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THE ECONOMIC VALUE OF REMOTE SENSING OF EARTH RESOURCES FROM SPACE: AN ERTS OVERVIEW AND THE VALUE OF CONTINUITY OF SERVICE

VOLUME X

INDUSTRY

Prepared for the
Office of the Administrator
National Aeronautics and Space Adminstration
Under Contract NASW-2580

October 31, 1974

NOTE OF TRANSMITTAL

This resource management area report is prepared for the Office of the Administrator, National Aeronautics and Space Administration, under Article I.C.1 of Contract NASW-2580. It provides backup material to the Summary, Volume I, and the Source Document, Volume II, of this report. The interested reader is referred to these documents for a summary of data presented herein and in the other resource management areas.

The data presented in this volume are based upon the best information available at the time of preparation and within the resource of this study. This includes a survey of existing studies plus Federal budgets and statutes. Throughout the analysis, a conservative viewpoint has been maintained. Nonetheless, there are, of course, uncertainties associated with any projection of future economic benefits, and these data should be used only with this understanding.

ECON acknowledges the contributions of Keith Lietzke who authored this volume.

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ABSTRACT

By excluding the "natural" connotations of the term resource, the industrial resource may be defined as that source of support and supply that constitutes the world's capital plant. The primary usefulness of an ERS system to this "man-made" resource lies in the areas of transportation, construction, public administration and regulation.

Though ERTS imagery has successfully contributed to the improvement of shipping routes, detected previously unknown and potentially active faults in construction areas, and monitored industrial pollution (Volumes V, VII, IX), there has been little economic research concerning the subject of ERS applications into this resource area. As a result, the benefit estimations presented in this volume must be regarded as tentative and preliminary.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION AND OVERVIEW: INDUSTRY

In addition to the seven "natural" resources dealt with in Volumes III through IX of this report, there exists an eighth "man-made" resource which might be significantly impacted by earth resources satellites. This resource, which we refer to as "Industry," covers the entire capital plant: manufacturing facilities, transportation facilities and systems, institutions, residential facilities, etc., and man himself. The value of this resource certainly lies in the range of trillions of dollars and, in the United States alone, is used to produce several hundred billion dollars of additional goods and services annually. Some of the broad areas which might benefit by remote sensing of the ERTS type are discussed below. Other areas of potentially large benefits, not discussed here, are possible using different satellite systems, for example, SEASAT, SMS, SEOS, and SSOS. However, in addition to the contributions which these satellite systems might make, the potential benefits discussed below are largely independent of, and in addition to, the benefits of these systems.

Figure 1 shows a typical ERTS image of a highly industrialized and densely populated region including the metropolitan areas of New York and Philadelphia and most of New Jersey. From this image, it is possible to locate areas that are heavily industrialized, to discern residential areas and to observe certain transportation networks. Using advanced satellite systems with thermal IR sensors it might also be possible to estimate energy consumption in these areas. Monitoring change in certain parameters in near real-time provides many interesting opportunities.

Table 1 shows the resource management functions, (RMFs) dealt with in this resource area. While the nature of the investigations here have been exploratory and any benefit numbers derived must be treated as tentative and preliminary, the scope of the RMFs serves to indicate the potential in this area and the need for further economic analysis.

1.1 Transportation

Topographic and socio-economic, particularly demographic, maps constructed and updated using satellite data could expedite long range planning of transportation facilities. Although the benefits to the contiguous 48 states might be significant in this area, large potential benefits are thought to exist for

