies and decision making tools for waterway protection to mitigate some of the impact of stream-side ecological changes.

  It is yet more challenging to assess the water quality and subsequent threat to fish habitat that may result from changes in precipitation patterns, glacier melt rates and resultant heavy rivers flows and water quality and downstream salinity conditions in our coastal estuaries. Coastal estuaries are prime rearing and maturing grounds for commercial and subsistence fisheries. The climate change models foretell that changes are underway, but the projections of the global climate models are simply not mature enough for projecting changes at sub-regional scale within Alaska. To be able to assess consequences for our freshwater systems and coastal estuaries, DEC will be determining and monitoring key climate change indicators

- **Field monitoring of baseline conditions is essential for future decisions**. Because there will never be sufficient financial resources to address all of the adaptation needs as warming continues, wise decision making will be a triage of assessing and re-assessing the most urgent needs for decades to come. It is imperative that field measurements be strategically undertaken and integrate with predictive scientific tools so that forecasted consequences of climate change can

be juxtaposed to field trend data. The combined result of applying the best forecasting models with real world field data will minimize the misdirection of funds and improve the potential for addressing the most consequential impacts in a timely fashion. The letters from other agencies, most notably DNR and DOTPF, reinforce the importance of baseline field data.

- **Climate Change project is affecting DEC's staffing.** As the chair agency for the Governor's Sub-cabinet on Climate Change, DEC has shifted duties for a few key staff to undertake this planning project. The Commissioner has re-directed some staff assignments but has not added new staff for this project. Much of the work to be accomplished in FY 2008 and 2009 will be done with the aid of work groups consisting of agency staff and members of the public. Logistical and technical support will be provided to the work groups by the University of Alaska, agency staff and through contractors largely financed by available grant funds. A supplemental budget request by DEC for $230,000 was recently submitted to the Legislature. This funding request will leverage in excess of $1 million available through grant sources. The supplemental budget request does not include monies for DEC staff funding and no new positions are created.

  The Commissioner and the Director of the Division of Air Quality are the Governor's observers for the Western Climate Initiative (WCI). Under the WCI a growing number of western states and Canadian provinces have agreed to design a cap and trade program to reduce greenhouse gas emissions in all 'partner' states and provinces. The WCI forum is important because it is a large block of states designing the substantive details of a legal framework for climate change laws. These legal foundations may also become some of the underpinnings surfacing in federal bills. If Alaska is to have an influential voice in this forum, it would be necessary to increase the state's investment of time in this process. A good understanding of any cap and trade program will aid the State of Alaska in considering whether to join the WCI as a "partner" and in evaluating similar cap and trade programs that might be part of proposed federal legislation. A good understanding of regional and national discussions on greenhouse gas emissions, and possible alternative "cleaner" energy sources may provide valuable input into an integrated energy policy for Alaska.

  It is expected that Congress will enact climate change legislation in the next one to three years. When enacted, the legislation will likely add significant new work at DEC. Most predictably, but not exclusively, in air quality permitting to manage greenhouse gas emissions. However, until the Congressional debate is further matured, it is not possible to provide a firm projection of the workload increase, but we know it will increase.

- **Climate Change laws could positively affect market demands for Alaska natural gas, renewable energy growth and clean fuels from coal.** All bills under discussion in Congress, in one manner or another, reduce carbon emissions from fuel combustion. A carbon constrained fuel market will favor low

carbon natural gas and likely increase the U.S. demand for gas through reduced reliance on coal and oil fuels. Other financial incentives considered in federal legislation may favorably reduce or subsidize development costs for renewable energy projects suitable for rural and urban / railbelt Alaska. Alaska has a large, unrealized potential for wind, hydro and geothermal energy that could favorably benefit from congressional incentives. Alaska's coal resources, especially Cook Inlet area, could also favorably benefit through incentives for new clean coal technologies where sequestering the coal's carbon as it is gasified or combusted with subsequent injection into mature oil reservoirs could eliminate greenhouse gas emissions while improving oil field production. The coal sequestration work is gathering much attention nationally, but retains some technological challenges before we expect widespread use.

- Adaptive management will be necessary in DEC's programs. Where changes in environmental conditions are more rapid or severe, it may be necessary to use an adaptive management and permitting strategy to account for these changes in DEC's oversight of the management and disposal of hazardous substances. For example, additional monitoring requirements, which could financially impact permittees, might be required to track alterations a given discharge will have on a changing receiving environment. Changing climate forces will alter the scientific, engineering and health basis for other decisions routinely made by DEC. We expect this to be an adaptive process.

Key Long -Term impacts for the Department of Environmental Conservation

The impacts listed below are possible outcomes of an extended period of warming and other climate forcing parameters beyond the next one to two decades. These projections are speculative, based upon the early inferences about longer term consequences and appropriately warrant a more thorough review with the advent of greater confidence in the predictive models for a changing climate.

- Increased incidents of community, industrial or military landfill sites becoming exposed to surface waters or marine waters through melting permafrost, failure of freeze-back engineering designs, or erosion induced by sea level rise, river floods or storm waves – a public health and environmental contamination risk.

- Increased risk of oil spills in the Beaufort Sea and Arctic Ocean from offshore development and international marine traffic as the Northwest Passage becomes a viable year-round sea route – increases the demand for spill prevention planning and response capabilities at government and private sector operations. Particular emphasis will need to be put towards prevention planning.

- Significant changes in watershed hydraulics with expansive melting of permafrost dominated watersheds could result in large influences to water quality and fish

habitat as permafrost gives way to percolation and aquifer systems hydraulically connected to stream and river channels.

- Warmer temperatures may bring invasive species carrying new diseases increasing the risk of contamination of drinking water supplies.

- Climate change models predict a strengthening of weather extremes. Higher magnitude rain storms in some geographic areas may results in higher flood stages, greater eroding strength leading to water turbidity impacts, riverbank erosion and uplands flooding at river-side communities - resulting in loss of property, damage or failure of infrastructure, fuel spills and sanitation incidents.

- Warmer summer temperatures may result in more air pollution due to atmospheric chemistry reaction driven by temperature. Specifically, many U.S. cities experience seasonal ozone pollution, whereas Alaska is historically cool enough to avoid these photochemical reactions - may result in increased health incidents, greater restrictions or increase costs of pollution control for industrial operations and an expansion of state air pollution control rules.

