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H&M ENGINEERS & CONTRACTORS

# HENKELS & McCOY
## ENGINEERING DIVISION

CONTROL NO: 0309-B006-005

GTE SYLVANIA
INCORPORATED
COMMUNICATION SYSTEMS DIVISION

(9) Final rept.

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# ELF COMMUNICATIONS SEAFARER PROGRAM.

SITE SURVEY, - FINAL REPORT
MICHIGAN REGION.

ANTENNA CONSTRUCTION COST FACTORS AND INSTALLATION PLAN.

CONTRACT NO. CSD-C-75-1042
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by

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A study of the methods and costs associated with the installation of the underground antenna cable portion of the Seafarer Project is described. This study included a physical examination of the proposed installation site located in portions of the Upper Peninsula of Michigan.

Final installation plans and costs will be determined when system design has been completed. The baseline data contained in the report will be extrapolated as required to support final costing.

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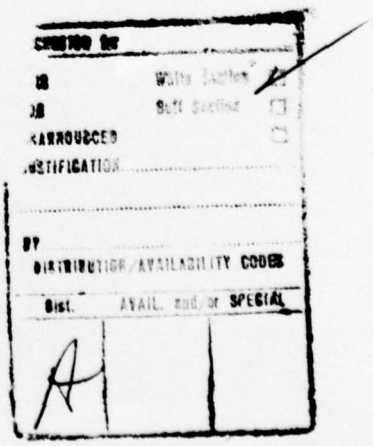


19 July, 1976

## FOREWORD

Henkels & McCoy was retained by GTE Sylvania, Inc. to perform a study of the methods and costs associated with the installation of the underground antenna cable portion of the Seafarer Project. This study included a physical examination of the proposed installation site located in portions of the Upper Peninsula of Michigan.

Our task was to field survey the site to obtain data on the physical nature of the areas, determine labor and equipment requirements and availability and to develop and describe a practical installation plan. Finally, we applied current cost figures to the plan to obtain cost for the installation of the cable. In addition to the basic plan and costs, we have provided several alternative cost figures for different placement depths and multiple cables.

A considerable number of conditions were established in order to arrive at the cost figures in the report. These conditions are listed along with the explanation where appropriate.

The exact size and configuration of the cable layout will be determined following the site survey and system design effort. For purposes of costing, we have used a 1350 linear mile configuration.

Final installation plans and costs will be determined when system design has been completed. The baseline data contained in the report will be extrapolated as required to support final costing.

19 July, 1976

# SECTION 1

# FIELD DATA

Field data was collected by a two man team working two weeks in December within the survey area of Michigan's Upper Peninsula. This area is outlined on the Map on page 3.

## 1.1 SURVEY TECHNIQUES

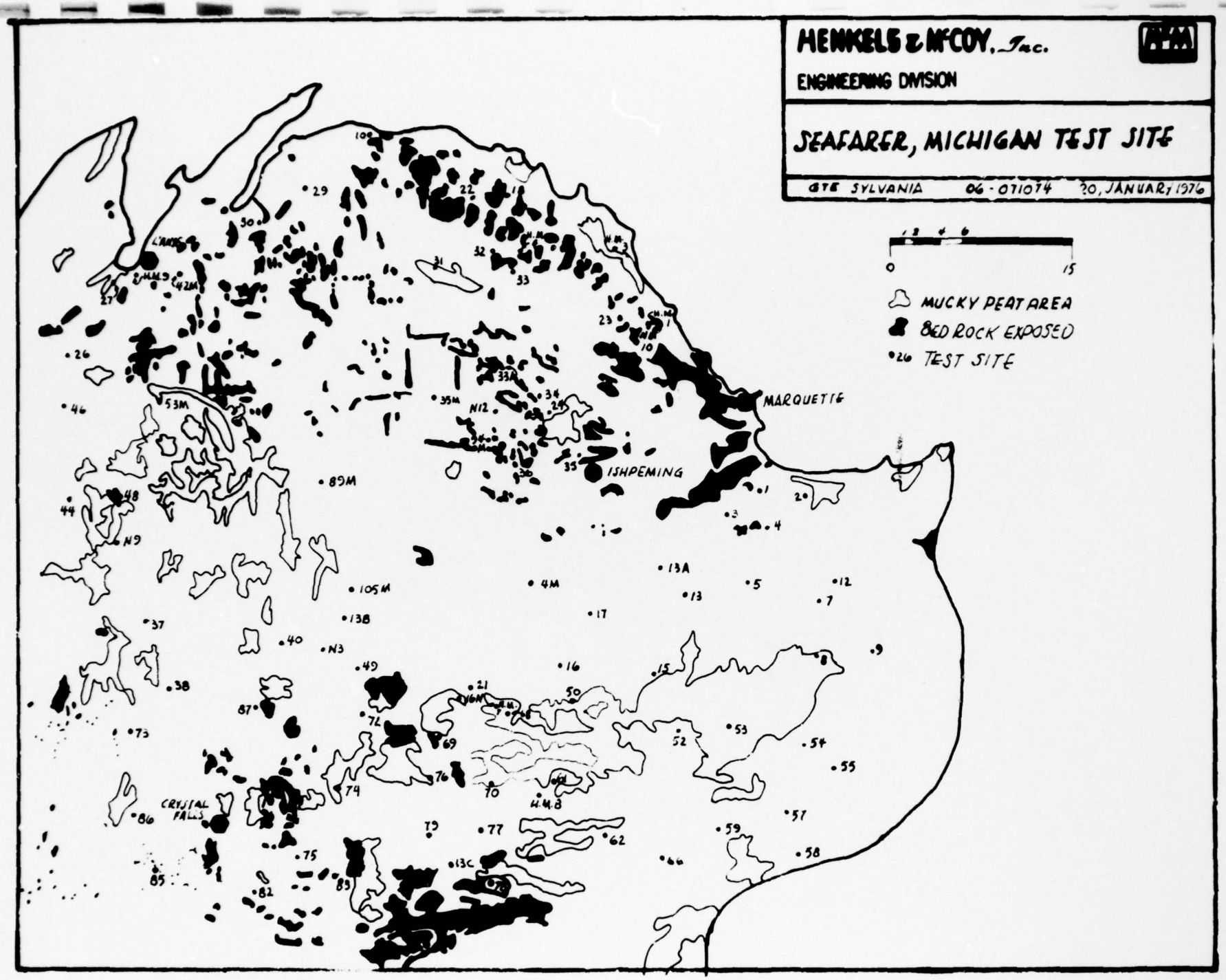
The Henkels & McCoy team used the list of proposed measurement test sites supplied in The Statement of Work as a base for selecting field observation locations. A number of additional sites were added to show unusual conditions on public land and in areas where further investigation was considered necessary.

A large percentage of the sites visited were photographed to illustrate the conclusions of the team. The 80 plus photographs were also used for later evaluation of the site conditions.

The refractive seismograph was found to be ineffectual in this region due to deep snow cover in many areas. The Henkels & McCoy team relied upon a method of physical probing and digging in the soil. This consisted of probing with a 7' steel probe bar. Also many holes were dug with shovel and digging bar.

Numerous physical observations were noted, photographs taken, rock samples taken, etc. to corroborate the conclusions of the survey team. Upon completion of tests, all sites were restored to the condition in which they were found.

The data points are shown on the map on page 3. Except for data points designated with an H&M, all site numbers correspond to those listed in The Statement of Work. The data is listed on pages 4 - 6.


HENKELS & McCOY, Inc.
ENGINEERING DIVISION
SEAFARER, MICHIGAN TEST SITE
GTE SYLVANIA 06-071074 20, JANUARY 1976
0 15
MUCKY PEAT AREA
BED ROCK EXPOSED
•26 TEST SITE
MARQUETTE
ISHPEMING
CRYSTAL FALLS

| SITE NUMBER | LATITUDE | LONGITUDE | | | PROBE DEPTH | SURFACE | HENKELS & MC COY COMMENT AND DESIGNATION |
|---|---|---|---|---|---|---|---|
| 1-S | 46° 28' 15" | 87° 23' 00" | | | 4.5' | Sandy Clay | Plow - Very Wet 3' Down |
| 2-S | 46° 27' 49" | 87° 18' 19" | | | Visual | Sandy Clay | Plow |
| 3-S | 46° 26' 45" | 87° 26' 31" | | | 3' | Pack Sand | Plow |
| 4-S | 46° 25' 32" | 87° 22' 20" | | | 4' | Sandy Clay | Plow W/Some Pre-Rip |
| 5-S | 46° 22' 04" | 87° 24' 30" | | | 6' | Sandy Clay | Plow |
| 7-S | 46° 20' 15" | 87° 17' 00" | | | 3' | Sandy Clay | Hard Packed & Frozen @3',Plow |
| 8-S | 46° 15' 50" | 87° 17' 42" | | | | | Posted No Trespassing |
| 9-S | 46° 16' 45" | 87° 12' 00" | | | 3' | Bog | Sandstone @ 3, Rip |
| 10-S | 46° 54' 06" | 88° 03' 10" | | | 5' | Bog | 1.5' Bog on Sand, Plow |
| 12-S | 46° 21' 45" | 87° 15' 55" | | | Visual | Sandy Clay | Plow |
| 13-S | 46° 20' 26" | 88° 06' 26" | | | Visual | Gravel | Gravel & Sand to 9', Plow |
| 13-A-S | 46° 23' 31" | 87° 33' 27" | | | 2 @ 3' | Boulders | Various Size Rock,Rip & Blast |
| 13-B-S | 46° 20' 26" | 88° 06' 26" | | | 2.5' | Gravel | Rocks @ 2.5'; Plow W/Pre-Rip |
| 13-C-S | 46° 02' 48" | 87° 55' 37" | | | 3' | Sandy Clay | Some Small Boulders, Plow |
| 15-S | 46° 15' 31" | 87° 34' 21" | | | 3.5' | Clay | Plow W/Possible Rip |
| 16-S | 46° 16' 46" | 87° 44' 39" | | | 5' | Pack Sand | Hard Pack Sand, Plow |
| 17-S | 46° 20' 27" | 87° 41' 06" | | | 4' | Pack Sand | Hard Pack Sand, Plow |
| 18-S | 46° 49' 30" | 87° 48' 56" | | | | | No Access, Huron Mt. Club |
| 19-S | 46° 44' 44" | 87° 40' 30" | | | | | No Access |
| 21-S | 46° 15' 24" | 87° 53' 46" | | | 6' | Sand | Plow |
| 22-S | 46° 49' 20" | 87° 52' 06" | | | | | No Access Huron Mt. Club |
| 24-S | 46° 34' 09" | 87° 44' 50" | | | 3' | Sandy Clay | No Sign of Rock Plow |
| 25-S | 46° 23' 20" | 88° 33' 50" | | | 1@6"&1@1' | Bog | Various Ø Boulders,Rip & Blast |
| 26-S | 46° 39' 06" | 88° 35' 28" | | | 4' | Bog | 1' Bog On Sand, Plow |
| 27-S | 46° 43' 37" | 88° 28' 55" | | | 4' | Sandy Clay | Plow, Wet |
| 29-S | 46° 49' 12" | 88° 05' 50" | | | 3' | Sandy Clay | Swampy Area, Plow |
| 30-S | 46° 48' 20" | 88° 14' 43" | | | 5' | Bog | 2'Bog on Sand, Plow |
| 31-S | 46° 44' 38" | 87° 55' 54" | | | 4' | Sandy Clay | Plow |
| 32-S | 46° 45' 30" | 87° 49' 52" | | | 3.5' | Sandy Clay | Plow |
| 33-S | 46° 44' 12" | 87° 48' 00" | | | 4' | Sandy Clay | Plow |
| 33-A-S | 46° 37' 22" | 87° 49' 40" | | | 3' | Pack Sand | Plow,W/Possible Pre-Rip |
| 34-S | 46° 35' 16" | 87° 45' 59" | | | 3' | Sandy Clay | Plow |
| 35-S | 46° 32' 27" | 87° 36' 51" | | | 2' | Earth | Hard Pack, Plow |

| SITE NUMBER | LATITUDE | LONGITUDE | | | PROBE DEPTH | SURFACE | HENNELS & MC COY COMMENT AND DESIGNATION |
|---|---|---|---|---|---|---|---|
| 36-S | 46° 31' 00" | 87° 41' 35" | | | 0' | Rock | Max. Cover 2' Blast & Rip |
| 37-S | 46° 20' 22" | 88° 27' 24" | | | 3' | Bog | Plow W/Possible Rip |
| 38-S | 46° 15' 39" | 88° 25' 00" | | | 2' | Rock | Rock-Blast |
| 40-S | 46° 18' 42" | 88° 13' 05" | | | 1@3'&1@2' | Gravel | Some Rock, Plow |
| 43-S | 46° 30' 29" | 88° 14' 00" | | | 2 @ 2' | Rocky | Boulders W/2' Cover, Rip&Blast |
| 44-S | 46° 28' 54" | 88° 35' 22" | | | 5@1'-1.5' | Earth | Various Ø Boulders, Rip&Blast |
| 46-S | 46° 35' 37" | 88° 35' 52" | | | 6.5' | Sandy Bog | Very Marshy, Plow |
| 48-S | 46° 28' 29" | 88° 30' 42" | | | 3@2' | Earth | Various Ø Boulders, Rip & Blast |
| 49-S | 46° 16' 51" | 88° 05' 14" | | | 5.5' | Sandy Clay | Some Rock @5.5'; Plow |
| 50-S | 46° 13' 50" | 87° 42' 58" | | | 3' | Pack Sand | Sand From Surface Down, Plow |
| 51-S | 46° 12' 26" | 87° 36' 10" | | | 6' | Bog | Sand From 1' Down, Plow |
| 52-S | 46° 11' 28" | 87° 32' 02" | | | 4.5' | Bog | Sandy Gravel 1.5 Down, Plow |
| 53-S | 46° 12' 12" | 87° 26' 13" | | | 6' | Bog | Plow, Very Swampy Area |
| 54-S | 46° 10' 17" | 87° 19' 36" | | | 4.5' | Bog | Gravel@4.5'Plow W/Pre-Rip |
| 55-S | 46° 08' 28" | 87° 16' 22" | | | 1@5',1@6' | Sandy Clay | Hard Pack Sandy Clay, Plow |
| 56-S | 46° 05' 40" | 87° 14' 55" | | | 6.5' | Sandy Clay | Soft, Plow |
| 57-S | 46° 05' 45" | 87° 21' 33" | | | 5' | Sandy Clay | Plow W/Some Pre-Rip |
| 58-S | 46° 01' 22" | 87° 19' 44" | | | 3' | Sandy Clay | Plow W/Pre-Rip Poss. Some Blast |
| 61-S | 46° 08' 29" | 87° 45' 10" | | | 2.5' | Sand & Boulders | Plow &Rock Excavation,Poss.Blast |
| 62-S | 46° 04' 27" | 87° 39' 50" | | | 6' | Sandy Clay | Plow |
| 64-S | 46° 11' 09" | 87° 38' 55" | | | 4' | Bog | Sand From 1' Down, Plow |
| 66-S | 46° 02' 34" | 87° 34' 20" | | | 5' | Sandy Clay | Sandy Clay W/Some Rocks, Plow |
| 68-S | 46° 13' 00" | 87° 49' 42" | | | 5' | Pack Sand | Hard Pack Sand, Plow |
| 69-S | 46° 11' 38" | 87° 57' 01" | | | Visual | Rockoutcrop | Plow W/Pre-Rip & Some Blast |
| 70-S | 46° 08' 03" | 87° 51' 47" | | | 5' | Sandy Clay | Sandy Clay to 5' Plow |
| 72-S | 46° 13' 05" | 88° 04' 55" | | | 1@5'&1@6' | Rock & Earth | Some Subsurface Rock, Plow |
| 73-S | 46° 12' 02" | 88° 29' 24" | | | 3@3' | Sandy Clay | Rip & Possible Blast |
| 74-S | 46° 08' 00" | 88° 07' 36" | | | 3' | Sandy Clay | Misc. Rock, Plow |
| 75-S | 46° 03' 59" | 88° 14' 20" | | | 6' | Sandy | Plow |
| 76-S | 46° 08' 39" | 87° 57' 55" | | | 6' | Sandy Clay | Sand & Clay - Plow |
| 77-S | 46° 05' 05" | 87° 52' 48" | | | 3' | Sandy Clay | Sandy Clay W/Some Rock, Plow |
| 78-S | 46° 01' 24" | 87° 51' 37" | | | 5' | Sand | Sand & Bog, Plow |
| 79-S | 46° 05' 15" | 87° 59' 25" | | | 3' | Bog | Plow |