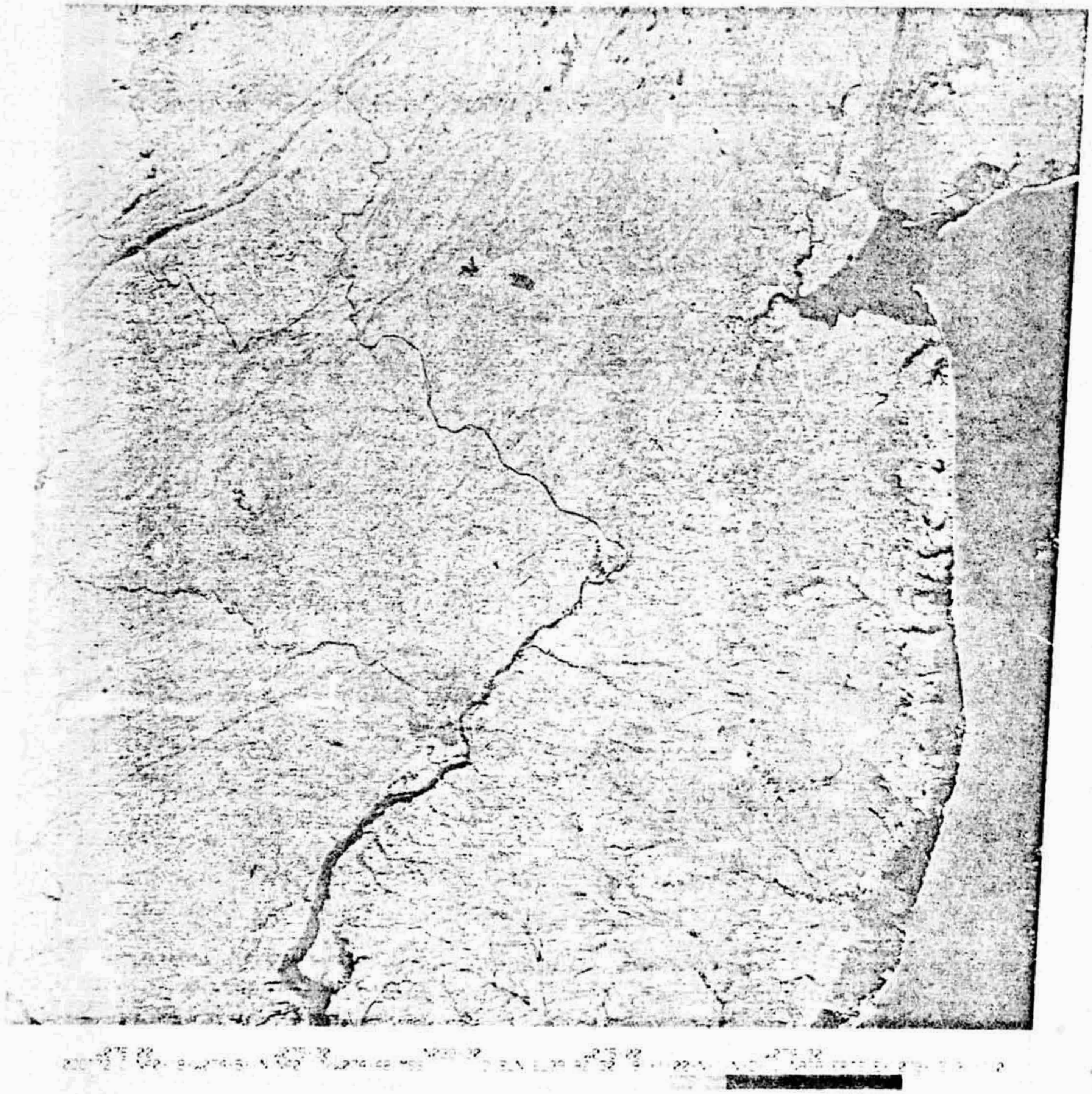

Figure 1 ERTS-1 Image of the New York and Philadelphia Metropolitan Areas and Most of New Jersey

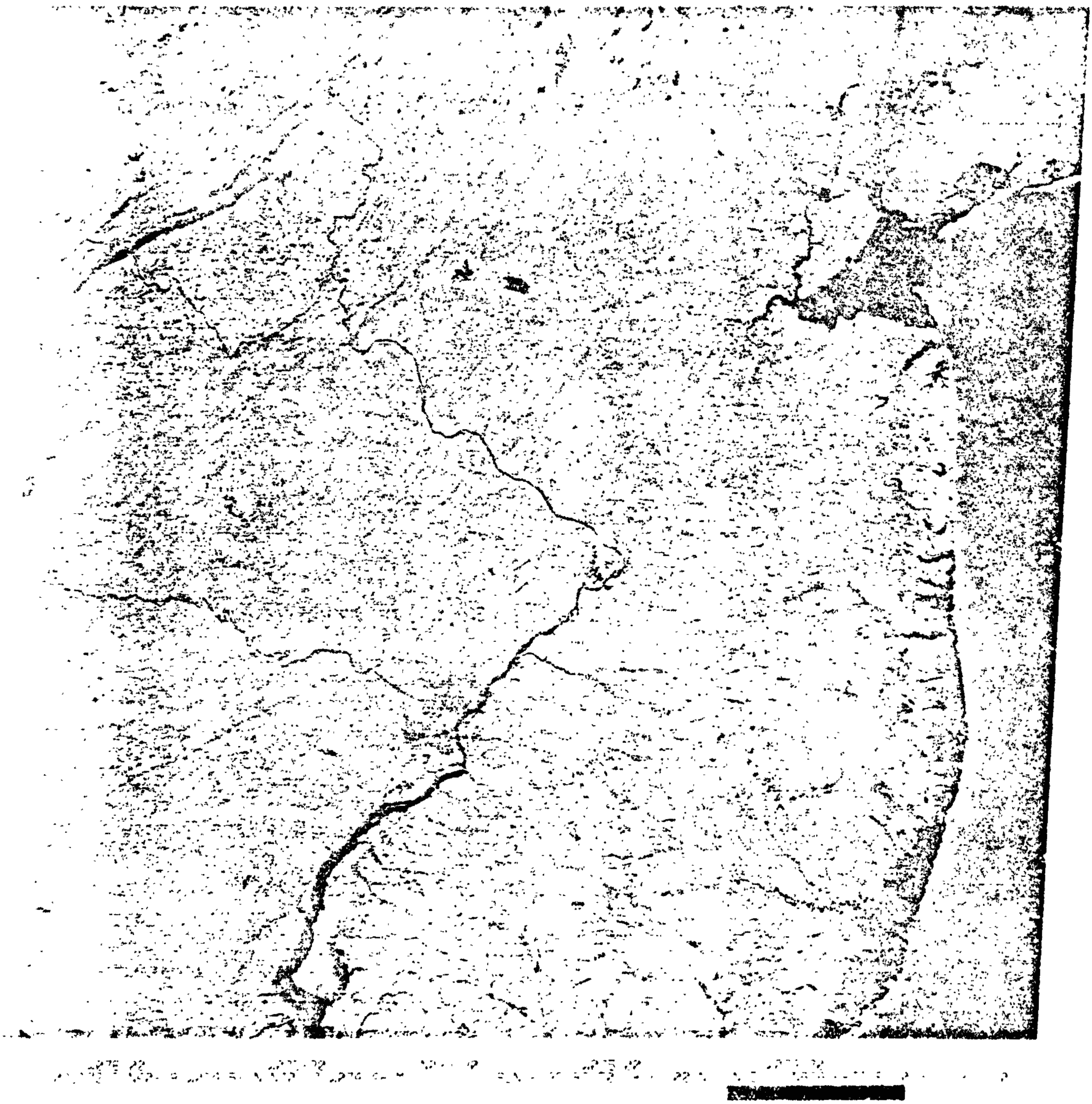

Figure 1 ERTS-1 Image of the New York and Philadelphia Metropolitan Areas and Most of New Jersey