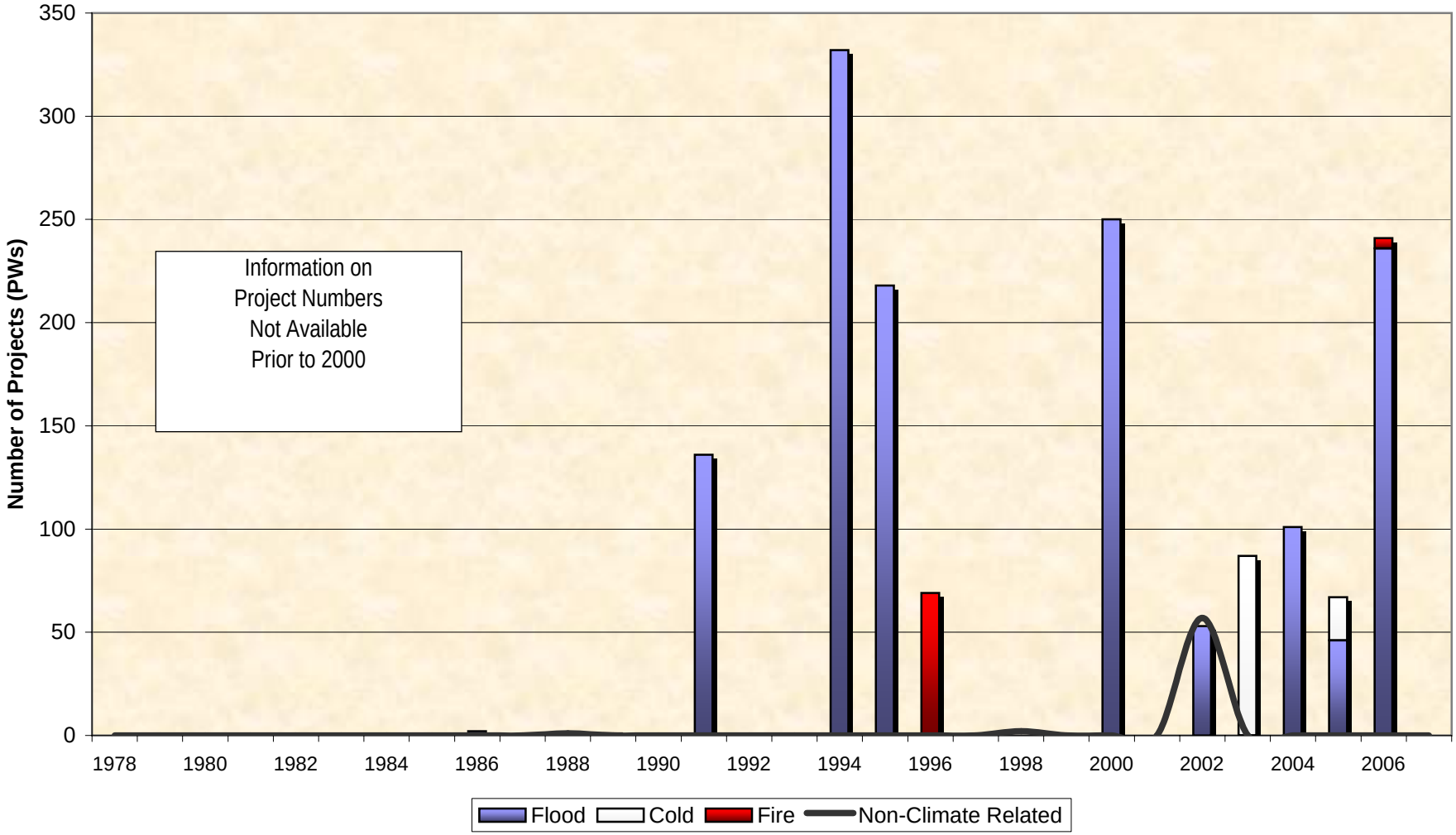
Please don't hesitate to contact me if you would like additional information.