| SITE NUMBER | LATITUDE | LONGITUDE | | | PROBE DEPTH | SURFACE | HENKELS & MC COY COMMENT AND DESIGNATION |
|---|---|---|---|---|---|---|---|
| 81-S | 46° 09' 55" | 88° 12' 22" | | | 6' | Sandy | Plow |
| 82-S | 46° 00' 31" | 88° 16' 34" | | | 6' | Soft Sand | Plow |
| 83-S | 46° 01' 50" | 88° 08' 20" | | | 2 @ 3' | Sandy Clay | Rock @24" Plow W/Some Rip |
| 85-S | 46° 02' 12" | 88° 26' 57" | | | 6' | Pack Sand | Plow |
| 86-S | 46° 05' 13" | 88° 28' 56" | | | 4' | Pack Sand | Plow |
| 87-S | 46° 13' 40" | 88° 15' 58" | | | 2' | Rocky | Rip,Plow, W/Possible Blast |
| 4-M | 46° 22' 49" | 87° 46' 15" | | | 5' | Pack Sand | Hard Pack Sand, Plow |
| 35-M | 46° 24' 53" | 87° 59' 51" | | | Visual | Rockoutcrop | Blast & Rip |
| 42-M | 46° 44' 56" | 88° 23' 14" | | | 3' | Sandy Clay | Various ØRock, Rip & Plow |
| 53-M | 46° 35' 58" | 88° 25' 26" | | | 6' | Bog | Bog & Sand, Plow |
| 89-M | 46° 29' 45" | 88° 08' 33" | | | 2@1.5' | Rocky | Rip,Plow W/Possible Blast |
| 94-M | 46° 32' 24" | 87° 50' 54" | | | 2@2' | Earth | Small Rocks,@2' Dn.Plow |
| 105-M | 46° 22' 35" | 88° 05' 44" | | | 4@2' | Rocky | Rocks, 1-4' Ø Plow W/Pre-Rip |
| N-3 | 46° 18' 15" | 88° 08' 51" | | | 1@1'&1@3' | Rock&Sand | Misc.Rock,Plow W/Poss Blast. |
| N-9 | 46° 25' 45" | 88° 30' 33" | | | 1' | Earth | Various Ø Boulders, Rip& Blast |
| N-12 | 46° 34' 21" | 87° 50' 24" | | | 2' | Boulders | Rock Shelves, Blast & Rip |
| H&M 1 | | | | | Visual | Rock | Blast & Rip |
| H&M 2 | | | | | 3.5' | Gravel | Plow W/Some Pre-Rip |
| H&M 3 | | | | | 3' | Bog | Plow, Very Wet Area |
| H&M 4 | | | | | 3'-4' | Pack Sand | Plow |
| H&M 6,59 | 46° 04' 41" | 87° 28' 30" | | | 2.5' | Pack Sand | Limestone or Sandstone,Plow & Rip |
| H&M 7 | | | | | Visual | Sandy Clay | Plow |
| H&M 8 | | | | | Visual | Sand & Boulders | Plow,Boulders Mostly Small |
| H&M 9 | | | | | Visual | Rock | Road Cut Blast |
| H&M 10 | 46° 37' 10" | 87° 37' 00" | | | Visual | Rock | Blast & Rip |
| | | | | | | | |
| | | | | | | | |
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## 1.2 DATA SUMMARY

The Statement of Work called for minimum data points in three classifications of soil conditions corresponding to three antenna installation techniques, plow, rip and drill/blast. Because of the anticipated subsurface obstructions of roots and rocks and due to the depth of plowed cable, 6 feet, all plowed areas will be pre-ripped. In order to comply with the statement of work, the field data has been tabulated as plow, rip and drill/blast. However, the data should be interpreted as plow meaning easy rip and rip meaning moderate to difficult rip.

Some data sites exhibited more than one type of construction approach. These were areas where some rock, or boulders, could be ripped and others would require blasting. It should be noted that these designations were made for the general area visible from one data site and not just a specific point on the ground.

The data summary is as follows:

53 sites - plow
13 sites - rip
2 sites - drill/blast
2 sites - plow & drill/blast
12 sites - rip & drill/blast
4 sites - plow, rip & drill/blast

Of these sites, 17 were classified wet, being peat bog, swamp or containing many small streams.

The only steep grade conditions observed in this region were either man-made (i.e., road cuts and gravel pits) or rock outcrops. Of the above sites, 2 were man made and 6 were rock out cropings.

1.2 DATA SUMMARY (continued)

Crossings with major pipelines, underground electric and telephone cables, roads, streams, fences and railroads were visited and investigated. No excavations were made at these locations other than the aforementioned probing. Information has been obtained to determine crossing requirements for these various systems. This information is included at a later point in this report. Drawings have been included in Section 2 showing some typical methods of crossing roads and railroads.

For purposes of evaluating the field data, as well as planning construction, a composite map was prepared using data found separately on other maps. A portion of the composite map is included on page 3. The reference maps for this composite are the EDAW maps of Soil Data and Bed Rock Geology along with The Department of Natural Resources Maps listed on page 9 .

The various size maps were brought to equal scales by projecting a photograph of each map on a ground glass screen. When information was desired from a certain map, it was projected on the screen and the information was traced off. By adjusting the projector-to-screen distance, the maps could be adjusted to any scale.

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## MAP BIBLIOGRAPHY

United States Geological Survey maps; (250,000 scale)

- Escanaba
- Iron Mountain
- Iron River
- Marquette

Michigan Department of Natural Resources Maps;

- Alger Co.
- Marquette Co.
- Baraga Co.
- Dickinson Co.
- Iron Co.

Glacial Geology - Marquette - L'Anse Region.

- Michigan Technological University

EDAW Project Sanguine, Upper Michigan Region Site Study Maps;

- Ownership
- Climatic
- Mineral Extraction
- Bed Rock Geology
- Subsurface Water
- Land Productivity
- Population & Demographic
- Market Value
- Transportation
- Surface Water
- Vegetation
- Land Use
- Soil Data

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SECTION 2

## REQUIREMENTS FOR CONSTRUCTION

The final total project cost and unit costs are arrived at after careful consideration of all aspects of the construction project. These various aspects are identified and discussed in this section.

### 2.1 TYPES OF CONSTRUCTION

The present Seafarer antenna layout requires two basic types of installation conditions. These are: cable placement on cross country rights-of-way and cable placement parallel to and within existing road rights-of-way. Within each of these categories are additional conditions to be considered. The most important of these are the bog and rock areas.

In order to arrive at a construction cost that took into consideration all of the different types of construction conditions, it was necessary to establish the extent of these conditions. This was done by analyzing the field data and studying the various map systems listed in Section 1. The model antenna layout provided Henkels & McCoy, dated 3 December, 1975, was a primary data source. This antenna layout, which was supplied by GTE Sylvania, represented preliminary design and will be modified several times before being finalized. It was utilized in this study as a baseline for cost modeling. The unit costs derived here can later be applied to the final antenna design to establish its construction cost. This layout showed a sample route for the 1350 mile baseline antenna system addressed by this report. The layout was keyed to show where the cable fell along existing roads, trails or rights-of-way and where new rights-of-way would be required. These distances were scaled off and, using other maps available, distances for rock and bogs were also obtained. This process provided the following distances that are used in Section 4 to obtain cost data:

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2.1 TYPES OF CONSTRUCTION (continued)

| Construction Type | | DISTANCE IN MILES |
|---|---|---|
| ROW - | Dry | 418 |
| | Wet (Bogs) | 60 |
| | Rock | 27 |
| | Trench | 5 |
| Road - | Plow Off Pavement | 705 |
| | Plow From Pavement | 87 |
| | Rock | 28 |
| | Trench | 20 |
| | TOTAL | 1350 |

A complete breakdown and explanation of the construction types listed here is given in Section 3, The Installation Plan.

2.2 MANPOWER

We estimate that approximately 77 percent of the total manpower for this project can be obtained from The Northern Michigan - Upper Peninsula Region. A breakdown of types of manpower required and that estimated to be available locally is listed below. Some classifications of manpower would be imported by the contractor regardless of the local availability. The numbers listed here are for the installation of the 1350 mile baseline antenna with cable plowed to a depth of six feet.

| CLASSIFICATION | TOTAL REQUIRED | OBTAINED LOCALLY |
|---|---|---|
| Administration and Supervision | 28 | 16 |
| Foreman | 90 | 45 |
| Operator | 165 | 70 |
| Journeyman | 37 | 30 |
| Tree Trimmer | 50 | 50 |
| Driver | 78 | 78 |
| Laborer | 190 | 190 |
| Blaster | 9 | 9 |
| Driller | 42 | 42 |
| Mechanic | 10 | 4 |
| Mechanic Helper | 6 | 6 |
| Welder | 5 | 3 |
| Welder Helper | 2 | 2 |

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2.2 MANPOWER (continued)

| CLASSIFICATION | TOTAL REQUIRED | OBTAINED LOCALLY |
|---|---|---|
| Watchman | 30 | 30 |
| Surveyor | 18 | 10 |
| Surveyor Assistant | 27 | 20 |
| Engineer | 2 | - |
| Assistant Engineer | 2 | - |
| Draftsman | 2 | 2 |
| Total | 793 | 607 |

2.2.1 Equipment

The types of equipment required for this project are listed below along with the anticipated quantities and availability of this equipment in the study area. The totals include back up equipment.

| EQUIPMENT | TOTAL REQUIRED | OBTAINED LOCALLY |
|---|---|---|
| D-9 W/Blade & Plow | 35 | 2 |
| D-7 W/Blade & Winch | 16 | 4 |
| D-6 W/Blade & Winch | 25 | 4 |
| Austin - Western 501 Super-Grader W/Plow | 8 | 3 |
| Cat. 980 Front End Loader | 7 | 4 |
| Case 580 Backhoe | 29 | 8 |
| Lubrication Truck | 8 | 2 |
| Fuel Truck | 8 | 2 |
| Welding Truck | 4 | 4 |
| Tow Truck | 2 | 2 |
| Air Compressor 600 CFM | 45 | 8 |
| Air Compressor 105 CFM | 15 | 15 |
| Pick-up Truck 3/4 Ton - 4 Wh. Drive | 25 | 15 |
| Stake Truck 4 Ton | 14 | 5 |
| Stake Truck 1½ Ton 4 Wh. Drive | 27 | 5 |
| Concrete Saw | 5 | 3 |

2.2.1 Equipment (continued)

| EQUIPMENT | TOTAL REQUIRED | OBTAINED LOCALLY |
|---|---|---|
| Crew Cab Truck 4 Wh. Drive | 102 | 20 |
| Wagon Drill | 45 | 5 |
| Low Boy W/Tractor | 35 | 15 |
| Cable Trailer | 2 | 2 |
| Diesel 18 Yd. Terex Dump | 18 | 10 |
| Fork Lift 2000# | 2 | 2 |
| Automobile | 8 | - |
| Conduit Pushing Equipment | 4 | 4 |
| Crane Pettibone Model 30-18 Ton | 1 | 1 |
| Tag-A-Long Trailer | 8 | 8 |
| Light Dump | 4 | 4 |
| Pumps Diesel 4" | 11 | 5 |
| Chipper V-8 | 24 | 10 |
| Case 850 Excavator | 11 | 5 |
| Farm Tractor | 9 | 9 |
| Chain Saw | 118 | 50 |
| Rock Saw Trencher | 3 | 1 |
| Trailer | 18 | 10 |
| Tractor & Trailer | 2 | 2 |
| Trailer Plow | 4 | - |
| Total | 702 | 249 |

## 2.3 HOUSING

We estimate a peak work force of 686 people during the major installation portion of this project. There are, within a reasonable distance from most work areas, sufficient facilities to provide food and shelter for the work force. While we do anticipate utilizing local people for a large segment of our labor force, we have included subsistence costs in the man day rate to cover either travel and/or living expenses as required by union rules. Transportation from the pre-determined reporting area to the work site will be provided where it is more practical or economical.

## 2.4 WAREHOUSING

Based on the configuration of the antenna system, we have chosen three locations for all warehousing and their use will be dependent upon work progress and needs. The three will be in Ishpeming, Crystal Falls and L'Anse. There are facilities available at all three locations for weather-proof secure storage.

## 2.5 STAGING

Company headquarters for this project will be located in Ishpeming. The choice of this location lends itself to the overall efficiency of the project by acting as a central warehousing and staging facility. It has facilities for receiving rail and road deliveries as well as being in close enough proximity to Marquette to make delivery by ship feasible.

As in the case of warehousing facilities, the staging areas would be located according to needs, in Ishpeming, Crystal Falls and L'Anse. These areas are located within a 30 mile radius from most of the work and the staging areas can be re-located if the need arises. All functions included in the project could be staged from these three locations dependent upon the time of year and work involved.

## 2.6 SECURITY REQUIREMENTS

Twenty-four hour security will be required at all warehousing and staging areas for equipment and material. In addition, a mobile security force would be utilized in the field to patrol areas where heavy equipment has been left either overnight or on weekends. Light, wheeled equipment will be returned to the staging areas at the end of each work day.

## 2.7 RIGHT-OF-WAY

A nominal right-of-way width of 25 feet is considered adequate for most of the work areas. However, wider areas of 50 feet spaced approximately every 1000 feet will be required to allow for equipment movement and parking. Also, there will be many areas where a minimum ROW of perhaps 15 feet will be sufficient. Such a case would be short sections of ROW between roads where it is not necessary to run equipment long distance up and down the ROW.

For purposes of cost estimating, all off-road right-of-way is assumed to be tree covered and will require clearing. Road ROW may require minimal tree cutting.

