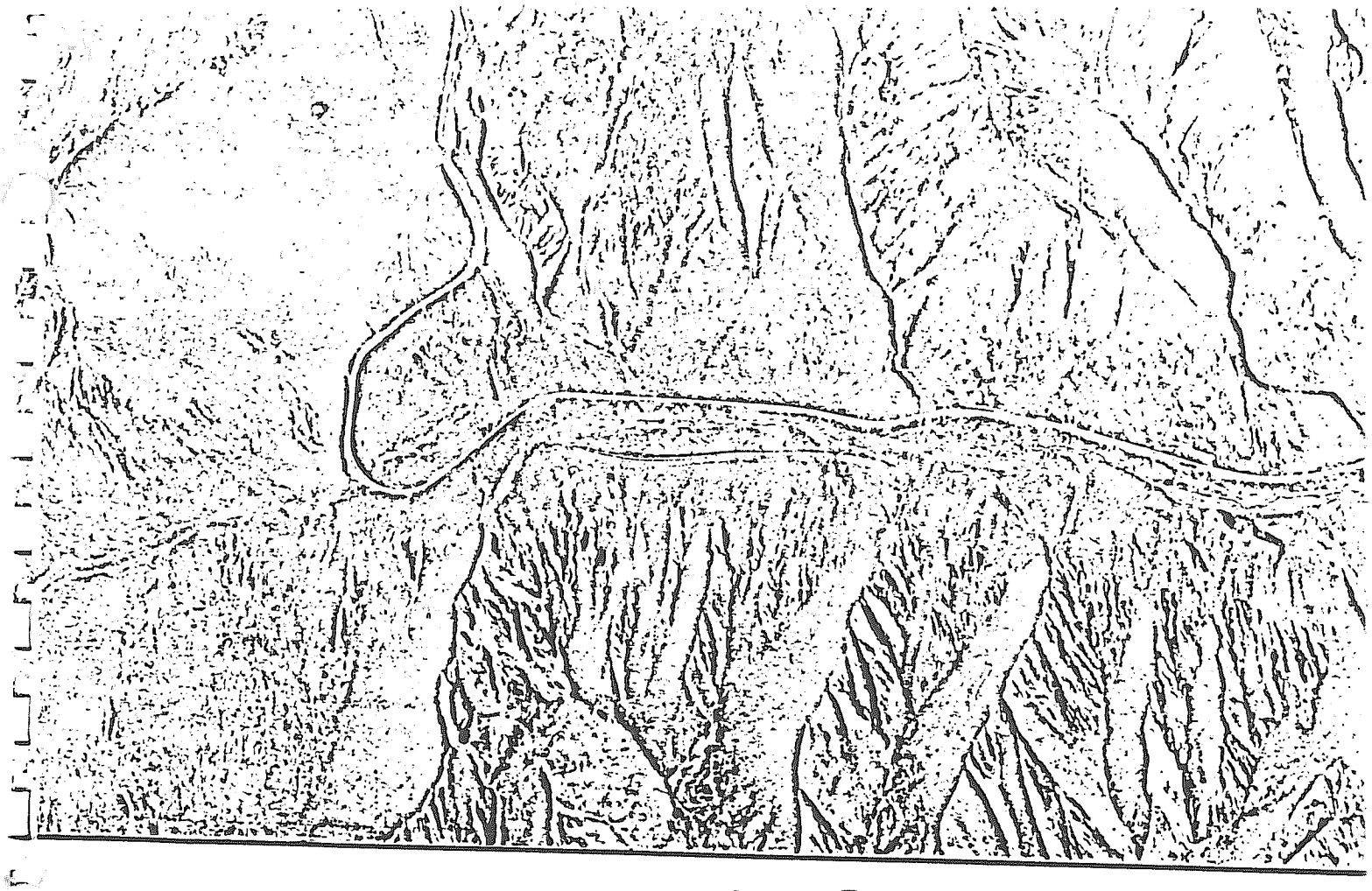

TASK 3
Review of Past Northwest Alaskan Revegetation Studies & Recommendations for Additional Research

prepared for:
FLUOR NORTHWEST, Inc

contract no. 468085-9-k054
LAND DESIGN NORTH
December 1979

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December 19, 1979

Mr. W. D. Fisch, Manager
Contracts Administration
Fluor Northwest, Inc.
1001 Noble Street
P.O. Box 60089
Fairbanks, AK 99706

Re: Contract No. 468085-9-K054
Erosion Control, Restoration
and Aesthetics Planning Services
LDN/FI 016

Dear Mr. Fisch:

By way of this letter we are submitting the final Task 3 Report incorporating review comments per Fluor-Northwest Letter No. FI/LDN-27, dated 11 December 1979.

We are delivering the report by express mail in order to expedite your request of an early turn around. We are sending, under separate cover, a copy of the final report to Mr. R. S. Sibley as per his request.

Very sincerely,

LAND DESIGN NORTH

Bruce G. Sharky, ASLA
Principal

BGS:mm

02322

TASK 3

REVIEW OF PAST NORTHWEST ALASKAN REVEGETATION STUDIES AND RECOMMENDATIONS FOR ADDITIONAL RESEARCH

Prepared for: FLUOR NORTHWEST, INC.