Sincerely,

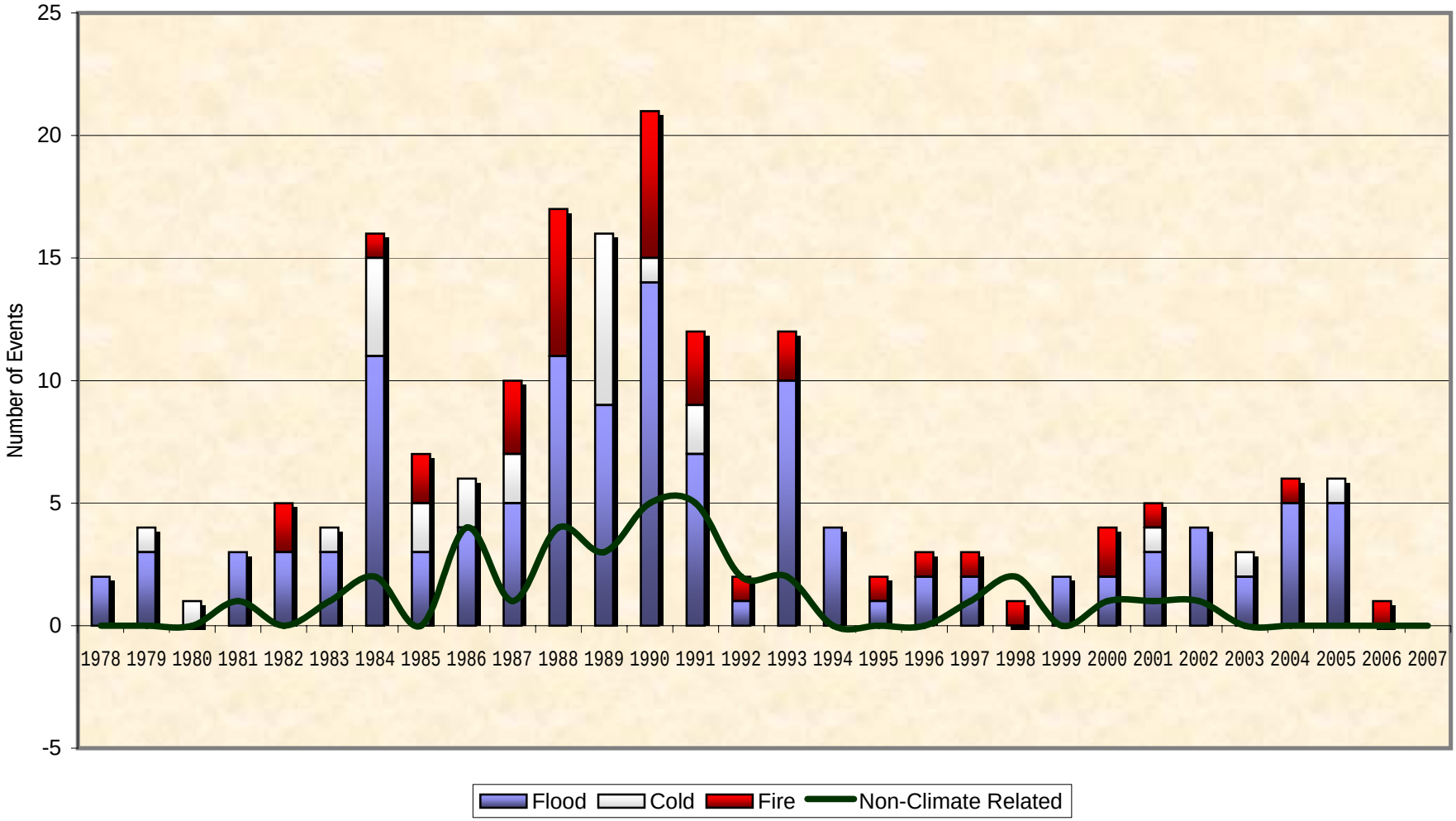
Larry Hartig
Commissioner

cc: Climate Change Sub-Cabinet Members

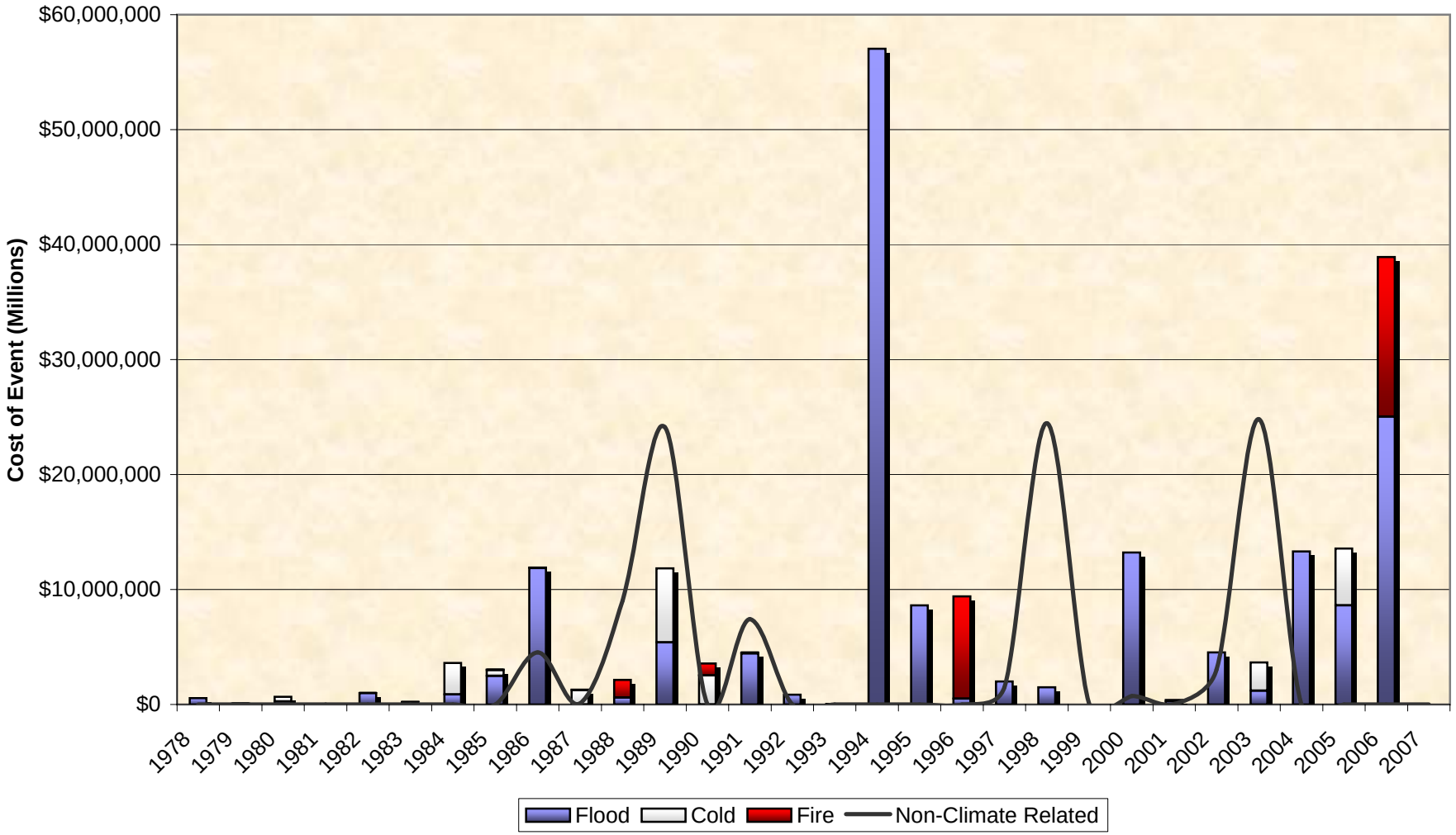
Comparison of Types of Climate-Related Public Assistance Project Numbers Totals to Other Projects:
Federal Declarations from 1978-2007



Comparison of Types of Climate-Related Disasters to Other Disasters: State Declarations from 1978-2007



Comparison of Types of Climate-Related Disaster Costs to Other Disaster Costs: State and Federal Costs from 1978-2007



Improved Projects, Alternate Projects and 406 Hazard Mitigation Procedures for Federal and State Disaster Assistance

(Provided by DHS&EM, State of Alaska)

A. The Public Assistance (PA) program under a declared disaster, whether State or Federal declared, provides State, Local and Alaska Native Village Governments and certain Private Non-Profit agencies (applicants) funding for permanent repair to infrastructure damages and reimbursement for Debris Removal and Emergency Response costs. State declared disasters are treated the same as Federal declared disasters with a few exceptions.

B. Disaster Assistance under the PA program for Federal Declared disasters:

(1) Separates small and large projects with different requirements for each.
(2) Allows for improved projects
(3) Allows for alternate projects
(4) Provides funding for disaster related mitigation efforts through the 406 Mitigation Program.

C. Disaster Assistance under the PA program for State Declared disasters:

(1) Does not separate small and large projects (all projects are treated the same),
(2) Allows for improved projects
(3) Does not allow for alternate projects
(4) Does not provide funding for disaster related mitigation efforts.

D. FEMA's Definitions for:

(1) Small and Large Projects

i. Projects are divided into small and large projects based on the monetary threshold established in Section 422 of the Stafford Act. The threshold is adjusted each fiscal year to account for inflation and published in the Federal Register.
ii. Small Project – is based on estimated costs, if actual costs are not yet available. Payment is made on the basis of the initial approved amount, whether estimated or actual. Even if not all funds are expended on the project, the Federal share amount is not changed.
iii. Large Project – is based on documented actual costs. When all work associated with the project is complete, the State performs a reconciliation of actual costs and transmits the information to FEMA for consideration for final funding adjustments.

> ***Note***: Under a State Disaster, reconciliation of actual costs is done for all projects regardless of dollar amount. All projects are treated the same.