Cable installation along roads will be made as close as possible to the edge of the road ROW. When it is necessary to place cable close to the road pavement, rubber wheeled equipment will be used to minimize damage to the road surface.

## 2.8 RESTORATION

All areas of construction, including rights-of-way, road shoulders, staging areas, water crossings and any other areas whose natural state is in any way disturbed by the construction operation, will be restored insofar as practicable. Road shoulders and rights-of-way will have the cable trench and/or slot properly tamped and closed to avoid erosion from water runoff. Where washouts are likely to occur, sand bags or crushed stone will be used. All areas will be graded to their original contour, disked, fertilized and seeded with materials suitable to the site and beneficial to wildlife as approved by The Michigan Department of Natural Resources (DNR).

Stream crossings will be restored in accordance with the rules and regulations concerning Inland Lakes and Stream Act of 1972, Act 346 (State of Michigan) paragraphs 281.837 and 281.838.

2.8 RESTORATION (continued)

Roads will be crossed by either open cutting, direct plowing or boring and will be restored and, where necessary, repaved in accordance with the requirements of The Michigan Department of Highways. Repaving in areas where roadways are damaged by construction equipment will also comply with these regulations.

All materials of construction will be removed from the work areas and disposed of accordingly. Brush from right-of-way clearing will be chipped and scattered. Trees too large for chipping will be either sold or cut and piled. This includes the logs used for corduroy roads which will be dismantled after use.

Costs for planting screens at road crossings have not been included in this study, but will be accomplished in accordance with DNR requirements.

2.9 SPECIAL OR UNUSUAL CONDITIONS

2.9.1 Fuel

We have estimated that over seven million gallons of diesel and gasoline fuel will be required in order to operate all equipment and support vehicles for this project. It is necessary that this amount of fuel be committed independently for this project since the contractor cannot depend upon local dealers to supply this quantity of fuel. The cost for bulk requisitioning, transportation and storage has been included in our estimate.

2.9.2 Road & Railroad Crossings

At least 300 paved and high grade gravel road and railroad crossings have been identified from the grid and county maps. These crossings will be accomplished by either placing a conduit under the road or railroad, or as in the case of some roads, cutting the road and then direct plowing across the road. Other, lesser grade roads, will be crossed by plowing without the need for any pre-cutting. All of these crossings constitute approximately 5 miles of the total array.

19 July, 1976

2.9.2 Road & Railroad Crossings (continued)

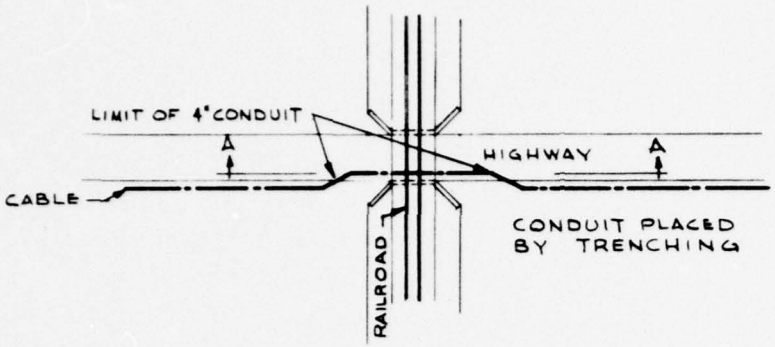
A major item to be considered in these crossings is the permits required by both the Highway Department and the railroads before construction is permitted to proceed. The time required to obtain these permits is three weeks for highways and up to six months for railroads. Drawings, such as the examples shown on the next several pages, are required for permit approval. The cost of preparing these drawings and obtaining the permits has been included in the estimate.

Both the Highway Department and the railroads have minimum depths for any structure crossing them. These are 48 - inches for highways and 42 - inches for railroads.

Any repaving required after a crossing is completed will be performed in accordance with the specifications of the Michigan Department of Highways.

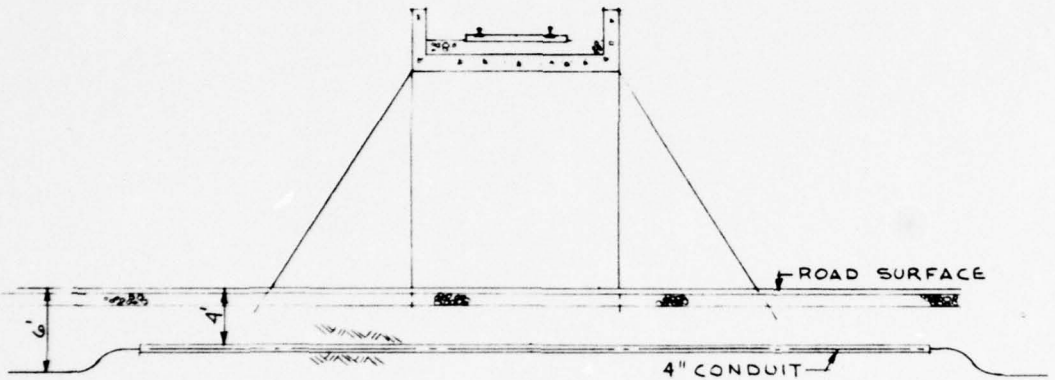
Abandoned railroads will be crossed in the same manner as operating railroads when track is still in place. Where track has been removed, direct plowing will be done. Due to the uncertain quantities and conditions of the abandoned railroads, no cost has been included specifically for their treatment. It is anticipated that any additional cost would be minimal.

The drawing on page 22 illustrates the detail required on the application drawing for railroad crossing permits. The form attached to the drawing (page 23) is typical of the information requested by the railroad.




PLAN

SCALE: NONE




SECTION A-A

SCALE: NONE

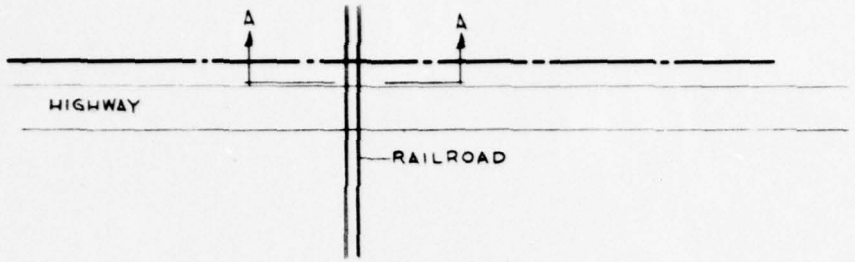
HENKELS & McCOY, Inc.

ENGINEERING DIVISION

RAILROAD UNDERPASS CROSSING

| | | | |
|---|---|---|---|
| CLIENT: GTE SYLVANIA | | JOB NO. | |
| DWN./DES. | DATE 3-2-76 | SCALE | REV. |
| CHK. | DATE | DRAWING NO. | |
| APPROVED | DATE LICENSE NO. | | |

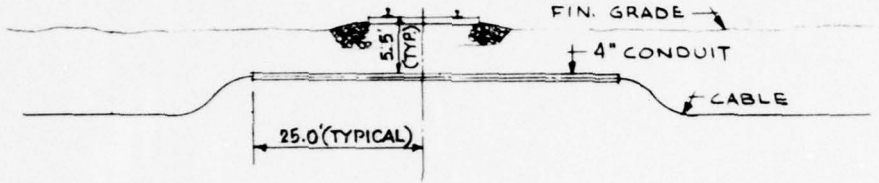
-18-




PLAN

SCALE : NONE

NOTE:
4" CONDUIT
PLACED BY BORING



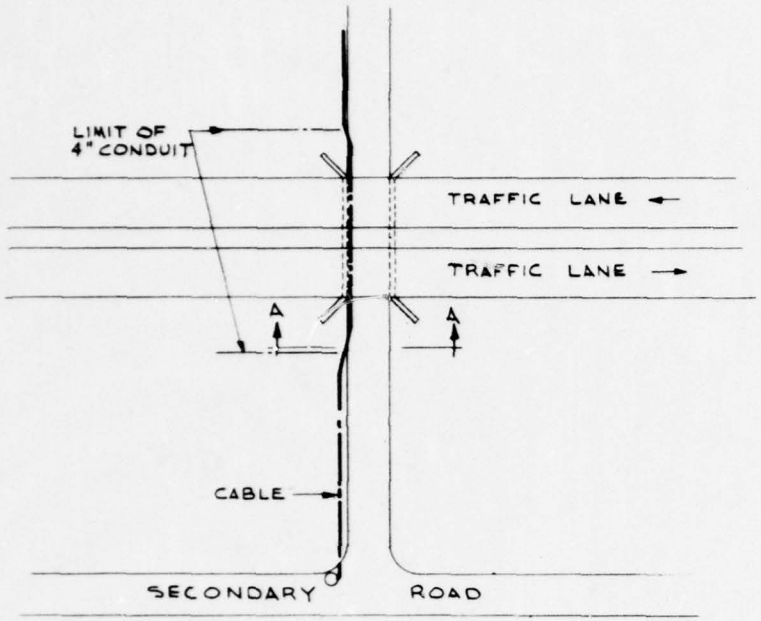

SECTION A-A

SCALE : NONE

HENKELS & McCOY, Inc.
ENGINEERING DIVISION

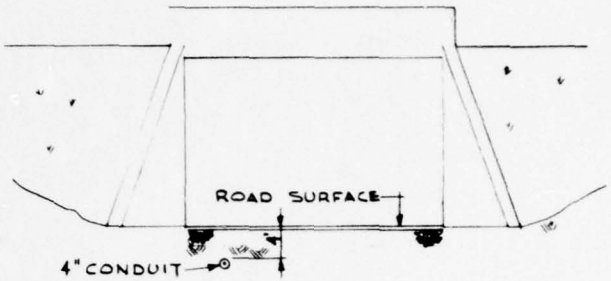
BORED RAILROAD CROSSING

| | | | |
|---|---|---|---|
| CLIENT: GTE SYLVANIA | | | JOB NO. |
| DWN./DES. | DATE 3-2-76 | SCALE — | REV. |
| CHK. | DATE | DRAWING NO. | |
| APPROVED | DATE | LICENSE NO. | |




PLAN

SCALE : NONE



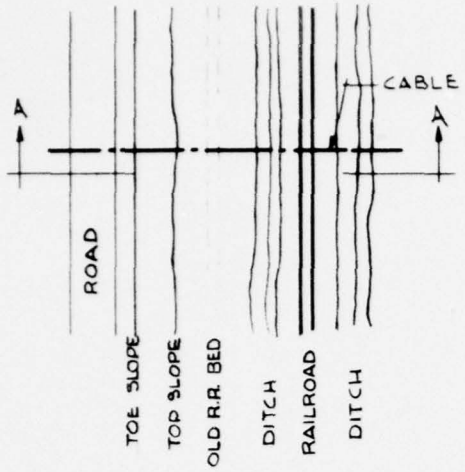

SECTION A-A

SCALE : NONE

HENKELS & McCOY, Inc.
ENGINEERING DIVISION

HIGHWAY
UNDERPASS CROSSING

| | | | |
|---|---|---|---|
| CLIENT: G.T.E. SYLVANIA | | JOB NO. | |
| DWN./DES. | DATE 3-2-76 | SCALE — | REV. |
| CHK. | DATE | DRAWING NO. | |
| APPROVED | DATE LICENSE NO. | | |




PLAN

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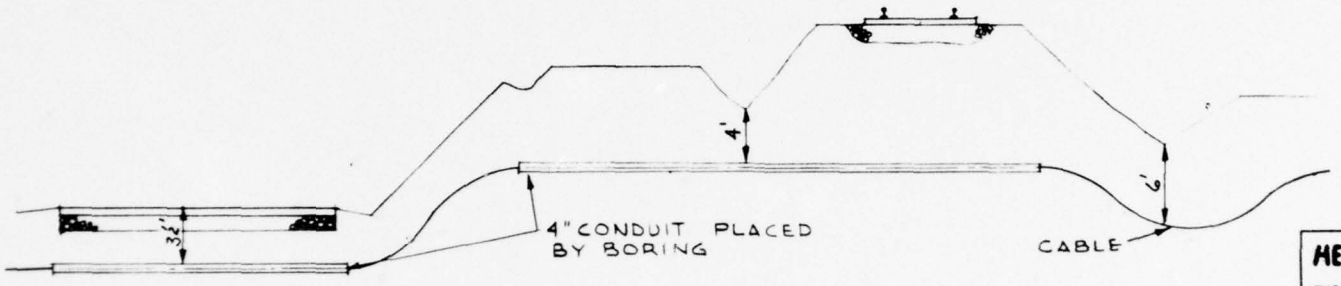



SECTION A-A

SCALE : NONE

HENKELS & McCOY, Inc.

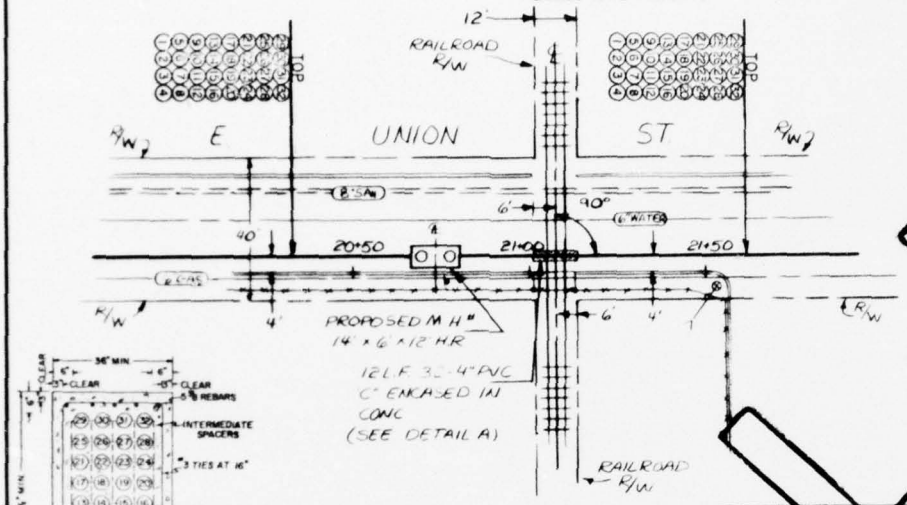
ENGINEERING DIVISION

UNEVEN TERRAIN CONDUIT BORING

| | | | |
|---|---|---|---|
| CLIENT: GTE SYLVANIA | | JOB NO. | |
| DWN./DES. | DATE 3-3-76 | SCALE | REV. |
| CHK. | DATE | DRAWING NO. | |
| APPROVED | DATE LICENSE NO. | | |

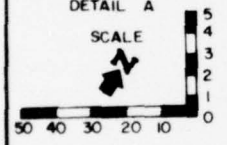
NOTE:

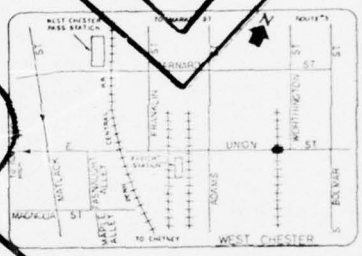
1. ALL CONSTRUCTION SHALL CONFORM TO THE SAFETY PRACTICES REQUIRED BY OSHA STANDARDS.
2. COORDINATE THE CONSTRUCTION OF THIS PROJECT WITH THE BELL TELEPHONE COMPANY OF PENNSYLVANIA PROJECT UNDER PROJECT NO. 23-01 & FOLLOW APPLICABLE REQUIREMENTS INCLUDED THEREIN.
3. THE INFORMATION ON THESE DRAWINGS IS NOT GUARANTEED. CONTRACTOR MUST VERIFY TO HIS OWN SATISFACTION.
4. COORDINATE WITH INDUSTRIES SERVED BY SIDING SO CONSTRUCTION DOES NOT INTERFER WITH PLANNED RAIL TRAFFIC.









