DEVELOPMENT OF A RESEARCH DESIGN RELATED TO ARCHAEOLOGICAL STUDIES IN THE ATHABASCA OIL SANDS AREA

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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

PROJECT HE 2.1

January 1976

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SUMMARY

Objectives To provide an overview of the archaeological potential and the development activities in the oil sands area of Alberta, with a recommended organization and program to maximize the recovery of valuable information through efficient and practical research and effective regulation of responsbilities by government and development agencies.

Background Although the limited archaeological work evidences human occupation of the oil sands area at least 8,000 years ago, we can say little about the human activities in the area during most of the subsequent time period. In order to reconstruct man's prehistory in this area, careful data collection and interpretation of data from a large number of sites is necessary.

Development of the bituminous sand deposits of the area has begun and is expected to increase over the next 20 years or more. The nature of the recovery methods used in the operations will cause permanent and extensive terrain disruption. One of the consequences will be extensive loss of archaeological data unless effort is expanded to recover evidence pertaining to man's occupation before damage is incurred.

Recovery of archaeological information in the developed area is the responsibility of the developers ; however, government is held responsible for the regional management of the resource, including administration of legislation and development of the baseline data to guide the local studies and to interpret the recovered data.

Project This research design includes three separate components : Administration and Coordination, Research Framework and Development Impact Assessment. The former two are considered in the proposed research project and are the fiscal responsibility of government ; the latter is that of the developing agency. The Administration section will manage the project and the efforts to salvage the archaeological resources of the area. The Coordination section will integrate the government and development studies in archaeology and coordinate those studies with the other social and biophysical studies being undertaken. Various classification systems, standards and criteria for studies, experimentation for tools to improve site discovery and evaluation techniques and training programs for native northerners will be required very early in the project and will be undertaken by the Program Development section of the Administration and Coordination component.

Through the Research Framework section the existing data base for the regional prehistory will be developed to provide the main predictive tool for local area assessment, for archaeological site location, evaluation of archaeological value of a site when discovered, and as an interpretive framework for the data as it is assembled.

The Development Impact section is designed to provide a routine for preventing or reducing permanent loss of important data due to the actual development activities. This section provides for a preliminary estimate of potential sites in an area, a series of field surveys to identify the sites before disruption, provision for recovery of valuable evidence and for monitoring the work.

Responsibility for the full program should be shared by government and developing agencies with AOSERP filling the role of communication and coordination. Where government departments find themselves in the role of developer, those departments should adhere to the same standards and requirements as any other developer.

Government (Alberta Culture)	Administration Coordination Research Framework
Developing agencies	Development impact assessment
AOSERP	Communication - Coordination - regional development

Recommendations The following are the specific recommendations included with this research design :

1. Collection of adequate baseline data for the terrain utilization matrix should be the first priority of the project and should form the basis of a data management system. An effective model of changing human utilization patterns would provide the most efficient guidance to archaeological salvage in the project area. Site inventorying before development could be made more effective, precluding problems arising by site discovery during development. Site evaluation for recovery, preservation or abandonment could be made more effective and less subjective, again, increasing efficiency and economy, as well as reducing or obviating delays in development due to archaeological requirements. This will require the assembly of existing environmental, ethnographic and archaeological information as primary data ; carried out during this spring it could be used to provide maximum guidance during the field season of 1976.

2. The potential benefits of a computer based data management system certainly warrant the added investment in that proposal, particularly as it could be extended to other parts of the province. However, there are several severe constraints on the practical implementation of the concept. The methods and programs must be developed, requiring unique combinations of experienced archaeologists and computer programming-systems analysts. The project schedule demands that the system be responsive as soon as possible, which would probably make it necessary to keep a supplementary file based system until the computer based system is operational. Further, experience with 'computer software' development tends to make one pessimistic when time deadlines are important. Therefore, unless there are two archaeological programmers available immediately, the file based data management system is recommended.

3. The project manager and at least one archaeologist should be appointed at the beginning of the 1976-77 fiscal year. Organization of the data management system and the determination of criteria, standards and classification systems should be completed by the first of June, 1976.

4. The project should be fully staffed by the first of June and field crews operational during that month.

5. All corporate and government agencies planning new developments in the area should be required to carry out and submit an estimate of the impact of the activity on the archaeological resources with a scheme for salvage or preservation. All such agencies currently active should be required to assess the impact resulting from their activities and submit plans for recovery of information.

6. A training program should be developed with Manpower for local people to begin in May, 1976.

7. An Advisory Committee should be set up during 1976.

Personnel Implications The following tabulation shows the recommended personnel requirements, assuming the full program is implemented, the file based data management system is used and the full-time staff includes four archaeologists.

	Manager	Archaeologist	Field Assistant	File Clerk	Stenographer
1975-76		0.25*			
1976-77	1	4.50	3	1	1
1977-78	1	4.00	3	1	1
1978-79	1	4.00	2	1	1
1979-80	1	1.00			
1980-81	1	1.00			
1981-82	1				
1982-83	1				
1973-84	1				
1984-85	1				
1985-86	1				

Figures in man-years
*Paid at rate of Research Officer - contract.

The reduction in personnel requirements in 1979 reflects the completion of the preparation of the Research Framework section, with continuation only to provide management and coordination.

Financial Implications The following tabulation includes estimated costs of the project providing for full time staff appointments for the field supervisors and for the file based option as the data management system.

	Capital	Personnel	Non-personnel	Total	
1975-76		6111	2955	9066	
1976-77	7150	155991	76485	239626	
1977-78	1500	143769	68375	213644	
1978-79	2500	115951	50045	168496	
1979-80	1000	39040	7850	47890	
1980-81	500	39040	3350	42890	
1981-82	300	22040	3350	25690	
1982-83	300	22040	3350	25690	
1983-84	300	22040	3350	25690	
1984-85	300	22040	3350	25690	
1985-86	300	22040	3350	25690	
	12650	499902	209060	721612	Total to 1981 (spring)
	14150	610102	225810	850062	Total to 1986 (spring)

ACKNOWLEDGEMENT

In addition to the technical reports credited in the study I would like to thank the following for the information and guidelines so generously provided :

Dr. W. Byrne - Archaeological Survey of Alberta

Dr. M.J. Bik - Syncrude Canada Ltd.

R. Piepenburg - Alberta Oil Sands Environmental Research Program

M.L. Marino - Ekistic Design Consultants Ltd.

E. Cudby - Chevron Standard Canada Limited

ARCHAEOLOGICAL RESEARCH DESIGN : ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

1.0 INTRODUCTION

The nature of archaeological resources makes them particularly susceptible to loss and destruction by the increasing industrial activity on which our civilization depends. Fortunately, awareness of the importance of the resource and a fiscal and scientific capability can prevent unwarranted loss and enable recovery, preservation and interpretation of the evidence to reveal man's fascinating past. This research project is designed to minimize loss and to maximize recovery of archaeological evidence in the area designated under the Alberta Oil Sands Environmental Research Program, and to ensure the translation of that evidence into increased understanding of prehistoric and early occupation of the area. The proposal was commissioned by the Human Environment Committee of the Program through Dr. W.J. Byrne of the Archaeological Survey of Alberta.

The following objectives of the program were provided with the Sub-Project Research Details : Alberta Oil Sands Environmental Research Program and read as follows :

> Research findings should help explain : the origin and the diversification of culture of the present native people; ethnographic analogies ; the connection between historical records and oral traditions and prehistoric peoples ; environmental conditions and limitations of the past ; the technical processes used in the past to produce implements ; the technological change ; diffusion , migration, seasonality and specialization of the past peoples .

The following basic premises were used to design this project :

1. All development that results in either direct or indirect disruption of the terrain should be accompanied by investigations for archaeological sites.

2. Development of effective predictive tools to guide archaeological survey reduces the effects of some constraints on the discovery of archaeological sites, particularly constraints such as the organic ground cover, active sedimentary processes and the changing pattern of human utilization through time. As man's technology during most of his occupation of the area was relatively limited, the environment played a very important role in his life style. Therefore, knowledge of previous environments is necessary for effective search, as a predictive mechanism and as a backdrop for the interpretation of the assembled evidence.

3. Archaeological sites should be identified and inventoried well in advance of development activities, allowing maximum recovery of information with a minimal conflict with the development schedule.

4. During the early stages of the project a broader range of activities is necessary to develop the systems, criteria and acceptable procedures, as well as the interpretive framework and predictive tool. As these components are developed and the data base increases, this activity level will be reduced.

5. During active development of those areas considered to be high in site probability, appropriate provision is required for monitoring those activities and for necessary emergency salvage.

The research program incorporates three distinct components : 1) collection and analysis of existing cultural and environmental background data on the area and how man used it in the past, 2) field collection of additional information on past environments and human adaptations, and 3) saturation surveying of areas to be disturbed, recovery of information where warranted and monitoring of the development where required. Preferably, the three components should be carried out consecutively, as the first two make the third more efficient, effective and economical. However, development is already underway ; therefore the components will have to be carried out nearly simultaneously. The first two should be completed in about two and a half years whereas the last will continue on a decreasing scale throughout the life of the development.

Protection of the environment is seen as the responsibility of those agencies whose activities cause terrain disturbance and from which they derive certain benefits. Primarily the responsibilities for identification and reduction of direct impact due to development belong to that developing agency. However, government must recognize the need for not only the legislation ensuring environmental protection, but also the development of a data base as a regional tool in assessing impact and measuring the results of protectuve or data gathering programs. The strategy of the developer is understandably specific, while that of government can maintain a broader perspective, ensuring maximum regional effectiveness of all programs. It is felt that the role of government should be to provide support and guidance to development to ensure intelligent and realistic environmental preservation. That viewpoint is reflected in this Research Design for the oil sands area.

Preparation of a research plan such as this makes the basic assumption that the objectives are in some ways absolute. In fact, they are relative and subject to priorizing against other objectives. To further complicate matters the priorities vary with other responsibilities of society; a realistic philosophy today may become unrealistic as new exigencies force changes in priorities. While the need for environmental protection and resource preservation is recognized, the levels of that necessity correlate with priorities attached to other needs and availability of time and money. These constraints have been recognized in preparing this proposal and the various activities recommended are felt to be realistic under the present circumstances and with the given objectives.

2.0 ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROJECT AREA

2.1 Definition of Area

The Alberta Oil Sands Environmental Research Program (AOSERP) was formed to assess the potential impact of development in the oil sands area of north-eastern Alberta and to inform government, industry and the people of Alberta on the measures necessary to ensure an acceptable quality for future environments in that area. The study area (AOSERP area) is defined by the main known distribution of potentially economic oil sands in Alberta, with minor extensions to include sections of secondary or tertiary impact. It lies between 56°15' North to 58°10' North Latitude, 110°50' West to 113° West Longitude, with a northern extension east of the Athabasca River to about 110° 50' West and north to 59°5' North. The area includes the municipality of Fort McMurray and the villages of Anzac , Fort MacKay and Fort Chipewyan. Indian reserves are located at Fort Chipewyan, Gardiner Lakes, Fort MacKay, Anzac, on the Athbasca north of Firebag River , at Old Fort Point and in the Athabasca River delta area.

Except by aircraft or by boat along the Athabasca River, access to the area is restricted to the extreme southern section where a main highway connects Edmonton to Fort McMurray then continues north along the west side of the Athabasca to a few miles north of Fort MacKay. Rail access from Edmonton terminates at Fort McMurray, the head of navigation for the Athabasca-Mackenzie system. A network of winter roads provide seasonal access to various parts of the area.

2.2 Biophysical Environments : Modern and Ancient

The following subsections describe the prevailing character of the area and summarize the present information available on the past environments, the prehistoric and early historic periods. In almost every category there is a distinct paucity of data and available information appears to generate more questions than to provide answers.

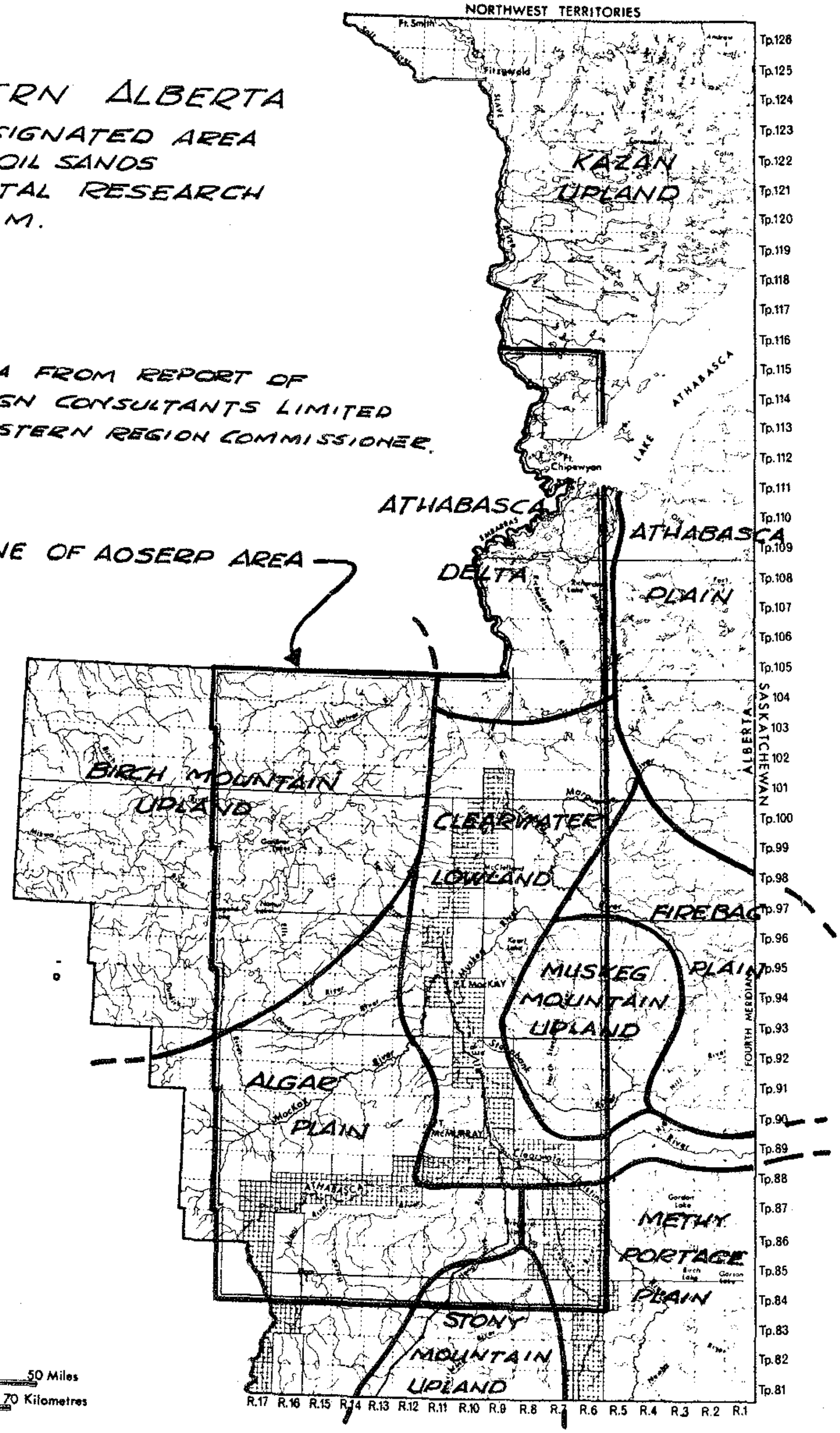
2.2.1 Importance - The present biophysical environment constitutes a point of departure for reconstructing past environments and therefore the world and resources of the human occupants. Not only does this provide an interpretive framework, it also establishes a developmental history of the terrain and its effect on the discovery of archaeological sites. A predictive tool is necessary by which sites can be located and any specific area can be assessed for its archaeological potential. The main tool proposed is a data matrix consisting of the terrain history and related changes in the accompanying human ecosystem correlated with changes in man's adaptive strategy.

FIGURE 2.

NORTHEASTERN ALBERTA
SHOWING DESIGNATED AREA
OF ALBERTA OIL SANDS
ENVIRONMENTAL RESEARCH
PROGRAM.

MAP AND DATA FROM REPORT OF
EKISTIC DESIGN CONSULTANTS LIMITED
FOR NORTHEASTERN REGION COMMISSIONER.

OUTLINE OF AOSERP AREA



10 0 10 20 30 40 50 Miles
10 0 10 20 30 40 50 60 70 Kilometres

2.2.2 <u>Modern Biophysical Environment</u> - Topographically, the region consists of three major divisions ; upland zones composed of hills and low mountains underlain by unsorted glacial till ; more widespread irregular plains underlain by sorted clays, sands and gravels ; and the lowland zone along the main Athabasca River (Map 1). The region is drained by the Athabasca River entering the area from the south and west, flowing northerly through the center of the area, discharging into the southwest end of Lake Athabasca. Several southern tributaries headwatering in the northern plains include the Christina and Gregoire Rivers, whereas those headwatering in the Shield to the east include the Clearwater, the Firebag, the Marguerite and the Maybelle Rivers. Other tributaries from the Birch Mountain Uplands flow along the west side of the area ; they include the MacKay, Dover, Ells, Tar, and McIvor Rivers. The Birch River headwaters in the Birch Mountain Uplands, flows northwesterly, then northerly and finally easterly into the largest of a cluster of lakes west of Lake Athabasca. Numerous lakes of various sizes are found in all of the major topographic subsections ; most are shallow and poorly drained constituting as questionable an asset to early hunters as they are to the present population. The more important lakes and lake areas are the Gardiner Lakes, Namur Lake and several other connected lakes of the Ells River system in the Birch Mountain Uplands area , as well as the lake cluster to the west and southwest of Lake Athabasca. Most of these lakes are important aquafauna habitats.

Much of the plains topography and lowlands areas are very poorly drained and can be classed as 'muskeg'. Even the depressions and lower slopes of the upland regions are muskeg covered. Between the myriad lakes and the widespread muskeg the spring runoff persists throughout most of the summer making much of the area difficult to traverse.

The climate ranges from dry subhumid in the lowland area to moist subhumid in the upland zones differing mainly in summer precipitation correlated with elevation, a topographic control of microclimates that is characteristic of this area. The winters are stable but severe, with temperature lows of -40° and -50° C and mean monthly temperatures in January down to -25° and -30° C, with very infrequent chinooks. Winds are generally light, but are locally strong, generally from the west or northwest. The summers are short, warm and frost free from early June to September. Mean monthly temperatures for July are about 23° C. Compared to lowland areas the uplands have a lower summer temperature, a higher winter temperature and higher precipitation.