(2) Improved Projects

i. When performing permanent restoration work on a damaged facility, an applicant may decide to use the opportunity to make improvements to the

facility while still restoring its pre-disaster function and at least its pre-disaster capacity. For example: FEMA has written a project worksheet for the applicant to repair a 2 mile stretch of gravel road, the applicant decides that now would be a good time to pave that road. This change would constitute an improved project and the Project Worksheet would be changed to reflect the applicants' decision.

ii. Funding for such a project is limited to the Federal share of the cost that would be associated with repairing or replacing the damaged facility to its pre-disaster design, or to the actual costs of completing the improved project, whichever is less, if the funding for the improvements cannot be separated from the costs for the original repair work.

iii. If the original facility is being repaired and improvements are being added, FEMA may provide assistance with hazard mitigation under Section 406 of the Stafford Act. These funds must be applied to the original facility. If the improved project involves a complete new facility on the same site or on a different site, FEMA cannot approve Section 406 Hazard Mitigation funding that may otherwise have been eligible for the original facility. For example: If floodwaters inundate a sanitary sewer, block manholes with sediment and damage some of the manholes, cost-effective mitigation to prevent blockage of the damaged manholes in future events may be eligible; however, work to improve any undamaged manholes that are part of the system is not eligible.

Note: Under a State Disaster, improved projects are allowed and the requirements are the same as FEMA's.

(3) Alternate Projects

i. An applicant may determine that the public welfare would not be best served by restoring a damaged facility or its function. In this event, the applicant may use the PA grant for that facility for other eligible purposes. Funds may also be used on more than one alternate project, and an applicant may request an alternate project in lieu of either a small or large project, but only on permanent restoration projects. The alternate project must serve the same general area that was being served by the originally funded project. The original facility must be rendered safe and secure, sold, or demolished. If an applicant opts to keep a damaged facility for a later or another use, it will not be eligible for FEMA funding in a subsequent disaster unless it is repaired to meet codes and standards, and mitigation measures that would have been approved are applied.

Note: Under a State Disaster, alternate projects are not authorized. DHS&EM is currently writing Regulations that could allow applicants to do alternate projects.

(4) Section 406 Hazard Mitigation

i. Hazard mitigation is defined as cost-effective action taken to prevent or reduce the threat of future damage to a facility. The applicant, FEMA, or the State may recommend that hazard mitigation measures be included in a Project Worksheet (PW). The costs of eligible hazard mitigation actions will be included in the overall funding of a project.

1. To be eligible, Section 406 hazard mitigation measures:
2. Must be appropriate to the disaster damage and must prevent future damage similar to that caused by the declared event.
3. Must be applied only to the damaged element(s) of a facility.
4. Cannot increase risks or cause adverse effects to the facility or to other property.
5. Must consist of work that is above and beyond the eligible work required to return the damaged facility to its pre-disaster design.
6. Cannot be applied to replacement buildings.
7. Applies only to structural measures and does not apply to buyouts.
8. No program-wide limits on funds, but each project must be cost-effective and approved by FEMA.

Note: Under a State Disaster, there are currently no provisions that allow for hazard mitigation measures.

STATE OF ALASKA

DEPARTMENT OF MILITARY AND VETERANS AFFAIRS

OFFICE OF THE COMMISSIONER

SARAH PALIN, GOVERNOR

P. O. BOX 5800
ANCHORAGE, ALASKA 99505-0800
PHONE: (907) 428-6003
FAX: (907) 428-6019

February 15, 2008

Representative Ralph Samuels
AK Climate Impact Assessment Commission
State Capitol #204
Juneau, AK 99801-1182

Re: Request for Information Relating to Climate Change

Dear Representative Samuels:

In response to your letter of December 20, 2007, the Department's Division of Homeland Security and Emergency Management (DHS&EM) has examined Legislative Resolve No. 49 and prepared an analysis describing actual and potential effects upon the division's roles and responsibilities related to events which may be associated, in part or whole, to a changing climate.

DHS&EM is observing an increase in community fuel shortage incidents. While not considered disasters or emergency events, DHS&EM maintains a high level of awareness of these issues in the event the shortages result in life, safety, or public infrastructure damage issues. The primary concern is the ability for riverine, coastal, and island communities to receive bulk fuel deliveries via barge. For riverine communities, the issue involves water levels and the ability for barges to travel upriver and make landings. For coastal and island communities, the issue involves the ability for bulk fuel deliveries to be made prior to the fall sea storm season. Although not disaster related, the economic impacts to communities that must fly fuel in when timely bulk fuel deliveries cannot be made are a recurring issue. In order to improve intergovernmental synchronization DHS&EM along with DCCED are developing an annual coordination program, to be conducted in the June timeframe, to allow communities, bulk fuel providers, and state agencies that provide energy and fuel assistance to assist in the development of a coordinated approach to bulk fuel deliveries, and to develop a system of indicators and warnings as a result of bulk fuel delivery disruptions due to seasonal and climatic events.

Trends show a significant increase in costs for disasters over the last 16 years along with a rising number of repair projects. These rising trends may indicate potential increased response and recovery costs to DHS&EM. A list of potential disasters appears below:

- **Coastal Erosion:**
  Coastal erosion is the wearing away of land resulting in loss of beach, shoreline, or dune material and is effected by waves, currents, wind, coastal storm surge, coastal storms, and flooding. The most dramatic erosion often occurs during storms, particularly because the highest energy waves are generated under storm conditions. Sea / shore ice serves as a

barrier and protection for coastal land from adverse weather. Climate change that diminishes the sea /shore ice thickness or longevity can dramatically effect costal erosion. Climate change that results in sea-level rise can also effect coastal erosion.

- **Storm Surge or Coastal Floods:**
  Storm surge occurs when the sea is driven inland above the high-tide level onto land that is normally dry. Often, heavy surf conditions driven by high winds accompany a storm surge adding to the water's destructive-flooding force. The conditions that cause coastal floods can also cause significant shoreline erosion as the flood waters undercut roads and other structures. Winds maintained from roughly the same direction over a long distance across the open ocean (fetch) contribute to storm surge. Thin or absent shore and sea ice significantly contribute to the costal erosion and damage from coastal storm surge.

- **Flooding:**
  Flooding may be related to climate change when waterways are altered due to ice jams or erosion changes when there is a change in rainfall-runoff, snowmelt, lake levels, ground water tables or glaciers, when there is storm surge flooding (see above):

- **Ivu:**
  Ivu, also called an ice override, occurs when floating sea ice is pushed ashore by wind. The ice usually over-rides the beach a few tens of feet inland. Ivu may be related to climate change because the sea ice thickness, age and longevity are influenced by changes in climate. The latest Ivu occurred in January 2006, where 400 miles of sea ice started to move inland near Barrow. This developed a wall of ice 20 to 40 feet high that stopped just short of destroying a major road and adjacent power lines.

- **Severe Weather:**
  Climate change could possibly increase storm frequency and intensity including wind, thunderstorms, lightening and precipitation.

- **Permafrost:**
  An increase in temperature from climate change could result in areas of permafrost melting with the result of unstable ground. Inland permafrost thaw could affect the State transportation and infrastructure with collapsed roads, shifted railroad tracks, and building supports constructed on melting permafrost.