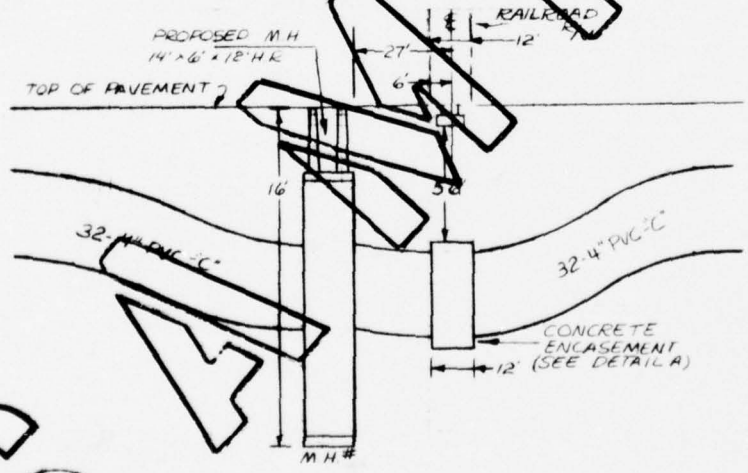



PLATE IV

## PIPE CROSSING - DATA SHEET

In addition to plan and profile of crossing, drawings submitted for [redacted] Transportation Company approval shall contain the following information:

| | Pipe Data | |
|---|---|---|
| | Carrier Pipe | Casing Pipe |
| Contents To Be Handled | | |
| Normal Operating Pressure | | |
| Nominal Size of Pipe | | |
| O. S. Diameter | | |
| I. S. Diameter | | |
| Wall Thickness | | |
| Weight Per Foot | | |
| Material | | |
| Process of Manufacture | | |
| Specification | | |
| Grade or Class | | |
| Test Pressure | | |
| Type of Joint | | |
| Type of Coating | | |
| Details of Cathodic Protection | | |
| Details of Seal or Protection at Ends of Casing | | |
| Method of Installation | | |
| Character of Subsurface Material at the Crossing Location | | |
| Approximate Ground Water Level | | |
| Source of Information on Subsurface Conditions (Borings, Test Pits or Other) | | |

NOTE: Any soil investigation made on railroad property or adjacent to tracks shall be carried on under the supervision of [redacted] Transportation Company's Chief Regional Engineer.

2.9.3 Weather

Weather conditions will play a significant role in this construction project. Production time will be lost. An estimate of 15 percent for winter and 10 percent for other seasons has been used in the cost estimate. Production will be slowed. Even during good days, the production of a crew will be less in the winter. This has been taken into consideration in the crew rates of advance. Work along highways will be curtailed during certain months of the year. The letter on the next page explains this limitation.

Probably the worst conditions will occur in the spring when rains and thaw will make many of the work areas very muddy. Work will be scheduled to avoid these areas as much as possible but it will still remain a problem.

2.9.4 Wet Areas

Due to the nature of the terrain in the Upper Peninsula, there exist numerous, wet, swampy areas that vary in size from small streams to bogs a few miles in width and length. While these areas will be avoided as much as possible in the antenna configuration, there are numerous areas where the crossing of these wet areas will be required and this requirement has been dealt with in the construction plan under separate conditions.

The first of these conditions is stream crossings. There are an estimated 365 stream crossings in the baseline antenna layout. Approximately 245 of these can be crossed by plowing with the tracked plow crew. This method is preferred by the Michigan Department of Natural Resources as it minimizes the disturbance to the natural condition of the stream and its banks. The second method, used for deeper waterways, requires the use of a trailer plow. This machine can be winched across the stream by a machine on the bank and the cable plowed into the stream bed. The trailer plow can operate in deeper water than the dozers and still place the cable at an optimum depth. An estimated 75 crossings will be made in this manner. There may be some water crossings too deep for any of the methods described here. In that event a trench will be dug across the bottom of the area using a drag bucket or clam shell. This equipment is not included in the cost of the project.

STATE OF MICHIGAN

ADDRESS REPLY TO
336 SUPERIOR AVENUE
CRYSTAL FALLS, MICHIGAN 49920

WILLIAM G. MILLIKEN, GOVERNOR

**DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION**

STATE HIGHWAYS BUILDING - POST OFFICE DRAWER K - LANSING, MICHIGAN 48904

JOHN P. WOODFORD, DIRECTOR

September 19, 1975

Henkels & McCoy Inc.
Engineering Division
28333 Telegraph Road, Suite 409
Southfield, Michigan 48076

Attention: Douglas E. Thompson

Dear Mr. Thompson:

Your letter of August 28, 1975 regarding the placing of cable along State highways has been referred to me for reply.

District #1 of the Department of State Highways & Transportation is composed of the following counties: Baraga, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Marquette, Menominee and Ontonagon. Other counties mentioned are in the Newberry District.

The starting and stopping dates for plowing of cable could be determined by a number of items such as:

1. Spring weight restrictions.
2. Frost conditions.
3. Seasonal limilation of bituminous items (Oct. 15th in the U.P.).
4. Soil types.
5. Restoration items to comply with Act 347, P.A. 1972, Soil and Sedimentation Control Act.

Generally plowing can begin in May and should be completed by the end of October in District #1. We do review each permit individually and do specify the completion date based on past experience for the area involved.

Should you have any further questions regarding this matter, please feel free to call or write to me.

Very truly yours,

G. W. Toivonen

G. W. Toivonen
District Utilities-Permits Engineer

906-875-6651

MICHIGAN
THE GREAT LAKE STATE

2.9.4 Wet Areas (continued)

A third method of crossing streams or other obstacles when highway or railroad bridges are available is to install conduit on the bridge structure and pull the cable through the conduit. This method is used for 45 crossings in the cost estimate.

The bogs constitute the major portion of the wet areas and three different methods are used to install the cable in these areas. The first method is to plow the cable in the same manner as dry areas. Although slower progress is made in the bogs, some of them (we have estimated twenty miles) have a hard enough bottom to support the construction equipment. Only one or two feet of water cover much of these sections. Where the bottom is not so shallow, or firm, a corduroy road will be built (estimated at 30 miles) using the logs left from the right-of-way clearing. Equipment will then be run on this road, which will be removed when construction is complete.

Some areas are expected to be nearly inaccessible except in the late winter when the bogs are frozen. No technical data on the load bearing properties of bogs in winter was located. If such data becomes available in the future, it may require some revision in those portions of the installation plan involving those areas. An estimated ten miles of cable will be installed during the winter. A trench approximately six inches wide will be cut with a rock saw through the ice and frozen earth to below frost and then a trailer plow will be used to place the cable to its proper depth.

Because of the delicate nature of the environment in the bogs, as well as the difficulties of working in them, extra planning is required to minimize the amount of equipment, number of trips through and the overall disruption of the area. Right-of-way width will be kept to 15 feet wherever possible. Special care will be taken to eliminate disposal of any construction material or the spillage of any fuels in the bog areas. Restoration will be made where possible but it is expected that most of the area traversed by the work crews will be covered with water.

All wet areas will be entered, worked in and restored in accordance with the rules and regulations of the inland Lakes and Streams Act of 1972, Act 346.

Permits are required by Act 346 for the construction of any structures on bottomland. This would apply to the Seafarer installation in the wet areas. The application for this permit is shown on the next page. No cost has been included for the preparation or obtaining of these permits.

2.9.5 Bridges

Most major roadways in the Upper Peninsula have bridges of sufficient size and strength to support most of the heavy equipment required in this project. However, there do exist a large number of secondary and unimproved roads which may present a transportation problem. While the transportation of the heavier equipment will not be undertaken very often, there will be certain conditions which may require their replacement or allocation to another work area. This would necessitate the availability of bridges capable of supporting the weight of the vehicle and its transport. We have made no effort at this time to determine which bridges would need additional structural support.

2.9.6 Underground Utilities

Buried telephone, electric, gas, water and sewer lines are found in many areas of the Upper Peninsula. As population density increases, so does the number of underground utilities. The Seafarer antenna cables will have to cross many of these structures. Careful route layouts can minimize these crossings, but they will still exist to some degree. The exact degree will not be known until the final antenna layout is approved. Most utility specifications call for a minimum of one foot of clearance between the utility and any other structure.

DNR USE ONLY

PERMIT NO.

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

# APPLICATION FOR PERMIT

(Act 346, P.A. 1972)

Date _____

In accordance with Act 346, P.A. 1972, the undersigned herewith makes application for a permit to:

_____
(indicate type of project proposed)

1. Project located in _____ County _____ Township

Section _____ T _____ R _____ on _____
(name of lake or stream)

2. Legal description of upland property at project site:

Name of Plat _____ Lot Number(s) _____

Is the applicant the owner of the above described property? ☐ Yes ☐ No If not attached the name and address of record owner and authorization for project.

3. State reason for this proposed project. (be specific)

4. Attach a drawing of existing and proposed site. (please refer to instructions on reverse side in preparing drawing)

5. If you have made application to the U.S. Army Corps of Engineers for this project and have received a process or permit number, please insert number _____

**6. Statutory application fee of $25.00 required with all non-governmental applications; make check payable to the State of Michigan.**

**PAYMENT OF FEE DOES NOT GUARANTEE PERMIT.**

7. Return completed application and accompanying material to: DEPARTMENT OF NATURAL RESOURCES, HYDROLOGICAL SURVEY DIVISION, STEVENS T. MASON BUILDING, LANSING, MICHIGAN 48926.

Applicant's Signature _____

Typed or printed name _____

Address _____

City, State, Zip Code _____

*Phone Number* _____

**APPLICATIONS NOT FULLY COMPLETED WILL BE RETURNED**

(See instructions on reverse side)

FOR CASHIER'S USE ONLY — DO NOT WRITE IN THIS SPACE

R 4508 Rev. 7/75

---

# APPLICATION FOR PERMIT

State of Michigan
Department of Natural Resources

| |
|---|
| Name of Remittor |
| Address |
| Purpose Act 346 |



R 4508 Rev. 7/75

2.9.6 Underground Utilities (continued)

To account for the cost of crossing these structures, we have estimated a total of 15 miles of trenching just for the purpose of crossing utilities.

The local utilities should be notified well in advance of construction (1-2 months) to allow them time to mark their locations prior to the actual trenching and plowing operations. The utilities are very willing and anxious to provide this assistance, especially in conjuction with any type of construction that poses a threat to their own plant. Close cooperation with them will be beneficial to all parties.

2.9.7 Permits

Three types of permits have been identified in the discussion of the previous paragraphs. These are permits to place cable across streams and wet areas, under railroad tracks and under or parallel in road rights-of-way. These permits are in addition to all right-of-way and easement permits.

The construction plan provides for the contractor to obtain the road and railroad permits. Average time required to obtain these permits are 3 weeks and 6 months, respectively. No cost has been included to obtain stream crossing permits which require approximately thirty to sixty days for approval. No cost is included for any right-of-way or easement procurement.

It is important that all necessary permits be obtained well ahead of construction to prevent any delays in field work.

INSTRUCTIONS for completing application:

In accordance with Act 346, P.A. 1972, as amended, the undersigned herewith makes application for a permit to: indicate type of project, i.e. dredge, place fill, construct seawall, construct or place bridge or culvert, modify or enlarge existing structure, etc.

1. Location of Project: The County, Township, Section, Town and Range, and the name of the lake or stream must be given.

2. Legal description of upland property where project is located (can be taken from tax statement). Attach an additional sheet if necessary.

   If applicant is not the record owner the name and address of the record owner, along with a letter of authorization or copy of easements, etc. must be attached.

3. State reason for proposed project. A brief statement indicating applicant's purpose is required.

4. Drawing need not be prepared by an engineer or surveyor, however, it must be in black ink or black pencil on standard weight paper of 8½" x 11" sheet size (see exception below), and the drawing must:
   a. be drawn to scale,
   b. have arrow showing north,
   c. show all existing and proposed structures,
   d. show dimensions of shore frontage, existing and proposed structures,
   e. show configuration of shoreline on both sides of your frontage,
   f. show sufficient soundings to represent bottom contours,
   g. indicate by arrow the direction of current in rivers,
   h. show names of waterways and prominent points, and
   i. show relative location to political subdivisions; include location map and address of project site.

   EXCEPTION: Blueprints and drawings on sheets larger than 8½" x 11" are acceptable; however, five (5) copies must be submitted with application.

5. In the event the project for which permit is being sought involves the use of explosives and/or tools, and equipment other than non-powered tools it shall be the responsibility of the permittee to meet all requirements of Act 53, Public Acts of 1974.

   Use complete address when submitting application. Provide complete address for applicant.

APPLICATIONS NOT FULLY COMPLETED WILL BE RETURNED!

Also, is there at present any litigation in process involving your property? ____yes. ____no.

State below the name and address of an officer of any appropriate property owners' association, as recorded with the county clerk of the county in which the proposed project will be located, and the names and addresses of adjacent or opposite riparians.

---

Do not write below this line--for cashier use only.

19 July, 1976

# SECTION 3

# INSTALLATION PLAN

This section lists the parameters and describes the methods to be employed in the installation of the baseline. The charts at the end of this section show estimated manpower and time schedules.

## 3.1 BASELINE PARAMETERS

### 3.1.1 Quantities

| Function | Miles |
|---|---|
| Rip-Plow Road Shoulder | 705 |
| Rip-Plow From Road | 87 |
| Rip-Plow Dry ROW | 418 |
| Rip-Plow Wet ROW | 50 |
| Rip-Plow Frozen | 10 |
| Drill/Blast Road | 28 |
| Drill/Blast ROW | 27 |
| Utility Crossing Trench | 15 |
| Trench | 5 |
| Road- RR - Water Crossing | 5 |
| Splices | 1974 |
| Right-of-Way Clearing | 510 |

3.1.2 Cable depth in Plow/Rip and Trench areas along roads and in dry right-of-way will be 6 feet. Cable depth in marshy areas to be 6 feet. Cable depth in drill/blast areas will be 30 inches. All rates of advance for the baseline plan are based on these cable depths.