Soils are primarily of the gray wooded variety, but vary locally to organic brown wooded, acid brown wooded, dark gray and dark gray wooded varieties. Isolated areas of permafrost are found in the organic soils of the upland area and the poorly drained muskeg areas.

Lying entirely within the Boreal Forest Region of Canada, the southern section is Mixedwood Forest, containing aspen, poplar , birch, white spruce and fir with jackpine in sandy areas and black spruce in the wetter, poorly drained areas. East of the Athabasca and in the Athabasca Sandstone area there is selection for gallery forests of Mixedwood variety along the rivers, streams and in the lake areas, with jackpine parkland in the sandy, well drained areas (Rowe, 1972).

Probably the most important and abundant ungulate species in the region is moose, usually found in the aspen, mixed aspen or white spruce stands. Generally winter populations concentrate in areas of abundant food and moderate snowfall, frequently in the willow groves or bar areas along the rivers or in the spruce-aspen groves. Similarly, other ungulates such as mule deer, white tail deer and woodland caribou frequent summer ranges in the drier sandy, upland areas but move into the frozen river habitat in the late fall until early spring. Bison are now restricted to the more northern areas of semi-open grassland. Mule deer have been reported recently from the area ; woodland caribou, barrenland caribou, elk and white-tailed deer have been reported in the area in the past (Soper, 1964).

The lake-muskeg environment of the Athabasca delta is a significant waterfowl breeding area, particularly for ducks such as the Mallards, the Lesser Scoups, the American Widgeon, Blue-Winged Teal, Common Golden Eye, White-Winged Scooter, Pintail and Shoveler. Additionally, the area is also significant as a staging and flyway area for such migratory water birds as white pelicans, whistling swans, sandhill cranes, blue herons, grebes and loons. Upland game birds in the area are ruff ed and spruce grouse, sharp tailed grouse and willow ptarmigan.

Aquafauna of the area include a variety of fish such as the goldeye, yellow walleye, Arctic grayling, northern pike, lake trout, etc. Fisheries vary in importance from negligible in the shallow , land locked, high-vegetation lakes that verge on muskeg to very high in the Lake Athabasca area, in other lakes of the Canadian Shield and the sandstone area, and in such lake systems as the Gardiner-Namur Lakes of the Ells River System. In no other aspect of the biophysical environment is the paucity of available information so serious as in the fisheries. It is likely that for at least 6,000 years man has been seasonally dependent on fish in this area. Consequently, to adequately interpret the utilization pattern of the area, it is important to be familiar with fish resources and habits, as well as man's prehistoric exploitive techniques. The habitat study made of Lease No. 17 by Syncrude (Syncrude, 1973) is interesting and valuable as an elemental component in assessing ethnographic human utilization patterns. A comparable regional extrapolation should be made to provide a broader, inclusive component, as well as a point of departure for extension to the early historic and prehistoric environments.

2.2.3 Ancient Environments - The character and chronology of deglaciation in this region has yet to be investigated in any detail but its complexities can be inferred from adjacent regions. The present terrain is the result of minor subsequent modification of glacial and related deposits.

The Birch, Caribou, Stony, and Muskeg Mountains were formed prior to the Pleistocene through erosion of earlier Tertiary and Cretaceous sediments, setting the general drainage pattern in the area. Glaciation occurred at least twice ; the most recent glacial cover, the Main Wisconsin, was responsible for the moraine deposits that blanket most of the area, as well as the glacial geomorphic features preserved on the Kazan Uplands and the Birch Mountains.

Silty clay deposits on the Algar Plains evidence a glacial-front lake during the glaciation, with a probable ice-damming of the Athabasca drainage between Fort MacKay and Fort McMurray. Later, during deglaciation, glacial outwash consisting of sand and gravel was deposited on the Clearwater Lowlands, Firebag Plain, and Methy Portage Plain. A few drumlins on the Firebag Plain indicate a brief readvance of the glacial front into that section.

Post-glacial terrain development is still active in dune and sheet deposits of aeolian sand derived from reworked glacial outwash deposits, as well as the erosional action of the upland area and depositional action on lowland and flood plain areas. The most active depositional areas are the mouths of the Athabasca and the Birch Rivers.

Like most other aspects of the modern and ancient environments the terrain development is poorly known in general and unknown locally.

Archaeological sites are nearly always obscured by organic deposits in the forest zone and frequently are buried within mineral soil deposits resulting from post-occupational deposition. The deposition processes are both local and general and depend upon a number of factors. Any site predictive capability depends on a familiarity with the active sedimentary processes and their applicability to local situations.

For both the chronology of deglaciation and the post-Pleistocene environmental change there is no known data from within the area. However, from work in the Churchill River area of Saskatchewan and north along the Mackenzie it seems likely that the lower Athabasca River was ice-free by at least 11,000 years ago (Christianson , 1975).

On the basis of work in central and southern Saskatchewan, southern Manitoba , central Alberta and in the Northwest Territories it is possible to make a speculative reconstruction of paleoenvironmental history for the post-Pleistocene (Ritchie, 1966, 1967 , 1972). On the basis of a variety of evidence Ritchie has postulated a vegetation sequence for the area east of the Cordillera. As the climate gradually warmed during the early retreat period the vegetation zones shifted north with a resulting compression of the tundra zone to the immediate area of the ice front. As the front gradually retreated, the zones paralleled the ice front and by 12,000 years ago a primitive boreal forest occupied the periglacial zone in southern Manitoba, southcentral Saskatchewan (Ritchie, 1966, 1967), and central Alberta (Lichti-Federovich, 1970). Dominated by white spruce , soapberry, artemisia and juniper, the assemblage is thought to have persisted in the southern plains throughout the Main Wisconsin. The complex moved north in a narrow latitudinal band trending sharply northwesterly-southeasterly parallel to the receding glacial front. In character, the primitive boreal forest was 'open' not unlike the vegetation in the Cypress Hills of southern Saskatchewan and Alberta at the present time. The data from southern Manitoba and southcentral Saskatchewan show very closely similar sequences ; deglaciation occurred somewhat over 12,000 years ago. Development of the boreal forest pattern in northcentral Canada was a blend of this early primitive boreal forest in the south, with some elements of the eastern boreal-deciduous forest introduced north of Lake Winnipeg after drainage of Lake Agassiz, with a jackpine component from a Cordilleran boreal refugium, either south of the Cordilleran sheet or in the northern Rocky Mountains (Ritchie, 1973 personal communication).

In central Alberta deglaciation was followed by the immigration of a poplar-shrub forest assemblage about 11,400 years ago. This was replaced by primitive spruce forest by about 10,000 years ago which persisted until about 200 years ago (Ritchie, 1968; Ritchie and Lichti-Federovich, 1962). The subsequent period shows a fairly sharp drop in spruce and rise in birch and alder. Some reflection of climatic amelioration is apparent during the interval up to 3,500 years ago. A gradual increase in spruce in the assemblage commencing about that time represents the development of modern conditions. The data suggest that grassland may have been closer to the sampled site than at present but that the grasslands of the south may not have been fully connected with those of the Peace River Plains. This information supports Raup's (1935) phytogeographic thesis that the northern grasslands were derived mainly from Sub-Arctic assemblages that once were extensive in the Western Sub-Arctic. There may well have been some merger, however, that might explain the appearance of a number of plains grass species in the existing grasslands of the Peace River and upper Mackenzie River area (Raup, 1947a : 80-91). This merger might well have taken place during the warmer period between 9,200 and 3,500 years ago (Lichti-Federovich, 1970 : 944).

Any environmental shift accompanying the warmer, dryer Altithermal is yet to be identified but tree-line advance in the north may well have been accompanied by a migration north of the aspen-parkland, or even the northern edge of the grasslands. The evidence of bison in the area well to the north of the AOSERP area historically, archaeologically and paleontologically implies either a major change in bison habitat or significant changes in environment.

2.3 Transect Areas

If the environment had been stable over the entire period of possible human occupation, or had a great deal of data been collected on the prehistory and environments of the specific area, it would be possible to construct a hypothetical diachronic utilization model of the area. In the absence of either of those sets of information, it will be necessary to extend the data base out of the AOSERP area into comparable environments by means of a pair of transects.

To develop a utilization pattern for the ethnographic period a semi-latitudinal transect must be used, extending northwest and southeast through areas of comparable modern environments, along the Boreal Forest and Aspen Parkland zone east to Manitoba, northwest into the southwestern Northwest Territories. This will broaden the potential data base but will require care in interpretation of ethnographic and late prehistoric terrain utilization patterns. This might be termed ethnographic environmental transect.

Since environments have changed over the period of human occupation, the ethnographic model has only a limited value prescribed by the modern environment and ethnographic adaptation. The post-glacial environments of the area have likely changed from periglacial tundra, through open Sub-Arctic woodland, the primitive boreal pattern to the present full boreal, with a further possibility of semi-open grassland. Once again, the potential data base can be broadened by using a transect, northerly and southerly, to sample areas of the modern environments analogous to the range of ancient ones. The available paleoenvironmental data based on geological, palynological and pedological research elsewhere on the northern plains should supplement this information. This might be termed the paleo-environmental transect, and extends from the northern plain of central Alberta to the Sub-Arctic woodlands of the northern part of Great Slave Lake.

2.4 Prehistory

2.4.1 Prehistoric Studies - An early reconnaissance survey of the south shore of Lake Athabasca by R. Nero between 1960 and 1963 extended into the AOSERP area at the west end of the lake. This was followed by a survey by J.V. Wright in 1970 and 1971 that again extended into the northeast corner of the area.

1970-71 - -

Reconnaissance survey of west end of Lake Athabasca. Located sites that show more relationships to the north than to the south. Area was surveyed without a clear research design during a wide-ranging survey of the Sub-Arctic waterways by the Archaeological Survey of Canada.

Publication : "The Prehistory of Lake Athabaska : An Initial Statement". Mercury Series 29 . Archaeological Survey of Canada. National Museum of Man, Ottawa. By J.V. Wright.

1973 --

Archaeological survey of Syncrude Lease No. 17 and southwestern section of Syncrude Lease.

Located 31 archaeological sites, most of which were small sites occupied for short periods of time. Survey followed a research design by which the area of the lease was classified as to the probability of historic and prehistoric human utilization on the basis of existing environment resources and native subsistence patterns derived from ethnographic analogy.

Publication : "Syncrude Lease #17 : An Archaeological Survey". Environmental Research Monograph 1973-74. Syncrude Canada.

1974 --

Excavation and Sample Testing Program of Beaver Creek quarry site on Syncrude Lease No. 22 discovered during the 1973 survey.

Site is estimated to be approximately 100,000 square feet of which about 500 square feet were excavated and 50,000 square feet randomly sampled by test excavation, totalling some 1,700 square feet. Although inconclusive , the majority of the artifacts and debris were interpreted as a single population thought to date to about A.D. 300-400 on typological grounds. A single artifact from the excavation suggests that the area was used by earlier peoples, perhaps 8,000 years ago ; again the interpretation is based on typology. The report includes an extensive theoretical background on the excavation, analysis and interpretation of quarry sites.

Publication : "The Beaver Creek Site : A Prehistoric Stone Quarry on Syncrude Lease #22". Environmental Research Monograph 1974 - 2 Syncrude Canada Limited.

1974 --

Sample Archaeological Survey of portion of Shell Lease C13.

Located 36 archaeological sites and 11 probable sites on the lease and two sites on the main access road on Home-Alminex Lease No. 30. This first phase survey program concentrated on the western half of the lease in the area of the main drainage stream and habitat diversity, where the main development will take place. Research was pretty well constrained by the area to be disturbed.

Publication : "Archaeological Investigation on Athabaska Sand Lease 13 : A Sample Survey ". Report by C.S. Sims for Shell Canada Limited . 1974.

1974 --
Reconnaissance survey of selected areas of highway construction in northern Alberta which included a six and a half mile section of secondary road 963 a few miles north of Fort MacKay.

Although restricted to the cleared right-of-way sections four sites were found of which little remained after the clearing activities.

Publication : "Archaeological Reconnaissance, Alberta Highways North 1974 ". Report for Archaeological Survey of Alberta by T. Losey, R. Freeland , and J. Priegert. 1975.

1975 --
Site Inventory of the Caribou and Birch Mountains and portions of Clearwater, Athabasca and Peace Rivers.

Discovered 95 archaeological sites with a minimum of follow-up testing, aimed at survey inventory of high probability areas to provide baseline framework for prehistoric interpretation and for terrain utilization model.

Publication : "Alberta North : End of Season's Report " . Report on Contract 75.8 by P. Donahue, for Archaeological Survey of Alberta. 1975.

1975 --
Proposal for Archaeological Survey of Home-Alminex Lease No. 30. The theoretical background is based on surveys of Lease Nos. 17, 22 and C13, surveys of the access road allowance for Lease No. 30, as well as a number of archaeological projects in northern Alberta. A research design is developed for estimating archaeological potential of a given portion of the oil sands area. The landscape ecosystem is seen as a set of subsystems interacting to form a variety of ecosystems, each with a certain relative value to prehistoric, early historic or even modern man. Subsystems considered include topography, geography, plant and animal distribution, climate, nutrients regime, soil types and moisture content. Certain assumptions are made concerning prehistoric or early historic human decision-making processes on utilization of terrain, mainly by analogy with ethnographic examples, translated to the area through three cultural subsystems, leisure maximization, resource proximity and communications.

As the proposal was never implemented the resulting classification was never tested.

Publication : "The Archaeological Potential of Tar Sands Lease 30". By Cort Sims. 1975.

This recent work has been remarkably well done considering the data base available and the difficulties of survey in this area. Apart from such special sites as the Beaver Creek Quarry the sites are generally small and contain relatively simple collections of tools and debitage distributed over relatively limited areas.

2.4.2 Prehistoric Summary

From the work in the southern Mackenzie Basin, the Lake Athabasca area, the Peace River and the northern plains, a very vague chronology can be postulated requiring detailed testing, amendment and expansion.

From work done in the Fisherman Lake Locality in the southwestern Northwest Territories , the earliest recorded occupation of the general region occurred shortly following deglaciation estimated at prior to 12,000 years ago, perhaps as long as 15,000 years ago in that area. The McLeod Complex of this period is characterized by simple flake and core tools.

During the interval between 11,000 to 7,500 years ago deglaciation of northern Canada was completed and two different complexes are found in the region, again at Fisherman Lake. The stratigraphically earlier assemblage appears to derive from the northwest, perhaps Asia, and consists of crude bipointed bifaces, large scrapers and burins. The later complex is radiometrically dated at about 9,000 years ago and appears to relate back to the plains to the south. The assemblage includes straight-stemmed leaf bladed spear points, thin pentagonal bladed spear points, large humpbacked scrapers, side and end scrapers on very large flakes and burins on prepared flakes and artifacts. Bison and elk remains found with the lithic complexes indicate that they were hunters of big game. Neither of these complexes is represented in the present collections from the AOSERP area.

Stratigraphically above the stemmed point component in one site and dated at 5,000 years ago at another site in the Fisherman Lake Locality, the next complex is widespread across the north, but seems to have had its origins in the south on the plains where it is identified as an early bison hunting complex. Found in a number of sites dating to about that time period from southwest Yukon to the edge of the Keewatin tundra, the complex is thought to represent an early northern interior-based tundra and semi-open grassland hunting tradition. The tundra subtradition is thought to have developed somewhere between the northern edge of the true plains -

now in the southern part of Alberta - and the southern edge of tundra - now at the eastern end of Great Slave Lake. The other subtradition, characteristic of the Mackenzie Basin and perhaps the intermontane/ Yukon likely developed from a similar precedent between the northern plains and the middle Mackenzie. At Fisherman Lake the complex consists of lanceolate points with straight or convex bases, bifacial knives, a variety of gravers, wedges and pointed piercing tools. Isolated finds of points of this general form from the AOSERP area (Losey at al 1975; Donahue 1975) imply occupation by people of this tradition.

In some parts of the north this tradition persisted until perhaps the first millenium B.C. whereas in the western middle Mackenzie the plain- related peoples were replaced by migrants from the west about 4000 B.C. These forest hunters , fishermen and collectors seen to have been ultimately related back to Asia and commenced their slow diffusion from Beringia about 10,000 years ago. The very characteristic tool assemblage must have been flexible to adapt to local conditions, but maintained a fundamental integrity. The complex, found at Fisherman Lake and a number of sites down the Mackenzie and in southern Yukon, consists of small lanceolate points, medium sized side-notched points, large thick end scrapers, with two technologies, microblade and large core tool. The multitude of thin, prismatic blades from prepared polyhedral cores are made into a number of microtools. The large core tool industry seems to have been an adaptation to the forest. Dates on the tradition extend from 3635 B.C. to 500 B.C. While not represented in AOSERP area, a site at Calling Lake (Gruhn,1969) contains a small sample of linear flakes that may be microblades. This may represent a southern dimension to the movement of the forest adapted people from the northwest.

In the middle Mackenzie Basin there is evidence of continuity between the late part of the microblade tradition with the tradition identified with the ethnographic Dene. At Fisherman Lake, this continuity is exemplified in two complexes dated to the time of Christ and A. D. 500. The earlier material is distinctive in particularly well made leaf shaped bifacial knives and unifacial knives, small tear drop shaped end scrapers and side-notched end scrapers, large side-notched half-moon side blades and a variety of point types. The later artifacts retain some of the earlier characteristics such as the bifacial knives, scrapers and gravers ; new artifact types consist of copper awls and projectile points, drilled pebble pendants and a corner-notched projectile point.

2.5 Historic Studies

It is difficult to define the end of the prehistoric period, particularly so in the northwestern part of Canada. Here, the influence from European demands for furs probably occurred well in advance of Samuel Hearne's ascent of the Slave River in 1771 returning to the home port of Churchill by striking east from Lake Athabasca. Subsequently, continuous contact was established through a series of trading posts built by Peter Pond. In 1778, Pond crossed the Methy Portage from the headwaters of the Churchill River system into the Clearwater and down the Athabasca River. During the summer of 1778 he built a trading post on the Athabasca about 40 miles upstream from the lake. Later that fall, a post was established at Fort Chipewyan which was then located at Old Fort Point, well east of the mouth of the Athabasca. Before the end of the century posts had been built on the western shore of Lake Clair, near the mouth of the Muskeg River and a few miles downstream from the present site of Bitumount.