Table 1 Resource Management Functions Discussed Under Industry

8.1 Cartography, Thematic Maps, and Visual Displays

8.1.1 Mapping Ice Build-up and Break-up

8.2 Statistical Services

8.2.1 Aids to the Survey of Industrial Growth and Decline

8.3 Calendars

8.3.1 Long Range Temperature Cycles

8.4 Allocation

8.4.1 Site Selection for Industrial, Residential and Institutional Construction

8.4.2 Transportation of Commodities

8.7 Unique Event Recognition and Early Warning

8.7.1 Monitoring the Environmental Impact of Construction and Operation of the Alaskan Pipeline

8.9 Administrative, Judicial and Legislative

8.9.1 Monitor Compliance with Zoning and Construction Permits

Alaska and developing countries. Medium range planning, month to month, vis-a-vis the use of existing transportation resources such as the distribution of agricultural produce might benefit substantially from remote sensing. Frequently, problems of food supply are not due to a lack of production, but to improper or poor distribution. These problems can be alleviated somewhat through improved knowledge of the production and consumption by area.

ERTS has already had some effect in short-term planning in transportation. In particular, ERTS images have been used to locate icebergs in the North Atlantic and Hudson Bay in order to improve shipping in those regions.* Due to the improved resolution of ERTS compared to other existing civilian space systems, ERTS images have been beneficial in this regard despite the fact that the coverage is not always as frequent as some users would desire. Figure 2 illustrates the capability of ERTS to depict ice break up. This image shows Lake Erie in early March near the time that shipping is being resumed for the summer. Both ice floor and ice break up patterns are easily observed in the image indicating that useful aids to navigation are obtained and that more efficient ice breaker routes could be selected. While this benefit does appear to exist for ERTS at present, future space systems, especially SEASAT, might eventually substantially replace the current use of ERTS.

1.2 Construction

A significant potential application of remote sensing exists in the construction industry. Topographic and socio-economic maps could aid in site selection and planning. Mapping sink areas, mudslide areas, forest fire hazard areas, avalanche areas and earthquake zones can also aid in site selection. The development of accurate "risk" maps covering various hazards often requires repetitive coverage over many years and, in many instances, must be updated on a continuing basis. An ERTS satellite system could provide an economic capability for data gathering in this area. ERTS-1 images have already been instrumental in the relocation of a bridge in Alaska that would otherwise have been built on a previously undiscovered fault line.** Even in relatively

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* _Oilweek_, vol. 24, no. 40, Nov. 19. 1973, Mc Lean-Hunter Publications, Calgary, Alberta.

** Baker, "ERTS Updates Geology," _Geotimes_, August 1974, p. 21.

Figure 2 ERTS-1 Image Showing Ice Break Up on Lake Erie in Early March

Figure 2 ERTS-1 Image Showing Ice Break Up on Lake Erie in Early March

populated areas, such as California, ERTS has led to the discovery of previously unknown and potentially active faults and to a better understanding of the known fault systems.

In a second area, an advanced system including a thermal IR band could facilitate large scale thermal mapping on a repetitive basis from which climactic calendars could be developed. These calendars should find use in construction planning, particularly in road building and heavy construction involving concrete. Whereas certain activities require temperatures above freezing, others, for example, transportation of heavy equipment, can benefit substantially from colder temperatures and harder ground. ERS applications in construction will probably be of greatest benefit in northern and developing areas.

1.3 Public Administration

Remote sensing has broad possibilities in public monitoring and planning for industrial purposes. Many government contracts for construction or removal of mineral and fuel resources carry stipulations which must be adhered to by the working firms. These activities must be monitored in order to assure compliance with the regulations; e.g., strip mining or offshore drilling might be limited to certain areas. Zoning laws and construction permits also carry similar stipulations limiting activity. Certain environmental regulations on industry such as those restricting atmospheric and water pollution also require monitoring. These applications are discussed in Volumes V, VIII, and IX. The output of large-scale, multivariate models which use demographic statistics to measure and predict trends in land use are used for private and political decision making. These models may be adaptable to, or replaced; by models which use remote sensed inputs. The use of ERS data could allow more continuous and timely data inputs to be used and more accurate and less expensive output may be possible. The possibility of real-time or near real-time inputs to demographic models using ERS data is an area that requires further investigation.

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APPENDIX A:

DETAILED EXAMINATION OF BENEFITS BY RMF

This section contains documentation of benefits obtainable from an ERTS-like ERS satellite system applied to industry, as presented in Volumes I and II and in the introduction to this volume. In this appendix, benefits are discussed and demand for information in this resource area is identified.

RMF No. 8.1.1

MAPPING ICE BUILD-UP AND BREAK-UP

Rationale for Benefit

Ice build-up in navigated waters impedes and frequently halts transportation by ship in certain Northern areas. The Great Lakes and the Hudson Bay shippers experience this problem; the Great Lakes are generally open for shipping only from May through November, and most of the Arctic is only open at most two months of the year. The alternatives left during the winter months are relatively expensive: rail or truck transport or non-delivery and storage. With regard to the benefit of information in this function, the importance is centered in the marginal months when clear routes exist but passage is hazardous due to many freely floating pieces of ice. During these months there is little shipping due to lack of information about safe passageways. Knowledge of ice flows can also provide tactical information for Coast Guard ice breakers and can allow channels to stay open for a larger part of the year. Improved information, then, can increase the season of this most cost-effective form of transport. However, this information must be of a continuous and real-time nature due to the rapidly changing ice conditions. While the southern parts of the Arctic Sea never become entirely frozen, the frequency of icebergs on the sea changes and presents a threat to marine activity in the area. Information in this region is becoming increasingly important as Alaskan and other northern resources become more and more developed.