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December 1979

Contract No. 468085-9-K054

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TASK 3 - REPORT OBJECTIVES

1.0 REPORT OBJECTIVES

The overall objective of TASK 3 is to review past Northwest Alaskan revegetation studies and make recommendations for initiating additional research activity. Essentially this objective embodies three components:

1. Review of past Northwest Alaskan revegetation field studies initiated in 1977 by Dr. J. D. McKendrick and conducted on the sand dune uplands near Northway, Alaska;
2. Make recommendations for a findings wrap-up of the sand dune field studies; and
3. Prepare a program outline consisting of recommendations for initiating additional research and field studies that would aid in achieving a creditable and cost effective master ECR & A program responsive to government regulations.

1.1 BACKGROUND ON ECR & A REQUIREMENTS

ECR & A requirements fall under two basic categories of concern:

1. Environmental/Technical considerations; and
2. Governmental/Legal considerations.

1.1.1 ENVIRONMENTAL: Technical Considerations.

The activities associated with erosion control, restoration and aesthetics (ECR & A) are commonly followed to assist in stabilizing slopes, abating surface soil erosion, re-establishing disturbed animal habitat and reducing visual impact on construction sites. Establishing vegetation is one of the most economical ways to

protect exposed soil surfaces. The functional purposes for vegetating slopes are to establish an immediate and permanent cover for exposed soil surfaces, and to enhance constructed slopes in visually sensitive locations.

It should be apparent that vegetation can be successfully established only if certain minimum site and soil requirements are met. Successful establishment can, of course, be achieved more readily if the minimum standards are exceeded.

In Alaska, more particularly in soils along the route proposed by the Permittee, the establishment of vegetation is a considerable challenge; given low productivity of the typical soils to be found in Northern and Interior Alaska. These soils are characterized as having the following properties:

1. low fertility
2. toxic conditions (as high pH)
3. located in zones of low precipitation
4. located in regions of low ambient and soil temperatures
5. and, in some cases, highly water saturated conditions (bogs)

Post construction soils are often made worse for establishing vegetation as a result of certain construction activity. The increased adverse conditions as a result of construction place further stress on the seed or other revegetation means used to establish vegetative cover. The adverse conditions resulting from construction could include:

1. an increase of slope (steep/fill embankments)
2. changes in surface water runoff patterns
3. the reduction or complete elimination of natural soil covering (mulch) or degrading of the vegetative mat
4. exposure of thermokarst conditions
5. soil compaction
6. non-friable surface or unwettable condition

The purpose of research would be to aid in establishing what are the minimum requirements and best man-induced means for re-establishing vegetation on exposed soils. Findings from a well balanced research effort should make it possible to recommend techniques and/or materials to be applied in producing favorable growing conditions. Further, based on research or field studies, it would be possible for recommending procedures to be used in establishing an acceptable and desirable level of vegetative cover capable of abating erosive and mechanical deterioration of exposed soils.

1.1.2 GOVERNMENTAL: Legal Considerations

Recent experience (within the last 5 to 10 years) on large construction projects built in Alaska indicate progressively expanding ECR & A requirements being imposed on a permittee by the various state and federal regulatory agencies. The requirements for executing ECR & A programs are based on generally limited regulations, codes or administrative guidelines. These regulations and codes have been broadly interpreted and have been extensively applied on all phases of project activity from route selection and

planning through design, construction and, finally, project operation.

On larger projects (most notably being the TAPS project), ECR & A requirements have been applied on a somewhat discretionary basis placing specific ECR & A performance requirements on a wide variety of project activities. To a significant extent, what has been required from any single agency has even varied internally by regional entity, particularly within a state agency. Further, there are examples that can be cited indicating the exercise of ECR & A regulations and codes have been inconsistently applied whereby the specific ECR & A requirements imposed have been strictly enforced on certain occasions and given relatively minor importance on other. The sibject of variations in interpretation and enforcement of ECR & A requirements are a topic of discussion in the Task One report.

The following sections (2.0 and 3.0) have been prepared to address both the environmental and governmental considerations summarized in this section. The recommendations contained in section 3.0 have been formulated to provide a practical basis for the permittee to respond to the ECR & A requirements as described in the Task One report.

SECTION 2.0

EVALUATION OF PAST NORTHWEST REVEGETATION STUDIES

2.0 EVALUATION OF PAST NORTHWEST REVEGETATION STUDIES

As previously stated, one of the objectives of this TASK 3 Report is to review Northwest Alaskan revegetation studies and make recommendations indicating how the findings of these studies could be integrated into the broader context of ECR & A planning. To accomplish this objective, the consultant team has followed an approach consisting of:

1. Evaluating three research documents (which represent the extent of revegetation studies to date sponsored by Northwest) authored by Dr. J. D. McKendrick which include:
   a. Observations and Suggestions Concerning Vegetation Disturbances, Re-establishment and Management Site Selection for Northwest Pipeline Corporation's Proposed Gasline Route From Prudhoe Bay to the Alaskan-Canadian Border; 17 June 1976.
   b. Natural Plant Communities and Possibilities for Revegetation Along the Proposed ALCAN Pipeline Route in Alaska; 30 June 1976.
   c. Revegetation of Disturbed Sand Dunes Near Northway, Alaska. A First Year Progress Report; 1 June 1978.
2. Utilizing specific background and experience with respect to revegetation in Arctic and sub-Arctic regions which include:
   a. A literature review of pertinent state-of-the-art documents (see bibliography).
   b. Work completed as a research consultant to Woodward-Clyde for the U.S. Department of Interior, Fish and Wildlife Service: Gravel Removal Studies in Selected

Arctic and sub-Arctic Streams in Alaska, in progress.

c. As Senior Staff for the Alyeska Pipeline Service Company, Arctic Civil Engineering and Environmental Protection Departments, with involvement in all phases of ECR & A activities from planning through construction phases.

d. Specific revegetation research throughout Interior and Northern Alaska.

