ANNUAL REPORT TO DIRECTOR - FY81

RESEARCH SECTION

DIVISION OF PLANNING AND PROGRAMMING

ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

July 1981

Robert W. Ward	Commissioner
John Bates	Deputy Commissioner of Planning and Programming
Heinrich Springer	Director, Division of Planning and Programming, Interior and Western Regions

Foreword

A recent National Science Foundation publication contained the following statement:

> "One-third of the growth in the national income during the post-war period flowed from advances in knowledge, particularly in the sciences and the new technologies to which they give rise."

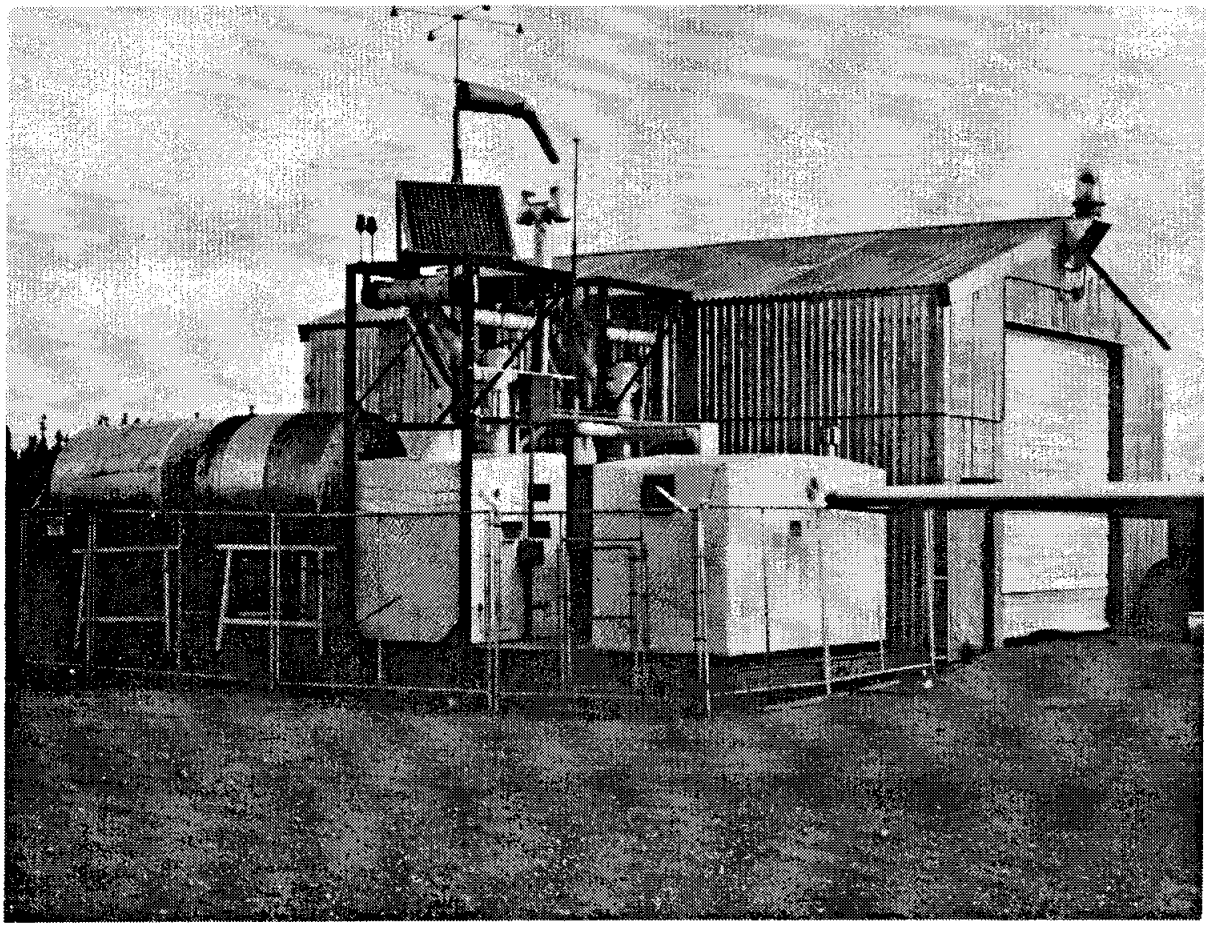
The message in this statement is that change, growth, and improvements in living conditions are a result of continually probing to find a better way to do things. The implementation of the results of applied research into standard usage flows from many years of basic research in Universities and other similar organizations, through the applied technology channels, and finally into daily life.

Through research comes change and without both there can be no growth.

Larry Sweet
Research Manager

Table of Contents

NOORVIK AIRPORT LIGHTING DEMONSTRATION



The Noorvik Airport Lighting project is testing the effectiveness of a new low maintenance turbine that may provide many small bush villages in Alaska with economical airport lighting. Previous to the installation of Federal Aviation Administration approved lights, Noorvik used the "firepot" technique for emergency lighting. The new lights are turned on and controlled by the pilot of an incoming aircraft and remain lit for 15 minutes. The photo shows the two Ormat Turbine Modules and fuel tanks located beside the airport storage building. For more descriptive information see Research in Progress, Section III, and Implementation, Section VI.

SECTION 1

OBJECTIVE AND BACKGROUND

OBJECTIVE

The Department of Transportation and Public Facilities has the mission of planning, building, and maintaining the greater portion of State owned facilities in Alaska. Whether involved with transportation systems or public buildings the emphasis of the Department is directed toward the creation of capital improvements for the people of the State. This task is complex and requires special knowledge of the unique Alaskan environment in a variety of technical disciplines.

To support the technical framework of the operational divisions of the Department, the Research Section of the Division of Planning and Programming was created. The objective of the section is to develop new technical knowledge to improve the Department's capability to carry out the assigned mission. The individual investigations undertaken by the Research Section vary widely. One study may evaluate the energy efficiency of a new lighting fixture, another may attempt to statistically predict the lifecycle cost of various highway pavement structures and yet another may assist the Division of Design and Construction in implementing a new computerized design tool for highway design. Overall the goals of the Research Section are to reduce the cost, improve the integrity, and increase the serviceability of State facilities by better understanding the materials and methods and the environment in which they are used.

BACKGROUND

The Research Section has its origins in the Alaska Department of Highways Material Testing Laboratory. Established in 1961 and located in the Duckering building on the University of Alaska campus in Fairbanks, the "Road Lab", as it became known, combined a highway construction materials test function with highway research. With the creation of the DOTPF on July 1, 1977 it was recognized that the expanded mission of the new Department would require a broader scope of research and testing support. The result was the division of the lab as it had existed for nearly twenty years. The Construction Materials Test Lab was moved to Anchorage and the Research function was expanded to cover departmental concerns beyond Highway Research.

Early in 1980 the Commissioner and the Governor approved the organizational structure of the Research Section as it exists today, and created the position of Research Manager. During the past fiscal year a publications group has been assembled comprised of a Publications Specialist, Publications Technician, Drafter, and Clerk Typist. A Procedures Manual for the Research Section has been prepared to further strengthen the organizational structure.

SECTION 2

FACILITIES AND STAFF

FACILITIES

The Research Section is housed in the Duckering Engineering Building on the University of Alaska campus in Fairbanks. The Section occupies approximately 2500 square feet of office space and shares, under a joint use agreement with the School of Engineering, approximately 4000 square feet of laboratory and storage space. Additionally a carpenter shop, machine shop, welding shop, and staging area are made available by the University for construction of special equipment or test facilities. This arrangement is mutually beneficial to both the DOTPF and the University. Engineers of the Research Section have easy access to the faculty of the engineering departments and the research institutes of the University, while the testing and applied research done by the Section provides practical educational examples of everyday problems to University students enrolled in the engineering curriculum, many of whom will one day become DOTPF employees.

A new Northern Engineering Research Facility is being planned by the University which will greatly expand the capabilities and facilities of the School of Engineering. The University plan includes provisions for housing the DOTPF Research Section in this new facility.

LABORATORY AND TEST EQUIPMENT

The Research Section laboratory and testing equipment includes high temperature ovens and low temperature chambers for testing materials under broad temperature extremes and hydraulic testing machines for tension and compression loadings of up to 300,000 pounds. One hydraulic test unit is enclosed in an environmental chamber with a capability to test samples from -40° to $+400^{\circ}$F.

A chemistry lab contains specialized equipment for asphalt testing. Other testing can be accomplished on a limited basis. A limited amount of electronic and photographic work is handled within the Section with larger jobs referred to University shops or the private sector.

For special cases requiring capabilities not contained in the Section the facilities and staff of the University can be utilized.

Facilities are available for a variety of soils testing. Commonly available tests include consolidation testing, triaxial strength testing, frost heave testing, gradation and aggregate soundness tests. A jaw crusher is available for preparation of samples as needed.

A full range of standard tests for asphalts is available including ductility, penetration, viscosity, abson recovery, and mix designs. In addition, special equipment is available for indirect tensile testing. Equipment for determining resilient modulus of asphaltic concrete is currently under construction.

The Research Section currently collects annual inventory data on the State's highway system. Available equipment includes a Mays Ride Meter to determine roadway roughness, rut measurement equipment, Benkelman Beam testing procedures and a Road Rater van to determine highway condition and strength.

Environmental chambers including two walk-in cold rooms are available for testing products under controlled conditions. ASTM thermal performance testing apparatus will be available in the near future for testing window systems, door systems and wall sections.