Federal Government Activities and Responsibilities

Tactical ice reconnaissance is carried out by NOAA and the Coast Guard while the function of strategic ice mapping is performed by NOAA and the Lake Survey Center. Acting within the framework of the Lake Season Extension Program, the Coast Guard presently expends about $300,000 on its ice reconnaissance activities. NOAA and the Lake Survey Center together spend about $200,000 under the same program. Since the inception of this program the burden of the actual reconnaissance flights has been transferred in large part from the Lake Survey Center to NOAA and the Coast Guard (Ninth District). These daily flights are equipped with sensor systems which include cameras, a laser profilometer, a ground mapping radar and an imaging infrared line scanner. NOAA flights also include day/night all-weather Side-Looking Radar. The information collected by the operational flights is transmitted to ships on the Lakes and to the Lake Survey Center, which eventually use it to prepare ice charts and maps.

Non-Federal Activities

Several other national governments also have ice survey programs, primarily Canada and the Scandinavian countries.

The Function of Remote Sensi~g

Remote sensing can provide coverage in area, frequency, and timeliness unavailable by other methods.

Economic and Technical Models for Estimating Benefits of Remote Sensed Data

Clough and McQuillan, * working with the Canada Centre for Remote Sensing, ahve reported an in depth investigation on the economic benefits of remote sensing of sea ice. They arrived at benefit estimates using improved information of sea ice from NOAA and ERTS to operate more efficiently. Although ERTS has a maximum coverage of only 10 consecutive days out of 18, navigators prefer ERTS-1 imagery over that of NOAA because of its superior resolution (100 meters compared to .8 km). Clough and McQuillian have documented large gross benefits in this area.

Their report considers three systems, two of which are significant for this analysis:

1. Reception of NOAA and ERTS imagery and transmission to Arctic ships (Cost: $85,000 annually for operations and $325,000 for capital equipment for transmission. Additional $900,000 to equip one-half of the Arctic ships with $12,000 receivers).

2. Addition to 1 of SOAR (side looking airborne radar) (Cost: $100,000 annually for operations and $2,000,000 for capital equipment. Expected total benefits to both Canada and U.S. for seismic survey, and Inbound Arctic Shipping are given in Table 2. Additional annual benefits of $55 - $90 million are estimated for Outbound Arctic Shipping. Benefits in pipelines and St. Lawrence Gulf shipping are discussed).

* Clough and McQuillan, "Economic Benefits of Sea Ice Remote Sensing Systems," INFOR Journal, 4 April, 1974.

RMF No. 8.1.1

Extracting benefits for the U.S. alone is a complicated process and would involve reviewing the statistics compiled by Cloug and McQuillan in their report. While it is clear that Alask is only a small, undeveloped part of the Northern Hemisphere above the U.S.-Canadian border, its importance as a source of raw materials will make shipping to and from Alaska an essential activity and the monitoring of ice conditions valuable. One could perhaps roughly estimate that anywhere from 0.05 to 0.1 of the total benefits cited by Clough and McQuillan might go to the U.S. via Alaska, however, such an estimate could be significantly in error.

Current ERTS Activities

A commercial seismic survey company has already begun using ERTS-1 imagery to aid tactical navigation in the Arctic.* Such information enabled a ship to survey a large area that would otherwise have been missed by showing a large opening in the ice and a path to it. This information allowed an additional one-day survey valued at $100,000 that would otherwise have been lost.

Analysis of ERTS-1 data indicates that sea ice can be identified in all spectral bands because of its high reflectance and the contrast with the almost-no-reflectance of water. Considerable information on ice type and ice surface characteristics can be obtained. Although sea ice and clouds have similar reflectances, methods have been developed for easy differentiation between them. Because of its higher resolution, ERTS-1 provides superior iceberg citing to Nimbus, ITOS, or NOAA.

The following information has been extracted from MSS images in conjunction with field data:**

(a) surface distribution of suspended matter, temperature and salinity along the coast

(b) coastal current directions from grounded ice and ice-distribution patterns

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* Oilweek, vol. 24, no. 40, Nov. 19, 1973, McLean-Hunter Publications, Calgary, Alberta.

* Barnes and Reiminitz, "New Insights into the Influence of Ice of the Coastal Marine Environment of the Beaufort Sea, Alaska. "Symposium on Significant Results Obtained from ERTS-1," NASA, March 1973, p.

(c) determination of ice-movement patterns from successive overlapped images

(d) correlation of grounded ice with topographic highs.

Estimate of ERTS Economic Capabilities

From the above analysis, it is felt that the U.S. would capture a portion of the benefits documented by Clough and McQuillan, perhaps 0.05 to 0.1, or anywhere from 2-25 million dollars annually. These figures should be considered to be very "soft."

Table 2 Benefits from Remote Sensing of Sea Ice

Benefits due to	Sensor System, benefits in $ million (1973)	
	Near-Term Augmented Info System	All-Weather Surveillance Capability Added to 1
Seismic Survey		
Marine	1.0	
On-Ice		2.5
Artic Shipping Inbound		
1974	1.8-2.4	4.2-4.8
1980	4.8-6.4	11.2-12.8
Total Benefits	2.8-7.4	6.7-15.3
Grand Total	9.5-22.7	

Figures compiled from: Clough and McQuillian, "Economic Benefits of Sea Ice Remote Sensing Systems", INFOR Journal, 4 April 1974.

RMF No. 8.2.1

AIDS TO THE SURVEY OF INDUSTRIAL GROWTH AND DECLINE

Rationale for Benefit

Statistics on industrial change are important for entrepreneurs and for local and regional commerical policy-making. Accurate records are compiled only at long intervals. Interpolation and extrapolation are not sufficiently accurate for much decision-making and are subject to falsification by special interest groups. Records of building permits are not compiled on a Federal or state level; local authorities frequently overestimate or underestimate so as to increase state and Federal aid.