- **Wildland Fire:**
  Should climate change result in an increase in temperature, decreased rainfall and drought there could be a corresponding increase in wildland fire activity.

All of the potential disasters listed above have current and potential effects on the citizens, natural resources, public health, and the economy of our state.

Since 1978, Alaska has declared over 226 disasters totaling a cost of over $378 million. Below is a list of the natural disasters and the total cost from 1978-2007:

- Flood, storm, landslide, and avalanche – over $250 million
- Wildland fire – over $42 million
- Earthquakes accounts – about $30 million
- Freezing Cold/Wind – over $22 million

Of the over $378 million expended, individual assistance accounted for over $35 million while and public assistance accounted for over $294 million. Refer to the attached document **Summary Data.pdf.**

The rapid warming Alaska is already experiencing is bringing substantial ecological and socioeconomic impacts, many of which result from thawing permafrost or melting sea ice. Permafrost underlies most of Alaska, and the recent several decades of warming have been accompanied by extensive thawing, causing increased erosion, landslides, sinking of the ground surface, and disruption and damage to forests, buildings, and infrastructure. Warming is also likely to impair transport by shortening the seasonal use of ice roads.

Retreat of sea ice allows larger storm surges to develop, increasing the risk of increasing erosion on coasts that are also made vulnerable by permafrost thawing. In some regions, shorelines have retreated more than 1500 feet due to erosion, over the past few decades.

The most current disaster with the specific circumstances of flooding and erosion that have affected life, property, economic and resource development in the state is the 2007 Kivalina fall sea storm. In this disaster the community was evacuated, sustained damage to the sea wall, and imperiled the loss of structural integrity for the fuel storage tanks owned by Alaska Village Electric Cooperative (AVEC) – all due to rapid erosion. Since 2002 this community alone has been involved in four other declared disasters.

- 2002 Northwest Fall Sea Storm (AK Disaster 03-201) – funds provided to the Community of Kivalina through the Northwest Arctic Borough (NWAB) for emergency protective measures.
- 2004 Bering Strait Sea Storm (FEMA Disaster DR-1571-AK) – funds provided to AVEC, the Community of Kivalina, and the School District for emergency protective measures, power line repairs, and movement of the principal's home. Permanent repairs to the sea wall were not approved.
- 2005 West Coast Storm (FEMA Disaster DR-1618-AK) – funds provided to DOT&PF, AVEC, the Community of Kivalina, and the School District for emergency protective measures, airport runway repairs, and relocation of the principal's home.
- 2006 October Kivalina Sea Wall Damage (AK Disaster 06-222/AO 231) – funds provided to NWAB, AVEC, and the Community of Kivalina for emergency response and emergency protective measures, not to include permanent repairs to or replacement of the seawall.

Other than Kivalina, the Village of Alakanuk has experienced recurring ice jam flooding. On June 13, 1984 Alakanuk experienced ice jam flooding which damaged the village road system. The State of Alaska funded a public assistance disaster grant to repair the damaged road. Since then, Alakanuk received in 2004 a grant for $278,530 to relocate and elevate 15 residential structures and one city structure to locations that were less susceptible to the seasonal flooding from the Alakanuk slough of the Yukon River. Although we enumerate but a few communities, there have been many disasters possibly related to climate change that have affected numerous cities and villages in the interior and coastal regions of Alaska.

State of Alaska DHS&EM has already taken steps to prevent and mitigate climate warming trends by: being involved in emergency and disaster response to flooding, sea storms, tidal surges and other natural and man-made emergencies; involvement with coastal erosion community relocation workgroups, planning and taskforces, training and education for climate change related emergencies including flooding, evacuation, storms surge, fuel spills; and involvement in Congressional and State Legislative and Executive Branch cabinets and working groups on climate change.

Local hazard mitigation plans, developed between Alaskan communities and the DHS&EM is also an alternative measure that is mitigating the effects of flooding and erosion within the State of Alaska. All communities with local adopted FEMA plans will qualify for federal grant money under the Hazard Mitigation Grant Program, and the Pre-Disaster Mitigation Program. Currently Alaska has 24 approved FEMA plans, and 50 plans that are under development through various communities and contractors. From Alaska Federal Disaster Declarations, Hazard Mitigation Grant Program (HMGP) a total $302,958 has been awarded. These funds have been split between mitigation projects and planning (Projects: $245,942/ Planning: $57,016).

- Examples of HMPG projects and plans:
  - May 2002 Interior Flood Disaster HMGP Grant:
    - Alakanuk: $200,000 to relocate homes and elevate foundations
  - April 2004 Denali Earthquake Disaster HMGP:
    - Alakanuk: $7,500 to develop local hazard mitigation plan
    - Kotlik: $7,500 to develop local hazard mitigation plan
  - November 2004 Bering Strait Sea Storm Disaster HMGP Grant:
    - Shishmaref: $45,942 to relocate Computer Center Cottage
    - Northwest Arctic Borough: $34,516 to develop local hazard mitigation plan
  - January 2005 North Slope Borough Sever Winter Storm Disaster HMGP Grant:
    - Nunam Iqua: $7,500 to develop local hazard mitigation plan
- Examples of PDM plans
  - PDM 2007 Planning
    - Shishmaref, Skagway, Craig, Tok, Kwethluk, Akutan, Cold Bay, False Pass, King Cove, Sand Point, Saxman, Port Alexander
    - Aleutians East Borough
    - Ketchikan Gateway Borough
    - City and Borough of Sitka
  - PDM 2008 Planning
    - Galena, Kaltag, Anvik, Nulato, Ruby, Huslina, Alatna, Allakaket, Bettles, Evansville, Hughes

Our public assistance section within the division is also engaged in preventing and mitigating the effects of flooding and erosion. The Public Assistance (PA) program under a state or federal declared disaster provides state, local and Alaska native village governments and certain private non-profit agencies (applicants) funding for permanent repair to infrastructure damages and reimbursement for Debris Removal and Emergency Response costs. State declared disasters are treated the same as federal declared disasters with a few exceptions.

- Disaster Assistance under the PA program for Federal Declared disasters:
  - Separates small and large projects with different requirements for each.
  - Allows for improved projects
  - Allows for alternate projects
  - Provides funding for disaster related mitigation efforts through the 406 Mitigation Program.

- Disaster Assistance under the PA program for State Declared disasters:
  - Does not separate small and large projects (all projects are treated the same),
  - Allows for improved projects
  - Does not allow for alternate projects
  - Does not provide funding for disaster related mitigation efforts

DHS&EM's role in response to climate change issues is limited due to FEMA Stafford act, federal coordination, and federal funding. These policies decrease the negative effect on climate change issues, allowing the state limited funding due to a lack in coordination efforts of mutual concern with federal agencies. Below is a list of these policies.