3.1.3 All plow areas will be pre-ripped.

3.1.4 A nominal 25 foot right-of-way will be used with 50 foot square turn arounds every 1000 feet.

3.1.5 All new right-of-way will require tree clearing.

3.1.6 All right-of-way survey and clearing will be completed prior to start of cable installation.

3.1.7 Cable to be supplied on reels containing approximately one mile of cable.

3.1.8 Select fill of 6-inches on top and bottom of cable in rock trench areas will be used.

3.1.9 Costs are based on labor and equipment rates in effect on 1 March, 1976. No inflation factor has been included.

3.1.10 As-built drawings will be provided by the contractor at the end of the job.

3.1.11 No material is included except drilling and blasting supplies and select fill.

3.1.12 Five - 9 hour days is the basic work week.

3.1.13 The project schedule includes the completion of all right-of-way surveying and most right-of-way clearing the first summer (May-October), completion of clearing in January and February, construction from May to October of the second summer, completion of installation in frozen areas in January and February of the second winter and final restoration that spring. Total project 26 months, major construction, 6 months.

3.1.14 All easement and/or right-of-way permits shall be obtained prior to start of survey.

3.1.15 No cost has been included for any payment for timber removed during the project.

3.1.16 Restoration costs include grading, fertilizing, disking and seeding in the right-of-way, where necessary,suitable to the site and beneficial to wildlife. This does <u>not</u> include the cost of materials nor does it include screen plantings that may be required at road crossings.

3.1.17 All work will be performed in accordance with all local, state and federal codes, rules, regulations and laws.

19 July, 1976

3.2 MAJOR EVENTS

3.2.1 Layout of cable routes on site maps.

3.2.2 In the first spring, survey and stake cable routes in right-of-way sections.

3.2.3 Establish first base of operations and gather ROW clearing equipment and men.

3.2.4 Begin right-of-way clearing.

3.2.5 Complete survey and all possible portions of ROW clearing.

3.2.6 Complete ROW clearing work in wet (frozen) areas during first winter.

3.2.7 Order material in sufficient quantity to assure at least two weeks supply on site at all times. This will amount to approximately 130 miles of cable and supplies for 200 splices.

3.2.8 Set up headquarters and initial construction operations center. Establish the coordinations necessary with all parties involved in the project.

3.2.9 Establish staging and warehousing areas and begin set up.

3.2.10 Move in equipment and hire labor force.

3.2.11 Begin rip/plow operations on ROW.

3.2.12 Begin rip/plow operations on roads.

3.2.13 Begin drill/blast operations.

3.2.14 Begin splicing and restoration.

3.2.15 Move operations centers as required.

3.2.16 Complete all operations by November 1, except some bog areas - suspend operations in them.

3.2.17 Complete work in bog areas during January and February.

3.2.18 Complete all restoration.

3.2.19 Remove all staging and operations areas and restore.

## 3.3 CREW FUNCTION

The installation effort consists of many separate functions that must be performed in proper sequence and in close coordination with each other. Most of the separate operations can be identified by the specific crew that performs that task. In a few instances, it has been possible to combine several functions with a single crew.

This section describes the basic function of each crew. The scheduling of these crews is the key to an efficient construction effort.

### 3.3.1 Survey Crews

Given detailed maps of the cable routes, these crews perform the actual field survey that marks the final route of the cable. In wooded areas, this work is scheduled for the first summer and the crew will include a tree removal force to enable line of sight for the survey. The portion of the cable route along roads will be surveyed during the second summer as construction proceeds. Any earlier survey along roads would probably result in lost stakes and survey marks. A daily crew rate of 0.5 miles in woods and 1.25 miles along roads is estimated.

An important function of these crews, especially the ones in the woods, is the identification of bogs, streams, and other conditions that will effect the progress of the work crews. This information will be fed back to the project manager who, along with his staff, establish the scheduling for cable installation.

### 3.3.2 Right-Of-Way Crews

Two different right-of-way conditions are anticipated. They are the normally dry areas and the bog areas. The ROW crews will remove all trees and brush along a maximum 25 foot area along the route of the cable. Trees in most areas, up to 6 - inch diameter, will be chipped along with the brush. In bog areas and immediately adjacent to them, trees will be topped, cleaned and left to be used for building corduroy roads through the bogs. In all cases brush and timber will either be chipped or cut and stacked according to Department of Natural Resource Regulations.

3.3.2 Right-Of-Way Crews (continued)

It may be necessary to complete ROW work in the winter in some bog areas. The procedure here would be the same. Rates of advance for this work vary from one acre per day in dry conditions (approximately 1650 feet of 25-foot ROW) to one half acre per day in the bogs (approximately 825 feet of 25-foot ROW). The ROW crews will also provide information on the location of wet areas, that will be used for installation scheduling purposes. Faster progress will be made in areas where 15 foot ROW is possible.

3.3.3 Corduroy Road Crew

This crew lays a log road using the trees left by the ROW crews. Approximately 1000 feet of road per day will be constructed by this crew. This crew will also remove the logs after work is completed and cut and stack the wood or dispose of it as required.

3.3.4 Rip Crews

All areas where cable is to be placed by plowing will require pre-ripping. This is especially important when the cable depth is to be 6-feet. The power required to pull the plow through the earth at this depth is not available without the assistance of a pre-ripped slot. This also minimizes the problem of backing up the plow equipment, a procedure that is difficult if not impossible.

Rip crews are also used in drill/blast areas. They may preceed all other crews and act as the method of locating rock areas. Also, for rock areas identified by other means, the rip crew will make a pass after all drilling, blasting, excavating and backfilling is completed. Although this may not be necessary in all areas, the rip crew has to pass the rock areas anyway in going from one plow area to the next so it is convenient to have them rip a path for the plow to make that operation easier.

Various rates of advance have been used for the rip crews depending on road and/or ROW conditions. Where work lies along the road but off the pavement, a daily rate of 1.67 miles per crew is anticipated. Where the rip machine must work from the road surface, rubber wheeled equipment is necessary and a daily crew rate of .25 miles is used. For right-of-way work in dry conditions, each crew can rip .83 miles a day with a reduction to .30 miles per day in wet areas.

3.3.5 Plow Crews

The plowing operation is broken down into the same catagories as those described for the rip operation. The cable plow follows the path of the rip machine, placing the cable to the desired depth in the narrow furrow left by the rip tooth. (The rip tooth does not leave an actual opening but rather a track of loosely packed soil). To ease the laying of the cable, the plow blade vibrates. As explained in paragraph 3.3.4, the plow operation must never back up. To help avoid this, a backhoe remains with the plow to remove any obstacles not taken care of by the rip operation. It is also necessary to expose all crossing structures to avoid hitting them with the plow.

The rate of advance of this operation has been broken down into the same four catagories as the rip operation. For plowing along road shoulders the rate is 1.67 miles per day. When rubber wheeled machines are necessary, the rate of advance per crew is cut to .55 miles per day. A daily rate of 1.11 miles can be plowed in dry right-of-way and .30 miles in wet ROW. The cable depth, set at 6-feet may vary plus or minus six inches but the average depth will be 6-feet.

3.3.6 Drill Crew

Although 55 miles of rock have been estimated for this project, this does not represent a drill/blast operation of one continuous 55 mile stretch. We anticipate many short sections of rock, both along the roads and in right-of-way. Allowing for the crew's set up, take down and moving time, we estimate that a drill crew will average 150 feet of rock drilled for blasting each day.

3.3.7 Blast Crew

Following behind the drill crews are the blasters. These crews load the blasting powder, cover the area to be "shot" with protective mats and detonate the charges. For the same reasons as explained in 3.3.6, the average rate per day of 400 feet includes set up, take down and move time.

3.3.8 Excavate and Backfill Crews

These crews come behind the blast crews and perform several functions. They first excavate the trench to a depth of 36 inches. Although the Statement of Work calls for a 24 inch cable depth in rock, this would require a concrete cap over the cable to meet local and National Electrical Code requirements of 30 inches minimum cover for power cable over 600 volts. The bottom 12 inches of the trench is filled with select fill and the remainder of the trench backfilled.

All of this work will be completed before the plow crews are scheduled through the area. As explained in 3.3.4, some areas will be pre-ripped. Cable in all rock areas, except possible short sections of trenching, will be placed by plowing. Restoration is performed after plowing.

A daily rate of 400 feet per crew is estimated for the excavate-backfill crews. The rip/plow operation is done at the same rate as the rip/plow of adjacent sections.

3.3.9 Splice Pit Crew

Splice pits are required at each cable splice location. To eliminate any pits being left open over night, these crews work at the same rate as the splicers which is 3 pits each day in all areas except wet right-of-way where a rate of 2 pits per day is anticipated.

3.3.10 Splice Crew

This crew connects the two cable ends together with a cable connector and completes the splice with a high-voltage splice kit. Expected progress for this work is 3 splices per day except in wet areas where 2 splices will be a day's production.

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3.3.11 Water Crossing Crews

As many water crossings as possible will be made using the basic plow crew.

When the water becomes more than 24 inches deep, it will be necessary to use an alternate method of getting the cable across the barrier. One such method is to use existing bridges and place conduit on the bridge structure for the cable. An average of one such installation per day is estimated. This method could also be used to cross obstacles other than water.

Where there are no bridges, these crossings will be made using a cable plow trailer. This unit can be winched across the water by a piece of equipment on the bank and cable placed in this manner. The cable reel mounts on the trailer and emplacement is in the same manner as the conventional plow. This trailer can be pulled through water too deep for the crawler equipment. An estimated one crossing a day can be made in this manner.

3.3.12 Road and Railroad Crossing Crew

All railroads and many roads will require placing conduit beneath them to permit crossing them with the cable. This crew is equipped to bore and/or push 4 inch conduit where necessary. Also, on some gravel and asphalt roads, it may be possible to cut the surface, trench a path across the road and backfill with select fill. The cable plow can then continue across these roads leaving only a narrow repave job for the crew. In either case, one crossing per day is the estimated production. This includes a return trip to place the concrete base for repave and another return trip to complete the repaving. No concrete highways will be cut, they will all be bored. Many dirt roads will be plowed directly with no preparation other than ripping.

3.3.13 Utility Crossing Trench Crew

Areas where a high density of underground utilities cross the path of the antenna cable can best be handled by trenching rather than plowing. This minimizes damage to the other utilities and reduces the number of splices necessary in such an area. The trench would be opened to the full depth (6-feet), all utilities carefully dug around, and the cable installed by hand under each crossing structure. The trench will then be backfilled and the area restored. An estimated 500 feet of this type construction can be completed in one crew day.

3.3.14 Trench Crew

There will be areas where cable placement by plow will be difficult or impossible but where blasting is not necessary. Trenching will be used in these areas. An estimate of 670 feet of trench can be dug, cable placed, backfilled and restored by one crew in a day.

Shoring will be necessary for both this trench work and that described in 3.3.13. The cost of this shoring is included as a support function and is not included as part of the field crew.

3.3.15 Bog Crew

We have estimated that cable placement in 10 miles of the bog areas will be possible only in the winter after the water has frozen hard enough to support heavy equipment. A separate crew has been assembled for this work which will perform all of the tasks necessary for cable placement. The frozen surface will be cut with a rock saw and a rip pass made through the slot. Cable will be placed using a trailer plow and the cable spliced at that time. The only return necessary will be for possible restoration. Approximately 1000 feet of cable per day can be installed by this crew.

3.3.16 Restoration Crew

As soon as all work is completed in an area the restoration crews will come through and return the area to as close to its original condition as practicable. Paragraph 2.8 on page 15 describes the steps to be taken for restoration.

Restoration is considered to be the key to a successful and satisfactory conclusion to the installation project. Sufficient time has been allocated to perform this task thoroughly and correctly. Daily crew rates include 2 miles for roadways where wheeled equipment was used, 1.50 miles along roads where tracked equipment was used, 2.25 miles for dry ROW and .30 miles for wet ROW. Except for the open areas left by tree removal, there will be no visible evidence that a cable has been buried.

## 3.4 INSTALLATION NARRATIVE

The project begins with the field survey to mark the cable route and construction right-of-way. This work is scheduled to start in April of the first summer. Survey work for the first year will be limited to those areas requireing "New" right-of-way. In addition to marking the cable route, an important function of these crews will be to identify areas of bogs, deep streams, rock and any other features that will affect the production of the cable installation crews.

After one month of surveying is completed, the right-of-way clearing crews will begin their work. They are expected to finish most clearing by the end of October. It is anticipated that some wet areas will be nearly impossible to work in during the warm seasons and will require a winter's freeze before work can be completed in them. This work is scheduled for January and February of the first winter.

Survey work, this time along roads and existing rights-of-way, will begin again in April of the second summer and continue until all survey work is completed.

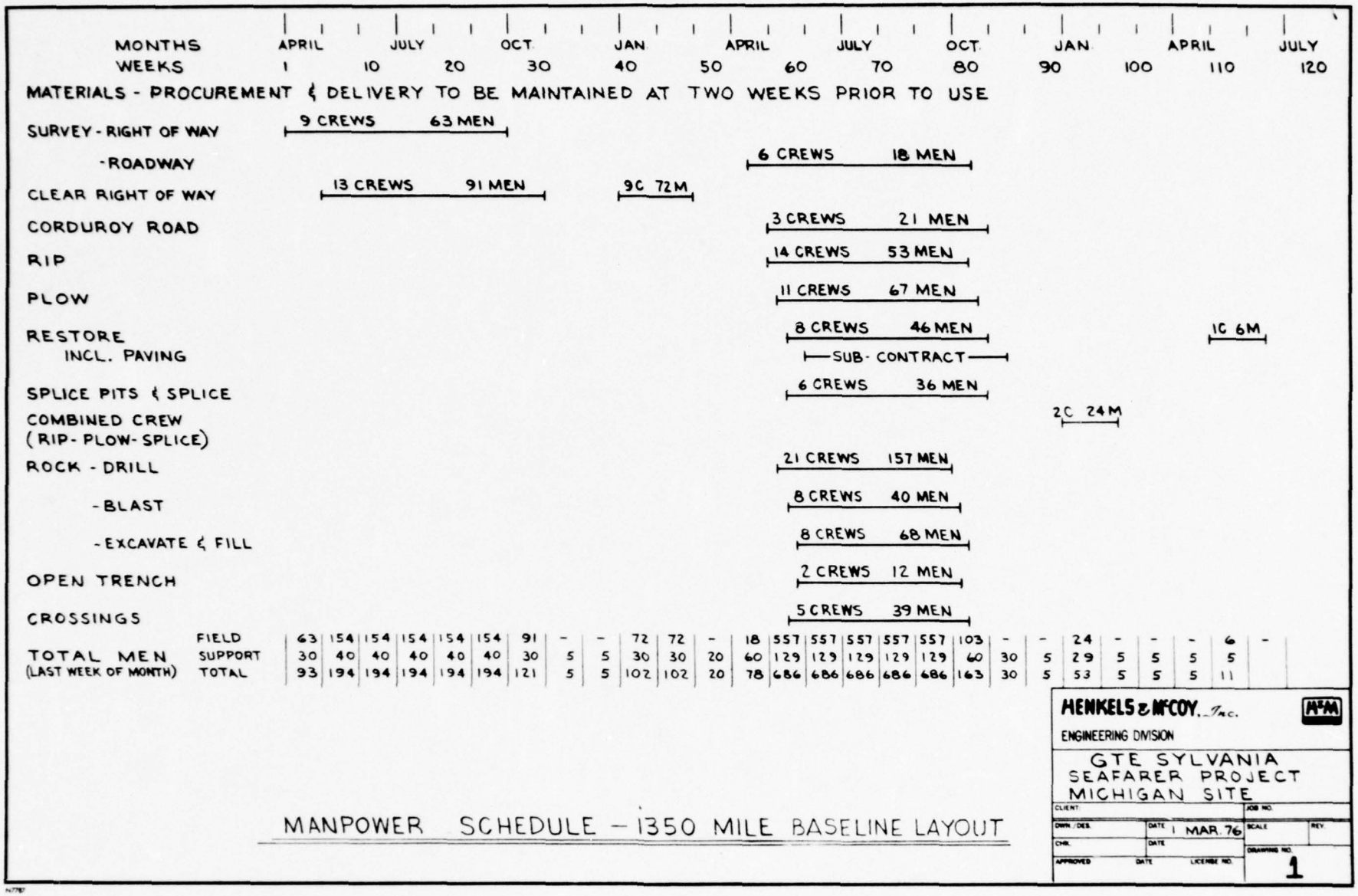
3.4 INSTALLATION NARRATIVE (continued)

May sees the start of cable installation. Starting in areas of good surface conditions, the work flows along the schedules established from data provided by the survey and ROW crews. The worst wet areas are kept until fall when water will be at its lowest point. Those areas still too wet to work in will be completed during January and February of the second winter. Final restoration is scheduled for late spring of the second year, resulting in a total project length of 26 months with major activity being concentrated in the middle six months of the second year.