The only historical survey made in the oil sands area was a traverse of the Athabasca River down to Old Fort Point by Nicks and Clark in 1970 (Nicks, 1970). Although the Athabasca River was a main access route from the east into the Athabasca area and its rich fur resources, the area itself does not appear to have been very productive in furs. As a result, direct evidence of the fur activities is not expected to be found, rather the area more likely contains data of a strategic nature ; the important information might well be the impact of the trading activity rather than the fur itself.

2.6 Native Inhabitants

There are a number of native communities within the AOSERP area today associated with several hunting reserves. Algonquin speaking Cree reserves include those at Anzac, Fort MacKay, Fort McMurray and a small parcel on the east side of the river, north from the mouth of the Firebag River. The band at the Fort MacKay reserve also holds a trapping and hunting reserve on the Namur-Gardiner Lake system. Athabaskan speaking Chipewyan occupy reserves at Fort Chipewyan and Old Fort Point, with hunting and trapping reserves on the delta of the Athabasca River.

3.0 OIL SANDS AND RELATED DEVELOPMENTS

3.1 General

It is anticipated that energy demands over the next 25 years will require increased production of petroleum products from the shallow oil sand deposits in northeastern Alberta and western Saskatchewan. The exploration, development and production activities represent potentially adverse effects to the environment of the area. The secondary development activities in support of the oil sands exploitation as well as the tertiary developments resulting from the improved access and by-product availability, will have further, less predictable impact.

In response to the obvious need for a program of study of the existing environment and the potential impacts, the Alberta Oil Sands Environmental Research Program (AOSERP) was instituted by the Government of Alberta and the Government of Canada. As one of eight technical research committees within the program, the Human Environment Committe is responsible for a number of socio-economic and other social baseline studies which includes investigation into the record of human utilization and ecological adaptation to the area. The information derived from this archaeological research design will be a contribution to that project.

While it is clear that the most serious disturbance of the terrain will result from the primary developments which are connected with excavation and treatment of the oil sands deposits themselves, there are already some secondary activities underway that are in direct support of the oil sands operations themselves . As time goes on, the increased accessibility and population, as well as the availability of by-products from the operations will attract new industrial developments . The same requirements for environmental protection will apply to those endeavors and provision for comparable assessments and studies will be necessary.

Virtually any development will include direct disturbance of the organic and mineral soil and most will require significant supplies of granular products which will extend that disturbance. In all such disturbances there is a demonstrable danger of loss of important prehistoric data that will require assessment and study, and subsequent recovery.

3.2 Oil Sands Development

3.2.1 Distribution of Oil Sands Deposits - There are four known main areas underlain by potentially valuable petroleum bearing sands deposits : Athabasca, Wabasca, Ell Lake and Peace River with all but a portion of the Cold Lake deposit in the province of Alberta. Although the Athabasca deposit was reported by Mackenzie in his journal of 1798, a combination of technology and economics has only recently made a profitable production a possibility.

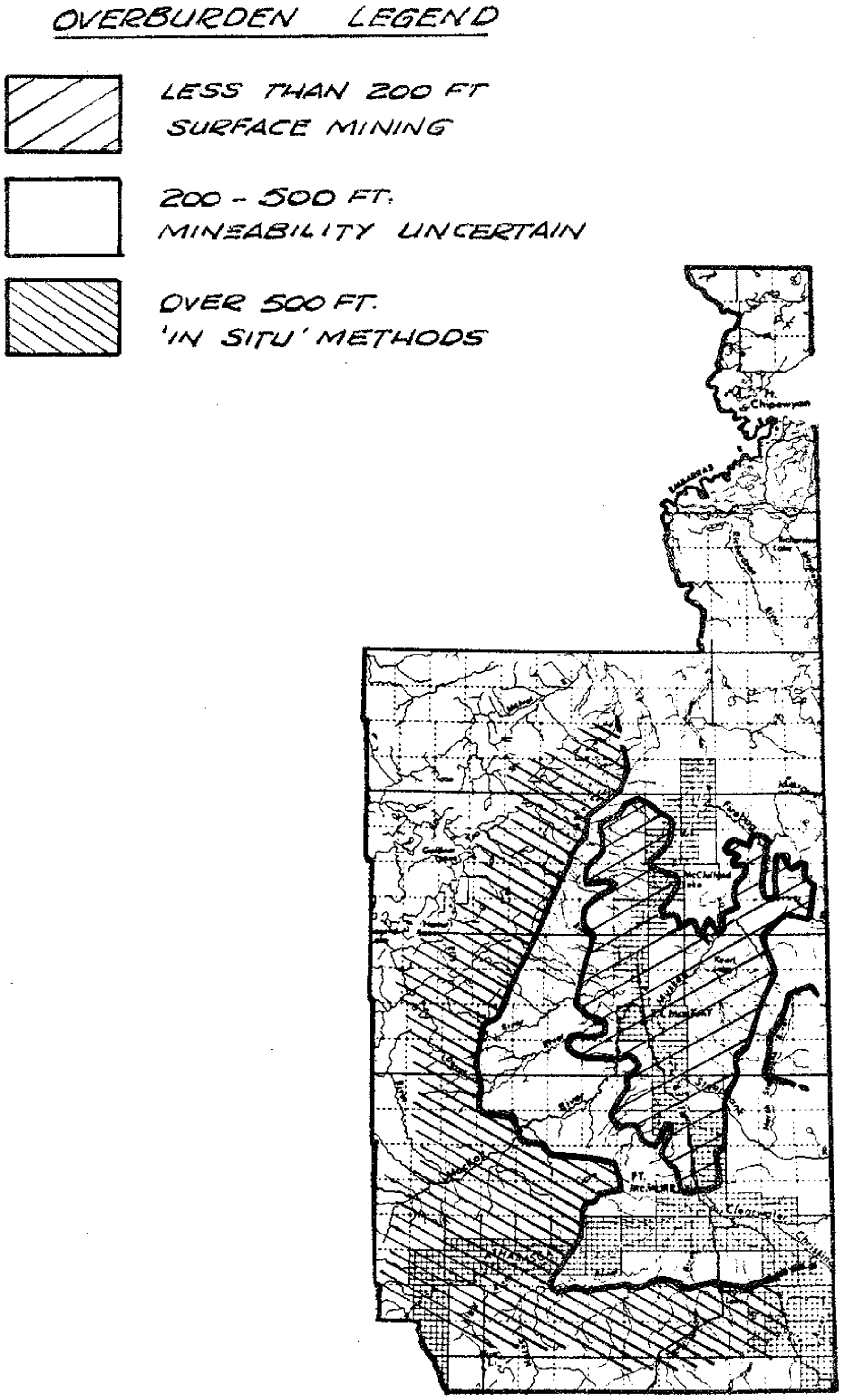


FIGURE 3.

DESIGNATED AOSERP AREA
SHOWING OVERBURDEN DEPTHS

10 0 10 20 30 40 50 Miles
10 0 10 20 30 40 50 60 70 Kilometres

The oil sands deposits are nearly horizontal, lying beneath an overburden of barren sand and soft shale , all below varying depths of surficial deposits , mainly glacial drift. Exposed along the Athabasca River the deposits vary in thickness and grade and, equally important, in depth of overburden. In general, the depth of overburden increases while the thickness of the oil bearing sands decrease east and west from the Athabasca River. For the forseeable future the production will come from those shallow deposits along the lowlands along the Athabasca River.

3.2.2 Recovery Techniques - The three most important factors in selection of recovery technology are the thickness and grade of the deposit and the depth of overburden. As the amount of depth of overburden is by far the most critical the other two variables merely modify the effect of that factor. For overburden depths of up to 150 feet, surface mining methods can be used ; in fact although different equipment can be used, the general characteristics and surface effects are the same. For depths over 500 feet subsurface methods are feasible, mainly some system of mobilization of the bitumen and removal from the sand structure through a dense pattern of drill holes. For the overburden thicknesses between 150 and 500 feet, some other alternative will be necessary, and there is some discussion of underground mining methods for these areas. Production experience and improvements in the design of special excavation equipment and areas of increased oil sands grade and thickness will increase the allowable depth of overburden for surface mining, perhaps to 200 feet.

The exploration data and mapping to date has delimited an irregular region on both sides of the Athabasca River of commercial grade and thickness of oil sands with less than 200 feet of overburden. This is expected to be the main area of production for some time as the only commercially proven method for recovering bitumen from oil sands depends upon surface mining. Zones between 200 to 500 feet and over 500 feet lie east and west of this main region (Map 2).

The following table is based on information available in 1974 and refers to the Athabasca deposits only.

Depth of Overburden	Area	Percent of total AOSERP area	Percent of total oil sand area
less than 200 feet	827 sq. mi.	7.5	14.0
200-500 feet	1293 sq. mi.	11.8	22.0
over 500 feet	3776 sq. mi.	34.2	64.0
Total	5896 sq. mi.	53.5	100.0

(From data sheet Alberta Oil Sands Environmental Research Program)

3.2.3 Operational Schedule _ The character of the deposits and the technology of production require disruption of the surface deposits of various times and in various ways in the program. The operational sequence consists of three relatively well defined phases : exploration , development and production. The results of the exploration program lead to a decision concerning the development and ultimately production from the deposits as well as the scale and schedule of the operation.

(a) Exploration Phase - This phase is generally drawn out in time and marked by periodic flurries of activity responding to technological developments and changes in the economics or politics of production. As the phase proceeds , investment increases markedly and the activity becomes more intensive and consistent. Generally, the exploration phase for any part of the oil sands deposits will be very similar in nature , varying in expense with the complexity of the geological structure of the deposits, depth and location.

The exploration program usually commences with winter construction of a few access bush roads and a few cleared lines, followed by seismic surveys and preliminary drilling. As the program proceeds the cleared lines develop into a grid network of cleared lines. Periodic drilling activities in this network might require an acre each of extra clearing. Most of the line-clearing and exploration work is done in winter and resulting surface disruption varies with the terrain and the operation but can be kept to a minimum with some attention to the task. Overburden mapping and grade and thickness of the oil bearing sands is determined by combined seismic and drilling, leading to the definition in any lease of a potentially economic deposit and determination of its geographical and geological extents. The advanced exploration program concentrates on this economically described area to prove a minimum of necessary reserves to warrant development for production. It is difficult to estimate the area that would be 'covered' by exploration activities, but it is likely that most parts of any lease will ultimately be explored to some degree. Usually, a company continues exploration through the production phase to increase reserves and assist in mine-planning.

(b) Development - The final stage of the exploration phase is the preparation of a feasibility study, following which a number of years might pass with no field activities. When the decision to go into production is made there are a number of separate development operations that are activated. The precise operations and their character depend on the nature of the deposits and the recovery techniques to be employed. Most of these activities and operations will be the same in any recovery technique ; namely, access preparations, water and power provision, tailing pond preparation and plant site preparation, supply and development of granular materials and construction. The main differences will lie in the preparation of the mine area.

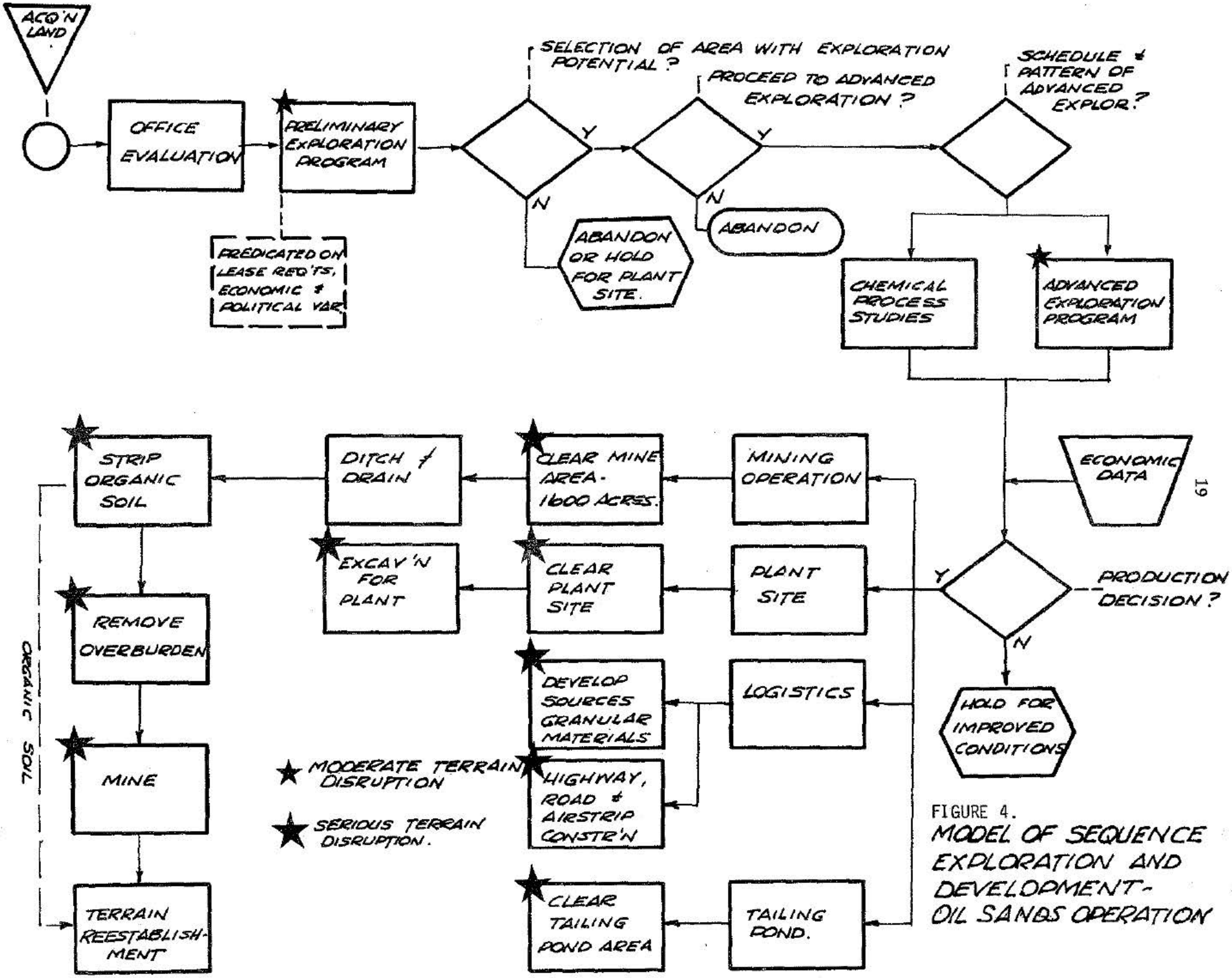


FIGURE 4.
MODEL OF SEQUENCE EXPLORATION AND DEVELOPMENT - OIL SANDS OPERATION

Access preparation varies with location depending on accessibility to pre-existing highways. Usually the responsibility of the Department of Highways, highway access disrupts between 15 and 25 acres per mile, depending on the need and accessibility of granular materials and topography. Winter airstrips often are built for exploration and improved to all-weather standards when production is planned ; they require about 20 to 30 acres of surface disruption, again depending on availability of granular materials and topography.

Provision of water for the plant is a major requirement entailing a large pumping station adjacent to the river or a large stream and a buried pipeline to the plant site, with clearing and road building. Several acres along the stream and about eight acres per mile will involve considerable surface disruption.

Power lines require clearing and brush removal with a little excavation, probably a minimum of disruption of mineral soil but considerable exposure, some ten to fifteen acres per mile.

The bitumen in the deposits is contained in a sand matrix (or vice versa) that must be separated in the treatment plant. The deleterious sand is removed and deposited in specially prepared 'tailing ponds' or in mined-out sections where the sands settle out and the liquor recycled. Although these tailing pond areas are cleared and some terrain disturbance is caused, the area is ultimately obscured by the deposits. For a 100,000 barrel per day operation, an estimated seven square miles will ultimately be required for this purpose, although the 'flooding' as well as the clearing preparation will only gradually reach that extent. Clearing will generally be a winter operation. Tailing ponds will be prepared about six years ahead of requirements.

The plant site for a 100,000 bbl. per day operation will require about 600 acres for all facilities, all of which will be cleared and stripped and about 100 acres excavated to some extent. This will be done very early in the development stage.

The plant, the network of roads and the dams for the tailing ponds will require large amounts of granular materials which are fairly scarce in the area. There will be a network of roads and a number of 'borrow' pits developed all of which will cause considerable disruption of the surface terrain. As to the extent of this activity there are too many variables to allow any realistic estimate.

All of the previously described activities will be common to all forseeable recovery techniques and operations in the oil sands operations. The main differences lie in the mine development and correlated extraction techniques. At the moment the only practical technology is that for surface mining but it is expected that methods will be developed for 'in situ' extraction and other subsurface mining methods. It is expected that some form of 'in situ' method will be developed and proved in the next few years. The following outlines the processes for both surface and 'in situ' mining.

Development of a surface mine commences with a program to clear a section of the mining area, usually sufficient for about 8 years of mining. The area is ditched for draining and after 2 or 3 years the organic soil is stripped to expose the mineral soil. The mine is then prepared for overburden removal and mining which commences as the plant is completed. The actual timing depends on the specific mining method to be used and the particular mining company.

For the Syncrude operation the stripped area will be left until up to 80 days before mining, when the overburden will be removed by dragline and used to backfill previously mined pits. When the overburden has been removed, the oil sands are excavated and transported to the plant. The mining will be done in 80-foot wide strips, 14,000 feet long ; each strip will take 80 days to remove and the equipment then moved 80 feet over laterally to work on the next strip. Any given longitudinal 'face' or cut-profile, will be exposed up to 80 days, while the overburden lateral cut faces would normally be exposed for several hours. Preparation for mining includes complete removal of the overburden along a single full-length strip leaving room for the subsequent backfilling.

For a 100,000 bbl. per day plant the initial cleared and drained area will need to be some 17-1800 acres in size. An area of about 220 acres will be used every year for such a plant. Each strip will be some 26 acres in extent and will take about 80 days to mine.

The area designated as the 'mine' for an 'in situ' operation is developed in quite a different manner. The method or technique will likely depend on some form of mobilization heating or solution (steam, fire-flooding or chemical) and pressure applied from a pattern of close drill holes spaced at thousand foot or half mile spacing and piercing the oil bearing function. Oil and sand will be extracted from other holes in the pattern. A number of steam or chemical pumping plant areas will need clearing, with the road network, the grid lines, the pump stations and drill stations ; some 10-30 percent of the area of the mine will have to be cleared and subsequent travel will disrupt the upper mineral soil over much of that portion of the area.