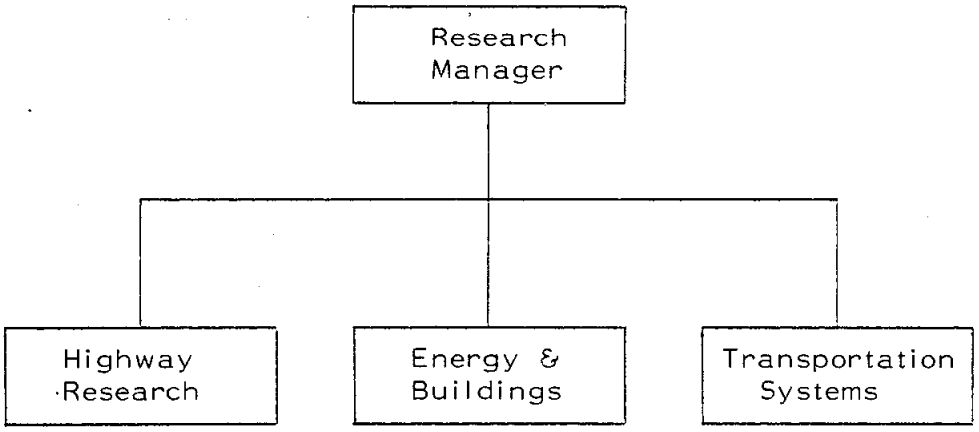
Facilities are available for limited metallurgical studies, including Rockwell Hardness classification, tensile strength determination testing, and Charpy impact testing. A muffle furnace is also available.

The Section is involved in collecting long term data concerning ground temperatures and heat flow under embankments. Other data collected includes air temperatures, windspeed and incoming solar radiation.

Computer capabilities include computer graphics, direct transcription of field data from recorded tape, data base management, mathematical modeling, statistical analysis and word processing. The section currently has access to the University of Alaska computer network and Boeing Computer Services. Current equipment includes a Tektronics 4052 desk-top computer capable of handling a wide range of problems without a host computer, two plotters, an ADM 3A CRT terminal, and a Diablo terminal. This combination allows a wide range of capabilities and the ability to meet almost any foreseeable need.

STAFF

The Research Section is organized into three components as shown below:



ADMINISTRATION

Larry R. Sweet	Research Manager
David C. Esch, P.E.	Chief, Highway Research
Leroy E. Leonard	Chief, Energy & Buildings Research
Ronald E. Miller, P.E.	Chief, Transportation Systems Research
Grace Ann Best	Clerk Typist

RESEARCH ENGINEERS

Billy G. Connor, P.E.
Lorena A. Hegdal
Rick W. Jurick
Robert L. McHattie, P.E.
John F. Rezek, P.E.

PUBLICATION UNIT

Barbara E. Trego	Publications Specialist
Firmin S. Murakami	Drafter
Dianna Blair	Publications Technician
Ute D. Levesque	Clerk Typist

TECHNICAL SUPPORT

Bruce K. Alderman	Engineering Aide
Tom C. Chang	Materials Lab Technician
Richard L. Gaffi	Equipment Technician
Kathy M. Mulder	Clerk Typist
Carol L. Pederson	Materials Lab Technician
Jana F. Harwood	Materials Lab Technician

In addition to the personnel shown above the following people worked at the Research Section part of the year, either in the Engineering-In-Training program or on loan from other divisions of DOTPF.

Clifford E. Baker	Engineer-In-Training
Donald W. Benjamin	Project Engineer
James L. Bennett	Engineering Aide
Nicholas T. Merrill	Project Engineer
Matthew K. Reckard	Engineer-In-Training

During the past year, as in previous years, the Research Section has had the opportunity to borrow staff from other divisions of the Department during off-season for project assistance. These same people bring to the Research Section good ideas for projects based on their experience with problems encountered in their regular assignments. When they go back to their regular jobs they take with them information regarding the latest ideas about such things as better designs for pavements, new techniques to more accurately determine when seasonal load restrictions are needed, how buildings can be designed to be more energy efficient, or how new airport lighting schemes can be economically used in small bush airports. These exchanges promote communication and advance the application of new technology in the State.

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SECTION 3

RESEARCH IN PROGRESS

SUMMARY OF RESEARCH PROJECTS

HIGHWAY RESEARCH PROGRAM

Project Manager/ Researcher	Project	Funding Agency	Duration
D. Esch	Stabilized Soils Study	State	2 years
D. Esch/ M. Economides D. Gaffi J. Morrow	Snow and Ice Control	State	2 years
D. Esch	Permafrost Culverts Study	State	3 years
D. Esch/ R. Berg	Pavement Thermal Studies	State	3 years
B. Connor/ J. Zarling	Solar Assisted Culvert Thawing Device	State	2 years
B. Connor	Engineering Computer Software	State	2 years
R. McHattie/ F. Finn	Highway Life Cycle Costing	State	2 years
R. McHattie	Resilient Soil Properties Study	State	2 years
B. Connor, R. Jurick	Rut Measuring Device	State	1 year
D. Esch	Control of Permafrost Degradation Beneath Roadways	FHWA	3 years
D. Esch/ J. Henry	Pavement Performance Study	FHWA	3 years
B. Connor	Performance of Bituminous Surface Treatments in Alaska	FHWA	2 years
B. Connor/ J. Zarling	Evaluation of Air Duct Ground Stabilization System	FHWA	2 years

Project Manager/ Researcher	Project	Funding Agency	Duration
R. Jurick	Prethawing of Permafrost by Surface Modifications	FHWA	2 years
R. Jurick/ T. Osterkamp	Geophysical Methods for Detecting Permafrost and Ground Ice	FHWA	2 years
R. Jurick/ T. Osterkamp	Field Evaluation Site for Ground Ice Detection	FHWA	2 years
R. McHattie	Asphalt Pavement Properties Relating to Roadway Surface Performance	FHWA	2 years
R. McHattie	Correlating Dynamic Deflections with Pavement Performance	FHWA	2 years
R. McHattie/ B. Connor D. Esch	Pavement System Evaluation of Alaskan Highways	FHWA	4 years
J. Rezek	Gasohol and Alcohol as Vehicle Fuel	FHWA	2 years
D. Esch/ E. Johnson	Applications of Engineering Fabrics in Alaska	FHWA	3 years
D. Esch/ T. McFadden	Ice Forces on Northern River Bridges	FHWA	3 years
D. Esch	Rubberized Asphalt for Roadway Ice Control	FHWA	3 years
D. Esch	Soil Stabilization for Remote Area Roads	FHWA	2 years
D. Esch/ D. Gaffi	Optimum Sand Specifications for Roadway Ice Control	FHWA	2 years
R. McHattie	Economic Aspects of High Speed Unpaved Roads	FHWA	3 years
D. Esch/ E. Johnson	Road Construction on Muskeg	FHWA	2 years
D. Esch/ A. Phukan	Design Guides for Pavements on Permafrost	FHWA	2 years
D. Esch/ A. Phukan	Design Manual for Muskeg	FHWA	2 years

Project Manager/ Researcher	Project	Funding Agency	Duration
D. Esch/ A. Phukan	Evaluation of Research Work on Substitute Materials in Frost Protection	FHWA	1 year
D. Esch/ J. Burdick	Instrumentation of New Gastineau Channel Bridge	FHWA	2 years
R. McHattie	Mechanistic Design Methods for Alaskan Pavements	FHWA	Ongoing
R. McHattie	Reliability of the Alaskan Pavement Rating Procedure	FHWA	2 years
R. McHattie	Evaluation of Road Rater Test Methods	FHWA	2 years
B. Connor	Rational Seasonal Load Restrictions and Overload Permits	FHWA	1 year
B. Connor	Special Projects/Farmers Loop Sinkhole	State	1 month

ENERGY RESEARCH PROGRAM

Project Manager/ Researcher	Project	Funding Agency	Duration
L. Leonard/ R. Seifert J. Matheson J. Zarling J. Strandberg C.B. Bettisworth	Passive Solar Alaskan School	FHWA & State	3 years
L. Leonard/ J. Zarling J. Strandberg	Thermal Performance Standards	State	1 year
L. Leonard/ J. Zarling J. Strandberg L. Hegdal	Building Energy Conservation	State	2 years
L. Leonard/ R. Seifert J. Matheson	Passive Solar Heated Fire Station Demonstration Project	State	Ongoing
R. Jurick/ J. Tiedemann	Remote Facilities Monitoring	State	2 years

Project Manager/ Researcher	Project	Funding Agency	Duration
L. Leonard	Fuel Cell Testing	State	1 year
L. Leonard/ D. Hawkins	Gas-Sorptive Properties of the Zeolite Mordenite	State	2 years
J. Rezek/ T. Wentink M. Reckard M. Newell	Wind Power User's Manual	State	2 years
J. Rezek/ J. Zarling	Small-Scale Heat Recovery	State	1 year
L. Leonard/ L. Hegdal J. Rezek	Climate-Adapted Solar Collectors	State	1 year
J. Rezek/ R. Jurick	Special Projects/Tracer Gas	State	2 years
R. Jurick/ T. Roberts R. Merritt K. Kokjer	Data Transmittal Study	State	1 year
J. Rezek	New Roof Materials Research	State	2 years
R. Jurick/ T. Roberts	Meteor Burst Demonstration	State	2 years
J. Rezek/ J. Coutts	Vehicle Air Quality	State	2 years
L. Leonard/ R. Seifert	Solar Design Manual	State	2 years
J. Rezek/ City of Bethel	Fire Protection in Bush Areas	State	2 years
L. Leonard/ R. Carlson C. Hok	Improvement of Fairbanks Atmospheric Carbon Monoxide Model--A Program for Calibration Verification and Implementation	State	1 year
L. Leonard/ J. Zarling	Passive Solar Heating in Alaska	State	1 year
R. Jurick/ L. Schnurr	Radio-Connected Automatic Trunk Circuit Feasibility	State	2 years

TRANSPORTATION SYSTEMS RESEARCH PROGRAM

Project Manager/ Researcher	Project	Funding Agency	Duration
R. Miller	Paint Performance Testing	State	2 years
R. Miller	Anchorage Traffic Computer Improvements	State	2 years
R. Miller	Thermoplastic Systems	FHWA	3 years
J. Swift/ R. Miller	Air Cushion Vehicle Demonstration Project	State	2 years
R. Miller	ACV Environmental Impact Study	State	2 years
R. Miller	Noorvik Airport Lighting Demonstration	State	2 years
R. Miller	Airship Operation	State	2 years
R. Miller/ D. Pruhs	Strobe Lighting Demonstration Project at St. Michael, Alaska	State	2 years
R. Miller	Yukon River Bridge Use	State	1 year

HIGHWAY RESEARCH PROGRAM

Stabilized Soils Study - Various soil additives are being evaluated for reducing thaw weakening in silty gravels and for bonding of sands and silts. If successful trace will be used as a replacement for clean gravels in highway and airfield pavement structures.