2.1 SAND DUNE REVEGETATION RESEARCH

As stated in the introductory section of Dr. McKendrick's 1 June 1978 report, his selection of the sand dune upland areas for revegetation research was based on the following premises:

1. Sufficient research has been carried out on revegetation in the Tundra Vegetation Zone. This research has been conducted by the Alaska Agriculture Experiment Station and has also been done by Arctic Gas Co. (1)
2. Within the Taiga Vegetation Zone, "There appears to be little problems with natural reinvasion of existing disturbed sites by native plants except on exposed sand dunes and rocky areas such as gravel pits and granite slopes between Tetlin Junction and the Alaska-Canadian border". (McKendrick, 1977).

Dr. McKendrick's field research program was developed to better understand the growth response of two grass species as affected by various combinations of nutrients (nitrogen, phosphorus, and potassium) within sand dune soils

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(1) It should be noted that significant revegetation research in northern climes has been accomplished by several other American, Canadian and Russian institutions including CREEL, Alyeska Pipeline Service Co., and ARCO.

and as affected by the application of various surface mulch materials. In addition, soil nutrient deficiencies were investigated through a soil sampling study.

2.1.1 Evaluation of Research Conducted

In general, the sand dune revegetation research of 1977 was directed at developing methods of revegetating sand dune and other soil types of low productivity. The research program was, by design, narrow in scope with respect to experimental variables included. While the field studies conducted were intensive, they focused on a few variables within the context of a much larger problem, for example:

1. There was too elaborate an investigation of N, P and K individually. There already exists sufficient general soils data for various "mainland" Alaska locations to know that the Alaskan soils are, in general, deficient in N, P and K. Most grasses and native plants will show, often times dramatic, responses to added fertilizer. Elaborate soil testing to determine if the sands fell within the usual range for Interior Alaska (as opposed to being of high fertility) should have been given an educated estimate for fertilizer rates. Testing with two different levels of application of a complete fertilizer would have been adequate and would have provided reasonable results without the need of a study program involving partitioning into the three elements - N, P and K.
2. Other grass species should have been tried that have been known to perform in sub-Arctic conditions such as

Calamagrostis and Arctagrostis.

3. Testing included evaluating the effectiveness of forest litter as a practical mulching material. It is fairly well established that forest litter makes poor seedbed under most weather and topographic conditions in Alaska due to its tendency to dry out and become almost un-wettable. Tests utilizing other more commonly used mulch materials would have been preferable.

4. Perhaps some of the difficulties Dr. McKendrick encountered in interpreting the first year's data and low cover of grass (given the very heavy seed applications used) may have been soil moisture related. It is commonly known that soil moisture is one of the most critical factors for plant establishment. The availability of moisture as an agent for translocation of plant nutrients is of primary importance. Monitoring for soil moisture and methods of retention would have been a valuable addition to the field study program.

2.1.2 Research Conclusions

Given Dr. McKendrick's research objectives and to the extent one can draw any conclusions from just one season of growth, his study is interesting and should provide some worthwhile conclusions with additional follow-up work. It might be possible to derive useful insight on the effectiveness of various fertilizer applications and soil preparation techniques in establishing vegetation on exposed sand dune soils. Useful findings possible from this research

activity might be able to address:

1. Optimum and minimum ranges of fertilizer application required to establish two grass species (Common Bluegrass - Poa pratense, and Creeping Red Fescue - Festuca rubra).
2. Response potential of exposed sand soils to establish vegetation with the application of (a) silt topsoil, or (b) forest litter mulch.
3. Soil test requirements (sampling primarily) for determining soil nutrient deficiencies and for recommending fertilizer application rates to correct assessed nutrient deficiencies.

2.1.3 1977 Research Wrap-up

It is the opinion of the consultant team that although the scope of the sand dune revegetation studies conducted near Northway, Alaska was limited, there are several technical areas that could yield useful results pertinent to the ECR & A program. It is recommended a wrap-up of findings be prepared based on data previously collected and summarized by Dr. McKendrick through supplemental field evaluations of the 1977 test plots. Recommendations for continued field studies are made within Section 3.0 of this report.

SECTION 3.0

RECOMMENDED ECR & A RESEARCH/ STUDY PROGRAM

3.0 RECOMMENDED ECR & A RESEARCH/STUDY PROGRAM

The objective of this section is to make recommendations covering two areas which include:

1. Recommendations for wrapping-up the revegetation research efforts initiated in the sand dune area near Northway, Alaska by Dr. J. D. McKendrick. The wrap-up to include a summary of findings based on previously collected data supplemented by data to be collected and evaluated in 1980; and
2. Recommendations for additional field studies and/or experiments that would augment past programs and provide a sound basis for developing a creditable ECR & A project program.

The state-of-the-art for erosion control and restoration has achieved a fair degree of sophistication in recent years. This is particularly true in Alaska. However, Alaskan research and project execution has generally focused on fairly limited products and methods; ie. use of selected grass species rather than woody species.

For the most part, additional areas requiring research to meet ECR & A objectives could best be characterized as studies focusing on the refinement of established methods and selection of materials to meet the unique requirements of specific geographic site conditions.