A very speculative estimate of the area of potential terrain disturbance associated with 'in situ' methods would be about 10-50 percent of that for the surface methods. This makes no allowance for a lower recovery by the 'in situ' method and therefore a greater area per unit of oil produced.

Tabulation of terrain area disturbance per 100,000 bbl. per day operation

Initial Exploration	*	
Advanced Exploration	*	
Access provision		
roads	20 acres/mile	
airstrip		25 acres
Water Supply	8 acres/mile	10 acres
Power	10-15 acres/mile	
Tailing pond		4500 acres
Plant site		600 acres
Borrow & Road network	*	
Surface Mine Area	220 acres/year	
In Situ	30-60 acres/year	

* inestimable

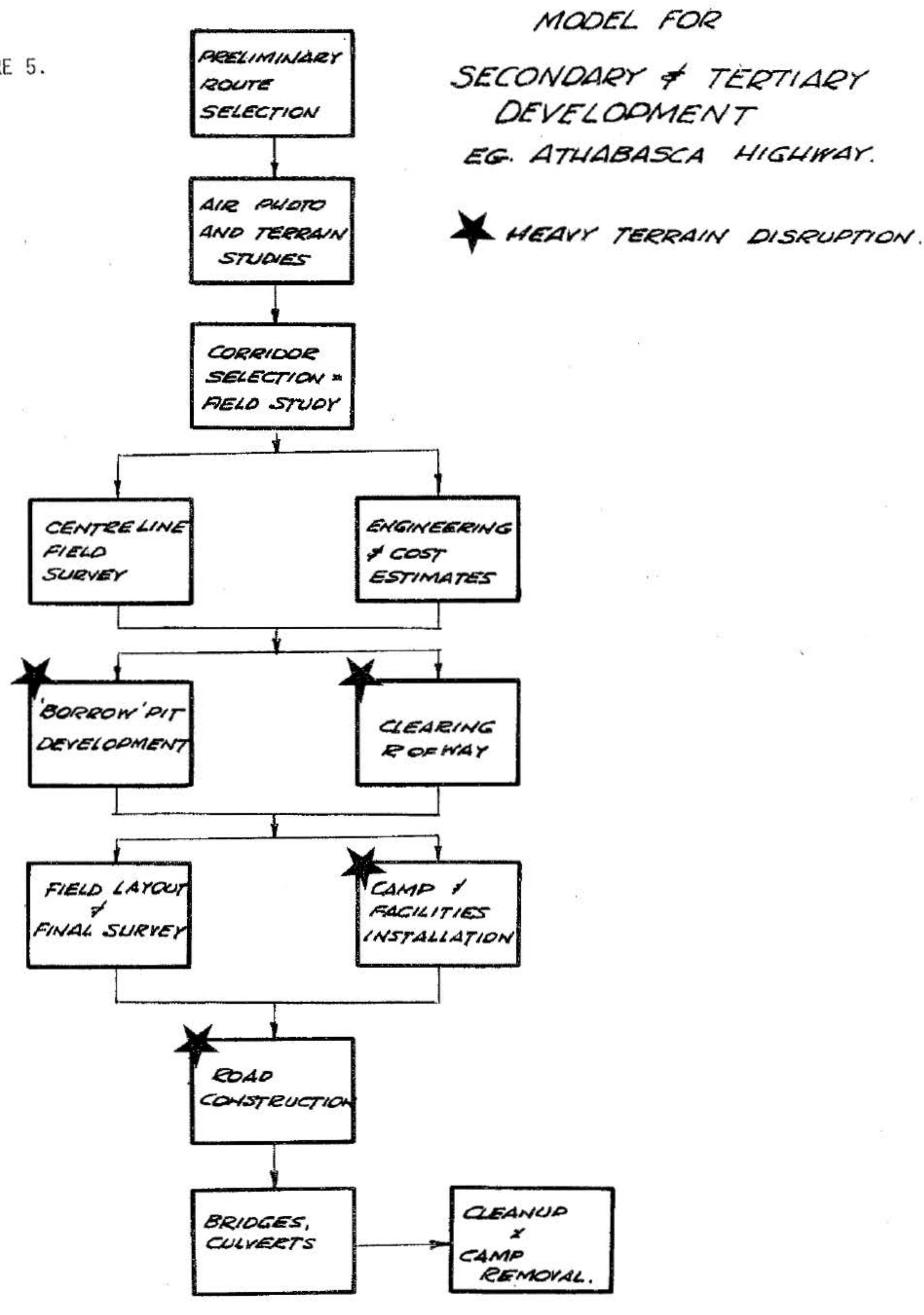
3.3 Secondary Development

3.3.1 General Note - The oil sands development in general, in addition to each individual plant, will be accompanied by a series of secondary or support industries necessary to maintain the equipment, logistics systems, people and to connect individual operations to existing systems. Some of these secondary operations will be the responsibility of the developing government department or agency, while some will be that of industrial corporations, quite often companies independent of the oil sands developers.

3.3.2 Secondary Development Activities - A transportation corridor has been designed to connect McMurray in the southern part of the AOSERP area with the Edmonton area. Each plant has to be connected to the pipeline , rail and highway facilities and each of these will involve some degree of terrain disruption.

Each plant will require a number of support facilities such as mechanical repair depots, marshalling yards, contractors plants, equipment supply and parts depots. While none might be extensive in themselves, the gross area disturbed will be significant.

FIGURE 5.


MODEL FOR
SECONDARY & TERTIARY DEVELOPMENT
EG. ATHABASCA HIGHWAY.
HEAVY TERRAIN DISRUPTION.
PRELIMINARY ROUTE SELECTION
AIR PHOTO AND TERRAIN STUDIES
CORRIDOR SELECTION = FIELD STUDY
CENTRE LINE FIELD SURVEY
ENGINEERING & COST ESTIMATES
'BORROW' PIT DEVELOPMENT
CLEARING R OF WAY
FIELD LAYOUT & FINAL SURVEY
CAMP & FACILITIES INSTALLATION
ROAD CONSTRUCTION
BRIDGES, CULVERTS
CLEANUP & CAMP REMOVAL.

Regulations of the Land Surface and Conservation and Reclamation Act, passed in 1973, require that the terrain be re-established following disruption. To accomplish this re-establishment a nursery operation will be established to develop a supply of suitable plants. Again, a substantial area will be needed and some disruption of the terrain will result.

The present total population of the AOSERP area is about 16,000 distributed into a number of communities; 12,500 in Fort McMurray, 1500 in Fort Chipewyan, 250 in Fort MacKay and 150 in Anzac. Development of each new plant requires a peak work force of about 4000 men who will have to be housed and entertained. The camps alone require several hundred acres. Each plant will require about 3000 permanent full-time employees ; translated to a total population increase of 15,000 to include families and secondary service people. It has been estimated that three new plants will make a new town necessary, very likely north of Fort MacKay, probably on the east side of the river.

3.4 Tertiary Development

3.4.1 General Note - The oil sands development will spawn many small businesses and industries, too numerous to identify now. Additionally, and of more identifiable impact, are a number of major industries that might be made possible by the access that will accompany development or by-products made available by the oil sands extraction.

3.4.2 Tertiary Developments - Industries tentatively suggested as viable possibilities include coke production, cement manufacturing, wallboard manufacturing, brick manufacturing and almost unquestionably the need for a recreation industry, if only for the large work forces and support personnel needed in the oil sands operations and towns. Each of these will have its own kind of environmental disruption or disruptions, but all will involve some disruption of the mineral soil.

Other perhaps less likely but still possible developments are the following:

- pulp mill for area if the new town is established
- railway extension north to the new town
- granite rock production near Fort Chipewyan
- peat moss production
- highway extension north along east side of Athabasca River to Old Fort Point, ferry crossing to Fort Chipewyan and highway connection west to Fort Vermilion.

3.5 Present Status of Development

Practically all of the acreage underlain by surface mineable bituminous sand deposits had been leased by 1961 and is now fully under corporate lease. Some 18 companies hold a total of 328,200 acres in the area designated by the

Energy Resources Conservation Board as 'surface mineable'.

Syncrude	83.8	Union	11.0
Petrofina	42.3	Amerada	8.5
Shell	38.4	Ashland	5.9
Supertest	32.0	Pacific	5.9
Home	30.7	Tenneco	1.4
Chevron	16.8	Can-Amera	1.3
Sun-GCOS	15.4	Aquitaine	1.1
Mobil	13.3	Atlantic-Richfield	1.0
		Canadian Export	0.6

(Figures in thousands of acres)

(Hydrocarbon Consultants 1975 :44)

While one of these lease holders is now in the production phase and another is in the development phase, the remainder are at some stage of exploration. At least three of the remainder have completed the exploration and proven sufficient tonnage to warrant continuing to production. The decision to continue to production seems to be a combination of economics and politics requiring negotiations, but some announcement is expected this winter or spring.

Great Canadian Oil Sands Ltd. commenced production in 1967 , reached full production in 1970 and is now rated at 50-70,000 bbl. of synthetic crude oil per day. Total recoverable reserves on the GCOS property are estimated at 630,000,000 bbl. for an expected life of 30 to 40 years. This company is mining approximately 180 acres per year through a program of clearing, draining and stripping ahead of mining. Long range estimates of increased production capacity by GCOS would increase the plants to 10 and an annual mining rate of 6600 acres. A terrain redevelopment and revegetation program will minimize permanent terrain destruction.

Syncrude Canada Ltd. received authorization to construct a 125,000 bbl. per day plant in 1973 based on bituminous sands reserves on Lease No. 17 , 25 miles north of Fort McMurray. Preparation of the site commenced in 1974 and is about completed with construction well underway. About 8 years mining area has been cleared and is being drained. Stripping of a part of this area has been done and will continue over the next year, with overburden removal commencing June , 1977. Production at about half of designed capacity is planned for 1978 with full production in 1979 and 1980. Over the 25 year life of the operation an estimated billion barrels of synthetic crude oil will be produced. When in full production something over 200 acres of terrain per year will be disturbed by mining operations, but will be redeveloped as required under the Alberta Surface Reclamation and Conservation Act.

Three other companies are in the feasibility study stage and production decisions might be expected this year. Shell Canada Ltd. have endorsements for installation of a 100,000 bbl. per day operation, Athabasca Oil Sands Project Group have approval for a plant with a capacity of 122,500 bbl. per day and Home Oil Company Ltd. and Alminex Ltd. have a joint application for a 100,000 bbl. per day operation. Most of the details on plant locations, tailing pond areas, mining areas, etc. will have now been decided for these operations. The remainder of the lease holders are in some stage of preliminary or advanced exploration. For the purposes of projections and without implying any active planning, Hydrocarbon Consultants Ltd. identified a number of additional attractive mineable leases or lease blocks ; one additional Shell lease, two more Syncrude leases and one each for the AOP group (three leases), Mobil and Amerada leases. These are mentioned to provide a measure of the work to be done and the terrain disruption possible.

The 'in situ' leases in areas underlain by depths of overburden exceeding 500 feet lag considerably in develop planning. No applications have been made to date for a plant based on 'in situ' extraction methods. Research is going ahead aggressively and the next five years may see a breakthrough in technology, costs and recovery.

4.0 ARCHAEOLOGICAL RESEARCH DESIGN

4.1 Nature of Archaeological Evidence

Historic and prehistoric archaeology is the study of man and his works in the past. It consists of a body of methods, theories and concepts that combine to recover the remains of man and his technology and to reconstruct how man lived and adapted to the environments of the past. Since man is both a biological and a cultural animal and is greatly influenced by his environment, it is necessary that the interpretation of the archaeological record be done in the context of environment and environmental changes. Consequently, archaeological studies have stimulated geochronological studies and palaeoenvironmental reconstruction.

From expanding development activities of the past few years it is clear that archaeological resources are subject to extensive destruction and loss if not identified, inventoried and recovered. As a resource it is limited and irreplaceable ; once destroyed it is gone forever. As a record of human heritage, it is of immeasurable value for present and future generations. Recognition of this value is reflected in legislation to protect antiquities on provincial and federal lands. In Alberta the protection of archaeological resources in all development is legislated directly by the Alberta Historical Resources Act (1975), an amendment to the Alberta Heritage Act (1973) and indirectly by the Land Surface Conservation and Reclamation Act (1973). These legislations require evaluation of the prehistoric and historic resources of an area prior to terrain disturbance for any development.

Post-glacial human occupation of the study area probably took place soon after deglaciation ; the earliest evidence collected to date may be as old as 8,000 years. Post-glacial climatic change induced a succession of environments in the area with a correlative sequence of human adaptive strategies and therefore terrain utilization patterns. Following occupation of a site, active sedimentary processes work to destroy or obscure a site in a variety of ways, controlled by a number of local conditions. The vegetation layer of the Boreal Forest effectively obscures the mineral soil, even in well-drained areas. Characteristic soil acidity of the forest zone works to further reduce the already meager sample of the material culture of prehistoric peoples by chemical weathering of any organic remains. All these factors combine with the very limited size of the prehistoric groups characteristic of such an area to make archaeological survey a very difficult one.

4.2 Objectives for Project

To effect the ultimate goal of the project, as provided by the working paper (see p. 1), the following research objectives were given for the project :

- "To establish a field inventory of archaeological resources ;
- To determine through sampling methods the age, size and content of archaeological sites located from inventory surveys;

- To protect or salvage through complete excavation any archaeological sites containing significant remains of the past which are in danger of being destroyed." (Sub Project Research Details- AOSERP)

Further to this may be added the practical objective of optimizing the time, money and resources available to maximize the information recovery and minimize the information loss due to the oil sands and related developments.

4.3 Criteria for Research Design

The following terms of reference for the research design have been assembled from the working paper and from discussions with W. Byrne and R. Piepenburg.

The research design should :

1. outline the general and specific conditions, systems and mechanisms required to effect the objectives of the project ;
2. promote cooperation between government, industry and the archaeological community in an effort to salvage archaeological evidence ;
3. provide a broad-scale research design incorporating the alternatives of five- and ten-year schedules ;
4. place responsibility for coordination of the project with the Archaeological Survey of Alberta, including care and custody of collections, development and integration of data management systems, supervision of government sponsored field or office operations and monitoring of other projects ;
5. provide for the development and continuous revision of an interpretive cultural framework ;
6. provide for assembly of an environmental-paleoenvironmental framework within which the archaeological evidence can be interpreted towards the goals of the project ;
7. attempt to develop a more effective predictive tool for archaeological surveying with recommendations concerning the need and the feasibility for a computer system application for this purpose ;
8. correlate archaeological research activities with development schedules for both specific oil sands developments and the area as a whole, including secondary and tertiary development activities ;
9. aim to obviate as far as is possible any delays during production due to the discovery, evaluation and salvage of archaeological sites.
10. provide a set of general regulations that might be used to ensure a minimum loss and maximum effective recovery of archaeological evidence ;
11. provide recommendations for the communication and results of the archaeological research and for the accessibility of the data from the research ;
12. provide for public participation in the project through programs of training and dissemination of public reports ;
13. consider the overall interests of native persons in regard to the project area , particularly as related to reserve boundaries, hunting, fishing and trapping locations.

4.4 Theoretical Framework

Man's use of the terrain has varied with his adaptive strategy which has been closely correlated with changes in environment and resources, all tempered by his technological level. With sufficient data on human ecology associated with each of the varied sets of past conditions that obtained in the area it should be possible to make a reasonable evaluation of site probability for any given terrain and terrain complex. Requisite is a practical classification of the terrain and a suitable body of data on human utilization patterns in the terrain types at various times in the past. Such information is obviously not easily available for many areas covering many time periods and can be assembled only by considerable research, including search of present day and ethnographic data available , historical data and archaeological research throughout the range of the two extended transect areas. Both the changing cultures and environmental conditions must be studied to produce this multidimensional terrain utilization matrix. Resulting from this assessment will be an estimate of the site probability , obviously providing a priority classification based on a range of probabilities.

A practical classification will be required to portray the level or range of site probability expected for any given terrain type and relationship. In a paper prepared to evaluate the archaeological potential of oil sands Lease #30, Sims (1975) proposed and applied a method of making such an estimate on the basis of ten 'ecological attributes' ; namely, soil moisture, surficial landforms , topographic slope, aspect, drainage, soil texture, vegetation diversity, topographic situation, unique landscape features and bedrock geology. 'Locational attributes' considered included distances to major streams, confluences of major streams and the Athabasca River, as well as distances to favorable fish and game areas. While the method is concerned with essentially modern data it is likely valid for the late prehistoric and historic period. By assigning quantitative values to the variables for each attribute (with no attempt to weight the variables), an Environmental/Archaeological Index is calculated and expressed simply in a quadrapartite system, very good , good, moderate, poor. The system could be expanded and made more useful by making allowance for change in human ecology through time.

An important practical aspect of survey is the discoverability of sites due to sedimentary processes following occupation. While active sedimentation tends to obscure archaeological evidence, erosion tends to destroy as well as to expose sites to the surveyor. To remove bias from a survey the terrain history in terms of these two processes should be understood. A relatively recent site on an active floodplain is often below meters of sediments while on a hilltop, an early site may lie on top of the mineral soil. The effects of recent human activity are generally site-destructive but frequently remove the organic soil cover, easing site discovery. However, in the Boreal Forest an effective survey cannot be done by ground-surface survey only ; without some sense of the history of the terrain type it becomes pointlessly complex. Essential data for effective survey should include terrain classification according to its sedimentary history over the possible period of human occupation. The classification should be simple and aimed at providing a test to supplement the site probability classification in guiding survey.

4.5 Project Outline

The research project should be designed to set up the necessary administration, to develop the various information systems, to set criteria and classifications, to coordinate archaeological research and to provide monitoring and support services for the studies. It involves three main sections :

Administration and Coordination

Research Framework Studies

Development Impact Studies

They are identified on the basis of fiscal responsibilities, time scheduling and scope of responsibilities.