Snow and Ice Control - In the Maintenance Section of the Department approximately $10,000,000 is spent annually on snow and ice control on pavements. This expense is only to keep the roads open and safe for the traveling public and adds nothing to the overall improvements of the system. Since this cost represents approximately 20% of the total maintenance budget, significant savings can be realized by establishing improved and more cost-effective methods for controlling snow and ice problems. This study will look at various aspects of snow and ice control to develop new techniques and policies. Specific projects authorized under this funding program include snow fence studies at Thompson Pass, sand-ice friction studies, benefit studies on chip seals for increased traction, and culvert icing control work.

Permafrost Culverts Study - Culvert installations in permafrost areas present various problems which result in excessive long-term maintenance costs. Progressive warming of soils beneath the culverts can cause localized thawing which eventually results in the culverts settling below the surrounding ground and requiring expensive replacement. In other cases culverts can act as air circulation and cooling ducts, resulting in frost heaves at the culvert sites. The presence of permafrost around culverts also leads to early ice blockage where wintertime water flows must be carried.

Under this study a series of typical culvert installations in permafrost areas will be measured to determine the effects of the permafrost on culvert performance and related roughness.

Pavement Thermal Studies - The purpose of this study is to quantify the effects of pavement color and texture on average surface temperatures of road-

way and airfield pavements located on permafrost. This is accomplished through the use of instrumented field test sections located at Fairbanks and at Deadhorse, Alaska. White painted sections will be included in this study along with chip seals of white, regular, and dark rock.

Solar Assisted Culvert Thawing Device - The intent of this project is to design, assemble, install and monitor solar assisted thawing devices which would require minimal operating and maintenance expenses. The systems would be designed using commercially available components. One type analyzed for possible use will involve a photovoltaic solar panel to generate electrical heat cable through the culvert. Another unit to be designed will use a flat plate solar collector with a pump or a passive heat tube to circulate the heated fluid through a pipe laid at the bottom of the culvert.

Engineering Computer Software - Funds are being expended to implement a computer aided design package on the Boeing Computer System and lease/purchase appropriate terminals. Funds have also been used to train Design personnel to use the system.

Highway Life Cycle Costing - Recent developments in the field of highway management have been directed toward the evaluation of total "Life Cycle" costs. This approach utilizes new computerized design techniques to assess the serviceability and longevity of various construction and maintenance alternatives. Construction, maintenance and those user costs which are functionally related to pavement quality are then combined into a complete life cycle analysis. The overall effect of life cycle costing will be to minimize the total of construction, maintenance and user expenditures, thereby providing a net savings to the people of the State.

Resilient Soil Properties Study - The principal objectives of this study will be to determine the resilient modulus values of a full range of Alaskan highway construction materials, and attempt to identify and quantify those factors controlling their resilient behavior. A number of existing pavements and recent pavement designs will also be evaluated to determine condition and performance potential. A new testing system will be purchased and installed, and operators will be trained to perform modulus tests, which

will then be used to analyze the performance of Alaska's roadway pavement structures and to improve our pavement design methods.

Rut Measuring Device - The State of Alaska is in need of a safe, high-speed, reliable, accurate, and cost effective means of obtaining pavement wheelpath rutting depths for annual road surface inventory purposes. The preliminary report for this project consists of an investigation into what devices and methods are currently available and capable of fulfilling these needs. It recommended that the State begin developmental work on a vehicle mounted system which employs a non-contact optoelectronic means of acquiring these depths, a microprocessor based on-board system to process the data, and a magnetic tape unit for bulk storage of the information. This information would then be easily transferable to the existing computer system for analysis and placement in the roadway inventory data bank. The costs for such a system is estimated at $185,000.00 with the unit to be available approximately one and one half ($1\frac{1}{2}$) years after initiation of the design and development work. Due to the high cost of this unit, work was terminated on this study and remaining funds transferred to the Computer Software project. Further development work by other states is expected to reduce the future costs of rut devices. (Report No. AK-RD-81-1)

Control of Permafrost Degradation Beneath Roadways - Various design features have been incorporated in new roadway construction projects. Following construction, temperature monitoring systems have been installed and settlement and movement references established. Continuous air temperature recordings, monthly temperature measurements and annual thaw and settlement surveys are used to measure longterm benefits of these design features. Studies in this area began in 1979 with construction of an insulated roadway near Chitna, and have been progressively expanded to include long-term monitoring at six experimental roadway sites throughout the State.

Pavement Performance Study - The State of Alaska experienced a disproportionately large number of lay down problems and early deterioration on many newly constructed asphalt surfacing projects beginning in the early 1970's which appeared related to changes in asphalt grading systems made in 1974

and 1976. Deterioration to the point of failure occurred in some cases, where accelerated wear and even a complete loss of surfacing was observed.

This study was initiated to determine the causes of these failures by selecting and examining representative pavement sections constructed before and after asphalt specification changes.

Performance of Bituminous Surface Treatments in Alaska - Under this study, all Alaskan roadway projects utilizing the surfacing type designated as bituminous surface treatment (BST) were examined and evaluated to compare the effective life of this surfacing method with the project specifications and materials utilized. Project records and interviews with personnel provided construction data. Samples have been taken to determine the aggregate and asphalt properties where possible and to relate these to performances.

Evaluation of Air Duct Ground Stabilization System - A design manual will be prepared for using air ducts to stabilize thaw-sensitive ground. Coefficients of friction, required stack heights, heat transfer rates, and effects of bends will be determined. All procedures will be compared to the existing air duct installation near Fairbanks.

Prethawing of Permafrost by Surface Modifications - Repair of roadways having unstable foundations is both a major maintenance item within the Department of Transportation and Public Facilities and a major headache and hazard to the motorist. Experience from old roadway sections and test section results reveals that thermally stable embankments can be constructed over thaw unstable soils if a sufficiently thick layer of thawed soil overlies the permafrost. This thawed zone, however, should be developed either before or during the construction phase, not after.

The utilization of passive solar radiation and the preparation of the ground surface to absorb as much energy as possible is being investigated in this study as a means of achieving this thaw zone. This entails removing the naturally occurring vegetative and organic ground surface covering and the application of six common surface treatments to accelerate the net heat input into the ground during the summer months.

This study will indicate what surface modifications and times are needed to permit adequate thawing for construction applications.

Geophysical Methods for Detecting Permafrost and Ground Ice - Present preconstruction investigations in areas of permafrost rely almost entirely on soil boring to learn the nature of the subsurface soils. While drilling does give excellent subsurface information, it is very costly and only represents the soils actually encountered. Soil borings may fail to detect the presence of permafrost or ground ice only a short distance from the selected boring site. It is evident that other subsurface investigative techniques are needed to provide more general data on an area's soils conditions to supplement the information gained by drilling.

The Alaska DOTPF and the Geophysical Institute have, for several years, evaluated various geophysical techniques for their ability to detect and delineate permafrost and massive ground ice. Several instruments have shown promise.

This particular study provides a means for further field tests and more important, the integration of these methods into State sponsored preconstruction soils investigation programs.

Field Evaluation Site for Ground Ice Detection - Past experience with DOTPF's permafrost and ground ice detection program has revealed the need for a permanent evaluation site of known ground truth. The use of road cuts and heavily drilled investigation sites have proved less than satisfactory - often leaving important questions unanswered.

In order to conduct the evaluation program in a controlled environment where the unknowns are limited, a site containing a subsurface ice mass of known size, shape, and depth was fabricated during the winter of 1980-81. This mass (approximate dimensions 26" wide, 10' thick, and 120' long, buried $3\frac{1}{2}$' deep) was constructed in an area of nearly homogeneous frozen silt near Fairbanks by flooding a trench dug for this purpose.

In the years ahead this site should prove very useful in the continuation of DOTPF's evaluation program and helpful in the development of new ground ice interpretation techniques and equipment.

Asphalt Pavement Properties Relating to Roadway Surface Performance - This report examines asphalt pavement properties of 117 older highway sections within the State of Alaska. Principal research objectives included: 1) documentation of commonly measured physical properties of the asphalt concrete cores and extracted asphalt cement and 2) characterization of materials properties which provided the best long term pavement performance.

Correlating Dynamic Deflections With Pavement Performance - This study will comparatively evaluate the use of Road Rater and Falling Weight Deflectometer testing methods for routine pavement inventory use in Alaska. The ability of each instrument to characterize observed pavement condition and to function properly throughout the project's duration will be addressed.