- FEMA Stafford Act limitations:
  As currently legislated, the Stafford Act, on which all FEMA mitigation activities are based, is primarily limited to actual disasters or imminent threats to life and property. For example, relocation of properties and infrastructure to entirely new community sites is not an activity which FEMA would consider eligible under the Stafford Act.

- Federal Coordination limitations:
  FEMA mitigation grant funding is limited to activities for which another federal agency is not responsible. Therefore, FEMA mitigation funds can not be used for projects that are primarily the domain of the US Army Core of Engineers or Natural Resource Conservation Service.

- Federal Funding limitations:
  FEMA mitigation grant funding is limited to either a small percentage of a federally declared disaster (HMGP) or a yearly nationally competitive grant program (PDM). Both these grant programs have many more eligible projects from around the State and Nation than they have funds for.

Since 1978 Alaska has experienced 226 disasters, and not until those disasters take place is the Division able to respond. This is due to the current Stafford Act, federal coordination, and federal funding limitation making DHS&EM unable to provide pre-disaster mitigation (other than planning) to communities that may be affected by climate change disaster. Until an amendment is made to the Stafford Act, the DHS&EM is unable to provide any protective solution, but rather wait until the disaster strikes.

Sincerely,

Craig E. Campbell
Commissioner

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

OFFICE OF THE COMMISSIONER

SARAH PALIN, GOVERNOR

☐ P.O. BOX 111000
JUNEAU, ALASKA 99811-1000
PHONE: (907) 465-2400
FAX: (907) 465-3886

■ 550 WEST 7TH AVENUE, SUITE 1400
ANCHORAGE, ALASKA 99501-3650
PHONE: (907) 269-8431
FAX: (907) 269-8918

February 29, 2008

Representative Ralph Samuels
Chair, Alaska Climate Impact Assessment Commission
State Capitol #204
Juneau, AK 99801-1182

Dear Representative Samuels:

In response to your letter dated December 5th, 2007, the Department of Natural Resources (DNR) has put together a bulleted list of potential natural resource impacts associated with climate change. As you are aware, the northern latitudes may experience dramatic environmental alterations, and as is the case with all change, there will be both positive and negative impacts experienced in Alaska. It is important for the state to identify what mitigation measures are possible and feasible.

The Department of Natural Resources is working with the Governor's Sub-Cabinet on Climate Change, led by the Department of Environmental Conservation (DEC) and Commissioner Hartig, to identify both current and future impacts. The following list of bullets outlines our understanding of potential impacts. Identifying future costs associated with possible impacts will be a complex undertaking because of interdependent variables and significant uncertainty in forecasts.

Potential Near-Term Impacts to Natural Resources affecting DNR

- **Data Collection Needs**
  - ***Baseline data*** is required in all sectors to enable identification and monitoring of change. Most areas have limited quantitative information. Increased data collection and interpretation could require additional funding to acquire initial data sets and imagery (depending on resolution, coverage needed, and federal partnerships) and for site-specific mapping efforts and identification of local climate impacts/hazards

  - ***High resolution LIDAR imagery and satellite data***
    - High resolution Digital Elevation Models (DEM) for select developed areas, or areas of potential development
      - We need better tools to track changes in the geomorphology, such as an accurate statewide digital elevation model, and high-resolution imagery that require regular updates. This information will enable us to identify trends in coastal and non-coastal erosion. The imagery will enable tracking of vegetation changes. The State is already leading an effort to develop a statewide digital base map, and this effort needs to be supported.

- For example, the Forest Inventory and Analysis (FIA) program in the U.S. Forest Services Pacific Northwest Research Station just acquired a LIDAR dataset for the Kenai Peninsula at the cost of $3 million.

- ***Hazards mapping***
  - Detailed geologic mapping in order to identify areas requiring hazards designation
  - Derivative mapping of potential hazards areas for use in planning and permitting activity
  - Detailed mapping of permafrost conditions to identify areas susceptible to thaw settlement under warming conditions
  - Mapping of vegetation fuel types and infrastructure around communities to development risk maps for wildland fire threats

- ***Wildland Fire Risk***
  - Warming trends are causing both a longer and more intense fire season across Alaska. Changes in permafrost conditions and weather patterns, particularly precipitation, which can have a large impact on both the long and short term impacts to vegetation across the state.
  - The 2004 and 2005 fire seasons burned over 11 million acres of land in Alaska with the 2004 season setting a record for acreage burned in one season, 6.5 million acres. The combined State fire costs for FY04 and FY05 were $95 million. How much can be attributed to climate change can't be determined.
  - While the 2007 fire season was one of the lower years for total acreage burned, a late season wildfire on the North Slope caused problems until late September. The Anaktuvuk Pass fire reached 256,000 acres in size and caused air quality (smoke) issues from both a health and safety viewpoint. (Figure 1) Is the fire regime changing in the Arctic?
  - Earlier fire season length and implementation of the program would substantially increase the fire preparedness budget.
  - An increase in large project fires over the next 10 years would also considerably increase the State's costs for fire suppression.
  - Deployment of DNR's Incident Management Teams (IMT's) that respond to natural disasters and associated emergencies will have budget impacts

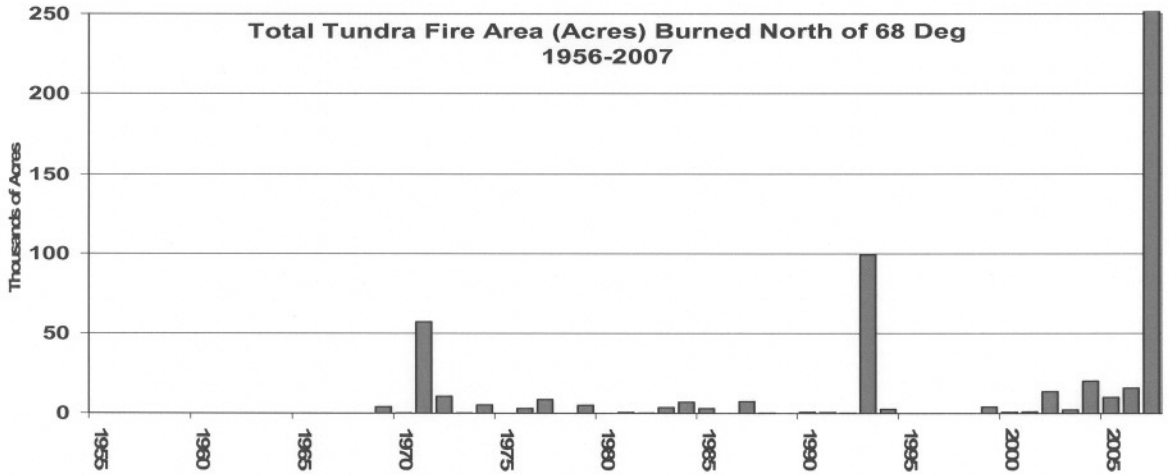


Figure 1- Acreage burned in Alaska North of 68 Degrees for the years 1956 to 2007, source Alaska Fire Service.