It is important that cable and splicing supplies be maintained ahead of their usage by the field crews. Any delay caused by lack of materials would jeopardize the completion schedule. Materials are expected to be made available to the contractor at his warehousing locations. Transfer to the work areas would be by the contractor.

As important to the project as the field forces are the support men and equipment. This support includes standby equipment, equipment maintenance and repair, fueling services, warehousing, traffic control, material delivery, engineering and supervision. It is the purpose of this support to assure no delays are encountered by the field forces for reasons other than weather or terrain.

The schedule for crew deployment and manpower levels is shown on the next page for the antenna described in this report.




| TOTAL MEN (LAST WEEK OF MONTH) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FIELD | 63 | 154 | 154 | 154 | 154 | 154 | 91 | - | - | 72 | 72 | - | 18 | 557 | 557 | 557 | 557 | 557 | 103 | - | - | 24 | - | - | - | 6 | - | | |
| | SUPPORT | 30 | 40 | 40 | 40 | 40 | 40 | 30 | 5 | 5 | 30 | 30 | 20 | 60 | 129 | 129 | 129 | 129 | 129 | 60 | 30 | 5 | 29 | 5 | 5 | 5 | 5 | | | |
| | TOTAL | 93 | 194 | 194 | 194 | 194 | 194 | 121 | 5 | 5 | 102 | 102 | 20 | 78 | 686 | 686 | 686 | 686 | 686 | 163 | 30 | 5 | 53 | 5 | 5 | 5 | 11 | | | |

# MANPOWER SCHEDULE – 1350 MILE BASELINE LAYOUT

HENKELS & McCOY, Inc.
ENGINEERING DIVISION

GTE SYLVANIA
SEAFARER PROJECT
MICHIGAN SITE

CLIENT: JOB NO.
DWN / DES. DATE 1 MAR 76 SCALE REV.
CHK. DATE
APPROVED DATE LICENSE NO. DRAWING NO. 1

19 July, 1976

SECTION 4

# INSTALLATION COST

This section contains all costing information for the baseline antenna installation plus a breakdown of the various functions into unit costs.

## 4.1 UNIT COSTS

### 4.1.1 Basic Costs

| FUNCTION | CABLE DEPTH | UNITS | $/ |
|---|---|---|---|
| Rip-Plow - Road Shoulder | 6 feet | 705 miles | $ 2.04/foot |
| Rip-Plow - From Road | 6 feet | 87 miles | 3.58/foot |
| Rip-Plow - Dry ROW | 6 feet | 418 miles | 3.13/foot |
| Rip-Plow - Wet ROW | 6 feet | 50 miles | 10.38/foot |
| Rip-Plow - Frozen | 6 feet | 10 miles | 9.55/foot |
| Drill/Blast - Road (select fill) | 30 inches | 28 miles | 45.69/foot |
| Drill/Blast - ROW (select fill) | 30 inches | 27 miles | 56.93/foot |
| Trench - Utility Crossings | 6 feet | 15 miles | 4.92/foot |
| Trench | 6 feet | 5 miles | 3.33/foot |
| Water Crossing - Trailer Plow | 6 feet | 75 crossings | 8,964.21/crossing |
| Road - RR - Bore & Cut Crossings | 4-6 feet | 308 crossings | 4,377.11/crossing |
| Road - RR - Conduit Crossing | - | 45 crossings | 3,621.71/crossing |
| Survey - Road | - | 840 miles | 0.09/foot |
| Survey - ROW | - | 510 miles | 0.63/foot |
| ROW Clearing - Dry | 25 feet wide | 462 miles | 1.94/foot |
| ROW Clearing - Wet | 25 feet wide | 48 miles | 4.76/foot |
| Corduroy Road | | 30 miles | 6.521/foot |
| | | TOTAL COST | $45,995,452.00 |

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4.1.2 Alternative Costs

The following chart lists all the unit costs called for in the Statement of Work. All prices are per foot except items 14, 15 and 16 which are per crossing.

| | 6' | 3½' | 2½' | 2 cables 2 passes* | 3 cables 3 passes* | 2 cables 1 pass | 3 cables 1 pass |
|---|---|---|---|---|---|---|---|
| 1. R/P Road Shoulder | 2.04 | 0.87 | - | 2.66 | 3.28 | 3.67 | 5.53 |
| 2. R/P From Road | 3.58 | 1.53 | - | - | - | - | - |
| 3. R/P ROW - Dry | 3.13 | 1.12 | - | 4.09 | 5.95 | 5.49 | 8.00 |
| 4. R/P ROW - Wet | 10.38 | - | - | 14.92 | 19.45 | 14.03 | 14.30 |
| 5. R/P Frozen | 9.55 | - | - | - | - | 12.44 | 14.18 |
| 6. D/B Road Select Fill | - | 62.54 | 45.69 | 46.31 | 46.93 | 47.32 | 47.52 |
| 7. D/B Road W/O Fill | - | 50.06 | 36.19 | - | - | - | - |
| 8. D/B ROW Select Fill | - | 78.22 | 56.93 | 57.55 | 58.17 | 58.24 | 58.43 |
| 9. D/B ROW W/O Fill | - | 61.71 | 44.40 | - | - | - | - |
| 10. Trench Select Fill | 5.43 | 4.48 | 4.22 | - | - | - | - |
| 11. Trench W/O Fill | 3.33 | 2.38 | 2.12 | - | - | 4.61 | 5.00 |
| 12. Trench Utilities Select Fill | 7.02 | 5.90 | 5.54 | - | - | - | - |
| 13. Trench Utilities W/O Fill | 4.92 | 3.80 | 3.44 | - | - | 7.01 | 7.96 |
| 14. Road & RR | 4,377.11 | | | | | | |
| 15. Water x-ing- Trailer Plow | 8,964.21 | | | | | | |
| 16. Conduit | 3,621.71 | | | | | | |
| 17. Survey - Road | 0.09 | | | | | | |
| 18. Survey - ROW | 0.63 | | | | | | |
| 19. Clearing - Dry | 1.94 | | | | | | |
| 20. Clearing - Wet | 4.76 | | | | | | |
| 21. Corduroy Road | 6.52 | | | | | | |

* 2nd & 3rd passes @ 3½' depth.

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## 4.2 UNIT RATES

### 4.2.1 Labor Rates - Hourly

The following rates are those in effect under the present union contracts. The unions used for this estimate and their contract expiration dates are: IBEW Local 876, 5-31-76; Operating Engineers Local 324, 4-30-76; Laborers Local 1329, 4-30-76; Teamsters Local 328, 4-30-76.

The exact classification of workman and the union with jurisdiction over that classification on a specific job is often a point requiring negotiation between the contractor and the union(s). On a project the size of Seafarer this situation is even more likely to occur. For that reason, the final decision of which union and what classification of labor might finally perform a certain function will only come when the job is a reality and about to be performed. For purposes of costing the construction plan, an estimate of jurisdiction, with the corresponding rates, has been used.

| CLASSIFICATION | WAGE | BENEFITS | TAX & INS. 18.67% | SUBSISTENCE | OVERHEAD & PROFIT-25% | TOTAL |
|---|---|---|---|---|---|---|
| Foreman | 9.44 | .96 | 1.94 | 1.00 | 3.34 | 16.68 |
| Journeyman | 8.75 | .89 | 1.80 | 1.00 | 3.11 | 15.55 |
| Heavy Operator | 7.95 | 2.12 | 1.88 | 1.00 | 3.24 | 16.19 |
| Light Operator | 7.40 | 2.07 | 1.78 | 1.00 | 3.06 | 15.31 |
| Driller | 7.40 | 2.07 | 1.78 | 1.00 | 3.06 | 15.31 |
| Blaster | 7.40 | 2.07 | 1.78 | 1.00 | 3.06 | 15.31 |
| Tree Trimmer | 6.75 | .74 | 1.40 | 1.00 | 2.47 | 12.36 |
| Groundman | 4.88 | .50 | 1.00 | 1.00 | 1.85 | 9.23 |
| Laborer | 6.65 | .74 | 1.38 | 1.00 | 2.44 | 12.21 |
| Driver | 7.15 | .83 | 1.49 | 1.00 | 2.62 | 13.09 |
| Welder | 7.95 | 2.12 | 1.88 | 1.00 | 3.24 | 16.19 |
| Welder Helper | 7.40 | 2.07 | 1.78 | 1.00 | 3.06 | 15.31 |
| Mechanic | 7.95 | 2.12 | 1.88 | 1.00 | 3.24 | 16.19 |
| Mechanic Helper | 7.40 | 2.07 | 1.78 | 1.00 | 3.06 | 15.31 |
| Watchman | 6.27 | .74 | 1.31 | 1.00 | 2.33 | 11.65 |

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4.2.2 Equipment Rates - Weekly

The following equipment rates are for the machine only and do not include maintenance costs.

| EQUIPMENT | WEEKLY COST | WEEKLY SALES |
|---|---|---|
| D-9 W/Blade & Plow | $ 6,057.57 | $ 7,571.96 |
| D-7 W/Blade & Winch | 1,396.28 | 1,745.35 |
| D-6 W/Blade & Winch | 1,322.18 | 1,652.73 |
| Austin - Western 501 Super | 1,095.96 | 1,369.95 |
| Cat. 980 Front End Loader | 1,598.85 | 1,998.56 |
| Case 580 Backhoe | 471.46 | 589.33 |
| Lubrication Truck | 310.00 | 387.50 |
| Fuel Truck | 190.00 | 237.50 |
| Welding Truck | 120.00 | 150.00 |
| Tow Truck | 380.00 | 475.00 |
| Air Compressor 600 CFM | 342.90 | 428.63 |
| Air Compressor 105 CFM | 68.85 | 86.06 |
| Pick-Up Truck 3/4 Ton 4 Wh. Drive | 60.37 | 75.46 |
| Stake Truck 4 Ton | 157.50 | 196.88 |

4.2.2 Equipment Rates - Weekly (continued)

| EQUIPMENT | WEEKLY COST | WEEKLY SALES |
|---|---|---|
| Stake Truck 1½ Ton 4 Wh. Drive | $ 66.94 | $ 83.68 |
| Crew Cab Truck 4x4 | 68.25 | 85.31 |
| Drill Wagon | 450.90 | 563.63 |
| Low Boy W/ Tractor | 536.81 | 671.06 |
| Cable Trailer | 80.00 | 100.00 |
| Diesel 18 yd. Terex Dump | 862.31 | 1,077.89 |
| Fork Lift, 2000# | 306.29 | 382.86 |
| Automobile | 80.00 | 100.00 |
| Boring Tool | 302.40 | 378.00 |
| Crane Pettibone Model 30-18 Ton | 874.73 | 1,093.41 |
| Tag-A-Long Trailer | 43.00 | 53.75 |
| Light Dump | 223.13 | 278.91 |
| Pumps Diesel 4" | 151.50 | 189.38 |
| Chipper V-8 | 752.13 | 940.16 |
| Case 850 Excavator | 743.56 | 929.45 |
| Farm Tractor | 71.88 | 89.85 |
| Chain Saw | 23.08 | 28.85 |
| Rock Saw Trencher | 600.00 | 800.00 |
| Trailer Office & Storage | 20.00 | 25.00 |
| Tractor & Trailer | 686.03 | 857.54 |
| Trailer Plow | 240.00 | 320.00 |

## 4.3 CREW COST PER DAY

The following paragraphs show the cost for each field crew on a daily basis. The costs are based on a 9 hour day. These total daily costs include all loading factors and represent the "selling" rate for that crew. These crews are for the baseline depths of 6-feet plow and trench and 30-inches in rock.

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| 4.3.1 Survey Crew (Road) | Cost Per Day |
|---|---|
| 1 - Surveyor | $ 100.00 |
| 2 - Assistant Surveyor | 150.00 |
| 1 - Pick-up Crew Cab | 17.06 |
| Equipment | 10.00 |
| | $ 277.06 |

| 4.3.2 Survey Crew (ROW) | |
|---|---|
| 1 - Supervisor | $ 150.00 |
| 1 - Surveyor | 100.00 |
| 3 - Assistant Surveyor | 225.00 |
| 2 - Tree Trimmer | 234.84 |
| 1 - Pick-up Crew Cab | 17.06 |
| 2 - Chain Saws | 11.54 |
| 1 - Pick-up | 15.09 |
| Equipment | 10.00 |
| | $ 763.53 |

| 4.3.3 Right-of-Way Clearing (Dry) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 2 - Tree Trimmer | 234.84 |
| 3 - Laborer | 347.98 |
| 1 - D/6 W/Tree Fork | 330.55 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Stake Body 1½ Ton 4 Wheel | 16.74 |
| 1 - Chipper | 188.03 |
| 4 - Chain Saws | 23.08 |
| | $ 1,470.54 |

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| 4.3.4 Right-Of-Way Clearing (Wet) | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 2 - Heavy Operator | 307.61 |
| 3 - Laborer | 347.98 |
| 2 - Tree Trimmer | 234.84 |
| 1 - D/6 W/Tree Fork | 330.55 |
| 1 - Case 850 Excavator | 185.89 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Stake Body 1½ Ton 4 Wh. Drive | 16.74 |
| 1 - Chipper | 188.03 |
| 4 - Chain Saw | 23.08 |
| | $ 1,810.24 |

| 4.3.5 Rip Crew (Tracked) | |
|---|---|
| 2 - Heavy Operator | $ 307.61 |
| 1 - Laborer | 115.99 |
| 1 - Driver | 124.35 |
| 2 - D-9 W/Blade & Rip | 3,028.78 |
| 1 - Pick-up Crew Cab | 17.06 |
| | $ 3,593.79 |

| 4.3.6 Rip Crew (Wheeled) | |
|---|---|
| 2 - Heavy Operator | $ 307.61 |
| 1 - Laborer | 115.99 |
| 1 - Austin - Western 501 | 275.99 |
| 1 - Cat. 980 Front-End Loader | 397.71 |
| 1 - Pick-up Crew Cab | 17.06 |
| | $ 1,114.36 |