Pavement System Evaluation of Alaskan Highways - A three year study was made to review the construction and performance of pavement structures in Alaska. One hundred twenty uniform pavement sections were chosen and characterized by fatigue (alligator) cracking, thermal cracking, roughness of ride and peak springtime deflection levels. Sections were distributed throughout each principal climatic zone within the state. Materials were sampled to a depth of 54 inches and analyzed to determine their relationships to pavement performance.

Results indicate correlations between soil fines content and several of the performance factors. Performance relationships were also found involving asphalt concrete thickness, pavement age and accumulated traffic loadings. Climate variables showed little correlation with performance except with major transverse thermal cracks.

Deficit thickness-design requirements based on both supporting soils stability (R-value) and frost susceptability were compared with performance for a number of locations. While a trend was observed between existing overlay deficit and performance, the extra materials required by present Alaskan design methods apparently led to overly conservative structures in many cases.

Alaska's pavement rating system was also correlated with a more conventional "PSI" method as developed by New York State. (Report No. FHWA-AK-RD-81-7 and No. AK-RD-81-9)

Gasohol and Alcohol as Vehicle Fuel - The use of gasohol as a vehicle fuel is gaining popularity nationwide. Current research has identified problems associated with its use under cold conditions, but has not addressed those problems with field studies. This project demonstrates the use of gasohol throughout a year in Fairbanks to determine the feasibility in a cold climate.

Applications of Engineering Fabrics in Alaska - This study will evaluate the successes and failures of all Alaskan engineering fabric installations designed to act as filter layers or roadway fill reinforcement layers, and will provide design guidelines for future projects which will improve their performance.

Ice Forces on Northern River Bridges - The intent of this study is to provide data on actual ice forces for thick river ice conditions, and to use these data to recommend modifications to current code requirements for ice forces on river crossing structures. The site of this work is the Yukon River Bridge on the Dalton Highway. Various load cell types have been installed on Pier #5 to measure ice forces during the spring break-up period.

Rubberized Asphalt for Roadway Ice Control - This project will design and evaluate test sections of asphalt pavements constructed with 3% to 4% of ground rubber particles included in the paving mix to determine the benefits of this product in reducing surface ice formation and increasing tire friction in winter.

Soil Stabilization for Remote Area Roads - Literature reviews will be made to assist in determining the most suitable soils stabilization methods. Soil surveys will be made in gravel deficient areas of Alaska which are scheduled for future transportation projects to determine typical soil properties and to obtain samples for laboratory evaluations of the benefits of different stabilization treatments. The benefits of various stabilizers will then be measured by extensive laboratory testing.

Optimum Sand Specifications for Roadway Ice Control - Expenditures for roadways and traction improvement on icey pavements annually approach one million dollars in Alaska. Recent ice control

studies have been aimed almost entirely at uses of salts rather than sands.

In view of the rapidly increasing costs of salts, and the vehicle corrosion and environmental damages which result from their usage, studies of comparative friction levels attained by different sand gradations and angularities were performed at Fairbanks, Alaska, during 1980 and 1981. Coal ash was also included as an alternative product. Different materials were evaluated by field tests on clear ice and on packed snow using a Mu-Meter friction test trailer and a Tapley meter equipped sedan. Laboratory cold-room testing with a "British Pendulum" friction test device was used to evaluate comparative friction levels of the different materials when applied on clear ice at different temperatures. Freezer tests of sands with different anti-freeze agents were made to evaluate stockpile handling properties at subfreezing temperatures. Results of these studies are summarized and recommendations for roadway sand specifications and usage are made.

Although roadway sanding provides a significant friction improvement over clear ice or packed snow, it still does not provide nearly the friction available from bare pavements.

Economic Aspects of High Speed Unpaved Roads - The costs of constructing and maintaining gravel roads with dust control procedures as utilized in the Yukon Territory will be compared with those of constructing and maintaining paved roads in permafrost areas between Fairbanks and the U.S./Canada border.

Road Construction on Muskeg - This project involves a post-construction evaluation of design stage calculations for anticipated settlements and lateral movements of embankments constructed over muskeg on the Kenai River construction project. The objective is to determine if present design calculations and peat consolidation and strength testing procedures are adequately predicting actual performance, or if adjustments in design procedures are necessary.

Design Guide for Pavements on Permafrost - A design guide manual to include all aspects of permafrost engineering related to roadways is essential to bridge the gap between the latest research work and the previously used procedures. This manual will

update the existing design principles and will play an important role in reducing the costs of construction of stable roadways on permafrost.

Design Manual for Muskeg - This project will involve compiling available literature and field data analysis to serve as the basis for a roadway design method for muskeg terrain. A manual will then be prepared to summarize the necessary information and to formulate a systematic design method. Latest soil reinforcement and the use of soil-fabric aggregate systems will be carefully analyzed in light of all other available methods and their applications will be evaluated with all existing data.

Evaluation of Research Work on Substitute Materials in Frost Protection - There is an urgent need for the collection of existing facts and data with reference to the modification or replacement of gravels by substitute materials for use in frost protecting layers. This study will obtain facts and data on materials treated with lime or cement or chemicals that are sufficiently effective as frost action reducers. Development of design criteria and construction techniques for the construction and stabilization of MESL (membrane encapsulated soil layers) will also be attempted.

Instrumentation of New Gastineau Channel Bridge - A new and innovative design for a prestressed segmental concrete bridge structure is being constructed across the Gastineau Channel at Juneau during 1980 and 1981. The strain and deflection history of the cantilever and anchor spans will be measured and compared with the load history and the theoretical predictions of these same strains and deflection. Particular emphasis is placed on the monitoring of creep. The purpose of this research is to monitor the structural behavior of the new bridge so that it can serve as a full-scale model to provide information for advancing the state-of-the-art of designing and constructing segmental structures.

Mechanistic Design Methods for Alaskan Pavements - This study will examine state-of-the-art methods for evaluating the structural designs of asphalt concrete pavements. Selected procedures will be made available to the Alaskan pavement engineer through a "user's manual" section in the summary report and installation of selected programs on a computer system accessible throughout the State.

Reliability of the Alaskan Pavement Rating Procedure - This study will evaluate the new Alaskan pavement inventory rating method. The repeatability in measuring various distress features as well as minimum required sampling densities will be determined. Work will involve a statistical study of data aquisition and significance levels associated with the description of pavement performance on paved Alaskan roadways. This study will consist primarily of two parts. First, sections of highway will be rated by teams of Alaska DOTPF personnel, and studies on the repeatability of the ratings will be performed. Second, a number of sections will be rated by continuous measurements and an evaluation of these data will be used to determine if a lower frequency of observation would be possible. The objectives are to establish the range of variability which might be expected when a paved roadway is performance rated and to determine the minimum sampling frequencies necessary to produce a reliable pavement rating.

Evaluation of Road Rater Test Methods - This study will provide an operational evaluation of the Road Rater Model 400A by defining: 1) load/frequency operating mode which provides the best correlations to Benkelman Beam deflections, 2) pavement temperature effects on Road Rater deflections, and 3) proper sampling frequencies. Objectives of this project include the development of a standardized test method for use of the Road Rater in Alaskan pavement design.

Rational Seasonal Load Restrictions and Overload Permits - Seasonal load restrictions have been enforced in Alaska since the first paved road in 1950. The time frame and level of such restrictions have historically been based on the experience and judgement of the maintenance personnel. This results in a lack of continuity from region to region. A rational load restriction policy has been developed based on the load-damage relationships on a pavement structure. Deflection data is used to monitor the strength of the embankment, thereby providing the information on which to base the time frame and level of restrictions.

The overweight permit policy presented is based on the ability of the roadway system to carry the load and the load-damage relationships. The policy uses the philosophy that the user should pay for any damage in excess of that which would be incurred by legal loading. (Report No. FHWA-AK-RD-81-8)

Special Projects/Farmers Loop Sinkhole - The "sinkhole" which has developed on Farmers Loop near the College Road intersection has plagued the Department of Transportation for many years, especially since it represents a hazard to the public. It has been shown that this is not due to a massive ice lens as is popularly believed. Rather it is due to thaw-consolidation of peat beneath the road. The thermal regime is still not understood, however, recent drilling has offered some clues. (The Northern Engineer, Vol. 12, No. 4)

ENERGY RESEARCH PROGRAM

Passive Solar Alaskan School - A cooperative project jointly funded by the State of Alaska and the U.S. Department of Energy, the Passive Solar Alaskan School Project seeks to develop cost effective design criteria for integrating passive solar energy collection features into Alaskan public buildings. Phase I concentrated on the development of a unit school building which would receive 45% of its space heating requirement and a similar portion of its lighting energy by collection of solar energy. In Phase II the unit building concept is thematically repeated in a complex building. The Two Rivers School, a seven classroom facility designed by C.B. Bettisworth and to be built approximately 30 miles northeast of Fairbanks includes the solar features contained in the unit building. Construction on the Two Rivers School will begin this summer (1981). Phase III will include the thermal monitoring of the new school to verify the design calculations as well as the economic evaluation of the cost effectiveness of the Passive Solar concept. (Report No. AK-RD-81-10)

Thermal Performance Standards - Building Energy Performance standards, often called BEPS, are a high priority of national energy policy as directed by the U.S. Department of Energy. However, as with other subjects of national interests the research in this area has neglected the special considerations necessary for the unique environment of Alaska. The result has been the continuation of less than optimum energy conscious building design and construction in Alaska. This project is intended to develop the necessary engineering and design criteria to provide Alaskan architects and engineers with the information they need to design with confidence energy efficient structures for the Alaskan environment at the lowest possible life cycle cost. It is a

project expected to continue in successive phases and will eventually draw on the expertise of several segments of the Alaskan technical community. (Report No. AK-RD-81-19)

Buildings Energy Conservation - Under this project title the second phase of "Thermal Performance Standards" is being funded as well as several spin-off projects which involve energy conservation in buildings and are identified as problem areas requiring resolution before a satisfactory energy performance standard can be completed. A list of problem areas which are currently being investigated are:

1. Vapor Barriers - The Energy savings associated with vapor barriers, proper installation techniques and associated construction cost factors.