4.5.1 The Administration and Coordination Section - will continue throughout the life of the project and probably beyond, although in a much reduced role. It is responsible for all of the organization, supervision, coordination, monitoring, data handling and general management of the project. The section will be responsible for the design and operation of a suitable data management system through which archaeological data might be handled and a matrix developed as the basis for estimating the site probability and discoverability (terrain development and utilization matrix). This data matrix will serve as the main predictive tool for assessment of development impact on archaeological resources. The fiscal responsibility for this section will be that of the Government of Alberta, mainly through the Archaeological Survey of Alberta but partly through the Human Environment Technical Committee of AOSERP. The operational responsibility of the Administration and Coordination Section will lie in the Archaeological Survey of Alberta (ASA).

4.5.2 The Research Framework Section - consists of a series of specific baseline studies that give this section a limited term and which will phase out as the data accumulates. The purpose of the section is to assemble a preliminary data framework from available library resources and extend that framework through to two sets of regional saturation surveys ; one a sampling program to test human utilization patterns of the various terrain types represented in AOSERP, and the other a set of saturation surveys of selected optimum potential areas to provide interpretive background, as well as additional information on terrain utilization. Both field surveys should follow the library research and preparation of the preliminary phase of the data management system. This section will be the fiscal responsibility of the Government of Alberta through AOSERP. Operational responsibility for the section would be most effective through ASA.

4.5.3 The Development Section - should continue through the life of the program with provision for a modified extension. Any company actively planning installation of a production facility or any new secondary or tertiary activity, should be required to complete, or have completed, an assessment of the potential impact on the archaeological resources. Plants now in production or developments under construction should be required to assess the remaining impact from their particular stage. Steps should be required to minimize this anticipated damage by survey and inventory, with excavation where warranted. This section will be the fiscal and operational responsibility of the developing corporation and/or government department, with the cooperation and supervision of the ASA.

4.6 Operational Systems

In each section there are a series of components and systematic operations that require definition and correlation. It is expected that they will require some modification with experience or for any particular circumstance. Each, in some way, fits into the overall research design and therefore contributes to the objective of the project.

4.6.1 Administration and Coordination Section - The organizational systems in this section divide conveniently into three groups based on the relationship to the project ; management, coordination, program development.

The management systems are those that deal with the administrative and supervisory responsibilities of government.

The coordination systems include those that facilitate connection between the various interest groups concerned with the archaeological resources of AOSERP; namely, the Government of Alberta (ASA) and AOSERP, the development industries and the archaeological community, the people of the area of Alberta and the Advisory Committee. Probably the most important coordination function between the various groups responsible for archaeological studies is that between the development groups and the archaeologists whose job it will be to carry out the studies. The most common problem in archaeological salvage is that of coordination and scheduling archaeological studies with development activities. Sufficient notice must be given of development intentions and schedules to permit adequate supervision and coverage. Much of the extra cost of archaeological salvage can be attributed to poor correlation of activities.

Program development systems include the design of specific systems for use in the project and the establishment of certain criteria and standards for consistency throughout the project.

The following are Management Systems required :

(A) Administration of Regulations - The general regulations of the Alberta Historical Resources Act and specific regulations developed under the AOSERP must be implemented and administered.

(B) Contract Negotiations and Monitoring - Throughout the life of the project a number of contracts may be required for data collection. The effectiveness of the individual studies should be monitored and evaluated.

(C) Decision Making and Approval Mechanisms - Particularly in the case of salvage archaeological projects there is a necessity for assessment and approval of studies, making decisions on releasing certain areas from further archaeological studies, approving excavation requirements or deciding against necessity for excavation. Decisions of this nature on the public resource should be made by a formal body, an Advisory Committee. Membership on this committee should be by appointment from the AOSERP. Sufficient information and appropriate recommendations must be available on which a decision might be made. Approval of standards and archaeological methods should be made by the ASA.

(D) Monitoring and Supervision of Development Impact Studies - Under this research design the developing agency (industry or government) must have prepared a preliminary estimate of impact on archaeological resources, with a plan for protection or recovery of those resources. In the plan are a number of phases of survey, excavation and surveillance, all the direct responsibilities of the developer. Under this design these archaeological activities and the related development activities will have to be monitored by the ASA.

(E) Progress Reports - Yearly progress and status reports would be required for the archaeological project and would be prepared by the ASA under this administrative responsibility.

(F) Reports, Inventory and Artifact Repository - A substantial responsibility of many archaeological studies is to make the data available in full to the archaeological community. Normally this is done by a series of site reports containing much of the data recovered in the study. The total recovered data will be stored in the data management systems, and the archaeological community including those working under the developing agencies should have free access to the system. Reports would be necessary to describe the analysis and interpretation of the data from any particular study or to provide a synthesis of a number of studies.

The artifacts, records, photographs, inventory, etc., would be the responsibility of the ASA. Facilities and equipment would be necessary to support that responsibility.

(G) Public Participation - In many parts of Canada and the world there has been a trend toward increasing the level of public participation in development, but more often in making the public more aware of the fact of development and reporting to the public on the impact of development. The usual professional or archaeological reports are of little value in this respect, being produced for other experts in the field or for a small audience of interested para-professionals. For a program such as the archaeological project under AOSERP, a series of popular pamphlets would suitably familiarize the interested people of the area and Alberta on the progress of archaeological knowledge through the project and the efforts taken to safeguard that resource.

The following are Coordination Systems required :

(A) Interpretive Studies - To meet the overall goals of the project, and to integrate the results with those of the Human Environment Technical Committee, a series of interpretive reports will be necessary. These should be prepared by the ASA, or under contract to that branch; one at the completion of the Research Framework Section, the other at the end of year five, the final report at the end of year ten.

(B) Data Management System - The value of a computer-based archaeological data handling system for the project is difficult to assess. An effective and useful system would be costly and time consuming to develop but would of great long-term value. A file-based system could more easily be developed and implemented, but would be less effective as the quantity of data increases ; yet it is precisely then that a good system would be required. The value to any system depends on accurate implementation early in the program. The system should be developed by the ASA in cooperation with the Population Research Laboratory at the University of Alberta or the Alberta Bureau of Statistics, whichever has the greater capability for such an assignment.

The data management system must serve two main purposes : first , serve as an inventory and repository for all archaeological data, and second , to provide for manipulation of that data into the main theoretical predictive tool for the location of archaeological sites and therefore the evaluation of any given lease or section for its archaeological potential. The data matrix should initially be derived from the preliminary data framework studies and updated with relevant data recovered during the various later studies throughout the life of the project. The matrix variables should be designed to reconstruct environmental change and terrain development through time and correlate that to the change in the manner and character of human utilization. Required will be studies on terrain, environments and resources, paleoenvironments, ethnography, history and prehistory as a base with feedback from subsequent archaeological studies of this project and biophysical studies from AOSERP. The resulting matrix should systematize the relationship between man and the environments as they change through time. All that would be required would be a local environment and terrain history description for a researcher to make an estimate of site probability and discoverability. The matrix is based on the theoretical premise that there are certain critical factors or factors in any given environment for a given human ecological adaptation that will constrain man's utilization of that environment. Knowing those constraints and the effect of any given adaptive strategy, it should be possible to predict site location with good statistical accuracy. Certain factors in some environments provide high probability localizers for some activities ; for example , one very common localizing factor for human groups depending seasonally on fish are fish habits and drainage patterns. It is almost certain that fish had been an important seasonal factor at least in the late prehistoric period.

The data matrix should span the time from the post-glacial period to the historic period. Many of the factors influencing location of historic and prehistoric sites are similar, and include transportation, communications, accessibility to fur-bearing mammals, presence of trapping peoples, accessibility to food resources ; firewood , water and shelter being secondary. It is important that the data collected for the matrix be accurate, complete and systematic. Data collection criteria and guidelines should be set by the Program Development Systems. As with any information system, its value lies in accuracy, completeness and relevance ; the development of the matrix must be done by experienced, professional archaeologists of the ASA.

The following are the Program Development Systems required :

(A) Data Criteria and Standards - Fundamental to the effectiveness of the project is a suitable and consistent standard of accuracy and completeness of data being collected with a consistent site nomenclature, description and analysis. A standard form of data collection with explicit guidelines on its application should be a prerequisite for any further fieldwork and would be required for the baseline data collection.

(B) Approval of Studies - At certain points in the Development Impact Studies for the development agencies, evaluation of the work will be necessary. The preliminary estimates of impact on archaeological resources and the related salvage plans must be assessed and approved or rejected. Adequacy of survey will have to be evaluated and perhaps some monitoring done. Decisions must be made on which sites warrant excavation, or further testing or preservation. As time goes on and the prehistoric record becomes more clear, it would be expected that more can be abandoned, but in the meantime care and judgment must be exercised.

(C) Development, Terrain and Site Potential Classifications Systems - The great range of development activities will cover nearly an equal range of potential impact sequences. The developmental activities should be classified according to the degree and schedule of terrain disruption and this taxonomy used with the estimates of development impact and the related salvage plans.

In evaluation of any given area for potential impact on archaeological resources some estimate of site probability must be made. The data matrix will form the basis of that estimate but will require a classification system to make it useful and interpretable. Any given area will contain a variety of terrains with various potentials dependent upon a complex of variables. The scheme proposed by Sims (1975) would make a good point of departure, but the diachronic aspect included in the data matrix should be reflected in the system.

A second and equally important set of variables in the matter of archaeological survey is the discoverability of the sites in an area ; therefore history of the terrain classification is needed to indicate the anticipated survey problems in an area. The site discoverability has some further implications when the area has been cleared and partially stripped of organic cover. If such an area were in or had been in an area of active deposition, it would be expected that sites occupied prior to the sedimentation would be left intact, but buried. The discoverability of site is a function of its age, the local terrain history subsequent to occupation, as well as size and of course recent human history .

A terrain classification system will be a prerequisite for both the site probability and discoverability systems, as well as being essential to the evaluation of the area. The data entry into the data matrix will have to be the modern terrain characteristics, followed by modern and ancient environments where available. Again, the proposed variables used by Sims (1975) should be a suitable point of departure for a more sophisticated design.

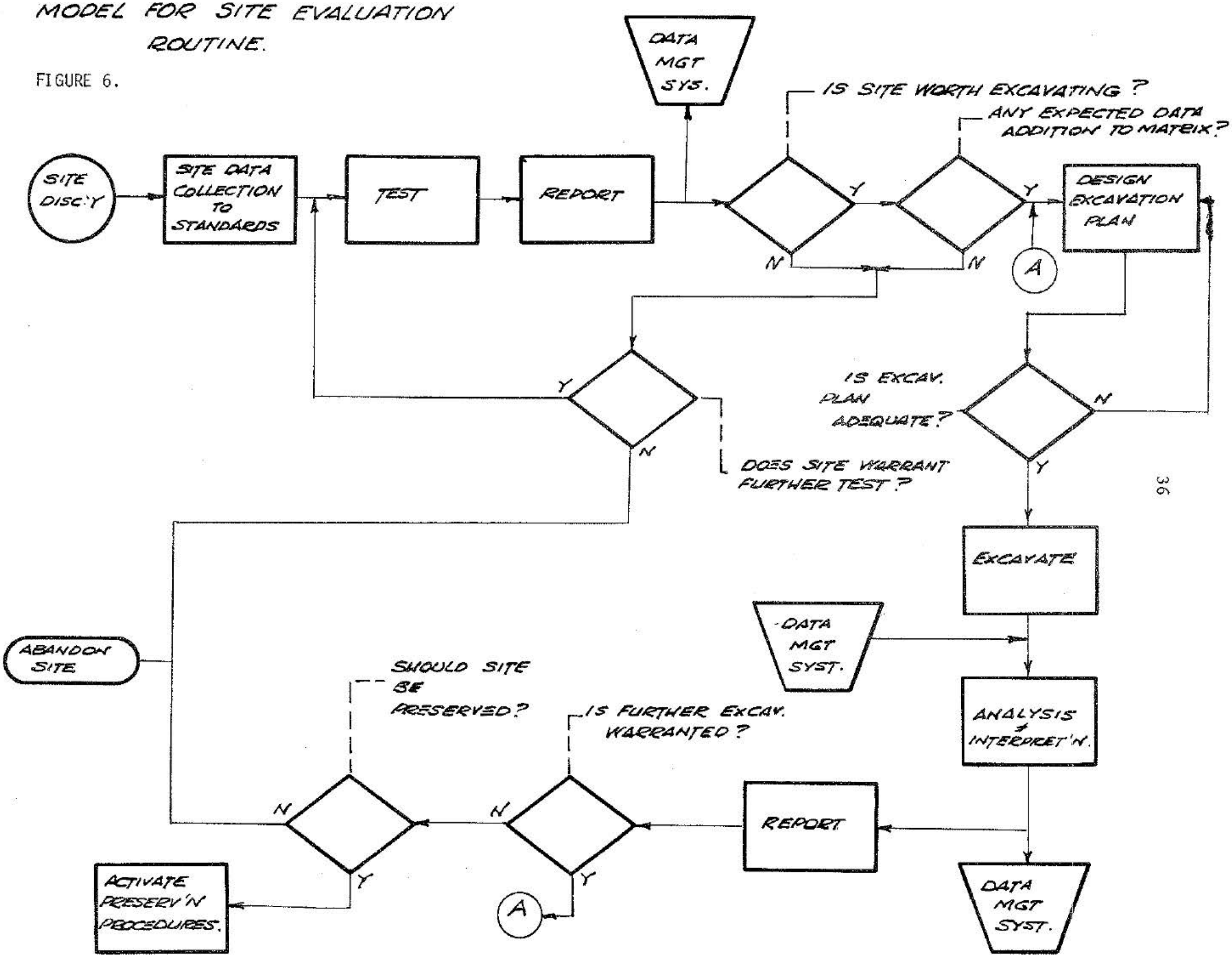
(D) Experimental Archaeology - There are a number of possible techniques that might be explored as improvements or attractive supplements to present survey and site testing techniques. While many of recently developed techniques are clearly of very low potential for site discovery in this part of the Boreal Forest, the following warrant experimentation as having some real possibilities of modest cost :

(i) Methodology of survey : Various methods and routines of survey should be systematized and tested.

(ii) Drilling : Core augering or drilling with light equipment to test for buried occupation floors, through chemical changes in phosphorus due to occupations, cultural debris or magnetic susceptibility. Such a method could be very valuable in areas of high site probability but in low discoverability terrains ; or it

MODEL FOR SITE EVALUATION ROUTINE.

FIGURE 6.



could be used to test possible superimposed sites; or as a method of delimiting sites for testing or excavation. It could offer increased efficiency in the use of funds and time.

(iii) Remote sensing : On the basis of recent work the value of remote sensing in directing archaeological survey is restricted to low-level sensing surveys in certain areas with adequate testing and ground truthing. However, the method does offer excellent potential for terrain and environmental mapping. The method also is being used by the development of the oil sands operations for plant and mine layout. It would be well worth training an archaeologist in interpretation of the data for this purpose.

(iv) Air photo analysis : Complete air photo coverage on a range of scales should be assembled for the AOSERP area. The sets should be updated with the local surveys that are being flown by the government or developing companies. With the remote sensing data they are valuable for mapping terrain. Some experimentation in predicting site probability should be done with these data, comparing the results with those derived from analysis of the matrix and later from ground survey.

(E) Training Program for Archaeological Assistants - In many parts of the north the most effective archaeological surveyors are northern native peoples who have been trained and have been given experience in the field. The work proves to be interesting and is in a familiar environment. A training program for native northerners could well serve to develop a core group of expert experienced archaeological surveyors from which some might well go on to professional careers.

(F) Site Evaluation Routine - The object of the archaeological study is to identify and inventory the archaeological resources of the AOSERP area and to recover relevant information. The majority of archaeological evidence is stored in 'sites' of one kind or another. The discovery of a site should then trigger a special action or evaluation routine.

(i) Collection of site data : Follow the standard date requirement developed for the project (Guide to Archaeological Site Inventory Data Form - ASA).

(ii) Test : Follow methodological procedures developed and standard archaeological practice.

(iii) Decision concerning excavation : Depending on the results of the tests, the status of the data matrix and the potential contribution of the site excavation. Decision alternatives : further test, excavate or abandon.

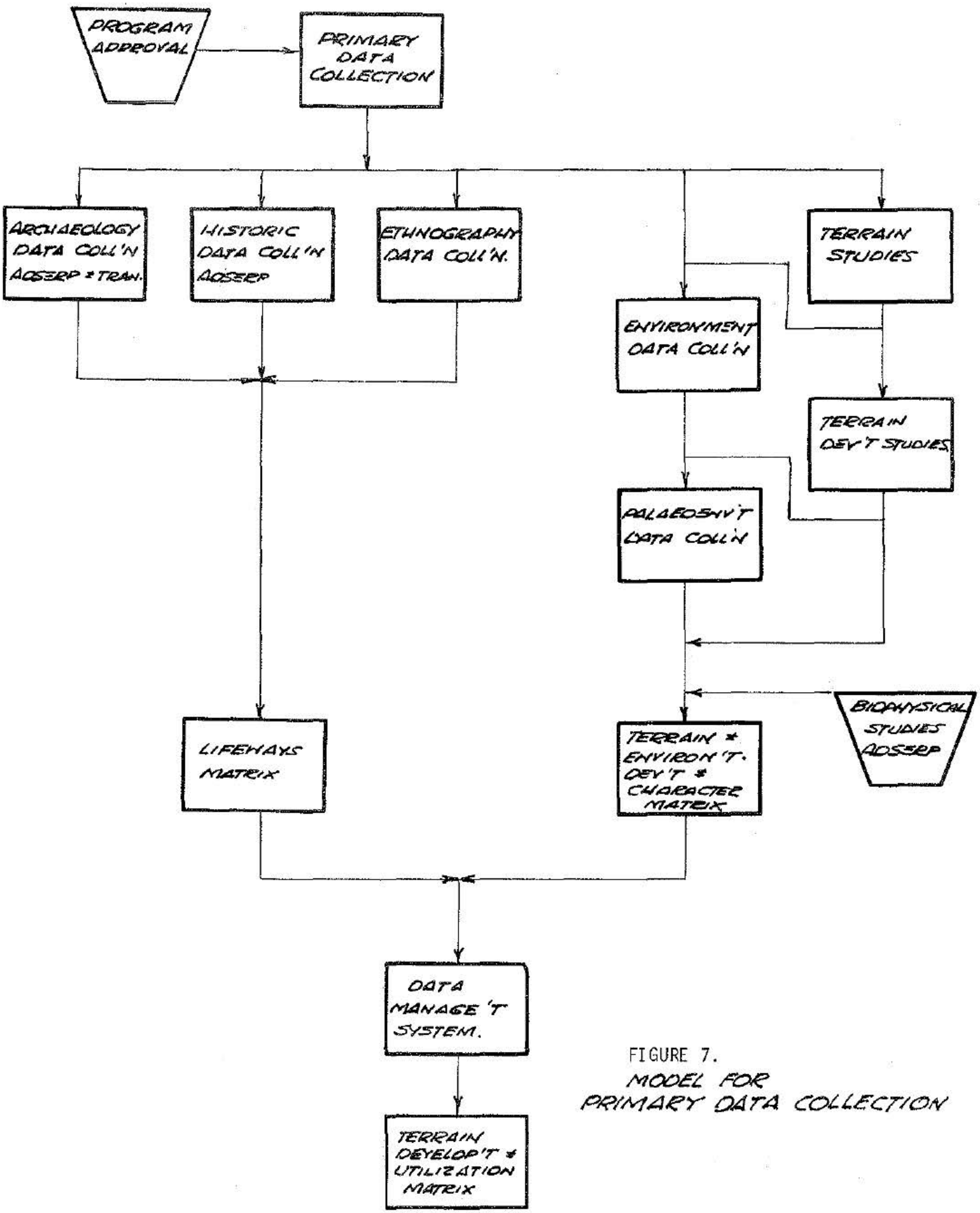


FIGURE 7.
MODEL FOR PRIMARY DATA COLLECTION

(iv) Design excavation program.

