Chapter 4

Pipeline Route Selection and Surveys
CHAPTER 4 PIPELINE ROUTE SELECTION AND SURVEYS

TABLE OF CONTENTS

PART 4.1 ROUTE CONSIDERATIONS 4-1
PART 4.2 ROUTE SURVEYS—GENERAL 4-1
PART 4.3 ENGINEERING INSTRUMENT SURVEY 4-2
PART 4.4 USE OF USGS QUAD SHEETS 4-2
PART 4.5 ALTIMETER 4-3
  4.5.1 Procedure for Using Altimeter 4-3

FIGURES

Figure 4.1 Measuring Wheel 4-3
Figure 4.2 Example Altimeter Notes (Pressure Change Corrections Only) 4-5
Figure 4.3 Example Altimeter Computations (Pressure and Temperature Corrections) 4-6
Chapter 4
Route Selection and Surveys

4.1 ROUTE CONSIDERATIONS

There are many considerations which should be made in selecting the route for a stockwater pipeline. Some of the most important ones are:

- Stockwater tanks should be located at sites with good drainage, be on solid ground and be where it will be easy to provide a tank overflow.

- The pipeline route should be selected to minimize the number of high and low spots in the line. High spots require air valves and low spots in shallow lines require drains.

- Routing the pipeline over moderate slope terrain makes it easier to trench for the pipeline.

- There must be access to all portions of the route by trenching equipment.

- Soils should be deep enough for trenching to the design depth.

- Avoid landslide areas and avoid crossing watercourses that are eroding.

- Avoid crossing Federal or State land where possible. Permits are required for crossing these lands and the permitting process takes a considerable amount of time and effort to complete.

- Full consideration should be given to the possibility of future expansion to the system. If a pipeline extension is anticipated then pipe size and rating should be appropriate for the ultimate extension.

- If large stock tanks or storage tanks are to be installed, locate them where access to heavy equipment is possible.

4.2 ROUTE SURVEYS--GENERAL

The type of survey information required for a pipeline depends on the characteristics of the pipeline. For example, consider a spring development with a 300-foot pipeline, with total fall between water surface in spring and a tank of only four feet. This system may require a very detailed survey to insure that the pipe grade and tank elevation will allow the system to operate properly.
On the other hand, a four mile long pipeline that has an elevation gain of 400 feet may only need a careful study of contours on a U.S. Geological Survey (USGS) quadrangle map to get enough information for an adequate design.

And in a third example, a four-mile pipeline traveling over gently undulating topography and with total elevation differences not exceeding 25 feet may need a detailed profile run with an engineers level.

The difference in these installations is that we must predict where air can collect in the pipe system and provide means for releasing it. Defining where these problem locations are will usually dictate the type of survey that should be completed.

4.3 ENGINEERING INSTRUMENT SURVEY

An engineering instrument survey should be used when available pressure head is small and where many small undulations in the terrain make it difficult to determine where all the high and low spots are located.

There are generally three types of instrument surveys that can be used:

- Differential level route surveys
- Stadia surveys, using vertical angles if necessary
- Total station instrument (Geodimeter) surveys

The type of survey which should be used will depend on which one will give the degree of accuracy necessary and which will be the most time and cost effective.

4.4 USE OF U.S. GEOLOGICAL SURVEY QUAD MAPS

For long pipelines with major elevation changes, it is usually adequate to use contour elevation data from 7-1/2 minute USGS quadrangle maps. Contour interval on most quad sheets of interest in Montana is 20 feet. Fairly accurate interpolations can be made to an elevation of 10 feet which is usually adequate for high pressure pipelines. One caution is that it is extremely important to accurately locate ground locations on the map. If there is any question as to location, other methods of determining elevations should be used.

Horizontal distances can be estimated from the maps to the nearest 100 feet. Corrections must be made for additional distance caused by elevation changes.

A common method of measuring pipeline lengths in the field on long pipelines is a measuring wheel. Figure 4.1 illustrates this device. The wheel should be run over the route in two directions. If the first and second run do not match within 2 percent, the route should be traversed again. The average of the readings should be used. Heavy grass, rocky ground or mud will prevent use of a measuring wheel.
4.2A ROUTE SURVEYS—GENERAL

The extent of the survey will be determined by the person with job approval for the project under consideration.

4.4A USE OF U.S. GEOLOGICAL SURVEY QUAD MAPS

The accuracy of contour maps is usually one-half of the contour interval. Therefore, the design head should be increased by one-half interval if USGS quad maps are used for design.

In the Sandhills, the use of USGS maps may not be reliable because of the similarity of terrain and difficulty in location of exact position during the design process. During the construction phase, it may be very difficult to find the designed location for the given plan or map.
4.5 ALTIMETER

Where a 7-1/2 inch quad sheet is not available for an area, and you need to determine elevations for a pipeline with large elevation differences, an altimeter may be used.

The altimeter should be at least capable of being read to the nearest five feet.

Some altimeters are temperature compensated. There is a considerable advantage to using this type of instrument as corrections for temperature do not need to be made.

A measuring wheel is usually used to measure distances in conjunction with an altimeter survey.

4.5.1 Procedure for Using an Altimeter

There are three principal reasons for barometric variations at one elevation: (1) temperature changes, (2) overall weather changes, and (3) changes in local wind velocity and pattern.

The altimeter should be temperature normalized before use. Temperature of the altimeter should be as close as possible to that of the surrounding air when used.
The survey should be performed as rapidly as possible. After completing all readings throughout the length of the line, return to the beginning point and take a final reading. Corrections must be made for the difference in readings at the beginning point. This difference is proportionately applied as a correction to each reading point along the profile. Example notes, Figure 4.2, illustrates how to do this.

If the instrument is not temperature compensated, temperatures should be taken along with barometric readings. Corrections must then be made for temperature changes. Correction for temperature is approximately 0.0020 feet per degree F for each foot read from the instrument. For example, if temperature is 50 degrees F at the initial point, and it is then moved to an unknown point where, at a temperature of 70 degrees F, it reads 100 feet higher, the 100 feet should be increased by 0.0020 x (70 - 50) x 100, or 4 feet.

Example notes, Figure 4.3 shows a computer spreadsheet output for making temperature and elevation corrections.

Barometric pressure changes due to changes in weather and high or gusty winds can cause severe variations in altimeter readings. An altimeter should not be used during periods of significant weather changes and high or gusty winds.
Figure 4.2
EXAMPLE ALTIMETER NOTES
Figure 4.3
EXAMPLE ALTIMETER COMPUTATIONS
(Pressure and Temperature Corrections)
Using Computer Spreadsheet Program
(altimeter.wk1)

<table>
<thead>
<tr>
<th>Comment</th>
<th>Station</th>
<th>Observed Temperature (degrees F)</th>
<th>Time (hr)</th>
<th>Time (min)</th>
<th>Corrected Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>End at start</td>
<td>0</td>
<td>5018</td>
<td>100</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start</td>
<td>0</td>
<td>5000</td>
<td>96</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1800</td>
<td>5075</td>
<td>100</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>5170</td>
<td>104</td>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>3900</td>
<td>5190</td>
<td>104</td>
<td>2</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>4500</td>
<td>5243</td>
<td>108</td>
<td>2</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>