2. Air Infiltration in Buildings - Data are being gathered and analyzed from various public buildings in the State to determine the existing levels of air infiltration which can be expected and what levels of energy conservation could be achieved by reducing infiltration.

3. Economics of Super Insulated Structures - Data on the cost of construction for various insulation designs are being gathered and refined for accuracy in predicting life cycle costs.

4. Windows and Night Insulation Systems - A facility is being constructed which will test various window and night insulation systems. Night insulation on windows is expected to recover substantial energy cost savings if a design can be worked out which is appropriate to the Alaskan environmental conditions.

5. F-load Building Energy Analysis Computer Programs - This interactive computer program is being used to evaluate various building energy conservation design schemes as a research tool. However, part of this project includes the implementation of this program in the three regional offices of General Design and Construction to be used on a routine operational basis.

Passive Solar Heated Fire Station Demonstration Project - The Chena Goldstream Volunteer Fire Department, serving a suburban area west of Fairbanks, has been awarded a construction grant from the State to build two truck garages to house fire

fighting equipment. This small volunteer department is unable to afford high maintenance and utility bills once the buildings are complete and has therefore requested assistance in developing an energy efficient solar assisted design. The fire department will construct the buildings. After construction the Statewide Research Section will monitor the performance of the buildings as a demonstration and gather design data for future designs. (Report No. AK-RD-81-11)

Remote Facilities Monitoring - Alaska DOTPF has initiated a program to investigate the feasibility of electronically monitoring critical operational parameters associated with State public facilities, particularly those facilities located in remote areas where maintenance and replacement costs are unusually high. Given the proper selection of factors to be instrumented and monitored, both local and centralized monitoring are being considered. Performance of critical building systems, energy use, and potentially hazardous conditions could be identified and corrective measures taken. The thrust of the investigation is aimed at determining whether or not the life cycle cost of a facility could be lowered by eliminating high costs for emergency repair, equipment replacement, and excessive fuel usage due to improper equipment operation and maintenance.

A report will be available August 1981 which outlines the preliminary findings of this study.

Fuel Cell Testing - While fuel cells have been successfully used to power space satellites as well as other specialized applications, the industry is beginning to develop medium size (5 to 100 kw) power systems which might one day result in a highly efficient alternative to the diesel generator for rural application in Alaska. Fuel cells which are fueled with methanol may be able to supply both heat and electricity to rural facilities with overall energy conversion efficiencies of close to 80 percent. This project is aimed at investigating the feasibility of such a scheme and will provide the preliminary stages for a full scale test in Alaska if a reasonable probability of success can be expected.

Gas-Sorptive Properties of the Zeolite Mordenite - A long range aspect of the energy and buildings research program is concerned with the potential of hydrogen fuel for use in rural Alaska where it could

be produced from local resources such as: wind energy; electrolysis of water; coal, wood and/or peat gasification.

One problem facing hydrogen fuel use is the development of inexpensive and safe storage systems. This project seeks to determine if Alaskan mordenite, a zeolite mineral abundantly available in Alaska, could be used as an absorbent storage medium for hydrogen. If so, bulk storage of hydrogen could be accomplished at low pressures at a fraction of the cost of metal hydrid storage which is the method commonly used today. (Report No. AK-RD-81-3)

Wind Power User's Manual - An abundance of information exists concerning the potential for utilizing wind energy in Alaska. However, much of this information exists in a form which is of little use to individuals, groups, planners, designers, etc. considering the incorporation of a wind energy system into a new or existing facility. This project is intended to consolidate all of what is known about wind energy in Alaska, its potential, its limitations, its problems. The presentation is made in a form suitable for both the ultimate user of a facility as well as the designer. We expect that an authoritative reference of this type will help promote more numerous and better planned wind power projects resulting in a more significant utilization of a valuable, renewable energy resource for both State facilities and for the private sector. (Report No. AK-RD-81-2)

Small-Scale Heat Recovery - With the escalation of fuel costs, many people are turning to tighter, better insulated buildings as a means of achieving energy conservation. This is especially true in northern climates, where heating seasons are long and severe. Installing efficient well sealed vapor barriers, weather stripping and caulking around doors and windows reduces cold air infiltration but can lead to damaging moisture buildup, as well as unpleasant and even unhealthy accumulations of odors and gases. To provide the necessary ventilation air to maintain interior air quality while holding down energy costs, air-to-air heat exchangers have been proposed for residential and other simple structures normally not served by an active or forced ventilation system.

Four basic types of air-to-air heat exchangers are suited for small scale use: rotary, coil-loop, heat

pipe, and plate. The operating principles of each of these units are being investigated and their individual advantages and disadvantages considered. A test program has been initiated to evaluate the performance of a few commercial units as well as several units designed and/or built at the University of Alaska. Preliminary results from several of these tests are presented along with a critique on their design in the interim report. (Report No. AK-RD-81-12)

Climate Adapted Solar Collectors - A simple technique to capture useful quantities of solar energy in existing, non-solar buildings is to attach a sun space, or a greenhouse to the southside. From this point storage and other techniques can be added in varying degrees of complexity to transfer the collected energy to the interior. A project to prepare a design manual for attached sun spaces used as solar collectors is now in progress. The intention is to better define the techniques of using solar energy for energy conserving retrofits of existing buildings or in new construction. Primary emphasis is placed on rural facilities where simple techniques using renewable energy offer the most favorable return on investment.

Special Projects/Tracer Gas - The above EPA maximum acceptable carbon monoxide (CO) level which often occur during prolonged temperature inversions in Fairbanks has been a major concern for the local governing agencies for several years. While progress has been made in reducing the problem from its source, understanding of CO disposition and dispersion has not significantly advanced due in part to the lack of good meteorological data. This study tested the methodology of using sulfer hexafloride (SF_6) tracer gas to determine if such a technique could be successful at measuring the wind field and mixing layer height in the Fairbanks Basin. The results indicate a high probability of success for using SF_6 as the trace element in a future comprehensive study and data gathering effort. (Report No. AK-RD-81-13)

Data Transmittal Study - The need to transfer digital information to and from the Alaskan bush is increasing with the extension of public services into these outlying areas. This desire for an inexpensive data net is now being felt within several state agencies. The State of Alaska is currently investigating means of telecommuting aviational weather

reports from rural airfields and operational data from remote public facilities. Educational, scientific, public safety, judicial, environmental, social and administrative interests could be aided through the establishment of an appropriate net. A reliable and moderately high data rate link could also permit some form of interaction with existing data and computer networks. Printed material either alpha-numeric or facsimile in nature could be transferred rapidly from point to point within the net. In many instances travel could be reduces as a result.

This study, conducted by the School of Engineering, UAF, investigated several telecommunication systems which could provide a statewide rural digital communication network to meet these needs. The following techniques were reviewed:

1. Radio propogation employing ionized meteor trails to reflect (scatter) the radio carrier wave.

2. The transfer of information over the existing earth station-satellite phone system on a call-by-call basis.

3. An information packet contention scheme involving the use of one voice grade satellite channel, for use by all users, and the associated earth stations that already exist in many parts of rural Alaska.

4. The implementation of a dedicated earth station network.

In general the techniques are characterized as being low to medium data rate, real to near real time interactive, inexpensive, and moderately to highly reliable. Points addressed in this report include anticipated unit costs, system operational characteristics and estimated developmental costs. Possible system usage was not directly addressed other than in a general manner as necessary to frame specifications. Neither was a great deal of attention been given to the assemblage and processing of information which could be handled by such systems. These points were felt better left addressed to particular applications. What was emphasized was the conceptual limitations and constraints associated with the general nature of each particular technique. (Report No. AK-RD-81-6)

Meteor Burst Demonstration - Meteor burst systems use the short-lived ionization trails of meteors as

the refractive medium for returning radio frequency signals to earth. Although the operationally useful time interval associated with such an event is typically only a few tenths of a second the use of micro-computer technology allows the passage of appreciable amounts of data in a "burst" mode. Meteor trails occur quite frequently allowing, under typical ionospheric conditions, reliable transmission of data from sensors or short messages over distances of up to 1200 miles.

A federally funded meteor burst network within Alaska has been in operation for several years primarily for use in gathering scientific and meteorological information from unmanned sites. This particular demonstration project has been funded by the State to evaluate the operational characteristics associated with this system in acquiring information of interest to the State. Remote facilities operational parameters, remote aviational weather information and emergency statewide communications are examples of possible utilization of this technique. A field station has recently been established at a remote communication facility located 40 miles north of the Yukon River Bridge and data is being compiled and analyzed by the School of Engineering, UAF.

New Roof Materials Research - Maintenance of the roofs covering State facilities is a continual drain on the budget. This project will research materials and methods by which the annual maintenance of roofs would be reduced and their useful life extended, representing a substantial savings to the State.

Vehicle Air Quality - Carbon monoxide (CO) level above the acceptable limit is a problem faced by both Fairbanks and Anchorage, the major source being the gasoline powered automobile. This project involves the measuring of vehicle emissions, both during cold starts and while following a yet to be developed "Alaskan Driving Cycle," using a mobile emission test facility (METFAC) provided by E.P.A. Research Laboratory of Ann Arbor, Michigan. The project results are to be used in a carbon monoxide computer model for the Fairbanks Basin useful to planning new highways and public facilities.