Federal Government Activities and Responsibilities

The Department of Commerce handles all Federal data-gathering functions in this area. The Social and Economic Statistics Administration is the primary agency active in this area.

Non-Federal Activities

Activities similar to those in the Federal government are carried out at state, regional, and local levels.

Functions of Remote Sensing

Remote sensors can pictorially depict how regions are expanding. They can determine location and direction of the movement and make this information available to authorities in one consistent and continuous format. Sites of industrial as well as residential construction can be detected. Levels of economic activity might be inferred from thermal infrared radiation patterns if the sensors have sufficient resolution. Intensity of capital employment (and, therefore, labor employment) would be indirectly measured. Factories as well as multi-shift factories could be located. All this information could add to better economic decision-making at Federal, regional and local levels.

Economic and Technical Models for Estimating the Benefits of Remote Sensed Data

This information would be of a "new capability" type. It is unlikely that it would replace any existing data-gathering activities. Mostly it would compile and provide already existing information to authorities in a single format. No attempt at estimating the value of this information has been made.

Estimate of ERTS Economic Capabilities

ERTS-1 does not carry a thermal IR sensor. Visual wavelength sensing resolution is borderline for measuring industrial construction. Without highly improved sensing including a very high resolution infrared sensor, it is unlikely that an ERS system could capture any of the above-mentioned benefits.

RMF No. 8.3.1

LONG RANGE TEMPERATURE CYCLES

Rationale for Benefit

Histories of ground freezing can impact construction planning. Estimate of the duration of the season will aid in determining work force size in order to avoid the cost of working with frozen, snow-covered, or swamp-like ground. This information will be of greatest use to construction crews and planners in Alaska and the Mountain states.

Federal Government Activities and Responsibilities

The Environmental Science Services Administration is the primary agency active in this area. Whereas they have a sizable budget and large responsibilities, these are generally not impacted for this function.

The Function of Remote Sensing

Satellites with thermal infrared could map ground temperature and document histories of ground freezing from which estimates of construction season lengths could be made more accurately. The same function could be done by remote sensing in areas where seasonal flooding occurs.

Economic and Technical Models for Estimating Benefit of Remote Sensed Data

An analysis of the benefit of improved information of work season duration would depend upon the type of set-up under which construction is carried on in the more remote, northern areas. It is likely that the job contractor for an excavation would contract workers for what he expects to be his work season. Whereas in most markets such contracts are not necessary to attract workers because of short supply of labor, it is felt that these agreements are necessary in remote areas such as Alaska.

One way which one might approach estimating benefits from this improved information would be to pose a hypothetical situation under which a contractor works. In this situation we will say that the contract is worth more the quicker he agrees to complete the building because the sooner it is inhabitable by the owner the more it is worth to him, e.g. he could rent it out. However, there is a penalty if the building is late in completion because it is unavailable to the owner.*

Thus in bidding upon the contract, the builder wants to know how much time he can expect to work over, say, a two year period. One factor which must be taken into consideration in the northern latitudes is the period of time during which the ground is not frozen. Excavation on frozen ground is considerably more costly than on unfrozen ground. Thus in working in Alaska, the builder might only wish to plan upon doing excavation for, say, ten weeks out of the year, but he would like to have the best possible information as to exactly how long he can expect the ground to be workable. If he overestimates the work season length, he either continues work under unfavorable conditions and works at a loss for that period, or he does not work for that time and is late upon completion, suffering a penalty. If he underestimates the work season length, he foregoes the opportunity of having the building completed in a shorter time and therefore having it worth more money to him. A history of ground freezing for previous years would enable him to a better judgement of his work season length.

Another way of looking at the value of this information is to determine the contractor's committed costs, which he foregoes if he estimates the season. The contractor faces a decision involving a trade-off between hiring a large amount of capital (rental of excavation equipment, cement mixers, etc.), anticipating a short season or a small work force and capital outlay, anticipating a longer work season. If he underestimates the length of his season, he has hired too much capital and too many workers for the project and he foregoes extra profit that he could have been earning during that time. If he overestimates the season, he is either forced to cease work losing all committed expenses and profit or to work under poor conditions, thus losing productivity and profit. An accurate history of ground freezing for an area would give the decision maker better information in which to work.

For example, in 1972 total construction expenditures in Alaska were $374 million (up 44% from 1971), broken down as follows: $112 million for non-residential, $108 million for residential, and $154 million for non-building (i.e., highways, airports, etc.). See Table 3.

If we assume an average work season of 20 weeks, overestimation of which forces work to progress under unfavorable conditions, data for past years might cause an improvement in season length prediction accuracy of 5% or one week. As stated above, if the contractor underestimates the work season by one week, he then loses one week's profits and has hired too much capital; if he overestimates the season, he either shuts down, losing about 36.8% of his expected costs for that week, or he continues work under adverse conditions, sufficient, we will assume, to also negate all profits for that week. Thus in Alaska an average improvement in prediction accuracy by one week* could save 5% of overhead and profit or $2.4 million.

Current ERTS Activities

Snow cover in ERTS-1 imagery is easily seen thus enabling snow cover histories to be prepared. However, ERTS has no thermal infrared sensor, which would be necessary for this function. Seasonal flooding can also easily be mapped from ERTS-1 imagery.

Estimate of ERTS Economic Capabilities

No attempt at firm benefit estimation for this function has been made, although possible models for such estimation are presented.

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* This is only an assumed improvement; there are no grounds for that particular figure. This improved accuracy can come either at the beginning or at the end of the season, or both.