Ultimately the research and studies conducted under the ECR & A program will aid in achieving multiple objectives including:

1. Developing sound design criteria for use by engineering;
2. Meeting government agency requirements;
3. Developing cost effective methods and procedures; and

4. Developing environmentally appropriate methods and materials.

The recommendations should in no way be viewed as a study design. The detail required in preparing a research study design goes beyond the scope of this report effort.

GENERAL RECOMMENDATIONS:

General recommendations for augmenting Dr. McKendrick's 1977 - 1978 sand dune research are based upon the following ECR & A objectives:

1. That the development of procedures for quickly establishing vegetative cover on exposed sandy soil surfaces to abate erosive and mechanical deterioration on a temporary basis are of primary importance;
2. To develop procedures for increasing natural invasion for re-establishing native vegetation on sandy soils disturbed or altered during construction for purposes of long term:
   a. slope stabilization
   b. erosion control
   c. restoration at visually sensitive locations
   d. restoration at oil spill sites
   e. restoration of critical wildlife habitat

General recommendations are also made for augmenting the 1977 field revegetation research program:

1. Site Selection

   Establish experimental plots on a wide geographic range in order to:

simulate on-line application techniques and conditions.

2. Soil Testing

There is sufficient general soils data for various Alaskan locations to know that Alaskan soils in general are deficient in N, P and K (nitrogen, phosphorus and potassium). Futher, experience and research strongly indicate that most native and non-native plant species will show positive responses to additional fertilizer.

Obtain bulk soil samples from a wide geographic range and use the samples to determine basic soil nutrient properties.

3. Soil Moisture and Mulch

Perhaps the most limiting factor in successfully establishing revegetation on exposed soils in Alaska (North Slope and Interior, in particular) is available moisture in soil. Subsequent research activities should include simple soil moisture sampling. The exploration of a broad range of moisture retention aids should be investigated.

4. Grass Species and Rates

Basic seed mixes have been developed and are in use in Alaska. Particular attention should be directed at field testing of those formulations developed by the Alaska Agricultural Experiment Station, University of Alaska Cooperative Extension Service as well as evaluations of the mixes used on the TAPS right-of-way. Future research should attempt to develop material formulations applicable to on-line application.

5. Woody Plant Species

Woody plant species have been observed to be early invaders on some disturbed sites. These plants, once established, require little maintenance.

Woody species can be established from seed, cuttings, seedlings, or transplants, depending on species, availability, source, and time of year.

6. Wind Erosion

Investigate techniques to combat the effects of wind erosion. In some locations, soil erosion induced by high winds is as much of a problem as water induced erosion.

RESEARCH RECOMMENDATIONS:

The research recommendations are presented in a summary format that includes a brief description of each research item. Where appropriate a suggested approach for carrying out the research such as literature review, field inventory, or specific research project is indicated. For the convenience of the reader and as a technique for helping establish time-frame priorities, Table 3.0 has been prepared listing each recommended research activity with a time segment and duration designation.

3.1 DR. McKENDRICK'S RESEARCH, EVALUATIONS AND RECOMMENDATIONS

3.1.1 Field Evaluations of 1977 Test Plots

Conduct an initial on-site evaluation during spring 1980. The purpose of this on-site evaluation is to collect additional data on plant establishment and the responses of plants to the various fertilizer and soil preparation tests applied earlier.

3.1.2 Prepare Final Program Findings

Incorporating 1980 field evaluations with earlier progress report findings, prepare final program evaluation that includes assessment of research study design, and recommendations for future study. The report should include recommendations or conclusions for the following:

a. Grass seedling establishment of species selected;

b. Fertilizer formulation or recommended procedure for designing fertilizer application in aiding the establishment of acceptable levels of grass cover at exposed sand dune sites;

c. Mulching materials and techniques to the extent possible for application at test plots; and

d. Topsoiling recommendations in particular identifying topsoil materials and techniques that have potential for large scale application.

3.1.3 Prepare Final Recommendations for the Design of a Soil Sampling Program

It is recommended that guidelines be prepared for conducting a project-wide soil sampling program, the use of which will aid in identifying fertilizer and/or soil preparation requirements, system wide.

3.1.4 Native Plant Establishment

It is recommended a final summation be prepared indicating conditions expected in establishing native plant species either through natural processes or a specialized treatment program.

3.2 ADDITIONAL SAND DUNE REVEGETATION/STABILIZATION RESEARCH

It has been acknowledged by Dr. McKendrick and others of the problems in stabilizing soil and establishing vegetation on disturbed sand dune slopes. Additional research sites should be established, the design of which should include much broader investigations that address:

3.2.1 Soil Sampling and Preparation

a. Obtain bulk soil samples from as many different sand dune sites for purposes of determining soil nutrient levels.

b. Investigate the merits and desirability of utilizing various spoil materials for use in establishing stabilized, revegetated disturbed slopes in sand dunes.

3.2.2 Standard Seed Mix

The 1977 test plots by Dr. McKendrick used two grass species - common Bluegrass (Poa Pratensis) and Creeping Red Fescue (Festuca Rubra). Other grass species should also be considered such as Calamagrostis, Arctagrostis, Rye Grass (annual and perennial) and woody species such as Alder. The literature, although not extensive for Alaska, can provide good direction on other species that should be considered.

3.2.3 Soil Moisture

Soil moisture is perhaps the single most critical factor in establishing a reasonably acceptable level of vegetation. In the future all revegetation testing should include simple moisture sampling. With this data, interpretation of other research components may give a more complete picture, particularly where poor revegetation response results.