Solar Design Manual - The research being done within the DOTPF with respect to solar energy has indicated that substantial energy savings can be achieved if the design properly considers the unique

environment of Alaska. Since design information for solar applications in high latitudes is almost non-existent, it was determined that the best way to transfer the technology being developed through research would be to concurrently develop a design manual for solar applications specifically intended for the Alaskan environment. The manual is intended to enable designers to develop design schemes appropriate to the Alaskan environment by supplying state-of-the-art methodology and relevant design data. (AK-RD-82-1)

Fire Protection in Bush Areas - Traditional water sprinkler fire protection systems in bush area institutions and hostels have proven to be very expensive to install and maintain and when employed, cause tremendous damage to above grade, piling supported structures (the common construction method in bush areas). The structure may also be left unprotected for an extended period, if the system is tripped or if it suffers freeze damage, as they are prone to do if not properly maintained. This project attempts to demonstrate that an industrial Halon 1301 gaseous fire suppression system, which has been modified for residential use in simple structures can be installed for about the same price, reduce maintenance cost, provide adequate protection at greater reliability, and eliminate structural damage and greatly reduce down time after employment as compared to the water sprinkler system.

Improvement of Fairbanks Atmospheric Carbon Monoxide Model--A Program for Calibration, Verification and Implementation - For over a decade the relationship between high levels of ambient carbon monoxide and automobile emissions has been documented for the city of Fairbanks. This relationship of highway transportation and air pollution inextricably links the Department of Transportation and Public Facilities to the search for plausible air pollution control strategies at the planning and programming level as well as for environmental assessment during design and construction. With high carbon monoxide levels being recorded in other Alaskan cities the potential need for the Department to consider the air pollution problem on a statewide basis becomes more evident. This project was undertaken to survey the potential for up-grading and implementing a carbon monoxide dispersion computer model on a broader basis than used to date which would support the planning process and aid in environmental impact assessment. (Report No. AK-RD-81-14)

Paint Performance Testing - The Division of Maintenance and Operations presently has traffic paint specifications which detail the composition of paint that will qualify under DOTPF bid specification. It has been found, however, that these specifications do not always determine the durability of the paint. The development of a bid procedure where the major criteria is the durability of the paint needs to be developed in order to reduce the cost of traffic painting. Several states have set up a similar procedure.

Anchorage Traffic Computer Improvements - The Anchorage area bowl has almost 100% of its traffic signal lights tied into a centralized computer system to control the flow of traffic. This system was completed approximately two years ago and has been operating very successfully for about two years. During that time improvements to the existing system have been proposed, but before any changes on an area-wide basis are made development and demonstration of the changes must be conducted to determine the benefit of each change. These development projects are all needed to improve traffic flow within the Anchorage area in an attempt to keep up with the increased traffic.

Thermoplastic Systems - These funds will be used to test the application of thermoplastics for marking (striping) highways in Alaska. Thermoplastic is a material which is in a liquid form when it is heated up and is a solid when it is cooled. This project will determine the best formulation of thermoplastic and thickness of application for highway striping. Also, this project will involve an experiment with bonding agents so that the thermoplastics will better adhere to the pavement. Once the Department has determined the optimum formulation and application of thermoplastics for pavement marking, the use of paint may be obsolete. It is estimated that thermoplastic highway markings could last five years longer than paint markings.

Air Cushion Vehicle Demonstration Project - The Air Cushion Vehicle (ACV) Demonstration Project is being conducted in Bethel, Alaska. This project includes the demonstration of two sizes of air cushion vehicles. One is a six passenger, high speed, gasoline powered vehicle and the other a diesel powered,

Passive Solar Heating in Alaska - This project was the first undertaken by the Research Section in the area of energy conservation in buildings. Although a relatively small project, it became a foundation for several investigations now in various stages of completion. The setting up of the TRNSYS computer program during this project has put in place a powerful tool by which the thermal performance of buildings can be analyzed. Results of this project illustrate the basic design theory of passive solar energy capture in high latitudes by using several Alaskan locations as examples. (Report No. AK-RD-81-15)

Radio-Connected Automatic Trunk Circuit Feasibility - The State of Alaska has a significant number of small isolated population centers and remote facilities which need connection to trunk telephone switching equipment. Because these centers are geographically separated by terrain which precludes direct connection by wire or the economical use of satellite, microwave or other repeater systems an alternative carrier system is required to facilitate connection to the switched telephone network.

Upon learning the Telecommunication Research Section at Chelmer Institute had an appropriate low cost and reliable trunk connection technique which might satisfy these requirements, Chelmer Institute was contracted to undertake a feasibility study to determine the specific problems involved in the establishment of a radio-connected automatic trunk circuit within Alaska. This report summarizes the investigation and its findings.

The results indicate that the Chelmer signal recovery technique can be used to supplement an existing radio system by allowing the connection of telephone trunk circuits onto the radio carrier system. A radio telephone network could then be developed allowing one party to "ring" another paty within the system. The automatic trunk switching circuit would provide for the bookkeeping functions necessary for internal system management and the interface circuits needed for signal transferral to and from the radio carrier. Although the technique can offer some immunity to carrier fading, the use of HF non line-of-site radio propagation in polar and auroral regions will continue to hamper such a network's reliability. (Report No. AK-RD-81-20)

60 ton payload hoverbarge propelled by wheels and/or paddle wheels. The project includes operation of both craft on a year round basis, serving villages along the Kuskokwim River and travelling over water, land, ice and snow. Both craft have been operating since early January 1981. The small craft has executed approximately 150 twenty mile trips as of June 30, 1981 while the hoverbarge has made 12 trips each approximately 180 miles in length during this same time span. The small craft serves three villages while the hoverbarge serves 15 villages each month.

This project was initiated to test the feasibility of air cushion vehicles in providing an economically and environmentally acceptable year round means of transporting freight and passengers in western Alaska.

ACV Environmental Impact Study - This project provides for environmental study of the air cushion vehicle (ACV) project at Bethel and studies the feasibility for statewide use of data derived at Bethel being applied to other future ACV operations.

Noorvik Airport Lighting Demonstration - A research project was conducted over the summer and fall of 1979 to identify and develop a highly reliable, low maintenance electric power supply system which was an appropriate alternative to the diesel-electric generator for powering runway lighting systems at rural Alaskan airports. What came out of that project was a system which utilized an organic Rankine cycle turbo-electric generator as the primary component. The major advantages of this system are its high reliability, its minimal maintenance requirements, and its relatively long life cycle (twenty years). Also, it was found that the generator permitted the use of a simple waste heat recovery system which greatly enhanced the overall efficiency.

In early October of 1980, an experimental FAA approved lighting system was installed at the Noorvik airport using AVEC supplied electricity as the power source. In late March 1981 two Ormat organic Rankine cycle generators were installed. This project will provide a demonstration for comparison of reliability and costs of both power sources.

Airship Operation - An evaluation of the utility of lighter-than-air vehicles (airships) for Alaskan ser-

vice suggests that very large vehicles operating at low speeds could transport heavy loads to remote areas with excellent fuel economy, but that the potential market for such vehicles would not justify the cost of their development in present circumstances.

Equations relating the effect of design parameters on the ratio of payload weight to fuel weight may be used to verify performance claims made for innovative designs. (Report No. AK-RD-81-4)

Strobe Lighting Demonstration Project at St. Michael, Alaska - This project involved the investigation of a strobe lighting system as an alternative to conventional airport lighting systems. The overall intention was to study the possibility of developing an alternative lighting system which could satisfy FAA requirements while providing a less costly and more maintainable system for rural application.

The St. Michael study established that the installed system of strobe lighting was not an acceptable alternative. Although the use of the strobe system helped runway alignment orientation, the system was not, by itself, suitable for night operations. (Report No. AK-RD-81-5)

Yukon River Bridge Use - Pursuant to an agreement with the Pipeline Coordinator, Division of Pipeline Surveillance, the Department of Transportation and Public Facilities contracted with Peratrovich and Nottingham, Inc. for professional services to prepare criteria for the factors to be addressed by Northwest Alaskan Pipeline Company (NWA) in completing studies, including risk analysis, for using the Yukon River bridge as their gas pipeline river crossing. This report develops those criteria. Peratrovich and Nottingham, Inc. will also assist the State in determining the validity of the investigations performed by NWA. (Report No. AK-RD-81-17)

SECTION 4

SPECIAL PROJECTS

OBJECTIVE

The Research Section responds to inquiries and requests regarding new products or techniques which may be of some use to the State. These requests come from within the Department, the legislature, other State agencies, or from the private sector. Some of these requests form the basis of continued research projects which may be funded through the normal budget request cycle while others require a few hours or days of evaluative effort. Special projects which received funding this fiscal year are summarized below.

HIGHWAY RESEARCH PROGRAM

Reinforced Earth Slab Evaluation - The new Brotherhood Bridge in Juneau was built with a reinforced earth slab to reduce the stresses induced by a retaining wall on a concrete box culvert. This is the first time in the United States that a reinforced earth slab of this type has been used in this manner. Funding was provided to help instrument this slab so that the performance could be monitored. Data will be collected for several years to evaluate the effectiveness of this concept.

Dust Control Studies - Many Alaskan roads, and notably the North Slope Haul Road, experience dust problems in the summer months. The North Slope Haul Road has been opened to the public since June 1, 1981 which presents additional potential dust control problems.