(v) Decision concerning preservation or abandonment. A few sites in strategic locations might be designated as Heritage Sites for preservation under Alberta Heritage Act.

4.6.2 Research Framework Section - To provide preliminary input for the data matrix two series of studies will be required : the first, Primary Data Collection is a library resource study and the second, the Field Data Collection is a set of sampling programs.

(A) Primary Data Collection - Complete available information is required on the biophysical environment and cultural history. Studies should commence immediately as high priority in the following areas :

(i) Biophysical environment : Survey of published information on the environment, the terrain and the resources of the area as they were important to prehistoric man and the early travellers and traders. Studies into the biophysical environment will be carried out under AOSERP and should be included as source material. The scope of the search should involve the AOSERP area and both the ethnographic and archaeological transect.

(ii) Terrain studies : Analysis of terrain in the AOSERP area on a broad scale with provision for ground truthing under the Field Data Collection. The regional terrain description must be fairly gross by necessity, but it should be suitable for finer definition as the studies become more localized and area specific. The important processes are sedimentary and periglacial, dominated by glaciation and post-glacial ice-evacuation phenomena, ice-front lakes, outwash and outwash reworking ; river , stream and aeolian erosion and sedimentation, slopewash as alluviation, and lacustrine shore action erosion and reworking.

(iii) Palaeoenvironment and terrain development studies : Survey and study of work in the AOSERP and in both transects.

(iv) Ethnographic studies : Survey and study of published and available data on the historic and recent lifeways of the people in the area and both transects, particularly their use of the terrain and environment, Sources would include ethnographic works , missionary reports, historic journals, etc.

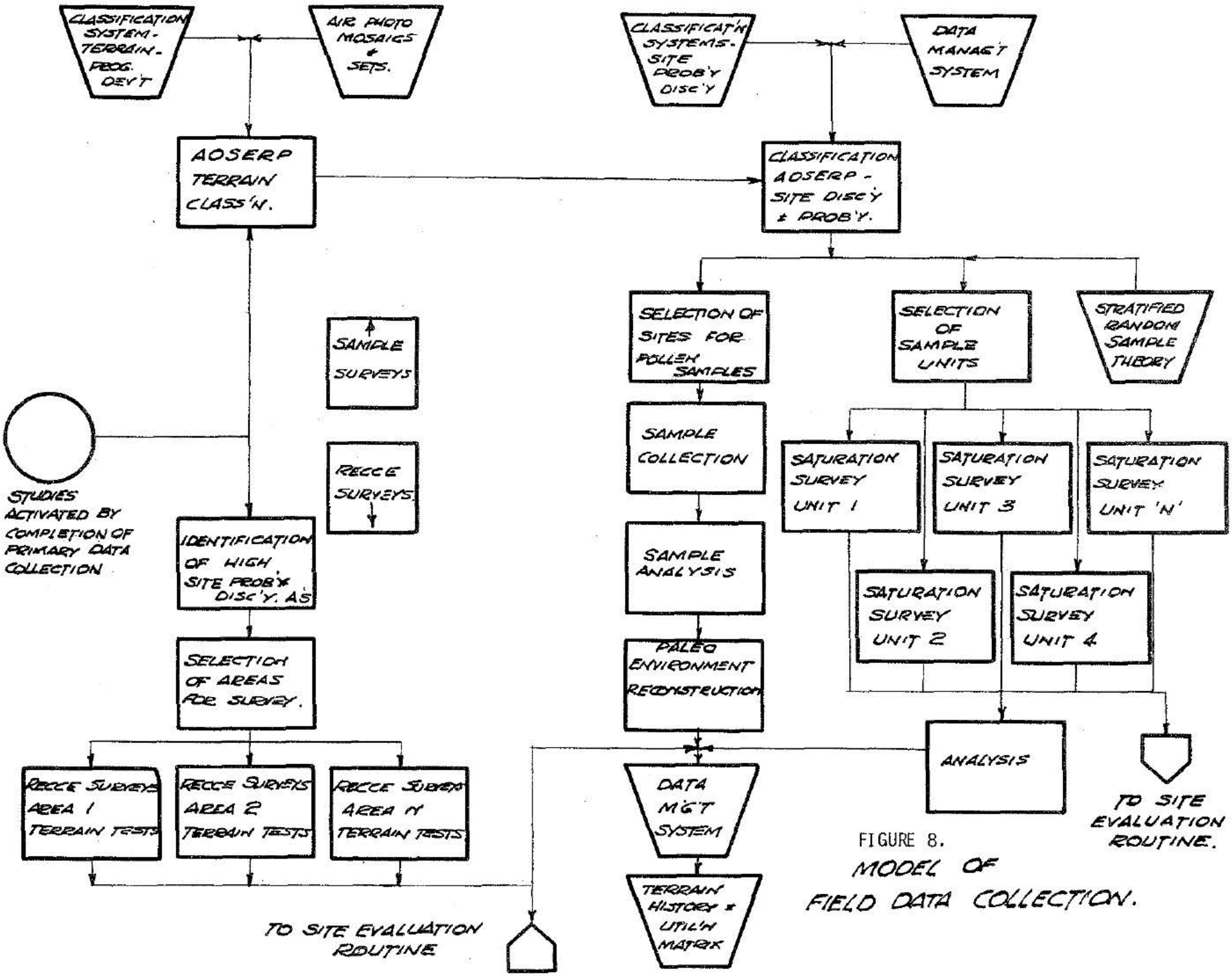


FIGURE 8.
MODEL OF FIELD DATA COLLECTION.

(v) Historic studies : Survey and study of historic journal records in the utilization pattern of the area during the fur trade era. Studies should extend into the ethnographic transect.

(vi) Archaeological studies: Survey and study of prehistoric archaeological work and publications in the AOSERP and both transect areas. Study should provide a cultural chronological framework and temporarily changing utilization patterns as input for the data matrix.

(B) Field Data Collection - to fill out each of the archaeological data components for the interpretive framework and the data matrix a set of surveys will be required.

The initial archaeological survey of a portion of the Boreal Forest is practically never effective as familiarity with a region is an absolute necessity. Development of a good data matrix will correct some of the problem but only if the data is practical and tested. Surface traces of sites in the virgin forest are rare, except on some naturally exposed surfaces, such as a stream cut or beach, or activity-exposed bulldozer cuts, roads, clearing, etc. A survey which depends on such exposures will find sites but the kinds of sites will be biased by those locations. Haphazard testing is better, but still is inevitably influenced by the experience of the surveyor. For both reconnaissance and stratified sampling surveys, the results are only as good as the coverage of the survey. For this data gathering and classification-testing stage of survey then, a saturation coverage of smaller areas is necessary to insure as unbiased a result as possible.

(i) Reconnaissance surveys : In the AOSERP area there are several obvious high priority areas that should be surveyed and sites excavated to provide the interpretive framework necessary for effective evaluation of areas and sites. While it would be possible to accomplish the same thing through many sampling surveys and those accompanying the Development Impact Studies, it would be time-consuming and costly. In addition, the high priority areas are usually areas that are now attractive to development and to recreation and will thus be susceptible to destruction at some time in the near future. This study actually commenced last summer by the ASA with the reconnaissance survey of the Namur-Gardiner Lake System. Areas such as this should be identified from the results of the Primary Data Collection and surveyed by small mobile crews with follow-up excavation, specifically for data to supplement the data management system and matrix.

(ii) Palaeoenvironmental data collection : There are no data on the terminal Pleistocene geochronology or subsequent environmental change for the AOSERP area. From the terrain studies in the Primary Data Collection, areas for ground truthing should include areas that might be examined for pollen cores to produce a more reliable palaeoenvironmental framework.

(iii) Sampling surveys : The Primary Data Collection studies will provide the initial input into the data management system and matrix from which hypotheses can be made on the human ecology as it changed through time. To test these hypotheses it is proposed that a series of sampling surveys will thoroughly examine a variety of terrain types. The total AOSERP area will have been classified as to gross terrain character. On the basis of that classification the various types of terrain should be divided into units and random sampled for selected units for saturated surveying. Care should be taken to thoroughly survey every part of each unit selected. By this stratified sampling program the original hypothesis can be amended and some relative estimates of site densities can be made.

(iv) Ethnographic data collection : There is a wealth of data on ethnographic lifeways in the memories of the older people. In companion projects under the Human Environment Technical Committee some of this information will be collected, hopefully by training local people in such investigations. This data would be a valuable supplement to ethnographical and historical sources as input to the data systems and matrix.

4.6.3 Development Impact Section - It has been estimated that Syncrude Canada Ltd. will pretty well disturb some 20,000 acres of existing terrain, obscure another 4,500 acres with tailings and cause some levels of disturbance to another 2,000 acres. The figures for GCOS are somewhat less but each additional plant installed can be expected to approach these. On the basis of the surveys carried out to date a very tentative site density figure could be calculated. However, the figure should be used with considerable caution for several reasons. It is an understandable and accepted fact that an initial survey in a region, with no good data base, without a personal familiarity with the area and with nothing more than the present terrain as a guide, can only be moderately productive. Any figure for site density at this stage will undoubtedly be very low. The following site density figures are offered as illustration only.

Source	Area	Survey Type	Estimated site Density per square mile	Number of sites Expected in Operation area and plant
Losey et al 1975	Secondary road 963 near Fort MacKay	Reconnaissance after clearing	0.25	4.5
Syncrude 1973-4	Lease No. 17	Saturation survey of priorized lease area 88 square miles	0.32	5.8
Sims 1975	Lease No. 13 (Shell)	Saturation survey of priorized lease area 7289 square miles	0.65	11.7

These data show the increasing productivity of the surveys with experience and background data. The results of the road survey also show the effects of excessive geographical constraints. A comparison with experience northwest of the AOSERP area might give another dimension to the problem of productivity. The first year of survey in the Fisherman Lake Valley resulted in discovery of 3 sites (MacNeish, 1951), the second year in the discovery of 12 sites, in the last year of six years of survey the discovery of 48 sites.

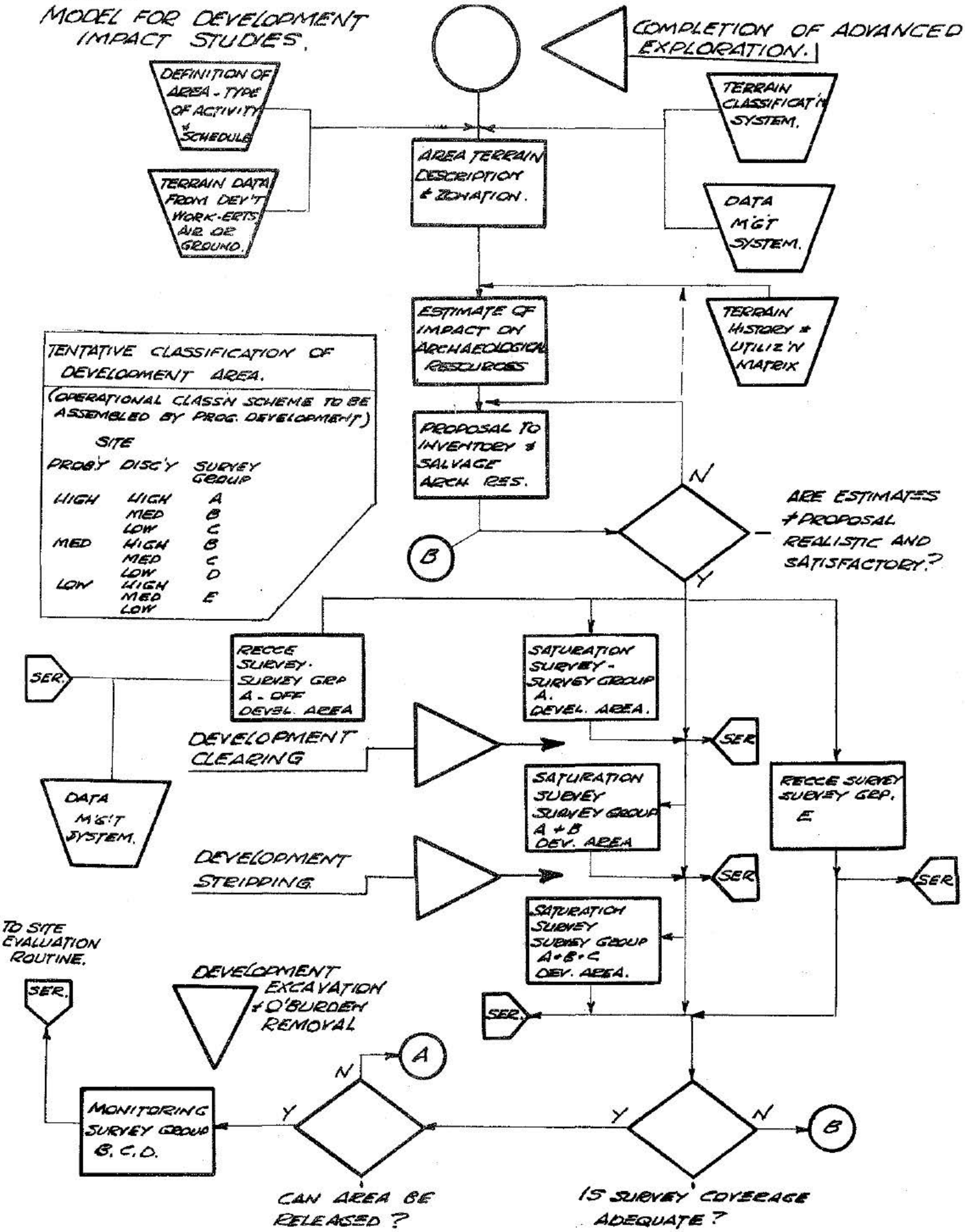
The potential loss of archaeological evidence can be partly avoided by implementing a program of estimating impact, inventorying sites, excavation of sites, analysis and interpretation. With the satisfactory completion of the preceding sections of the project the tools for this program would be available.

The keys to effective archaeological salvage lie in a professional study, designed with full cognizance of the development activity and schedule, and with coordination between the development activities and the archaeological study. It should be activated by the decision of the developing agency to continue with the development. Most resource developments and construction projects of this type are such that decisions are made sequentially. Such developments as the GCOS, the municipality of Fort McMurray, the northeast highway program, should be required to commence an assessment of past and potential archaeological impact. Various scopes of development will require some modification of this basic system.

The area type of activity and schedules should be defined as the basis for the study. An air photo terrain analysis should be carried out using

FIGURE 9.

MODEL FOR DEVELOPMENT IMPACT STUDIES.



available remote sensing 'pictures', topographic, terrain studies, soils, geology and other biophysical information. On the basis of that local terrain study correlated with the regional matrix from the data management system, the area should be classified into different site possibility and discoverability zones (Program Development System). This will provide an estimate as to the potential impact of development on the archaeological resources. The resulting statement should be approved by the ASA.

The following study plan for an oil sand surface mining development is offered as a model ; other developments will require a modification of this plan.

Before or during the advanced exploration phase, in any case before clearing, the area should be given a preliminary survey, concentrating in the high probability areas of high discoverability sites, again based on the data matrix. Following the clearing operations and prior to stripping the organic layer, surveys of high and medium site probability areas should be undertaken for all ranges of discoverability. The stripping operations should be monitored and followed by intensive survey of the high probability -- low discoverability areas. Adequacy of all surveys should be monitored before overburden removal starts. During the overburden removal and mining operations, the excavation should be monitored and provision be made for emergency excavation should anything be found during mining.