3.2.4 Mulching

Under most climatic conditions in Interior Alaska it has been generally demonstrated that the forest litter mulch provides a poor seedbed for tree establishment due to the materials tendency to dry out and become almost unwettable. Other mulch materials that help retain soil moisture but do not completely blanket the soil (such as straw, processed organic fibers or even chemical products) should be evaluated.

Testing of the various mulch materials should also be designed to include the evaluation for their soil erosion inhibiting characteristics.

3.2.5 Field Evaluation of TAPS Sand Dune Revegetation

Attempts at revegetating disturbed sand dune soils has precedence in Alaska. The TAPS project traversed sand dunes in the Rosa Pass area between Shaw Creek Flats and the Salcha River. Field evaluations should be conducted of this effort to assess areas of success as well as poor response.

3.3 EVALUATION OF THE TAPS PROJECT

The efforts in erosion control, restoration and aesthetics performed on the TAPS project must, without question, be evaluated on at least two counts:

a. To learn from the efforts, to the extent possible, hopefully as an aid in guiding in the design of the NAPLINE ECR & A program; and

b. To identify potential problem areas that must be addressed, particularly problems with respect to potential ECR & A problems where the NAPLINE closely parallels the state road and the TAPS facility.

Areas of field study should include at least the following:

3.1 Revegetation performance of grasses;

3.2 Potential upslope/downslope erosion hazards where the NAPLINE project closely parallels the state road and TAPS;

3.3 Willow planting experiment related to habitat re-establishment;

3.4 TAPS VIE (Visual Impact Engineering) plantings;

3.5 Thermal erosion and Aufeis problems;

3.6 Cross drainage of TAPS and potential effect on NAPLINE.

3.4 CONTINUED REVEGETATION STUDIES

ECR & A related research done to date by Northwest or available from Alyeska Pipeline Service Company, CREEL, Arctic Gas, ARCO or the Alaska Agriculture Experiment Station should provide an adequate amount of information and direction for resolving most revegetation questions. The state-of-the-art is sufficiently advanced to give at least rough guidelines. The exceptions would be the more adverse locations or specific problem areas such as:

a. Above treeline in alpine zones;

b. Brooks Range North;

c. Adverse Soil Conditions

   1. Rocky sites;

   2. Sandy sites;

   3. Un-wettable soils;

d. Adverse construction conditions

   1. Steep slopes (greater than 2:1);

   2. Compacted embankment.

Segments of gas pipeline to be located in conditions falling under any one of the above categories should be considered a candidate location for receiving some level of research effort. Generally, the research includes the following:

3.4.1 Development of Revegetation Seed Mix

Based principally on literature review of grass selection and seed mix formulation research conducted in Alaska by others, develop seed mix formulas for use in ECR & A revegetation. Seed formulas developed should be designed for each major climatic/soil type as well as solve for:

a. Temporary ECR & A requirements;

b. Permanent ECR & A requirements.

Consideration should be given to the use of native plant species, grasses, and other herbaceous plant species.

3.4.2 Fertilizer Formulation

Based principally on experienced research conducted in Alaska by others, prepare fertilizer formula recommendations for use in the ECR & A program. Sufficient data exists to indicate that both native and introduced species will show dramatic response to the addition of N, P, and K.

Research should focus on designing fertilizer formulations to match each general soil/climatic condition. Original research will not be necessary.

3.4.3 Develop Mulching Program

Original research may be required in this area. The focus here should be in identifying and evaluating various readily available

mulching materials. Factors to be considered include:

a. An effectiveness in retaining soil moisture as well as reducing surface soil erosion;

b. Cost effectiveness;

c. Ready availability;

d. Handling, storage, and transport requirements;

e. Application requirements including the use of specialized equipment needs (if any) logistics and man power;

f. Environmentally appropriate.

3.4.4 Seed of Native Woody Species

Woody plants are a major component of the natural vegetative cover in Alaska, and in many cases are the dominant plants in the landscape. There is good evidence that woody species are relatively easy to establish, and maintain. The soil holding qualities of their root systems, once established, are generally superior to grasses, a definite consideration in long term control and slope stabilization.

It is proposed that research involving a literature review followed by a field effort, investigate practical methods of revegetation with native woody species through the use of:

a. seed

b. hard wood cuttings

c. transplants

Work in this area would have application not only in erosion control and aesthetics but also in meeting potential animal habitat restoration requirements.

3.5 SPECIAL AREAS OF STUDY

There are several unique technical areas for which the existing state-of-the-art in ECR & A does not apply. It is proposed that original research be carried out for each of the following special study areas:

3.5.1 Un-wettable Soils

There currently exist some soils which, due to their physical characterisitics, tend to become dry and are unable to readily absorb and retain moisture. Attempting to establish vegetation under these conditions will be difficult at best. Un-wettable conditions are a particular problem when attempting to revegetate on spoil material high in peat content.

Research in this area should focus on investigating soil preparation techniques or application of chemical wetting agents to reduce these soil conditions.

3.5.2 Cold Pipe Testing

A research program should be developed to investigate the effect on revegetation to cold soil conditions above chilled pipe. Research should indicate methods for revegetation over chilled buried pipe, and could include field testing at the existing frost heave test site.

3.5.3 Spoil Utilization

Field studies should develop techniques for handling, temporarily storing, spreading, and if required, amending spoil material. Additional investigation should be directed at determining the potential of establishing vegetation on this reused spoil.