- Large fires in the tundra may have impacts on summer and winter range of caribou and affect migration routes.
- Smoke issues associated with large wildland fires can cause disruptions in economic activities for communities. Road closures and other travel restrictions can cause short-term economic hardships for communities such as the Taylor Highway closures in 2004. The communities of Chicken, Tok and the surrounding villages were all affected.

- **Changes in Regulatory Framework**
  - ***Permitting exploration and infrastructure development activities*** in an ever changing environment require increasing the number of regulatory staff and associated staff costs.
  - Physical environment changes may require permit modifications and re-assessment of development activities to ensure safe operations
  - Fine-tuning our ability to predict likely change and, where possible and feasible, mitigate it,
  - Potential surface condition changes could include upland to marine, wetlands to upland, frozen soils to thawed soils or wetlands, fresh water to salt water. Any change in surface conditions will result in changes to appropriate resource permitting.

- ***Energy Development Issues***
  - Tundra travel limitations and reduced operational windows for exploration and development of resources during the winter season
  - The possibility of new carbon dioxide emission standards and carbon taxes suggest that the State should actively promote the development of larger-scale renewable energy resources. The same reasons suggest that the State should consider the development of alternative energy projects, such as tidal power in Southeast

Alaska. The department is beginning research to develop a more robust model for permitting alternative energy projects.

- Moving buildings or facilities related to the oil and gas industry could result in a change in regulatory oversight. Especially if the relocation results in an ownership change from state to federal.
- Biomass opportunities, particularly sustainable wood energy projects for space heating may be implemented in many rural and urban locations. Wood fuel is "carbon neutral" in regard to CO_2 emissions because the new young forest sequesters carbon as it grows and thus no net gain in CO_2 emissions is realized by the harvesting and burning of wood fuels.
- Using alternative energy, such as hydro, wind, solar and biomass to replace fossil fuels, like coal and oil produces an "offset" credit. Because these projects do not use a fuel source that creates additional CO_2 emissions, the amount of CO_2 that would have been released by the burning of the fossil fuel can be calculated in tons of carbon "offset". This "offset" tonnage may be sold into a carbon trading market if one is available.
- Pipelines
  - Existing facilities near or at existing sea level may experience additional erosion if sea levels continue to rise. In some cases, this could result in redesign of miles of pipelines from vertical support members (VSMs) to burial in a marine environment.
  - A large number of existing VSMs that do not have thermal couplers or heat pipes could become unstable and the resulting movement could produce sufficient stresses to damage existing pipelines.
  - Existing buried pipelines potentially could experience the loss of support beneath the pipe due to thermal degradation.

- ***Energy Consumption Issues***
  - Carbon Dioxide emission standards
    - New federally mandated carbon emission caps, including credits for carbon sequestration, may put significant regulatory burden at the state level.
  - CO_2 Capture and Storage
    - CO_2 injection in subsurface could create a complicated regulatory burden due to minerals ownership and CO_2 migration liabilities
    - There is some potential of an injected plume migrating onto adjacent acreage and towards the surface into aquifers.
    - Depleted oil and gas reservoirs may become feasible sites for long-term sequestration of CO_2, however this could affect revenue streams if producible amounts of oil or gas remain in these reservoirs.
    - Potential need to develop a certification body to verify carbon mitigation projects and the tonnage of atmospheric carbon being captured or stored. A third party certification is required before a project can be sold on a carbon exchange, such as the Chicago Climate Exchange. Often a governmental agency fulfills this role. Alaska has no private or public certification body at this time.

- ***Mining Issues and Regulatory Challenges***

  - Mining projects are energy intensive. If energy costs experience additional increases due to carbon regulation issues, those cost increases may disproportionately impact mining projects which already face numerous hurdles in Alaska due to remoteness, seasonality, lack of transportation infrastructure, etc.

  - Mining projects in permafrost areas sometime look to "freezeback" in tailings dams and tailings disposal sites. "Freezeback" is the idea that permafrost will expand into the dam of tailings disposal site, helping to stabilize and seal the facilities and minimize seepage. Reliance on freezeback may become increasingly difficult. Tailings dams must be engineered and monitored to recognize permafrost changes.

  - Alaska has significant quantities of coal and most is substantially cleaner than much of the coal in the lower 48. We are currently in the permitting process for a proposed surface coal mine (the Chuitna Coal Mine) in the Beluga area. If permitted, it will be a large project with an approximate 25 year mine life. Global warming concerns often cite coal as being a significant CO_2 emitter, and we are hearing this in relation to the Chuitna project. Commentors appear to be seeking to link CO_2 and global warming to the permitting process and to expand the cumulative impacts analysis under NEPA to include global warming, even for coal to be shipped to foreign markets. Climate change concerns could have a significant impact on the development of Alaska's coal resources.

  - Changing patterns in precipitation should be analyzed to ensure that mine tailings dams are constructed with sufficient freeboard and adequately sized emergency spillways for anticipated future storm events; particularly where dams must be maintained in perpetuity.
  - With the thawing of permafrost over the past several decades, and the continued placer mining activity in areas of frozen loess, the State of Alaska may need to scrutinize future placer mining activities in these regions in order to minimize man-made erosion of these silts.
  - "Carbon taxes", depending upon how they are applied, have the potential to stifle future development of Alaska's coal resources and close existing operations.
  - Shortened winter travel seasons will adversely affect mineral and energy exploration and development programs, requiring the agencies to monitor the freeze-up and breakup periods ever more closely.

- ***Infrastructure and Development Zoning Issues***
  - It may be appropriate for zoning laws to reflect potential environmental change
  - Strict scrutiny, 'retooling', and enforcement of permit requirements (both existing and newly developed)
  - Increased focus on engineering and design activity to ensure appropriate development in hazardous areas
    - It is important to evaluate changes in coastline to understand potential changes. Permitting agencies need to have and use this information in order to make good permit decisions on proposed development activities on the coast.

- Local government authorities should also be vigilant in permitting development in erosion and flooding prone areas to ensure the activities are sited, designed, and constructed to mitigate potential.

- ***Pipeline and Energy Infrastructure***
  - There has been hundreds if not thousands of heat pipes or thermal piles installed for schools, airports, jails, and numerous other public and private buildings in Alaska. The state may want to consider a monitoring program similar to that used by the Alyeska Pipeline Service Company (APSC) for the 1,222,000 individual heat pipes along the Trans Alaska Pipeline (TAPS), for the other existing heat pipes or thermal piles found throughout Alaska.
  - The state may want to look to the lessons learned on TAPS for surface, slope stability and geotechnical maintenance on other projects.
  - Difficult problems often occur after construction. The trend is towards greater stabilization each year after construction. While construction disturbs thermal regimes of an area, the area does reach a new thermal equilibrium if properly restored.
  - A change in the Mean High Water level could result in a change in the interface between salt and fresh water. This change could result in a pipeline designed for contact with fresh water or air now being in contact with more corrosive salt water.
  - The degree and direction of the movement of contamination resulting from spills could change.
  - In some cases permafrost has been a barrier in the movement of groundwater and surface water and associated contaminants. Changes in permafrost could result in flooding of gravel pads and contaminants from the gravel pads migrating into the environment.