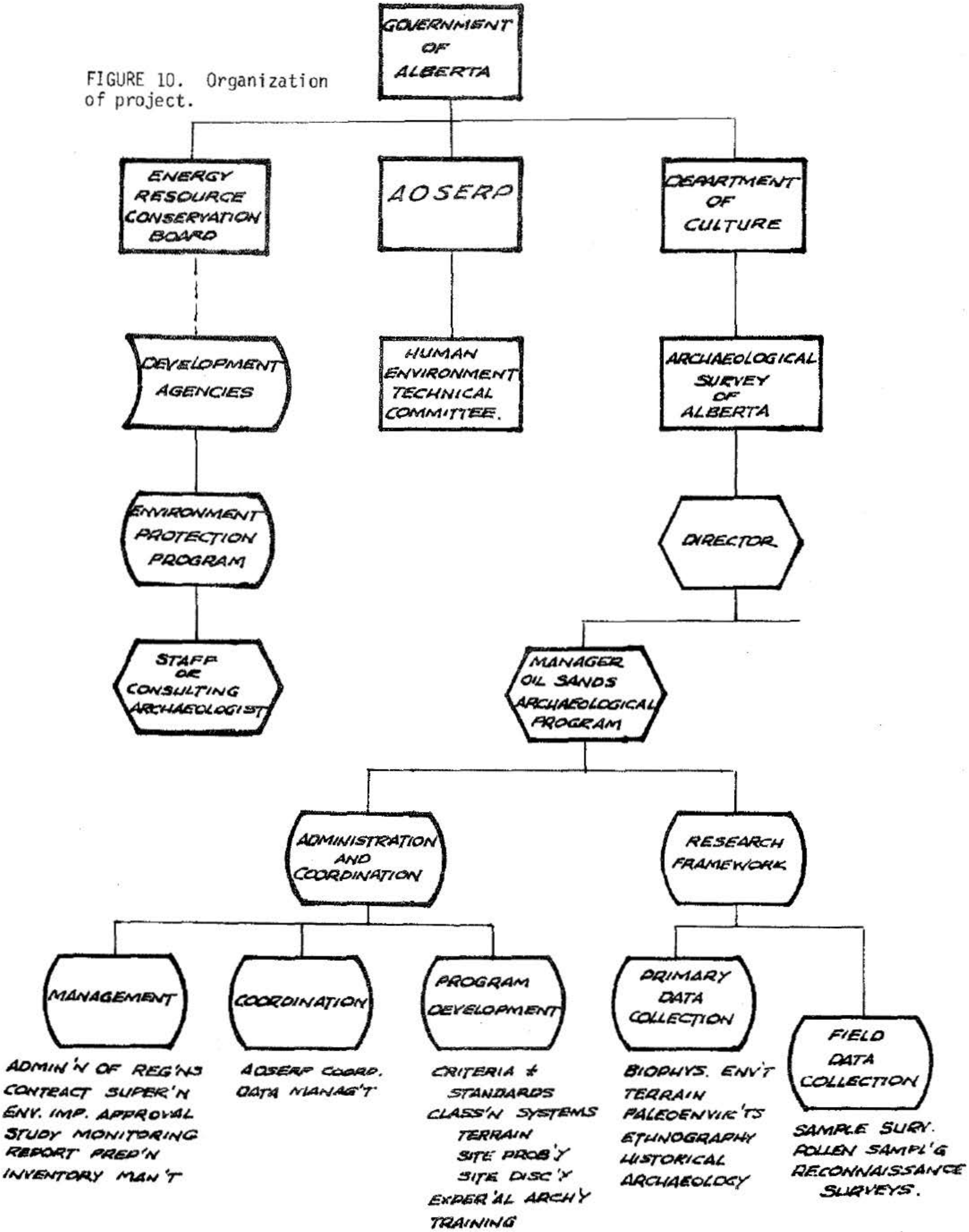
4.7 Organization of Project

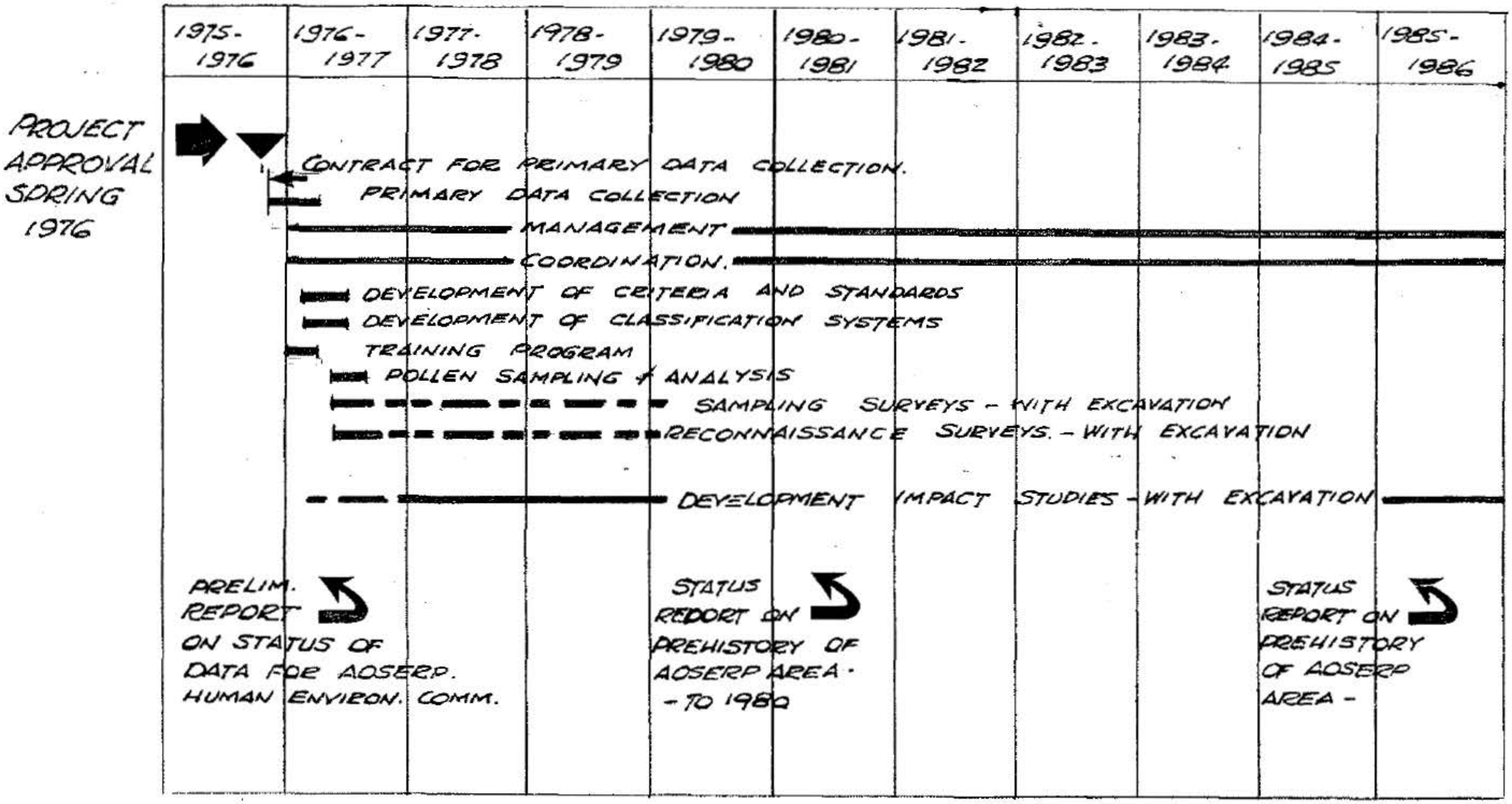
The project comes under the overall jurisdiction of the Alberta Oil Sands Environmental Research Program, administrated and coordinated through the Human Environment Technical Committee. The studies fall naturally into the area of concern and responsibility of the Archaeological Survey of Alberta which has achieved an excellent level of activity in two short years of its existence. The operational responsibilities should lie with the ASA which will require a staff supplement for the terms of the project.

The developing agencies should be required to satisfy the requirements as outlined in this Research Design either to obtain the development permit from ERCB (Energy Resources Conservation Board) or under the Development and Reclamation Review Committee.

The Advisory Committee to the project could be formed as the systems are developed, but should be appointed by the AOSERP, perhaps by the Steering Committee. Members might be appointed to represent industry, the local area, the native people, the Archaeological Society of Alberta and the archaeological profession.

FIGURE 10. Organization of project.





PROJECT SCHEDULE

FIGURE 11.

A site found at any stage should be referred to the site evaluation subroutine and all data should be forwarded immediately to the data management system.

4.8 Schedule

Under ideal conditions the project should be sequential through from the organization to the development of the research framework and followed by development impact studies. Since development cannot and will not wait for this ideal situation, it will be necessary to install the necessary management staff to develop the systems matrix and contract the primary data collections as soon as possible. These components should be operational well before the beginning of the 1976 field season. As funds already have been appropriated these studies could be implemented early in 1976. It is most important that the collection of field data for the data matrix commence during the summer of 1976 as a minimum of three field seasons will be necessary for that subsection. As development is underway the preliminary archaeological impact assessment should be required of all developers as soon as they can be implemented.

4.9 Methodology

Standard archaeological methodology should be used throughout the project, except where experimentation and testing develop special techniques or methods approved by the ASA. It should be noted that salvage archaeological survey projects demand more care and precision than normal. When dealing with decisions regarding possible destruction of archaeological sites, it is absolutely essential that the best techniques are employed and the results are precisely and thoroughly assessed. The results must be open to public scrutiny and audit.

The metric system should be used for all permanent records and reports. Site nomenclature should be standardized by the ASA, but might follow the present practice of having a field site number with a prefix indicating the development unit and a sequential number for the sites discovered. The Borden number should continue to be assigned by the ASA. Reconnaissance and sampling surveys could be identified by some geographical feature with sequential numbers. Often it is advisable to add the year of the initial discovery, using the final two digits.

Since the site data is to be digitized for data handling and much of the data will be used for the matrix, the descriptive information and details should be accurately and completely reported according to the requirements as laid out by the ASA (section 4.6.1 Program Development System A). In addition, sites should be accurately located relative to a labelled geographic or other recognizable feature.

Complete photo files should be maintained and coded for recovery through the data management system.

Standards and recommended methodologies will be designed by the Project Development Section to guide survey, testing and excavation work ; obviously experience and practice will require amendments. Periodically emergency excavation will be required for some of the sites located during the development activity. To preclude holdup or loss, arrangements for an available crew will have to be made and the excavation key personnel would probably have to be carried by the ASA.

Survey crews should be mobile, well-equipped and independent, not dependent on external or shared transportation facilities. The geographical boundaries for surveys should be clear and definite, and all of the office work should be completed before the crew goes into the field. Feedback from the field should be periodic during the field season to ensure maximum effectiveness in survey and site evaluation. Office facilities and staff should be prepared to coordinate the field activities with the development activities, with the data management systems, and with all approvals and site decisions, again to ensure maximum effectiveness and efficiency.

Regarding survey methodology, the surveys for the first few years should be designed partly to test the matrix and to provide amendments where necessary. These surveys should include periodic sample testing of the low probability and discoverability areas to test the classifications.

In recognition of the need for future estimating the ASA should request an accounting system designed to provide job costs in addition to the usual global financial statements.

4.10 Reports and Communication

Primary Data Collection Studies should provide only the total bibliography with the raw data ready for digitization or other data management system. Total final reports in the normal sense should be unnecessary.

Field Data Collection Studies should have a preconceived final progress reporting procedure and should produce full, final reports with the complete raw data ready for digitization.

All Development Impact Studies should produce data reports after the field work containing raw data for the data management system. Formal reports including interpretation could be published by AOSERP or the developing agency, but the policy should be set formally.

Prompt completion and submission of final study reports should be encouraged by a consistent, realistic, but non-punitive policy.

Annual summary reports of the status of archaeological studies will be required to follow the usual government requirements and schedules.

A series of formal interpretative reports on archaeological studies will be required periodically. A report should be prepared on the status of archaeological and human lifeways status at the end of the Primary Data Collection Studies. An interim status report will be required at the end of March 1980, and a final report at the end of March 1985. These should be prepared by the manager of the archaeological research project under AOSERP with the assistance of the ASA staff.

4.11 Personnel

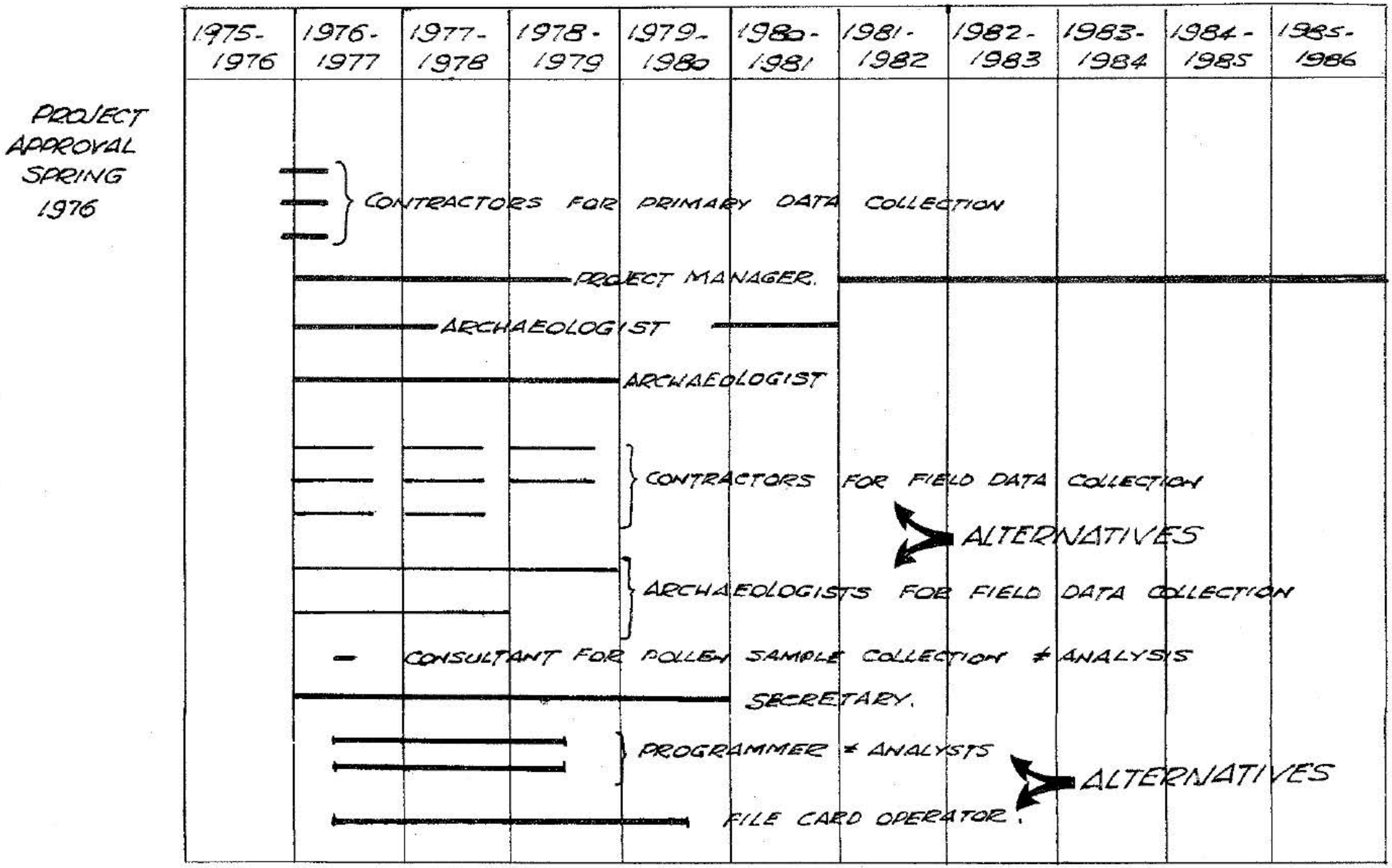
The administration, development and monitoring responsibilities of the project will require a full time staff during the life of the project and perhaps at a reduced scale, beyond that time. This staff requirement will vary in size through the period from a maximum of three to a minimum of one. Further, this Research Design provides for two procedural options, each of which will have a bearing on the personnel required. All of these positions should be assigned to the ASA.

A fundamental need will be for a project manager to act under the general guidance of the Director of the ASA. It will be the manager's reponsibility to coordinate the activities of this project with the ASA, AOSERP and the developers. The manager will prepare all the project reports, negotiate with contractors (archaeological), coordinate the studies carried out under the project, supervise and guide the activities of the Program Development Section and the Research Framework Studies. This position should be full time and continue until the termination of the project. The status of the studies and developments in five or ten years should determine whether the position should be continued for a further term.

Two additional full time positions should be established to take responsibility for each of the Program Development Section and the Research Framework Studies. They would work under the supervision of the Project Manager and would be responsible for carrying out the activities or , in turn, supervising contractors or other personnel in carrying out these responsibilities. All of these positions should be open-opportunity and held by professional archaeologists.

The Primary Data Collection should be contracted to capable researchers. This should allow an early start on this high-priority set of studies. Three contracts should be sufficient and about three months full-time work should be sufficient to accumulate the required information in the necessary form for the purpose. The professional archaeologists that have worked in the area over the past few years have demonstrated their ability, have already assembled some of the data required and have acquired an irreplaceable familiarity with the area.

FIGURE 12. PERSONNEL REQUIREMENTS



Over the project period there will be an increasing need for monitoring of the development activities. It is suggested that this be the responsibility, first, of all the staff of the project and second, of the staff of ASA, when available.

In addition to the above responsibilities there are two sets that require further decisions, the first, the form of data management system, and the second, the way the field data is collected.

That some form of data management system is necessary should be unquestionable, but there are two broad possibilities, computer based or cross reference file based. In addition to the cost of data handling the computer based system will require two fairly expensive program-analysts, one of whom would be well to have archaeological training. Their appointment would be required for two and a half years, and the archaeologically trained individual could well be required to continue, in training the staff of the project and ASA in the use of the system. The cross reference file alternative would require an experienced file clerk or archaeologist trained in data management, but would be required over the life of the project.

The field data collection surveys could be done by contactors supervised by a staff appointment or by three staff appointments. As the surveys are scheduled for only three field seasons, the difference in total cost is expected to be negligible and there are considerable benefits in having full-time appointments to assist in the Program Development Section, the development study monitoring, the development of the systems. Three full-time appointments would be necessary for the first two years, with two during the last.

A full-time secretary is a necessity for the first three years of the project ; following which the project requirements would fit into those of the ASA.

The following tabulation shows the total recommended staff addition, while the budget shows the effect of all alternatives , with that recommended.

Tabulation of Personnel Requirements

Position	Class'n	Level	Period	Salary Range
Manager	Research Officer		March 1976-1985	14,604 - 19,430
Archaeological Assistants	Assistant Research Officer		1976-1979	10,836 - 13,932
Field Assistant	Museum Aide	II or III	1976-1978	8,484 - 10,836
Program Analysts	Program Analysts			
Secretary	Clerk Typist	III	1976-1979	7,500 - 8,000

In addition there will be a need for field assistants, usually students, hired by the month and for the field season. The training program for archaeological work should provide a trained group of northerners familiar with the country. They should be given employment preference where possible. A critical shortage of trained, experienced archaeological workers and professionals is a danger if such a project as the Canadian Arctic Gas System Ltd. pipeline were to be constructed. With the Alyeska work, Mackenzie highway and the pipelines it could be impossible to employ an experienced archaeological worker.

4.12 Equipment

Normal office furnishings for a staff of seven or nine will be required depending on the data management option. Whether the field data collection is done under contract or by staff, about equivalent office equipment will be necessary. Microscopes and other tools of analysis should be available from the ASA. Special cabinets will be required for storage of collections and the need for additional capacity will continue throughout the project and probably beyond it.