3.6 VISUAL RESOURCE MANAGEMENT

Early attention should be given developing a systematic approach for resolving aesthetic issues. It is recommended that preliminary work include the two following items:

3.6.1 Conduct Field VRM Classification Program

A program must be developed that includes establishing criteria for defining aesthetic values and that can be applied in the field for identifying sensitive or high value aesthetic locations. Because the pipeline ROW traverses BLM managed land it is proposed that the visual resource management system employed by that agency be considered for use.

As a first step, the VRM system devised by BLM should be evaluated thoroughly, and then applied in the field in its actual or a modified format. This effort could be carried out independently or in cooperation with the state office of BLM.

3.6.2 Identify Visual Sensitive Areas

As part of ROW planning and the selection process for material sites, disposal sites and access roads, conduct field evaluations and prepare assessment reports documenting the visual or aesthetic aspects of proposed pipeline system and facilities locations.

The work here would be in addition to the required VRM field evaluations, involving the development of criteria consistent with the VRM program described above (3.6.1). To assist in this evaluation, a field manual or check list should be developed to insure thorough and consistent evaluations.

3.7 FIELD MAPPING AND INVENTORY PROGRAM

Whether prepared by the permittee or the authorized regulatory agencies, a project wide inventory of existing vegetation conditions is essential. The inventory would be the basis for identifying specific ECR & A program needs; and for the delineation of site specific requirements or design recommendations.

3.7.1 Inventory of Existing Vegetation

Vegetation maps will provide a documentation base in establishing pre-construction conditions. Having this data base will be useful in resolving potential conflicts involving questions of restoring pre-construction conditions.

3.7.2 Map Existing Wildlife Habitats

Mapping should be made of those habitat types generally considered critical for animal species under resource management protection.

3.7.3 Map Natural Invasion Potential

Alaskan soils, like soils found in other geographic regions, have the ability to support re-establishment of vegetation by natural means. Numerous examples can be found throughout Alaska, such as utility ROW's and highway cuts, where exposed soils have, through natural processes, become covered with native woody and herbaceous species.

Inventorying and mapping locations adjacent to the pipeline ROW where revegetation has occurred on disturbed sites will aid in establishing restoration criteria recommending locations of construction disturbed soils to receive no special restoration treatment given the potential of the soils to revegetate by natural processes.

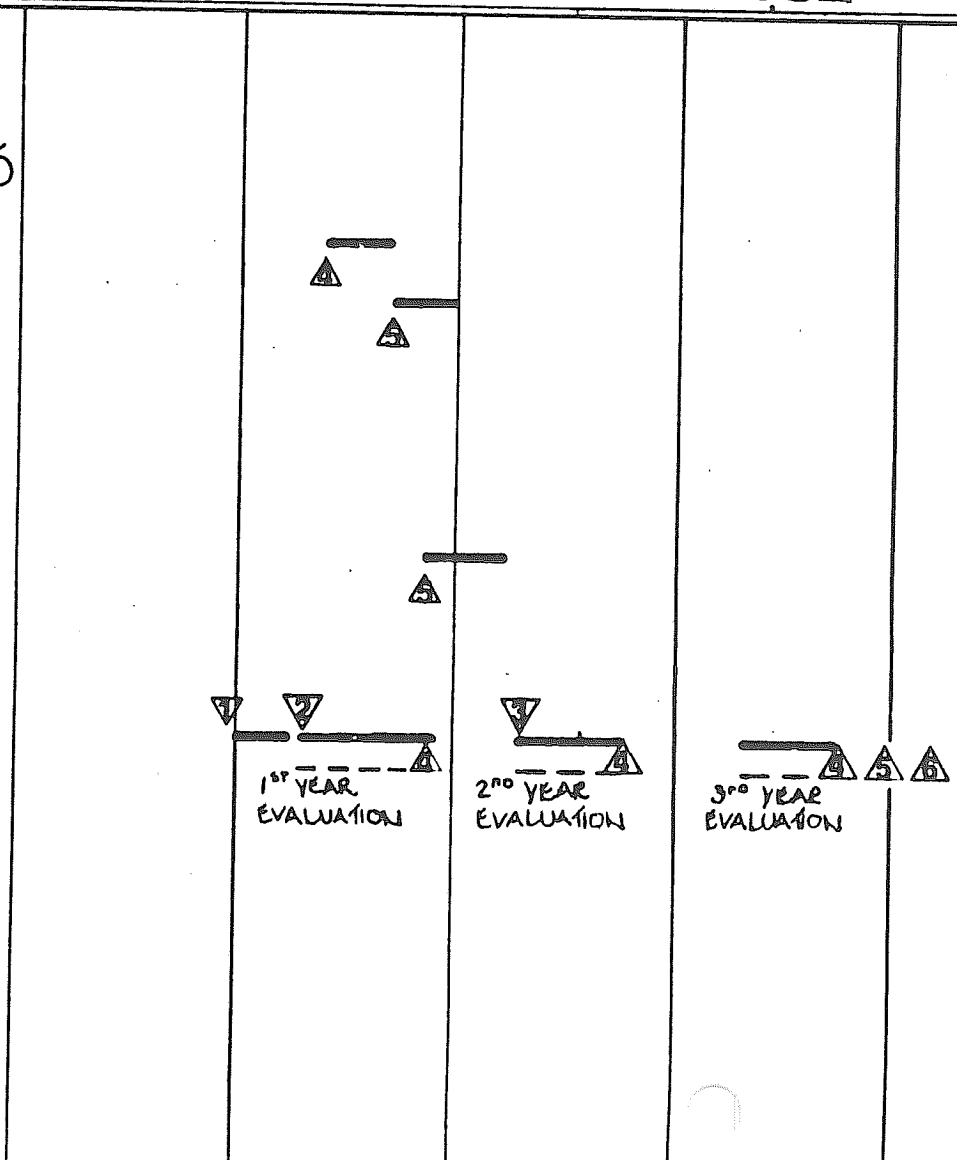
This concludes the research recommendation section of TASK 3. Following the review of these research recommendations it is suggested that the permittee adopt specific schedules and study designs for each research area to be conducted. Each study design should contain at least the following:

a. Research objectives
b. Approach and methodology
c. Design criteria
d. Locational requirements
e. Man power requirements, particularly specialized personnel or expertise
f. Materials and specialized equipment requirements
g. Permit requirements
h. Time schedule
i. Budget
j. Evaluative criteria
k. Specific recommendations

TABLE 3.0

Suggested ECR&A Research Program

Activity Description



3.1 McKENDRICK RESEARCH: EVALUATION & RECOMMENDATIONS OF 1977 TEST PLOTS

- 3.1.1 FIELD EVALUATION OF 1977 PLOTS
- 3.1.2 PREPARE FINDINGS
  - a. GRASS ESTABLISHMENT
  - b. FERTILIZER RESPONSE
  - C. MULCHING PERFORMANCE
  - d. TOPSOILING PERFORMANCE
- 3.1.3 PREPARE FINAL RECOMMENDATIONS OF SOIL SAMPLING PROGRAM
- 3.14 NATIVE PLANT ESTABLISHMENT

3.2 ADDITIONAL SAND DUNE REVEGETATION-STABILIZATION STUDIES

- 3.2.1 SOIL PREPARATION
- 3.22 STANDARD SEED MIX
- 3.23 SOIL MOISTURE
- 3.24 MULCHING
- 3.25 FIELD EVALUATION OF TAPS SAND DUNE REVEGETATION