- ***Land Ownership Issues***
  - Possible change to property boundaries due to sea level rise (change in Mean and Ordinary High Water Mark) or increased river erosion (not a new threat).
  - Increased ownership disputes, most will involve the state as the owner of the tidelands and submerged lands
  - Moving villages or buildings because of erosion; new sites required and vacated land ownership issues
  - The marine or off-shore boundary of state land could change. In some cases, there is a possibility that regulatory oversight could change from state to federal for existing facilities.

<u>Potential Long-Term Impacts to Natural Resources affecting DNR</u>

- **Residential, Commercial, and Infrastructure Development**
  - ***Loss or damage of Public Owned Facilities*** could impact replacement, maintenance and mitigation of state assets.
    - Parks Infrastructure
    - Schools
    - Other public facilities
    - Increased Maintenance costs
      - New cost only if originally built in hazardous area

- Increased Energy Costs
- Change in coastal zone hazard determination based on environmental changes
  - Loss of fast-ice and sea ice protection during storm events that creates increased erosion
  - Change in permafrost and drainage patterns
  - Thermokarst and land subsidence and elevation changes
  - Prediction of future water inundation areas due to sea level rise and river erosion / migration
- Changes in stream regimens could result in increased siltation of harbors and estuaries that will require more frequent dredging and increased costs.
- Ice-rich permafrost that is close to melting temperature could thaw, resulting in failure of even properly designed structures
- Distinguish between potential negative impacts that are the result of natural changes and those that are the result of faulty planning or design

- **Water and Hydrology**
  - All aspects of water within the hydrologic cycle will be affected under climate change scenarios.
  - ***Precipitation Issues***
    - Precipitation patterns may change (including changes in timing). These changes may vary according to season and location. Some areas may receive greater precipitation annually, some may receive less. Some may receive more in a single season, and that same location may receive less in another season.
    - Precipitation amounts may change (change in quantity). As with pattern change, the amount of precipitation received at any one site may be greater or lesser dependent upon location. Amounts received may also vary from historic norms on a seasonal basis.
    - Precipitation form may change. What had previously been snowfall may now be rain.
  - ***Surface Water***
    - Changing precipitation patterns (timing, quantity and form) may change seasonal surface flow patterns. There may be more water available at times of year, or less.
    - Change in surface storage. Change in water form and quantity may alter available snowpack, and the release of water from that snowpack. A possible result is release of water from snow pack earlier, reducing stream flows during the summer periods. Also, a "flashier" response would be expected to most rainfall events; in essence a lowering of base flow.
    - Change in evapotranspiration patterns. Increased temperatures would, in theory, result in increased evaporation. This change may be partially offset, or conversely exacerbated, by a change in plant life that may result in greater or less transpiration. Surface storage in reservoirs may be reduced, resulting in lesser release of water during warm/dry periods, effectively reducing base flows.

  - ***Ground Water***
    - Loss or reduction in permafrost will have a major influence on subsurface hydrology
    - What had been confined aquifers may be effectively changed to unconfined.
    - Perched aquifers and/or lakes resulting from permafrost may disappear.

- Local melting of permafrost in regions with artesian domestic water wells that puncture a permafrost layer acting as a confining layer may experience sufficient melting around well casings to allow for discharge outside of the casing.
- Possible increase in infiltration of surface water to the subsurface, reducing streamflow.
- Possible change in pattern of release of storage from the subsurface, resulting in change to surface water patterns.

- **Changes in Subsistence Practices**
  - Traditional means of winter travel could be impacted if there is less ice on lakes and rivers or shorter seasons when the ground is frozen or has adequate snow cover for winter travel
  - Gradual changes in habitat and species diversity will change what subsistence foods are available for harvest
  - Increased fuel costs will change harvest practices

- **Arctic Offshore**
  - Possible impacts to shipping and from increased shipping
  - Changes to near-shore habitat
  - Changes to fisheries and northern migration of habitat in all sectors
  - Change in climate pattern because of increased open seaway and different times of year

- **Flora & Fauna Habitat Changes**
  - There is a great deal of unique plant genetic resources in the coastal areas. This is especially true of plants on islands, which by the nature of isolation will have the highest probability of evolving unique genetic characteristics. Additionally, changing temperature will also change habitat with some species totally disappearing.
  - The state should take an active lead in collecting and storing these resources. The Plant Material Center already has a large collection of seed from the resources. However, more needs to be collected and the collections need to be sent to other facilities for backup storage in case the Alaska facility is damaged or rendered useless. We have a good start and actually lead the world in the collections of high latitude species.
  - Increased listing petitions of Endangered Species under ESA
    - Dramatic affect on resource management
    - Changes in habitat results in changes in the species found in a given area. For example, on a coastal plain with rising sea levels, the existing threatened upland species may then relocate. This could result in additional permitting issues and compliance with new ESA requirements
  - Changing climate can provide opportunities for increased agriculture; however, this may be coupled with the increased incidence of "pests". The Division of Agriculture could assist in off-setting increased transportation costs of food in both urban and rural areas by encouraging local sustainable food production.
  - Increased need for monitoring invasive species (weeds, insects, & plant diseases such as: potato late blight, Canada thistle, hawkweeds, amber-marked birch leaf miner, large yellow underwing moth, etc.)
  - In addition to invasive species, endemic species may also cause significant problems to forest and agricultural ecosystems. A case in point is the unprecedented spruce bark beetle outbreak on the Kenai Peninsula that began in 1989 and devastated the spruce forests of the region. The epidemic peaked in 1996-97 and continued into 2000. Pockets of activity still exist and on the Kenai Peninsula Borough over 1 million acres of spruce forests were

attacked by the insect. Many areas have 90% tree mortality and fire risk has increased substantially due to the dead trees and understory grass that has taken over many of the sites. The risk of catastrophic wildfire is at a historic high on the Kenai and untold economic impacts have resulted from this ecosystem replacement event. The Caribou Hills fire this past summer burned 56,254 acres and destroyed 94 structures.

If you have any questions regarding the information provided above, or other concerns, please feel free to contact Robert Swenson at (907) 451-5001.

Sincerely,

Thomas E. Irwin
Commissioner

cc: Larry Hartig, Commissioner, Department of Environmental Conservation
Tom Chapple, Director, DEC Division of Air Quality
Robert Swenson, Director, DNR Division of Geological and Geophysical Surveys