Two commercial products, Polar-Crete and Deep Penetrant, were suggested as possible dust control agents. These were tested in the lab and plans were made to evaluate test sections on the haul Road. Lab tests, however, showed that to obtain a proper effectiveness it would not be economically feasible to use either agent.

Chem-Crete Asphalt Additive - A commercial product known as Chem-Crete is being evaluated to determine its ability to produce a more stable and higher strength asphalt material at high temperatures while not affecting original low temperature properties.

Laboratory tests are presently in progress. At the same time a 1000 foot test section of asphalt pavement between Canyon Creek and Shaw Creek has been laid utilizing Chem-Crete as an additive to field test the effectiveness of the product.

Fabric Reinforced Embankments/Soil Stabilization - Two products are currently being evaluated to determine their effectiveness in stabilizing soils. A private consultant is concluding an analysis on fabric materials that may have application in spanning small settlement areas in highways. If the analysis is favorable a test section will be installed.

A second product, an expandable polyethylene grid, may have application in stabilizing silty soils. If successful, this could have application on airports in the arctic and along the western coast of Alaska where sources of gravel are in short supply or nonexistent.

Impulse Radar Evaluation - Portable radar devices are being developed that can penetrate many feet into the earth. An evaluation test of such a device was made to determine its effectiveness in locating frozen peat bogs and ice lenses under existing or proposed highway and airports. The test was successful in that considerable information could be determined but, at the present time, the data from the more portable, hand held, resistivity measuring devices are easier to interpret.

Traffic Detector Loop Sealants - Traffic signals at intersections are often actuated by detector loop wires in slots cut into the pavement. Because of a high failure rate of the loop detector wires a program of testing various sealants has been initiated.

Highway Delineator Posts - The installation and replacement of highway delineator posts can be a major problem in winter conditions. One hundred posts of a new type were bought and installed to determine the ease of replacement during winter conditions. The results were mixed for this particular brand.

Autotherm Energy Conservation System - An automobile energy saving device is being installed on 18 State of Alaska vehicles that have a known history of long idle times. The units will be divided between Juneau, Fairbanks, and Anchorage to evaluate climatic effects. The device, known as an Autotherm, has been used in Michigan and Minnesota but no data exists on its performance in the Alaskan environment. Data will be gathered for a period of a year on these devices.

Utilidor Freeze-up - The freezing of pipes in utilidors is a major problem in rural communities of Alaska. Preliminary tests are being run on various salts to determine if the latent heat of fusion of these salts as they change from the liquid to the solid state can be utilized to protect the pipes from freezing. This project is continuing.

Solar Room - A small structure that can be utilized as a greenhouse, sunspace, or a source of supplemental heat is being evaluated. This structure may have possible application in connection with rural school buildings. This project is continuing.

Ceramic Insulation - A sample of a commercial insulation that claims to have an equivalent R-factor of 70 for a three inch layer is being evaluated. Testing has not yet been concluded on this product.

Insulated Shutters - There is considerable interest at the present time in the use of insulated shutters on windows as an energy saving device. On the average there is approximately ten time as much heat loss through windows, on a square foot by square foot basis, as through walls. Information is being compiled from various manufacturers of insulated window shutters and a test program will be run to determine their performance under conditions of sub-zero temperatures, wind, air sealing ability, and condensation problems. This is another area that has considerable application at remote bush villages and schools.

PLASI Navigation Aide - A Pulse Light Approach Slope Indicator (PLASI) navigation aide has been installed at the general aviation gravel air strip at Anchorage International Airport and is currently in use. This device has been receiving considerable use during periods of rainy inclement weather.

SECTION 5

FUNDING AND EXPENDITURE CATEGORIES

Authorized Funding History

The table below summarizes the authorized funding history of the Research Section since the creation of the Department of Transportation and Public Facilities on July 1, 1977.

Much of the State appropriated funding is for Capital Improvement Projects (CIP) and does not lapse at the end of the fiscal year. Funds appropriated in one fiscal year, can, therefore, continue into subsequent years. The funding history is shown diagramatically in Figure 1.

	FISCAL YEAR			
Agency	1978	1979	1980	1981
State of Alaska		$1,030,000	$ 715,400	$3,092,625
U.S. Department of Transportation				
Federal Highway Administration				
- Highway Planning & Research Program	$242,250	355,971	550,000	550,000
- Other Direct FHWA Grants		5,000	50,000	
Other U.S. DOT		1,020,000		234,375
U.S. Department of Energy			40,892	58,000
TOTAL	$242,250	$2,410,971	$1,315,400	$3,935,000

RESEARCH SECTION

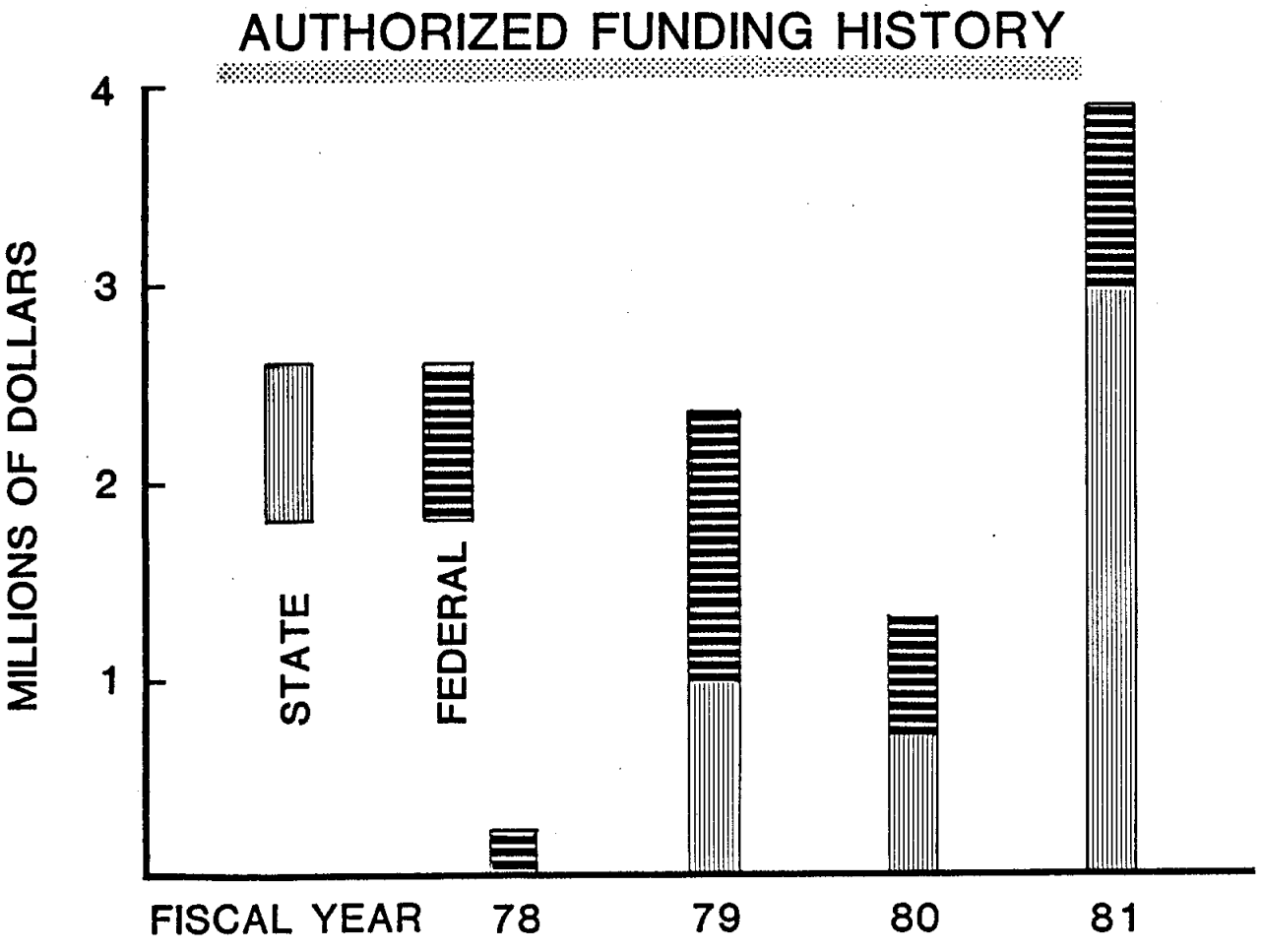

Figure 1 shows the authorized funding history of the Research Section since the creation of the DOTPF. The funding sources are broken down to show Federal and State sources.

FIGURE 1

HISTORY OF EXPENDITURES

The table below summarizes the expenditures of the Research Section for each year since the creation of the Department of Transportation and Public Facilities on July 1, 1977. The expenditures for fiscal year 1981 are shown in Figure 2.

	FISCAL YEAR			
Expenditures	1978	1979	1980	1981**
DOTPF Research Section	$242,250*	$ 377,477*	$ 972,368	$1,490,363
University of Alaska		24,966	250,935	295,573
Other State Agencies			15,000	18,000
Federal Agencies		11,200	71,200	72,696
Municipalities				29,346
Private Sector		1,315,000	50,000	1,190,380
TOTAL	$242,250	$1,728,613	$1,359,503	$3,096,358

* Exact figures for money spent on HPR projects are not available for these periods. Authorized amounts were used for the purpose of this table.