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| 4.3.7 Plow Crew (Tracked) | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 1 - Light Operator | 145.44 |
| 2 - Journeyman Electrician | 295.46 |
| 1 - Groundman | 87.69 |
| 1 - D-9 W/Plow & Winch | 1,514.39 |
| 1 - Case 580 Backhoe | 117.87 |
| 1 - Pickup Crew Cab | 17.06 |
| | $ 2,490.17 |

| 4.3.8 Plow Crew (Wheeled) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 2 - Heavy Operator | 307.61 |
| 1 - Light Operator | 145.44 |
| 2 - Journeyman Electrician | 295.46 |
| 1 - Groundman | 87.69 |
| 1 - Austin - Western 501 | 273.99 |
| 1 - Cat. 980 Front-End Loader | 399.71 |
| 1 - Case 580 Back-Hoe | 117.87 |
| 1 - Pick-up Crew Cab | 17.06 |
| | $ 1,803.29 |

| 4.3.9 Drill Crew (Road) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Light Operator | 145.44 |
| 1 - Driver | 124.35 |
| 2 - Laborer | 231.99 |
| 2 - Driller | 290.90 |
| 2 - Air Compressor 600 CFM | 171.45 |
| 1 - Pick-up Crew Cab | 17.06 |
| 2 - Multi-Head Drill Wagon | 225.45 |
| 1 - Low Boy Trailer & Tractor | 134.20 |
| | $ 1,499.30 |

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| 4.3.10 Drill Crew (ROW) | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 1 - Light Operator | 145.44 |
| 1 - Driver | 124.35 |
| 2 - Laborer | 231.99 |
| 2 - Driller | 290.90 |
| 1 - D/6 W/Winch & Sled | 330.55 |
| 2 - Air Compressor 600 CFM | 171.45 |
| 1 - Pick-up Crew Cab | 17.06 |
| 2 - Multi-Head Drill Wagon | 225.45 |
| 1 - Low Boy Trailer & Tractor | 134.20 |
| | $ 1,983.65 |

| 4.3.11 Blast Crew | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 1 - Driver | 124.35 |
| 1 - Blaster | 145.44 |
| 1 - Laborer | 115.99 |
| 1 - Low Boy Trailer & Tractor | 134.21 |
| 1 - D-6 W/Winch & Boom | 330.55 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Stake Body 4 Ton W/Hydro Lift | 39.38 |
| | $ 1,219.24 |

| 4.3.12 Rock Excavate & Backfill Crew (Road) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Light Operator | 145.44 |
| 2 - Driver | 248.71 |
| 4 - Laborer | 463.98 |
| 1 - Case 580 Backhoe & Front End Loader | 117.87 |
| 1 - Air Compressor 105 CFM | 17.21 |
| 2 - Pick-up Crew Cab | 34.12 |
| 2 - Diesel 18 cu. yd. Dump Truck | 431.16 |
| | $ 1,616.95 |

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| 4.3.13 Rock Excavate & Backfill Crew (ROW) | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 1 - Light Operator | 145.44 |
| 2 - Driver | 248.71 |
| 4 - Laborer | 463.98 |
| 1 - D/7 W/Winch & Blade | 349.07 |
| 1 - Case 850 Excavator | 185.89 |
| 1 - AC 105 CFM | 17.21 |
| 1 - Pick-up Crew Cab | 17.06 |
| 2 - Diesel 18 cu. yd. Dump Truck | 431.16 |
| | $ 2,170.78 |

| 4.3.14 Trench Crew | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Journeyman | 147.73 |
| 1 - Driver | 124.35 |
| 2 - Groundman | 175.38 |
| 1 - Light Operator | 145.44 |
| 1 - Case 580 Backhoe | 117.87 |
| 1 - Stake Body 1½ Ton 4 Wh. Drive | 16.74 |
| 1 - Tag-A-Long Trailer | 10.75 |
| 1 - AC 105 CFM | 17.21 |
| | $ 913.93 |

| 4.3.15 Splice Pit (DRY) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Light Operator | 145.44 |
| 2 - Laborer | 231.99 |
| 1 - Case 580 Backhoe | 117.87 |
| 1 - Pick-up Crew Cab | 17.06 |
| | $ 833.39 |

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| 4.3.16 Splice Pit (Wet) | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 1 - Light Operator | 145.44 |
| 2 - Laborer | 231.99 |
| 1 - D/6 W/Winch | 330.55 |
| 1 - Case 580 Backhoe | 117.87 |
| 1 - Pick-up Crew Cab | 17.06 |
| | $ 1,155.17 |

| 4.3.17 Splice Crew | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Journeyman | 147.73 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Diesel 4" Pump | 37.88 |
| | $ 361.13 |

| 4.3.18 Road Building Crew (Courderoy) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 2 - Heavy Operator | 307.61 |
| 2 - Laborer | 231.99 |
| 2 - Tree Trimmer | 234.84 |
| 1 - D/7 W/Tree Fork | 349.07 |
| 1 - Case 850 Excavator W/Sled | 185.89 |
| 1 - Stake Body 1½ Ton 4 Wh. Drive | 16.74 |
| 2 - Chain Saws | 11.54 |
| | $ 1,496.14 |

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| 4.3.19 Road & RR Crossing Crew | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 3 - Light Operator | 436.33 |
| 2 - Driver | 248.71 |
| 2 - Laborer | 231.99 |
| 1 - Case 580 Backhoe | 117.87 |
| 1 - Air Compressor 105 CFM | 17.21 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Pump 4" Diesel | 37.88 |
| 1 - Boring Tool | 75.60 |
| 1 - Stake Body 1½ Ton 4 Wh. Drive | 16.74 |
| 1 - Concrete Saw | 20.00 |
| 1 - Small Dump | 55.78 |
| 1 - Tag-A-Long Trailer | 10.75 |
| | $ 1,444.38 |

| 4.3.20 Water Crossing - Trailer Plow | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 2 - Heavy Operator | 307.61 |
| 2 - Journeyman | 295.46 |
| 1 - Driver | 124.35 |
| 1 - Groundman | 87.69 |
| 1 - D/9 W/Winch & Blade | 1,514.39 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Low Boy Trailer W/Tractor | 134.21 |
| 1 - Trailer Plow | 48.00 |
| | $ 2,687.23 |

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| 4.3.21 Conduit Crew | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 4 - Journeyman Electrician | 590.92 |
| 1 - Welder | 153.81 |
| 1 - Driver | 124.35 |
| 1 - Case 580 Backhoe | 117.87 |
| 1 - Stake Body 1½ Ton 4 Wh. Drive | 16.74 |
| 1 - Tag-A-Long Trailer | 10.75 |
| 1 - Welding Truck | 30.00 |
| | $ 1,202.90 |

| 4.3.22 Restoration Crew (Tracked) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 1 - Light Operator | 145.44 |
| 3 - Laborer | 347.98 |
| 1 - D/7 W/Blade & Winch | 348.08 |
| 1 - Pick-up Crew Cab | 17.06 |
| 1 - Farm Tractor & Disc. | 89.85 |
| | $ 1,260.67 |

| 4.3.23 Restoration Crew (Wheeled) | |
|---|---|
| 1 - Foreman | $ 158.46 |
| 1 - Heavy Operator | 153.80 |
| 3 - Laborer | 349.07 |
| 1 - Austin - Western 501 | 273.99 |
| 1 - Pick-up Crew Cab | 17.06 |
| | $ 952.38 |

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| 4.3.24 Bog Crew (Winter Operation) | Cost Per Day |
|---|---|
| 1 - Foreman | $ 158.46 |
| 3 - Heavy Operator | 461.41 |
| 3 - Journeyman | 443.19 |
| 3 - Driver | 373.06 |
| 2 - Groundman | 175.38 |
| 1 - D/9 W/Blade, Winch | 1,514.39 |
| 1 - Case 850 W/Backhoe | 185.89 |
| 1 - Trailer Plow | 64.00 |
| 1 - Rock Saw Trencher | 160.00 |
| 1 - Pump | 37.87 |
| 1 - Low Boy | 134.21 |
| 2 - Stake Body 1½ Ton W/4Wh. Drive | 33.47 |
| 2 - Tag-A-Long Trailer | 21.50 |
| 2 - Pick-up Crew Cabs | 34.12 |
| | $ 3,796.95 |

## 4.4 SUPPORT & ADMINISTRATION

The crews listed in paragraph 4.3 are not self sufficient. Considerable support must be provided to enable these crews to continue their work continuously on a day by day basis. This support, along with all the supervision and administration for the project, is listed in this paragraph. These costs are applied to the field costs on a proportional basis.

### 4.4.1 Board & Lodging

These costs apply to certain supervision and engineering personnel. Subsistence for field people, when required, is included in their hourly wage.

17 men @ $200.00/week for 100 weeks $340,000.00

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| 4.4.2 Equipment Maintenance & Support | Project Cost |
|---|---|
| 1 - Mechanic Foreman | $ 86,053. |
| 9 - Mechanic | 309,158. |
| 6 - Mechanic Helper | 237,609. |
| 4 - Welder | 209,182. |
| 2 - Welder Helper | 99,810. |
| 1 - Operator | 84,590. |
| 7 - Driver | 322,067. |
| 1 - Tow Truck | 52,250. |
| 6 - Shop Trailer | 16,500. |
| 6 - Fuel Truck | 76,950. |
| 6 - Lubrication Truck | 125,550. |
| 1 - Stake Truck | 21,657. |
| 1 - Pick-up Truck | 8,301. |
| 2 - Welding Truck | 20,400. |
| 1 - Tractor Trailer & Winch | 94,329. |
| 1 - Stake Truck & Crane | 25,500. |
| | $1,789,906. |
| Standby Equipment | 4,458,162. |
| Fuel & Storage | 4,200,000. |
| Equipment Maintenance (Replacement & Parts) 20% of Equipment Cost | 3,896,814. |
| | $14,344,882. |

| 4.4.3 Warehousing | Project Cost |
|---|---|
| 2 - Foreman | $ 53,876. |
| 2 - Operator | 52,292. |
| 1 - Electrician | 25,114. |
| 1 - Powder Handler | 18,908. |
| 8 - Trailer | 6,800. |
| 1 - Heavy Crane | 37,176. |
| 1 - Fork Lift | 13,017. |
| 1 - Stake Truck | 2,845. |
| 2 - Pick-up | 5,131. |
| | $ 215,159. |

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| 4.4.4 Administration & Supervision | Project Cost |
|---|---|
| 1 - Project Manager | $ 107,042. |
| 1 - Assistant Manager | 93,080. |
| 5 - Field Supervisor | 192,031. |
| 6 - Assistant Field Supervisor | 137,472. |
| 1 - Office Manager | 74,464. |
| 1 - Assistant Office Manager | 65,156. |
| 1 - Accountant | 65,156. |
| 1 - Secretary | 37,232. |
| 11 - Clerk | 113,772. |
| 4 - Office Trailer | 3,250. |
| 11 - Pick-up Truck | 45,125. |
| 5 - Automobile | 65,000. |
| | $ 998,780. |

| 4.4.5 Engineering | Project Cost |
|---|---|
| 1 - Project Engineer | $ 93,080. |
| 1 - Engineer | 74,464. |
| 2 - Assistant Engineer | 78,187. |
| 2 - Draftsman | 18,616. |
| 2 - Pick-up Truck | 19,620. |
| 1 - Automobile | 13,000. |
| | $ 296,967. |

| 4.4.6 Other Support | Project Cost |
|---|---|
| Utilities | $ 15,000. |
| Telephone & TWX | 30,000. |
| Office/Lot Rent | 31,200. |
| Radio | 300,000. |
| Equipment Move In & Out | 450,000. |
| Shop & Office Supplies | 20,000. |
| Set Up & Take Down | 125,000. |
| Security - 30 Men - 24 Hours | 569,985. |
| Subcontractor Costs | 200,000. |
| Union Overhead | 100,000. |
| | $1,841,185. |

| 4.4.7 Miscellaneous Field Support | | Project Cost |
|---|---|---|
| 4.4.7.1 | Cable Haul to Work Area | |
| | 1 - Driver | $ 16,166. |
| | 1 - Tractor-Trailer | 17,448. |
| | | $ 33,614. |
| 4.4.7.2 | Fence and Gate Repair | |
| | 1 - Foreman | $ 20,600. |
| | 3 - Laborer | 45,236. |
| | 1 - Crew Cab Pick-Up | 2,218. |
| | | $ 68,054. |
| 4.4.7.3 | Shoring and Mats for Equipment in Wet Areas | |
| | 4 - Driver | $ 64,664. |
| | 4 - Stake Truck | 8,702. |
| | 1000 Feet Mo-Mat | 70,000. |
| | Shoring | 100,000. |
| | | $ 243,366. |
| 4.4.7.4 | Traffic Control | |
| | 20 - Laborer | $ 301,574. |
| | 100 - Barricade | 20,000. |
| | | $ 321,574. |
| | Total | $ 666,608. |

4.4.8 Downtime

An estimated 10 percent downtime has been used for this project for all work except the winter function where 15 percent is used. Costs for calculating the downtime include 2 hours for all labor and a full day for the equipment. No support costs are included since these items are costed for the full project regardless of interruptions to the field work.