Table 3   1972 Weather-Sensitive Construction Costs in Alaska

Category	Costs, $ millions (1973)				
	Volume	Weather-Sensitive Portion			Total Sensitive Volumes
		Wages	Equipment	Overhead and Profit	
Non-residential	112	15.3	0.8	10.1	26.2
		(13.7%)	(0.7%)	(9.0%)	(23.4%)
Residential	108	10.2	0.4	13.4	24.0
		(9.4%)	(0.4%)	(12.4%)	(22.2%)
Non-building	154	38.5	24.6	24.6	87.7
		(25.0%)	(16.0%)	(16.0%)	(57.0%)
Total	374	64.0	25.8	48.1	137.9
		(17.1%)	(6.9%)	(12.8%)	(36.8%)

Sources: Construction cost figures from Statistical Abstract of the United States, 1973 Weather Sensitive percentages from "An Assessment of the Economic Benefits of Continuous On-Demand Earth Observation Data", prepared by ERIM and ECON, Inc. for NASA under contract NAS5-20021, 31 August 1974

RMF No. 8.4.1

SITE SELECTION FOR INDUSTRIAL, RESIDENTIAL AND INSTITUTIONAL CONSTRUCTION

Rationale for Benefits

A wide range of factors come into consideration in selecting a site for construction: socio-economic factors such as proximity to important commerce (e.g., shopping centers for for residential areas, distribution and supply centers for industry), and natural, physical ones such as weather and geology. For a supplier of consumer goods, information about population and population trends in his area can be important for his investment decisions.

Federal Government Activities and Responsibilities

On all government levels, information important to this function is accumulated and disseminated. The breadth of this type of data is enormous, extending from topography and geography from the U.S. Geological Survey and population statistics and trends from the Bureau of Census all the way down to local plugs from the Chamber of Commerce. However, this information is usually not sufficiently recent for many purposes.

Function of Remote Sensing

Remote sensing offers many capabilities which can be used by decision makers in evaluating a parcel of property for a particular construction purpose. The primary function demonstrated so far, which industry is apt to capitalize upon, is the ability of satellites to spot faults and lineaments and to pinpoint earthquake epicenters. Other geophysical factors are important in choosing a site; phenomena such as mud slides, avalanches, forest fires, and floods can be detected and their histories in given areas documented. The likelihood of forest and field fires might even be able to be determined by measuring ground wetness and vegetative conditions by satellite.

Demographic mapping is important for many firms in determining the best place to locate a new branch. Whereas this demographic information is generally available, remote sensing offers the possibility of frequent updating at low cost and providing topographic as well as demographic data in a single, consistent format. This last aspect of providing a broad range information in one format will probably be one of the biggest selling points for earth resources satellite data as used by industry.

RMF No. 8.4.1

Economic and Technical Models for Estimating Benefits of Remote Sensed Data

An ERTS-like ERS system offers many capabilities which aid in assessing the "true" value of a piece of land. Histories of floods, mud slides and earthquakes-- and other information which might help in determining the probability of these and other events -- are significant aspects of the real worth of any property. The risk of destruction of a proposed structure is part of the cost of that structure. An area which has a high likelihood of earthquake might be quite well-suited as a grazing land, but obviously a poor place for a nuclear reactor or an eighty-story building. Buildings such as houses which might be constructed in this earthquake area would require additional structural support, such as steel or concrete reinforcement, thus increasing their cost. These factors (limited usage possibilities and more costly usage) cause the demand for property in an earthquake-prone area to be less than the demand for comparable land in an earthquake-free zone. Imperfect knowledge of the real state of a piece of property (or any good, e.g., an automobile) leads to inefficient resource appropriations.

Consider an area which, taken as an aggregate, is known to have an earthquake probability, or "risk" value, based on past history. Such maps are already in existence, e.g., Figure 3, but not at a very high level of detail. If on the basis of new information, e.g., the detection and placement of a fault zone within the area, we are able to disaggregate the area into smaller areas each of which has a different level of risk, it will be possible to provide construction more nearly matched to the seismic risk of each specific area. This increase in efficiency provide an economic benefit. This benefit could, in principle, be measured by the increase in land values, for that land which is subsequently consumed, given the improved information.