** Tentative 6/30/81 information based on internal ledgers.

RESEARCH SECTION

BREAKDOWN OF FY 81 EXPENDITURES

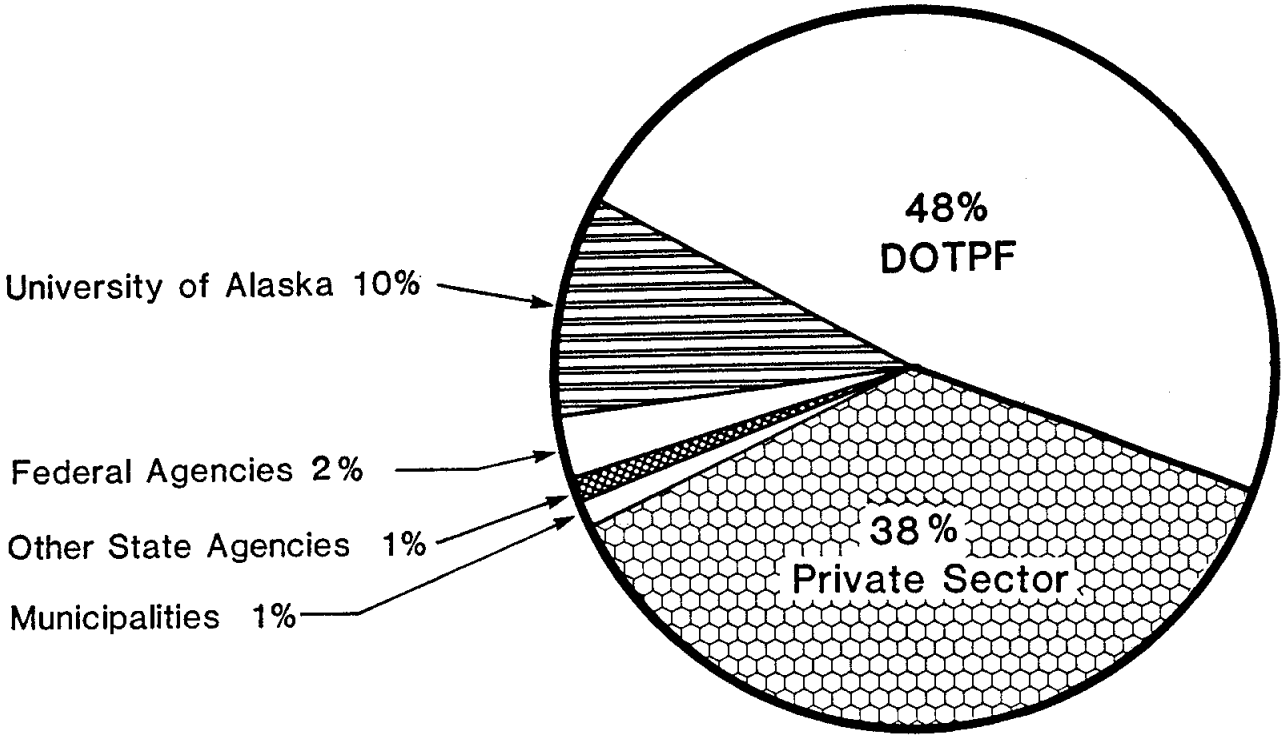

Figure 2 illustrates the expenditure pattern for the Research Section for FY 81

FIGURE 2

SECTION 6

IMPLEMENTATION

The end result of applied research and development is implementation. This is happening every day and takes place in many forms - research publications which bring new ideas to the operational sections, new products, and demonstration projects.

Without diminishing the value of any of the many important projects being investigated during FY81 the following are worthy of note. These projects are described in greater detail in the Research in Progress Section.

Noorvik Airport Lighting Project

This unique demonstration project may revolutionize runway lighting at numerous bush airports throughout the state. Actually turned on and controlled by the pilot of an incoming plane, the lights are powered by an Ormat Rankine Cycle external combustion turbine, a highly reliable independent electric power supply.

Computer Engineering Software

Engineers and scientists invented and developed computers and have continually advanced the state of their own art and technical expertise with these electronic machines. However, the administrative use of computers has increased so rapidly that engineering activities frequently take second priority. To alleviate computer bottlenecks at the level of the design engineer, computer terminals and plotters were installed in the three regional engineering offices under the direction of engineers from the Research Section. Earthwork software from the Washington State Highway Department Computer System has been loaded on the Boeing computer and is operational in all three regional offices.

Building Energy Analysis System

Public Facility Planners and Design Managers within the division of General Design and Construction have always been at a disadvantage when evaluating consultant designed buildings for energy analysis and life cycle cost alternatives. The only way to do this would be to repeat the architectural and engineering

design analysis by hand calculation as a check. Since the process is most time consuming work loads usually precluded such evaluation.

During the past year the Research Section has obtained an interactive computer program capable of analyzing the thermal performance of a building from a simple set of input data. Loaded with climatic data for 10 different regions of Alaska, the program can quickly evaluate several design alternatives even at the schematic design stage. A life cycle cost package is being added. So far the Research Section has been testing the program by analyzing a project building for General Design and Construction in the Central Region. If progress continues each region of General Design and Construction should have this computer capability within a few months.

SECTION 7

PUBLICATIONS

Listed below are the publications produced by the Research Section since July 1, 1980.

All Department of Transportation and Public Facilities Research Publications are available on microfiche from:

Arctic Environmental Information and Data Center
University of Alaska
707 "A" Street
Anchorage, AK 99501
Telephone: (907) 279-4523

NUMBERED PUBLICATION

AK-RD-80-1	Jurick, R., Automated Pavement Rut Depth Measuring System, 43 pps., 1980.
AK-RD-80-2	Wentink, T., Alaska Wind Power User's Manual, 1st Edition, 101 pps., 1980.
AK-RD-80-3	Hawkins, D.B., Gas-sorptive Properties of the Zeolite Mordenite, Interim Report, 13 pps., 1980.
AK-RD-80-4	Tiedemann, J.B., Airship Operation in Alaska, 17 pps., 1980.
AK-RD-80-5	Miller, R.E., and D. Pruhs, Strobe Lighting Demonstration Project at St. Michael, Alaska, 32 pps., 1980.
AK-RD-80-6	Roberts, T.D., R.P. Merritt, and K.J. Kokjer, Low Data Rate Digital Transmission Techniques for Alaskan Applications, 31 pps., 1981.
FHWA-AK-RD-81-7	McHattie, R., B. Connor, and D. Esch, Pavement Structure Evaluation of Alaskan Highways, 208 pps., 1980.
FHWA-AK-RD-81-8	Connor, B., Rational Seasonal Load Restrictions and Overload Permits, 52 pps., 1980.
FHWA-AK-RD-81-9	Esch, D., R. McHattie, and B. Connor, Frost Susceptibility Ratings and Pavement Structure Performance, Draft, 42 pps., 1980.
AK-RD-81-10	Seifert, R.D., Passive Solar Alaskan School, Report on Phase I, 212 pps., 1981.

AK-RD-81-11 Seifert, R.D., Passive Solar Fire Station Demonstration Project, Interim Report, 21 pps., 1981.

AK-RD-81-12 Zarling, J.P., Air-to-Air Heat Recovery Devices for Small Buildings, Interim Report, 19 pps., 1981.

AK-RD-81-13 Rezek, J.F., and R. Jurick, Tracer Gas for Meteorological Analysis in the Fairbanks Basin, 33 pps., 1981.

AK-RD-81-14 Carlson, R.F., and C. Hok, Improvement of Fairbanks Atmospheric Carbon Monoxide Model -- A Program for Calibration, Verification and Implementation, 74 pps., 1980.

AK-RD-81-15 Zarling, J.P., Passive Solar Heating in Alaska, 20 pps., 1980.

AK-RD-81-16 Jurick, R., and J. Murray, Implementation of the Governor's Haul Road Policy; Intra-Agency Communication Needs, 37 pps., 1981.

AK-RD-81-17 Peratrovich & Nottingham, Inc., Use of Yukon River Bridge Risk Analysis Criteria Development, 32 pps., 1981.

AK-RD-81-18 DOTPF Research Section, Research Procedures Manual, 76 pps., 1981.

AK-RD-81-19 Zarling, J., and J.S. Strandberg, A Thermal Performance Design Optimization Study for Small Alaskan Rural Schools, Draft, 162 pps., 1981.

AK-RD-81-20 Schnurr, L., Inter-Exchange Radio Trunking Using HF Circuits, 70 pps., 1980.

AK-RD-81-21 DOTPF Research Section, Annual Report to the Director - FY81

OTHER PUBLICATIONS

Bates, J., An Introduction To This Issue, The Northern Engineer, Vol. 12, No. 4, p. 5, 1980.

Sweet, L. and B. Connor, The Farmers Loop Sinkhole, The Northern Engineer, Vol. 12, No. 4, pps. 6-10, 1980.

Zarling, J., Passive Solar Design Elements for the Subarctic, The Northern Engineer, Vol. 12, No. 4, pps. 11-16, 1980.

McHattie, R., Highway Pavement Cracks: An Alaskan Overview, The Northern Engineer, Vol. 12, No. 4, pps. 17-21, 1980.

Leonard, L.E., Stalking the Organic Rankine Cycle in Alaska, The Northern Engineer, Vol. 12, No. 4, pp. 22-26, 1980.

Osterkamp, T.E., and R.W. Jurick, Detecting Massive Ground Ice in Permafrost by Geophysical Methods, The Northern Engineer, Vol. 12, No. 4, pp. 27-30, 1980.

Rezek, J., Indoor Pollution and Air-to-Air Heat Exchangers, The Northern Engineer, Vol. 12, No. 4, pps. 31-33, 1980.

Esch, D., Rubber in Pavements for Ice Control, The Northern Engineer, Vol. 12, No. 4, pps. 34-39, 1980.