3.3.1 REVEGETATION PERFORMANCE

3.3.2 IDENTIFY POTENTIAL UPSLOPE DOWNSLOPE EROSION HAZARDS

3.3.3 WILLOW PLANTING

3.3.4 VIE PLANTINGS

3.3.5 THERMAL EROSION PROBLEMS

3.3.6 CROSS DRAINAGE OF TAPS AND POTENTIAL EFFECT ON NAPLINE

3.4 CONTINUED REVEGETATION STUDIES

3.4.1 DEVELOP GRASS SEED MIX
- a. TEMPORARY
- b. PERMANENT

3.4.2 FERTILIZER FORMATION

3.4.3 DEVELOP MULCH PROGRAM

3.4.4 NATIVE WOODY SPECIES
- a. SEED
- b. CUTTINGS
- c. TRANSPLANTS

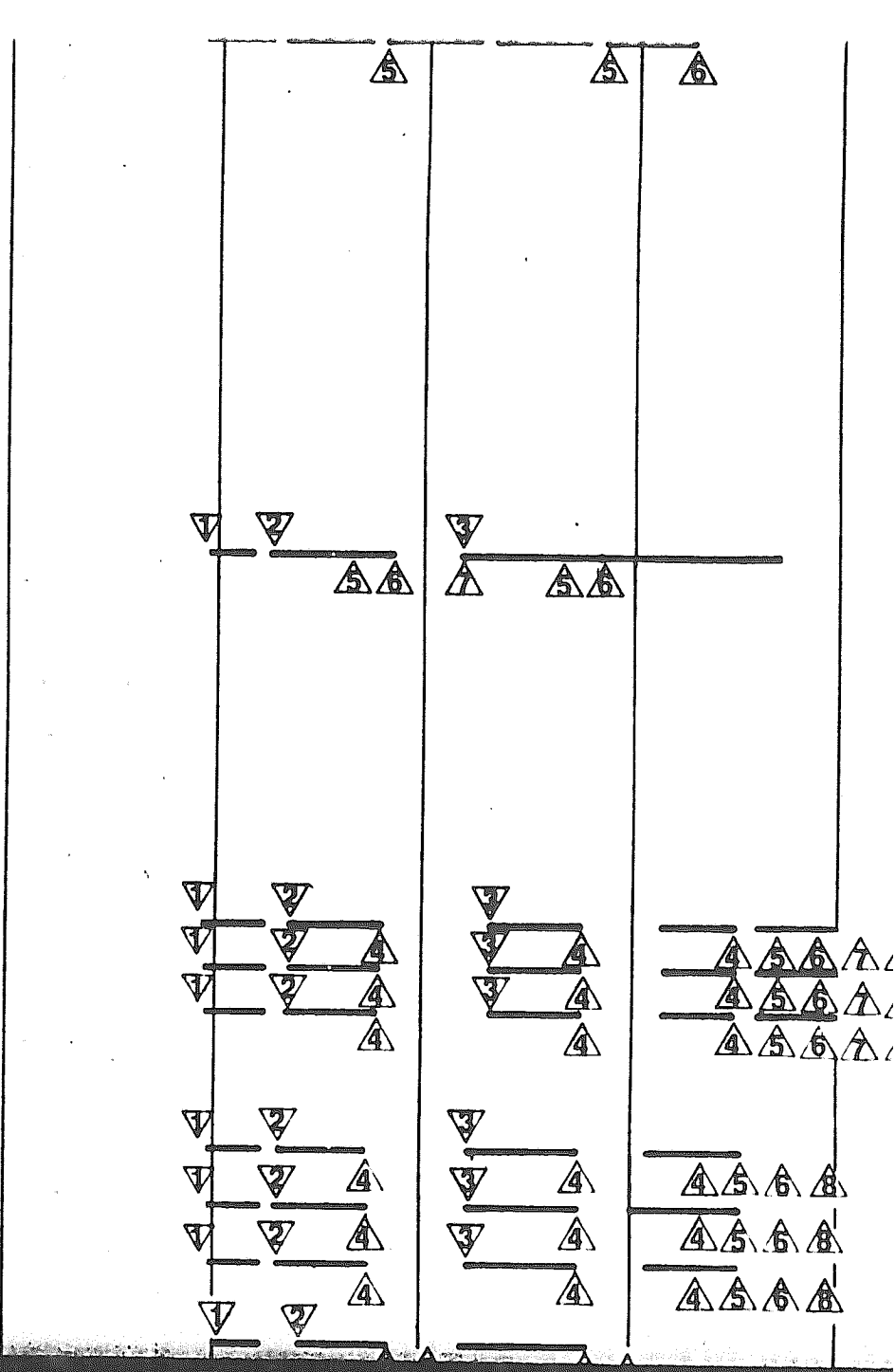
3.5 SPECIAL AREAS OF STUDY

3.5.1 UNWETTABLE SOILS

3.5.2 COLD PIPE TESTING

3.5.3 SPOIL UTILIZATION

3.6 VISUAL RESOURCE MANAGEMENT



3.6.1 CONDUCT FIELD VRM CLASSIFICATION PROGRAM

3.6.2 IDENTIFY VISUAL SENSITIVE AREAS EVALUATE ROW & M.S.A.R., ET.

3.7 FIELD MAPPING & INVENTORY PROGRAM

3.7.1 MAP EXISTING NATIVE VEGETATION

3.7.2 MAP EXISTING WILDLIFE HABITATS

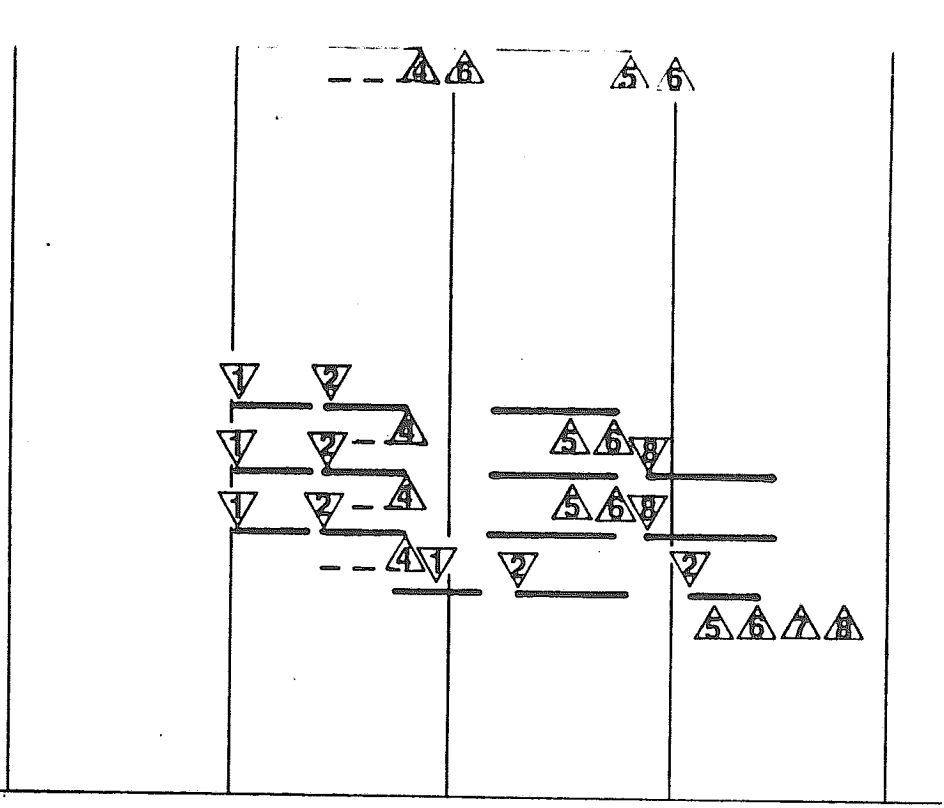
3.7.3 MAP NATURAL INVASION POTENTIAL

3.7.4 SOIL TESTING OF ROW

a. NPK

b. PH

c. SOIL TYPES



▽1 DESIGN STUDY PROGRAM (WITH LITERATURE REVIEW WHERE APPROPRIATE)

▽2 INITIATE STUDY PROGRAM

▽3 INITIATE SUPPLEMENTAL STUDY PROGRAM

△4 PROGRAM EVALUATION AND PRELIMINARY FINDINGS

△5 REPORT PREPARATION

△6 GOVERNMENT REVIEW SUBMITTAL

△7 INITIATE PURCHASE/SUPPLY CONTRACT

△8 DESIGN IMPLEMENTATION PROGRAM

--- INTERIM EVALUATION

LAND DESIGN NORTH

DECEMBER 1979