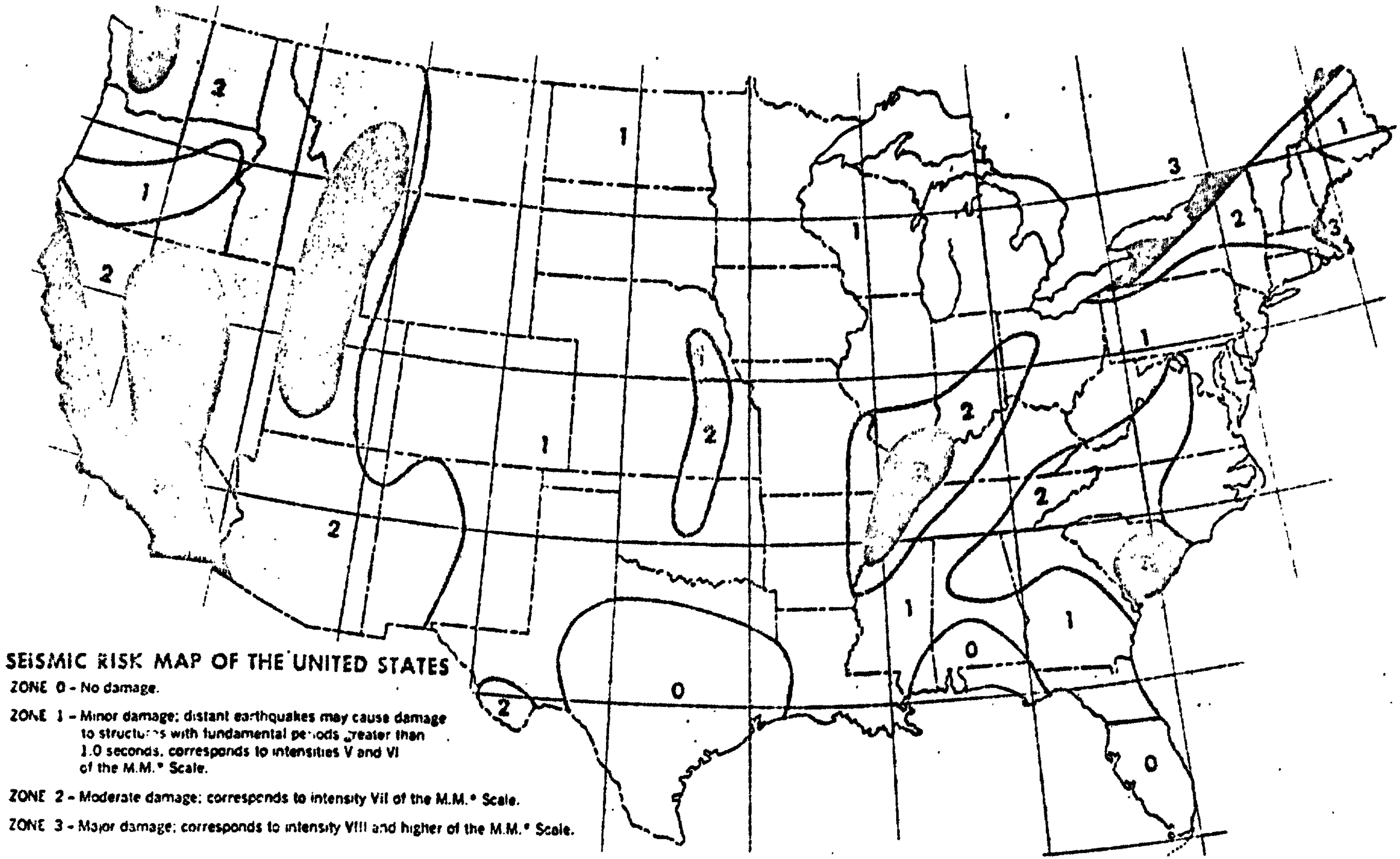

Figure 3 Seismic Risk Map of the United States

RMF No. 8.4.1

Current ERTS Activities

ERTS has demonstrated great effectiveness in locating previously undetected, potentially active faults and fault zones and in improving the placement of earthquake epicenters. As a result of ERTS imagery, new areas, previously considered safe from earthquake disaster, have been found to be potentially dangerous. Some investigators have also been led to the conclusion that seismicity patterns alone are insufficient for defining areas susceptible to earthquakes. (See RMF 5.1.1.)

This information will prove particularly valuable in the Arctic for the planning of the Alaskan pipeline. Companies investing in it wish to make up of all possible information to assure its continued useability. Fault information in Alaska has already led to the changing of the planned site of one bridge located near the proposed pipeline.*

Estimate of ERTS Economic Capabilities

Although it is obvious from the above discussion that significant benefits already exist from ERTS-1 data, no attempt has been made to quantify them for this function.

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* Baker, "ERTS Updates Geology," Geotimes, August 1974, p.21.

RMF No. 8.4.2

TRANSPORTATION OF COMMODITIES

Rationale for Benefit

World food authorities generally agree that current problems of food shortages are problems of spatial distribution and not of supply. Within the U.S., shortages of rail cars force grain to be stored instead of shipped to market. Remotely sensed information contributing to better crop yield estimates can allow for more efficient management of transport facilities both at home and abroad. Prior knowledge of where crops are failing can allow relief planning.

Federal Government Activities and Responsibilities

The U.S. Department of Agriculture engages in extensive activity in prediction of harvest in order to reduce price fluctuations in agricultural commodities. (See RMF 1.2.1 and 1.2.2.) This activity also has some impact in price leveling in the transportation industry.

Function of Remote Sensing

Remote sensing provides better estimates of crop production and thus allows for efficient planning for transportation of these commodities.

Current ERTS Activities

See Agriculture (Volume III).

Estimate of ERTS Economic Capabilities

No attempt has been made here to estimate the value of remote sensing in this RMF.

RMF No. 8.7.1

MONITORING THE ENVIRONMENTAL IMPACT OF CONSTRUCTION AND OPERATION OF THE ALASKAN PIPELINE

Rationale for Benefits

Proposals for the construction of the Alaskan pipeline came under strong criticism from environmentalists who feared that it would drastically upset the ecology of the area. In particular, it was feared that the pipeline would prohibit migration of the caribou herds, although other environmental fears were also expressed. Most all objections and counter-objections have been raised with little evidence to back them up. Now that the actual construction seems to be an eventuality, it will prove to be a testing ground for similar ecological questions. Information gained here can be used to more realistically argue positions and arrive at working decisions, if not improved insight into the Alaskan situation.

Federal Government Activities and Responsibilities

Activities in this area would fall under the jurisdiction of the Environmental Protection Agency and the Bureau of Sport Fish and Wildlife. However, no specific activity regarding this function is known.

Non-Federal Activities

There exists a state Land Use Planning Commission in Alaska which will oversee this type of activity.

The Functions of Remote Sensing

Satellite sensing will provide mapping of snow cover and vegetation which facilitate on-ground studies for environmental effects. It is not known how man's activity in the area will affect the Arctic environment. Remote sensing will enable monitoring of these effects and how long it takes for the Arctic to return to its original condition. These functions will allow further monitoring to be undertaken with greater cost-efficiency. Such improved cost-efficiency may mean the difference in implementation of such environmental data gathering, marginal as it is considered to be.