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4.4.8 Downtime (continued)

| | | |
|---|---|---|
| Labor Cost/day (2 Hours) | First Summer | $ 3,794. |
| | Second Summer | 15,285. |
| | First Winter | 1,988. |
| | Second Winter | 679. |
| Equipment Cost/Day | First Summer | 7,961. |
| | Second Summer | 91,541. |
| | First Winter | 6,849. |
| | Second Winter | 4,370. |
| 15 Days - First Summer @ 11,755. | | 176,325. |
| 15 Days - Second Summer @ 106,826. | | 1,602,390. |
| 6 Days - First Winter @ 8,837. | | 53,022. |
| 6 Days - Second Winter @ 5,049. | | 30,294. |
| | | $1,862,031. |

4.4.9 Total Support Costs

| | | |
|---|---|---|
| 4.4.9.1 | Board & Lodging | $ 340,000. |
| 4.4.9.2 | Equipment Maintenance & Support | 14,344,882. |
| 4.4.9.3 | Warehousing | 215,159. |
| 4.4.9.4 | Administration & Supervision | 998,780. |
| 4.4.9.5 | Engineering | 296,967. |
| 4.4.9.6 | Other Support | 1,841,185. |
| 4.4.9.7 | Miscellaneous Field Support | 666,608. |
| 4.4.9.8 | Downtime | 1,862,031. |
| | | $20,565,612. |

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## 4.5 BASELINE COST DETAILS

| OPERATION | NO. OF CREWS | CREW COST | CREW DAYS | COST |
|---|---|---|---|---|
| Survey Road | 6 | $ 277.06 | 672 | $ 186,184. |
| Survey ROW | 9 | 763.53 | 1020 | 778,800. |
| ROW Clearing-Dry | 13 | 1,470.54 | 1476 | 2,170,517. |
| ROW Clearing-Wet | 9 | 1,810.24 | 306 | 553,933. |
| Rip-ROW-Dry | | 3,593.79 | 536 | 1,926,271. |
| Rip-ROW-Wet | 14 | 3,593.79 | 167 | 600,162. |
| Rip-Road-Tracked | | 3,593.79 | 439 | 1,577,674. |
| Rip-Road-Wheeled | | 1,114.36 | 348 | 387,797. |
| Plow-ROW-Dry | | 2,490.17 | 401 | 998,558. |
| Plow-ROW-Wet | 11 | 2,490.17 | 167 | 415,859. |
| Plow-Road-Tracked | | 2,490.17 | 439 | 1,093,185. |
| Plow-Road-Wheeled | | 1,803.29 | 158 | 284,920. |
| Drill-Road | 21 | 1,499.30 | 1000 | 1,499,300. |
| Drill-ROW | | 1,983.65 | 964 | 1,912,238. |
| Blast | 8 | 1,219.24 | 724 | 882,730. |
| Rock Excavate-Road | 8 | 1,616.95 | 368 | 595,038. |
| Rock Excavate-ROW | | 2,170.78 | 355 | 770,627. |
| Trench-Normal | 1 | 913.93 | 39 | 35,643. |
| Trench-Utilities | | 913.93 | 158 | 144,401. |
| Splice Pit-Dry | 6 | 833.39 | 639 | 532,536. |
| Splice Pit-Wet | | 1,317.74 | 19 | 25,037. |
| Splice | | 361.13 | 658 | 237,624. |
| Corduroy Road | 1 | 1,496.14 | 317 | 474,276. |
| Road & RR Crossing | | 1,444.38 | 371 | 535,865. |
| Water Crossing-Trailer Plow | 5 | 2,687.23 | 102 | 274,097. |
| Conduit | | 1,202.90 | 45 | 54,130. |
| Restoration-Tracked | 8 | 1,260.67 | 887 | 1,118,214. |
| Restoration-Wheeled | | 952.38 | 44 | 41,905. |
| Bog-Winter | 2 | 3,796.95 | 50 | 189,848. |
| | | | | $20,297,369. |

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4.5 BASELINE COST DETAILS (continued)

| | COST |
|---|---|
| Drill Steel & Blasting Material | $ 726,000. |
| Select Fill & Rock Disposal | 100,000. |
| Total Field Costs | $21,123,369. |
| Support Costs | 20,565,612. |
| Performance Bond | 137,573. |
| Contingency - 10% Total Cost | 4,168,898. |
| Total Baseline Cost | $45,995,452. |

Field Cost/Support & Contingency Cost $1.00/$1.1775

Rip/Plow-Road Shoulder - 6' Depth

| | | | |
|---|---|---|---|
| Field | $3,161,753. | | |
| Splice | 326,273. | | |
| Support | 4,107,151. | | |
| | $7,595,177./705 miles | = | $2.04/foot |

Rip/Plow From Road - 6' Depth

| | | | |
|---|---|---|---|
| Field | $ 714,622. | | |
| Splice | 40,236. | | |
| Support | 888,845. | | |
| | $1,643,703./87 miles | = | $3.58/foot |

Rip/Plow Dry-ROW - 6' Depth

| | | | |
|---|---|---|---|
| Field | $2,981,833. | | |
| Splice | 193,215. | | |
| Support | 3,738,619. | | |
| | $6,913,667./418 miles | = | $3.13/foot |

Rip/Plow Wet-ROW - 6' Depth

| | | | |
|---|---|---|---|
| Field | $1,226,553. | | |
| Splice | 31,898. | | |
| Support | 1,481,826. | | |
| | $2,740,277./50 miles | = | $10.38/foot |

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4.5 BASELINE COST DETAILS (continued)

Rip/Plow Frozen ROW - 6' Depth

| | | | |
|---|---|---|---|
| Field | $ 231,450. | | |
| Support | 272,533. | | |
| | $ 503,983./10 miles | = | $9.55/foot |

Drill/Blast Road - 30" Depth

| | | | |
|---|---|---|---|
| Field | $3,089,323. | | |
| Splice | 13,147. | | |
| Support | 3,653,158. | | |
| | $6,755,628./28 miles | = | $45.69/foot |

Drill/Blast ROW - 30" Depth

| | | | |
|---|---|---|---|
| Field | $3,714,793. | | |
| Splice | 12,350. | | |
| Support | 4,388,711. | | |
| | $8,115,854./27 miles | = | $56.93/foot |

Utility Crossing Trench - 6' Depth

| | | | |
|---|---|---|---|
| Field | $ 144,401. | | |
| Splice | 34,659. | | |
| Support | 210,843. | | |
| | $ 389,903./15 miles | = | $4.92/foot |

Trench - 6' Depth

| | | | |
|---|---|---|---|
| Field | $ 35,643. | | |
| Splice | 4,780. | | |
| Support | 47,598. | | |
| | $ 88,021./5 miles | = | $3.33/foot |

Road & RR Crossings

| | | | |
|---|---|---|---|
| Field | $ 535,865. | | |
| Splice | 83,262. | | |
| Support | 729,022. | | |
| | $1,348,149./308 crossings | = | $4,377.11/crossing |

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4.5 BASELINE COST DETAILS (continued)

Right-Of-Way Clearing-Dry

| | | |
|---|---|---|
| Field | $2,170,517. | |
| Support | 2,555,116. | |
| | $4,725,633./462 miles = | $1.94/foot |

Right-Of-Way Clearing-Wet

| | | |
|---|---|---|
| Field | $ 553,934. | |
| Support | 652,257. | |
| | $1,206,191./48 miles = | $4.76/foot |

Corduroy Road

| | | |
|---|---|---|
| Field | $ 474,276. | |
| Support | 558,444. | |
| | $1,032,720./30 miles = | $6.52/foot |

Water Crossings-Trailer Plow

| | | |
|---|---|---|
| Field | $ 274,097. | |
| Splice | 34,659. | |
| Support | 363,560. | |
| | $ 672,316./75 crossings = | $8,964.21/crossing |

Conduit Crossings

| | | |
|---|---|---|
| Field | $ 54,130. | |
| Splice | 20,716. | |
| Support | 88,131. | |
| | $ 162,977./45 crossings = | $3,621.71/crossing |

Surveying-Road

| | | |
|---|---|---|
| Field | $ 186,184. | |
| Support | 219,232. | |
| | $ 405,416./840/miles = | $0.09/foot |

Surveying-ROW

| | | |
|---|---|---|
| Field | $ 778,800. | |
| Support | 917,037. | |
| | $1,695,837./510 miles = | $0.63/foot |

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## 4.6 ALTERNATE DEPTHS

Costs for placing the antenna cable at different depths were developed for several different types of installation methods.

### 4.6.1 Rip/Plow

An alternate depth of 3½ feet for cable placed by plowing in dry areas was costed. Since this depth was the one used to prepare the baseline costs for the interim report, the crews and support ratio for that plan have been used for this cost.

Road Shoulder

Rip - 3 miles/day, plow - 3 miles/day, splice - 3 per day

| | | | |
|---|---|---|---|
| Restore - 2 miles/day | Field Cost | 1,448,633. | |
| | Support Cost | 1,786,454. | |
| | Total Cost/705 miles | $3,235,087. | = $0.87/foot |

Road-From Pavement

Rip - 1 mile/day, plow - 1 mile/day, splice 3 per day

| | | | |
|---|---|---|---|
| Restore 2 miles/day | Field Cost | 315,073. | |
| | Support Cost | 388,548. | |
| | Total Cost/87 miles | $ 703,621. | = $1.53/foot |

ROW - Dry

Rip - 1.5 miles/day, plow - 2 miles/day, splice 3 per day

| | | | |
|---|---|---|---|
| Restore 3 miles/day | Field Cost | 1,109,634. | |
| | Support Cost | 1,368,400. | |
| | Total Cost/418 miles | $2,478,035. | = $1.12/foot |

4.6.2 Drill/Blast

One alternate depth in rock areas has been costed. This provides for a trench of 4 feet with a cable depth of 3½ feet. As with the basic plan, the cable is plowed into the trench after the select fill has been placed and the trench backfilled.

Road

Drill - 100 feet/day, blast - 300 feet/day,
Excavate and backfill - 300 feet/day, rip - 1.67 miles/day,
Plow - 1.67 miles/day, splice - 3 per day, restore 1.5 miles/day.

| | |
|---|---|
| Field Costs | 4,245,944. |
| Support Cost | 4,999,599. |
| Total Cost/28 miles | $9,245,543. = $62.54/foot |

ROW

Drill - 100 feet/day, blast - 300 feet/day,
Excavate and backfill - 300 feet/day, rip - 1.11 miles/day,
Plow - 1.11 miles/day, splice - 3 per day, restore - 2.25 miles/day.

| | |
|---|---|
| Field Costs | 5,121,482. |
| Support Costs | 6,030,545. |
| Total Costs/27 miles | 11,152,027. = $78.22/foot |

4.6.3 Trench

Two alternate trench depths are included here for both the straight trenching as well as the trenching in utility areas.

3½ Foot

Straight Trench - 1000 feet/day

| | |
|---|---|
| Field Cost | 28,910. |
| Support Cost | 34,042. |
| Total Cost/5miles | $ 62,952. = $2.38/foot |

Utility Crossing Trench - 700 feet/day

| | |
|---|---|
| Field Cost | 138,072. |
| Support Cost | 162,580. |
| Total Cost/15 miles | $ 300,652. = $3.80/foot |

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4.6.3 Trench

2½ Foot

Straight Trench - 1150 feet/day

| | | |
|---|---|---|
| Field Cost | 25,762. | |
| Support Cost | 30,335. | |
| Total Cost/5 miles | $ 56,097. | = $2.12/foot |

Utility Crossing Trench - 800 feet/day

| | | |
|---|---|---|
| Field Cost | 125,145. | |
| Support Cost | 147,358. | |
| Total Cost/15 miles | $ 272,503. | = $3.44/foot |

4.7 SELECT FILL

The baseline plan includes select fill in rock trench and no select fill in dirt trench. The cost to provide select fill for the dirt trench is the same regardless of depth since only 12 - inches of fill is being used in any sized trench. The added cost for this is therefore constant and represents the cost of hauling and spreading the fill as well as the fill itself. This cost is calculated to be $2.10 per foot of trench.

If no select fill were required in areas of blasted rock, there would be no need to excavate the rock provided ripping and plowing equipment could get to the blasted area. All sections of the proposed work area that require blasting are expected to be accessible by this equipment. The savings, therefore, of not using select fill are the cost of the excavation and the select fill. For the four different classifications of drill blast the cost per foot without select fill are:

| | |
|---|---|
| 2½ Foot - Road - $36.19 | 2½ Foot - ROW - $44.40 |
| 3½ Foot - Road - $50.06 | 3½ Foot - ROW - $61.71 |

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## 4.8 MULTIPLE CABLE INSTALLATION

The installation of more than one cable in the same right-of-way can be accomplished in several ways. One trench can be used for any number of cables, thus reducing the cost per cable. The more cables involved the more economical this method becomes.

If cable is to be placed by plowing, multiple cables must either be placed by sucessive passes or, using a special shoe on the plow, several cables can be placed by a single pass. The cost of additional construction equipment for using this method must be weighed against the economies of placing more than one cable in the same pass.

The three referenced methods of multiple cable lay has been investigated for placing two cables and three cables in the same right-of-way.

### 4.8.1 Multiple Pass - 2 Cables

Rip/Plow Areas: For costing the second cable it was assumed that a depth of only 3½ feet would be required. The total cost then becomes the cost of one-6 foot pass, including restoration, plus the cost of one - 3½ foot pass, minus restoration. Using the baseline figures in the chart in paragraph 4.1.2 the resultant costs per foot are:

Rip/Plow - Road Shoulder $2.04 + $.62 = $2.66/foot

Rip/Plow - ROW - Dry $3.13 + $.96 = $4.09/foot

Rip/Plow - ROW - Wet $10.38 + $4.53 = $14.92/foot

Rock: In areas of rock trench multiple pass becomes tricky because the rock trench is only two feet wide and there is the risk of hitting the first cable when installing the second cable. However, again using the baseline costs, the combined cost for two cables is:

D/B-Road $45.69 + $.62 = $46.31/foot

D/B-ROW $56.93 + $.62 = $57.55/foot

4.8.2 Multiple Pass - 3 Cables

The procedure for th- third cable is simply a repeat of the second cable. For costing this simply adds the second cost figure again. For the five conditions listed in 4.8.1, the new figure becomes:

R/P Road Shoulder - $2.66 + $.62 = $3.28/foot

R/P ROW - Dry - $4.09 + $.96 = $5.95/foot

R/P ROW - Wet - $14.92 + $4.53 = $19.45/foot

D/B Road - $46.31 + $.62 = $46.93/foot

D/B ROW - $57.55 + $.62 = $58.17/foot

4.8.3 One Pass - 2 & 3 Cables

Rip/Plow: This installation method requires that all cable sections be the same length and the reels be mounted on a single trailer. Cables are fed into the plow chute together and placed in one pass. Because the plow is operating to a depth of six feet, and with the added friction of larger plow surface and a wider plow, considerably more pull power is required. The additional equipment, a D-9 plus a cable trailer and a crane to load the reels, increases the crew cost to $4,969. per day.

Daily rates of advance of the plow are as follows:

| | 2 Cables | 3 Cables |
|---|---|---|
| Road Shoulder | 1.0 miles | .55 miles |
| ROW - Dry | 3500 feet | 2000 feet |
| ROW - Wet | .30 miles | .30 miles |
| D/B - Road | 1.0 miles | 1.0 miles |
| D/B - ROW | 1.0 miles | 1.0 miles |
| Bog - Frozen | 900 feet | 800 feet |

Apply the new plow crew rate and adjusted rates of advance to the baseline plan results in the following costs per foot:

4.8.3 One Pass - 2 & 3 Cables (continued)

| | 2 Cables | 3 Cables |
|---|---|---|
| Road Shoulder | $ 3.67 | $ 5.53 |
| ROW - Dry | 5.49 | 8.00 |
| ROW - Wet | 14.03 | 14.30 |
| D/B - Road | 47.32 | 47.52 |
| D/B - ROW | 58.24 | 58.43 |
| Bog - Frozen | 12.44 | 14.18 |

Note should be made that in the rock area, the second and third cables will probably be above the 30-inch requirement of the National Electric Code. If they are not over 600 volt cables, this will not be a problem except that they will be shallow and susceptable to damage by outside forces.

Multiple placement from rubber wheeled equipment is not seen as practical or, perhaps, even possible at the 6-foot depth.

Trench: The cost of installing additional cables in an existing trench includes the additional manpower and equipment necessary to handle more cables. For this analysis, the additional cost is $257.00 per crew and, when combined with the baseline crew, results in the following costs per foot. No reduction in daily production is seen for this operation.

| | 2 Cables | 3 Cables |
|---|---|---|
| 6' Trench | $ 4.61 | $ 5.00 |
| 6' Trench - Utility | 7.01 | 7.96 |
| 3½' Trench | 3.34 | 3.73 |
| 3½' Trench - Utility | 5.55 | 6.50 |