Each field crew should be supplied with a full set of field equipment appropriate to the requirement of a particular survey or excavation. Where practical, use of company camp facilities might be considered , but experience has proven it less expensive and more effective if the archaeological crew is equipped for camping or trailer-living.

Each field crew should be equipped with adequate photographic equipment (two cameras, tripod, variety of lenses, filters, dust proof covers and replacement parts). Compasses of the Brunton type, and dictation recording equipment should be standard equipment for each crew.

Transportation equipment should include a full-time four-wheel drive vehicle for the first three years of the project. This will serve for winter transportation on monitoring assignments, town transportation, for mobilizing and demobilizing crews and for emergency excavation transportation. For summer survey, vehicles should be available for the field season when necessary. Canoes, aircraft charters, or river boats will occasionally be necessary, as well.

4.13 Facilities

It would be advantageous if the field crews or the monitor archaeologists had a central base in Fort McMurray. If AOSERP were to open an office in the town, one room could be assigned to the archaeological program for the field season, at least.

The following tabulation summarizes the space requirements in the Edmonton offices of the ASA :

	1	200 sq. ft.	1976-1985
Office	2	200 sq. ft.	1976-1979
	5 or 7	150 sq. ft.	1976-1978
Laboratory		550-600 sq. ft.	1976-1980
		300-400 sq. ft.	1981-1985
Artifact Storage		200 sq. ft.	1976-1978
		300 sq. ft.	1978-1980
		400 sq. ft.	1980-1985
Equipment Storage		300 sq. ft.	1976-1985

4.14 Field Logistics

The field studies are planned for the seasons of 1976 through to 1979, three the first and second years and two for the third. Budget estimates for these studies are at best approximate and it is only practical to make an allowance for the work, whether it be done by staff or under contract. Arbitrarily a field crew will be allotted 12 man months of time in addition to the supervisor for the three field seasons. That should include mobilization and demobilization times.

The field logistics for the impact surveys and salvage excavation, including emergency work, will be the responsibility of the developing agency.

4.15 Budget

While this design covers the entire archaeological recovery project there are clearly two areas of fiscal responsibility. Where government is considered responsible for assembling background data, administration and monitoring, the developing agencies should be required to appraise, protect and salvage the archaeological resource of the areas under the terrain to be disturbed. The first might be referred to as fixed cost of the project which can be estimated to some degree of accuracy and can be treated as a term project. The latter is more difficult to estimate as costs will vary with location, size of area , site density and importance, timing, etc. These might be thought of as variable costs and are not included in the following budget estimates. Further, they will likely continue in some modified form throughout the life of the mining operations.

The budget provides year by year costs of the project as designed and any change of that design will obviously affect the budget estimates. The costs are totalled for termination at the end of five years and again at the end of ten. The estimates for the Administration and Coordination section, which would be reduced to a single position after the spring of 1979, and the Research Framework Section that is expected to be completed by the spring of 1979, are given.

The Research Design suggests several options for implementation ; namely, data management methods and technology, and staff vs. contracts for field work. The effects of these alternatives are shown in the budget and budget summaries.

Costs are expressed in 1975 dollars and would require increases for inflation. An allowance has been made for the expenses of the Advisory Committee as the costs are difficult to estimate with accuracy.

Costs for consultants are included on allowance basis as actual costs are difficult to predict.

Field and field expenses for administrative staff and consultants are included as expense allowances per year. For the purposes of a calculation the mid-points of salary ranges were used.

4.15.1 Budget Breakdown per Item per Year

	1975-6	1976-7	1977-8	1978-9	1979-80	1980-1	1981-2	1982-3	1983-4	1984-5	1985-6	Totals
Capital items		$ 7,150	$ 1,500	$ 2,500	$ 1,000	$ 500	$ 300	$ 300	$ 300	$ 300	$ 300	$ 14,150
Administration & Coordination												
Salaries		$ 66,496	$ 66,496	$ 66,496	$39,040	$39,040	$22,040	$22,040	$22,040	$22,040	$22,040	$387,768
Office		11,900	11,900	11,900	2,850	2,850	2,850	2,850	2,850	2,850	2,850	55,650
Consultants		5,100	2,200	2,200	1,000	-	-	-	-	-	-	10,500
Publications Allowance		3,000	3,000	3,000	2,500	500	500	500	500	500	500	14,500
Training Co.		2,000	-	-	-	-	-	-	-	-	-	2,000
Research Framework												
Primary Data Collection	$9,066	18,132	-	-	-	-	-	-	-	-	-	27,198
Field Data Collection		75,929	78,629	49,481	-	-	-	-	-	-	-	204,039
Advisory Committee		3,000	3,000	3,000	1,500	-	-	-	-	-	-	10,500
Base Total Operating Cost	$9,066	$185,557	$165,225	$136,077	$46,890	$42,390	$25,390	$25,390	$25,390	$25,390	$25,390	$712,155
Computer Option		$ 40,056	$ 40,056	-	-	-	-	-	-	-	-	$ 80,112
File Option		11,419	11,419	$ 11,419	-	-	-	-	-	-	-	34,257
Staff Option		35,500	35,500	18,500	-	-	-	-	-	-	-	89,500
Contract Option		34,250	34,250	23,030	-	-	-	-	-	-	-	91,530

4.15.2 Total Summary - Capital and Operating Costs

	Man-Years	Personnel	Non-Personnel	Total
(i) Totals for 1975-76	0.25	$ 6,111	$ 2,955	$ 9,066
(ii) Totals for 1976-77				
Base Budget total (v)	7.5	111,172	81,535	192,707
Totals for Project -				
Computer & Staff	11.5	180,028	88,235	268,263
Computer & Contract	11.5	180,028	86,985	267,013
File & Staff	10.5	155,991	83,635	239,626
File & Contract	10.5	155,991	82,385	238,376
(iii) Totals for 1977-78				
Base Budget total (v)	7	98,950	67,775	166,725
Totals for Project -				
Computer & Staff	11	167,806	74,475	242,281
Computer & Contract	11	167,806	73,225	241,031
File & Staff	10	143,769	69,875	213,644
File & Contract	10	143,769	68,625	212,394
(iv) Totals for 1978-79				
Base Budget total	6	88,132	50,445	138,577
Totals for Project				
Computer & Staff	7	105,132	51,945	157,077
Computer & Contract	7.34	110,912	50,695	159,607
File & Staff	8	115,951	52,545	168,496
File & Contract	8.34	121,731	51,295	173,026
(v) Totals for 1979-80				
All alternatives	2	39,040	8,850	47,890
(vi) Totals for 1980-81	2	39,040	3,850	42,890
(vii) Totals for 1981-82	1	22,040	3,650	25,690
(viii) Totals for 1982-83	1	22,040	3,650	25,690
(ix) Totals for 1983-84	1	22,040	3,650	25,690
(x) Totals for 1984-85	1	22,040	3,650	25,690
(xi) Totals for 1985-86	1	22,040	3,650	25,690

4.15.3 Total Costs - Capital and Operating for all Options - 10 Years

	1975-6	1976-7	1977-8	1978-9	1979-80	1980-1	1981-2	1982-3	1983-4	1984-5	1985-6	Totals
Capital & Base	$9,066	$192,707	$166,725	$138,577	$47,890	$42,890	$25,690	$25,690	$25,690	$25,690	$25,690	
Computer & Staff Option		268,263	242,281	157,077	47,890	42,890	25,690	25,690	25,690	25,690	25,690	
Computer & Contract		261,013	241,031	159,607	47,890	42,890	25,690	25,690	25,690	25,690	25,690	
File & Staff		239,626	213,644	168,496	47,890	42,890	25,690	25,690	25,690	25,690	25,690	
File & Contract		238,376	212,394	173,026	47,890	42,890	25,690	25,690	25,690	25,690	25,690	

4.15.4 Unit Costs

(a) Salaries - yearly gross costs

Project Manager (Research Officer)	Salary	$17,000	
	WC, UIC, CP	2,040	
	Exp. Allow.	3,000	$22,040
Archaeologist (Assistant Research Officer)	Salary	$12,500	
	WC, UIC, CP	1,500	
	Exp. Allow.	3,000	17,000
Field Assistant (Museum Assistant)	Salary	$ 9,660	
	WC, UIC, CP	1,159	10,819
Programmer-Analyst	Salary	$15,560	
	WC, UIC, CP	1,868	17,428
Secretary (Clerk-Steno)	Salary	$ 9,336	
	WC, UIC, CP	1,120	10,456

(b) Primary Data Collection - monthly contract costs per researcher

	Personnel	Non-Personnel	Total
Salaries			
Research Officer	$1,837		
Secretarial	200		$2,037
Equipment - rental			
Recording & Transcribing		$50	
Typewriter		50	50
Office operation - rental (100 sq. ft.)		60	
Supplies		25	
Photography		30	
Photocopying		100	
Rent telephone and telex		50	265
Travel			
Transportation Alberta			
Saskatchewan			
Ottawa		200	
Expense Allowance		300	500
TOTAL	$2,037	$865	$2,902

(c) Field Data Collection - costs estimated per crew for 4 month field season - exclusive of crew supervision to all calculations for both options, staff or contract.

	Personnel	Non-Personnel	Total
Salaries -			
3 Field Assistants @ 108.9	$10,818		$10,818
Mobilization - Demobilization			
Alberta - assume average			
Calgary - AOSERP			
Transportation 4 @ 120		$ 480	
Expense Allowance - 3 days both ways - 1 1/2 days in Edmonton 4 men		480	960
Equipment - including			
replacement amount for capital items		150	
Field Equipment - camp		400	
Field Equipment - arch. for 4		200	750
Supplies -			
Camp fuel		100	
Camp food, etc. 4 @ 20/days, 30 days/month		9,600	
Office		70	
Air Photo		50	9,820
Rentals -			
Radio		300	300
Tel. & telex		300	300
Misc. - office and field operation		1,000	1,000
TOTAL	$10,818	$13,130	$23,948

4.15.5 Yearly Costs

Estimates assume commencement of Primary Data Collection to be March 1, 1976 and that project would be fully operational by field season of 1976, i.e. June 1.

	Man-Years	Personnel	Non-Personnel	Totals
(a) Costs for Fiscal Year 1975/6				
(i) Capital				
(ii) Administration & Coordination				
(iii) Research Framework				
Primary Data Collection				
3 Researchers @ $3,022/mo.	¼	$ 6,111	$ 2,955	$ 9,066
(iv) Total		$ 6,111	$ 2,955	$ 9,066
(b) Costs for Fiscal Year 1976/7				
(i) Capital:				
Photographic Equip.				
6 sets at $300			$ 1,800	
Canoes (2 at $600)			1,200	
Storage cabinets			1,000	
Field Equipment - compasses, surveying, excav. equipment			500	
Field camps (3 at $750)			2,250	
Laboratory equipment			400	$ 7,150
(ii) Administration & Coordination				
Salaries - manager	1	$22,040		
- archaeologists (2 at $17,000)	2	34,000		
- secretary	1	10,456		66,496
Office - space rental 2500			10,000	
supplies			200	
misc. office operations			200	
photocopying			200	
telephone & telex			300	
air photographs			1,000	11,900
Consultants				
Radiocarbon 10 @ $120			1,200	
Palynology - sampling & analysis				
Sample collection				
3 days @ $150/day			450	
Expenses			300	
Sample analysis (200 @ 10)			2,000	
Interpretation report			150	
Miscellaneous			1,000	5,100
Publication Allowance			3,000	3,000
Archaeological Training Course				
Spring - Fort McMurray - 10 students & manpower liaison			2,000	2,000

	Man-Years	Personnel	Non-Personnel	Totals
(iii) Research Framework -				
Primary Data Collection				
3 researchers @ $2,022	0.5	$12,222	$ 5,910	$ 18,132
Field Data Collection				
3 field crews 4 months	3	32,454	39,390	71,844
Transportation Allowance				
4 WD - Gov't agency 4 mo.			485	
Aircraft - 30 hrs. @ 110			3,300	
Riverboat - rental			300	4,085
(iv) Advisory Committee Operations				
6 members, 2 meetings/yr.			3,000	3,000
(v) Total of (i) to (iv)	7.5	$111,172	$81,535	$192,707
(vi) Add for computer option				
Salaries				
Computer-Analyst 2 @ $17,428	2	$ 34,856		$ 34,856
Computer Time			$ 3,000	3,000
Travel - Transportation			600	
Expense Allowance			600	1,200
Office increment			1,000	1,000
Total for computer option	2	$ 34,856	$ 5,200	$ 40,056
(vii) Add for File Option				
Salary - File Clerk	1	$ 10,819		$ 10,819
Office equipment			$ 300	300
Office increment			300	300
Total for file option	1	$ 10,819	$ 600	$ 11,419
(viii) Add for Staff Option				
Reduce full time admin. staff				
by 1 arch. 17,000				
Salaries - archaeologists				
(2 @ $17,000)	2	$ 34,000		$ 34,000
Office increment			$ 1,500	1,500
Total for staff option	2	$ 34,000	$ 1,500	$ 35,500
(ix) Add for Contractor Option				
Salary - 3 arch. 4 months in				
field - 4 months office	2	$ 34,000		$ 34,000
Office increment			$ 250	250
Total for contractor option	2	$ 34,000	$ 250	$ 34,250
(c) Costs for Fiscal Year 1977/8				
(i) Capital				
Storage Cabinets			$ 1,500	$ 1,500

	Man-Years	Personnel	Non-Personnel	Totals
(ii) Administration & Coordination				
Salaries	4	$ 66,496		$66,496
Office operations			$11,900	11,900
Consultants				
Radiocarbon			1,200	
Other			1,000	2,200
Publication Allowance			3,000	3,000
(iii) Research Framework				
Field Data Collection				
3 field crews	3	$ 32,454	$39,390	$71,844
Transportation				
4 @D			485	
Aircraft - 30 hr. @ $110/hr.			3,300	3,785
Excavation equip. rental			3,000	3,000
(iv) Advisory Committee Operation	_	______	3,000	3,000
(v) Total of (i) to (iv)	7	$ 98,950	$67,775	$166,725
(vi) Add for Computer Option	2	$ 34,856	$ 5,200	$ 40,056
(vii) Add for File Option	1	$ 10,819	$ 600	$ 11,419
(viii) Add for Staff Option	2	$ 34,000	$ 1,500	$ 35,500
(ix) Add for Contract Option	2	$ 34,000	$ 250	$ 34,250
(d) Costs for Fiscal Year 1978/9				
(i) Capital				
Storage Cabinets			$ 2,500	$ 2,500
(ii) Administration & Coordination				
Salaries	4	$ 66,496		$ 66,496
Office operations			$11,900	11,900
Consultants				
Radiocarbon			1,200	
Other			1,000	2,200
Publication Allowance			3,000	3,000
(iii) Research Framework				
Field Data Collection				
Field crews	2	$ 21,636	$26,260	$ 47,896
Transportation				
4 WD			485	
Aircraft 10 hrs @ $110/hr.			1,100	1,585
(iv) Advisory Committee operation	_	______	$ 3,000	$ 3,000
(v) Total of (i) to (iv)	6	$ 88,132	$50,445	$138,577

	Man-Years	Personnel	Non-Personnel	Totals
(vi) Add for Computer Option	-	-	-	-
(vii) Add for File Option	1	$10,819	$ 600	$11,419
(viii) Add for Staff Option	1	$17,000	$ 1,500	$18,500
(ix) Add for Contract Option	1-34	$22,780	$ 250	$23,030
(e) Costs for Fiscal Year 1979/80				
(i) Capital				
Storage Cabinet			$ 1,000	$ 1,000
(ii) Administration & Coordination				
Salaries				
Manager	1	$22,040		
Archaeologist	1	17,000		$39,040
Office operation				
Space rental			$ 2,000	
Supplies, misc.			250	
Photocopying			300	
Telephone & telex			300	2,850
Consultants			1,000	1,000
(iii) Advisory Committee Operation			$ 1,500	$ 1,500
(iv) Publication Allowance			$ 2,500	$ 2,500
(v) Total of (i) to (iv)	2	$39,040	$ 8,850	$47,890
(f) Costs for Fiscal Year 1980/1				
(i) Capital				
Storage cabinets			$ 500	$ 500
(ii) Administration & Coordination				
Salaries				
Manager	1	$22,040		
Archaeologist	1	17,000		$39,040
Office Operation			$ 2,850	2,850
Report Preparation			500	500
(iii) Total	2	$39,040	$ 3,850	$42,890
(g) Costs for Fiscal Years 1981/6				
(i) Capital			$ 300	$ 300
(ii) Administration & Coordination				
Salary				
Manager	1	$22,040		$22,040
Office operation			$ 2,850	2,850
Report Preparation			500	500
(iii) Total	1	$22,040	$ 3,650	$25,690

5.0 PROJECT EVALUATION

When an archaeological project involves a substantial portion of a province and a corresponding part of the prehistory of that province, it is advisable to include an allowance for evaluating the effectiveness of the design and the work itself. Frequently substantial and practical contribution is made by an outside consultant surveying the conceptual design, methodology and results of a study such as this.

It may be that AOSERP has some overall committee that will serve this purpose; if so, an archaeological consultant should be added.

The evaluation should be done by an outside consultant familiar with the project, the area and the problems of salvage archaeology in this area. The funds should be an AOSERP responsibility and are estimated at about $2,500.00 per year. He should report to the Advisory Committee and AOSERP.

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LIST OF RESEARCH REPORTS

1		AOSERP First Annual Report, 1975
2	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975
3	HE 1.1.1	Structure of a Traditional Baseline Data System
4	VE 2.2	Preliminary Vegetation Survey of the AOSERP Study Area
5	HY 3.1	Evaluation of Wastewaters from an Oil Sands Extraction Plant
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9	ME 3.3	Preliminary Investigation into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
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11	AF 2.2.1	Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta
12	ME 1.7	Very High Resolution Meteorological Satellite Study of Oil Sands Weather, "A Feasibility Study"
13	ME 2.3.1	Plume Dispersion Measurements from an Oil Sands Extraction Plant
14	HE 2.4	Athabasca Oil Sands Historical Research Project (3 volumes) (at print)
15	ME 3.4	Climatology of Low Level Air Trajectories in the Alberta Oil Sands Area
16	ME 1.6	Feasibility of a Weather Radar near Fort McMurray, Alberta
17	AF 2.1.1	Survey of Baseline Levels of Contaminants in Aquatic Biota of the AOSERP Study Area

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For information regarding any of these publications, or the Alberta Oil Sands Environmental Research Program, please contact the Program office.

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