Current ERTS Activities

The University of Alaska is performing multi-disciplinary surveys of parts of Alaska, including the proposed pipeline site.

RMF No. 8.7.1

They are mapping areas favorable to caribou herds and locating environmental features that arise from large caribou aggregations. This activity increases our understanding of this environment and the animals in it and will enable better assessment of the effects of man's activity in the area.

Estimate of ERTS Economic Benefits

Although ERTS will help in contributing to our knowledge of environmental factors, no monetary benefit has been assigned to this function.

RMF No. 8.9.1

MONITOR COMPLIANCE WITH ZONING AND CONSTRUCTION PERMITS

Rationale for Benefits

Under various statutes and contracts the type and extent of construction and development activity is regulated. Examples are construction permits to industry and contracts to mineral and fossil fuel extraction firms. Similar regulations exist in forestry, limiting the area to be cut. Effective monitoring keeps the incidence of illegal activity low. Probably the biggest single application here is in strip mining; and example of blatant illegal activity is when Mid-State Coal Company (Kentucky) actually stripped a country road.

Federal Government Activities and Responsibilities

Regulatory activities are undertaken by many federal agencies, such as the Bureau of Land Management and the Bureau of Mines of the Department of the Interior.

The Functions of Remote Sensing

Remote sensing has the ability to cover a vast area repeatedly at very low marginal cost. The quantity of information received is merely a function of the desired level of resolution. Within likely resolution limits are detection of illegal strip mining activities, illegal forest harvesting, illegal construction, and, perhaps, offshore operations and fishing.

Economic and Technical Models for Estimating the Benefits of Remote Sensed Data

The type of operation discussed in this RMF is generally not performed on any specified basis, thus there is no real cost-saving potential involved. Any benefit involved would be in fines levied against the violators and in further inhibiting other offenders.

Current ERTS Activities

Resolution capabilities are presently capable of detecting illegal stripping activities, forestry harvesting violations and large-scale construction.

Estimate of ERTS Economic Capabilities

Although satellite monitoring will be of some benefit in this area, such benefit remains unquantified at present.

APPENDIX B:

SUMMARY OF APPLICABLE FEDERAL BUDGETS

There are three Federal departments that currently impact the resource management functions discussed in this volume. These are the Departments of Agriculture, Commerce, and Interior.

As mentioned in RMF No. 8.4.2, Transportation of Commodities, the USDA seeks to improve commodity distribution in both the domestic and worldwide markets (see also Volume III of this report). On the domestic front, the Agricultural Marketing Service, 1) provides market news concerning commodity movements and locations (FY75 budget for new service - $10 million); 2) has the responsibility for assisting farmers in obtaining the essential goods and services necessary for efficient transportation of farm produce; and 3) by direction of section 32 of the Agricultural Adjustment Act, the AMS has the power to divert surplus commodities from normal channels of trade to new markets and uses (AMS total budget FY75 - $39 million).

Internationally, the Foreign Agricultural Service has the express duty to assist American farmers in maintaining and expanding foreign markets. Under the authority of the Trade Expansion Act, and the Agricultural Trade Development and Assistance Act, the FAS assists foreign tradesmen and farmers in developing and transporting their commodities into the United States (total FY75 budget - $35 million).

Within the Department of Commerce, the National Oceanic and Atmospheric Administration and the Social and Economic Statistics Administration have particular importance to the industrial service. NOAA's responsibility for charting the coastal and Great Lakes regions* includes the mapping of ice build-up and break-up in northern shipping lanes (FY75 budget for charting - $51 million). (See RMF 8.1.1.) The Social and Economic Statistics Administration conducts intercensal demographic estimates (FY budget for intercensal surveys - $1.5 million) providing for the development and preparation of updated population and per capita estimates as required by the Department of the Treasury for the equitable allocation of funds under the General Revenue Sharing Act.** (See RMF No. 8.2.1.).

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* Office of Management and Budget, The Budget of the United States Government, (United States Government Publication Office, 1975), p.244.

** Ibid., p. 228.

Within the Department of the Interior, both the Bureau of Land Management and the Alaska Power Commission have responsibilities regarding the environmental impact of the Alaskan pipeline. The BLM is charged with the "conservation, management, and development of 278 million acres in Alaska."* (FY75 budget for national resource management - $97 million.) The Alaska Power Administration 1) is funded to provide investigative surveys to determine the economical and appropriate means of developing Alaskan energy sources (FY75 budget for general investigations - $636 thousand); 2) transfers funds to the Bureau of Sport Fisheries and Wildlife to investigate the fish and wildlife aspects of the Alaska Power Administration's general investigations program (FY75 budget for fish and wildlife studies - $10 thousand).

With regard to the enforcement of strip mining zoning, the Bureau of Mines conducts inquiries into surface mine use, reclamation and disposal of minerals and mineral fuels (FY75 budget for engineering and mine evaluation - $7.7 million).

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* Ibid., p.519.

APPENDIX C

SUMMARY OF APPLICABLE LAWS AND STATUTES

Table 4 provides a summary of applicable federal laws and statutes concerning the industrial resource area.

Table 4 Federal Statutes Pertinent to Remote Sensing of the Industrial Resource Area

Name of Federal Statute	Classification		
	Date	Agency Affected	Comments
Surface Mining Control and Reclamation Act of 1973	Pending	creates the office of Surface Mining Reclamation	Office is directed to make inspections of surface mining and reclamation operations
Surface Mining Reclamation Act of 1973	Pending	Department of Interior	requires inspections of surface mining and reclamation
National Environmental Policy Act	1969	All Federal Agencies	requires all institutions receiving federal aid to fill an environmental impact statement
Water Resources Planning Act Alaskan Water Resources	1955	Department of Interior	calls for planning of conservation and development of Alaskan water resources