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Executive Summary

Prairie Dog - Level I
Hydropower Feasibility Study

Prepared for

Wyoming Water Development Commission
Cheyenne, Wyoming
December, 1984

By

HDR
Henningson, Durham & Richardson
EXECUTIVE SUMMARY

PRAIRIE DOG - LEVEL 1
HYDROPOWER FEASIBILITY STUDY

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HDR
Henningson, Durham & Richardson, Inc.
Omaha, Nebraska
EXECUTIVE SUMMARY

LEVEL I STUDY REPORT
FOR THE
PRAIRIE DOG HYDROPOWER PROJECT

Purpose of Study

In July, 1984, the Wyoming Water Development Commission (WWDC) initiated a Level I Reconnaissance Study to investigate the technical, economic and institutional feasibility of installing hydroelectric generating facilities on the upper end of the Prairie Dog Water Supply Company irrigation ditch near Story, Wyoming (Figure 1). This Executive Summary reviews the study procedures and results. Full details of the study are reported in a separate 40 page Final Report available from the WWDC.

At issue in the study was whether hydropower would contribute to the proposed overall rehabilitation of the badly eroded upper section of Prairie Dog Ditch. If the hydropower development project was found to be feasible, it could also provide the needed erosion protection. If erosion protection is eventually constructed, it was desirable to know whether hydroelectric facilities should also be added. The hydropower part of the study looked primarily at the existing operation of the system rather than attempting to identify and evaluate alternative sources of water or operating modes. If the current operation was found infeasible, the study was to determine what volume of water, if any, would make the project feasible.

The current operation, as well as other more energy productive operations, were evaluated for several project layouts using today's costs and market prices. Under current conditions, none of the alternatives nor operating scenarios were deemed feasible, even if the erosion protection is built.
Project Background

The earliest components of the Prairie Dog Water Supply Company deversion and ditch (Figure 1) were constructed around 1900. A diversion from South Piney Creek was also constructed to carry additional flow from that watershed through Story to a point on North Piney Creek just above the diversion. The combined North and South Piney Creek diversion follows a northeasterly route through two steeply eroded waterfalls and along about a mile of steep grade before entering the more mildly sloping channel of Jenks Creek. The flow continues from this point through the irrigated areas all the way downstream to Prairie Dog Creek. It is in the steep reach that hydropower potential was questioned.

Kearney Lake dam and reservoir on South Piney Creek was constructed about 15 miles southwest of the town of Story in the 1900's and enlarged in 1962. The reservoir has a storage capacity of approximately 6050 acre-ft (normal pool) and is owned and operated by the Kearney Lake Land and Reservoir Company. Shareholders of the Prairie Dog Water Supply Company also own stock in the Kearney Lake Land and Reservoir Company. Releases from the reservoir supplement the North Piney water available for diversion to Prairie Dog Ditch.

Initiative for Study

The U.S. Soil Conservation Service (SCS) roughly evaluated erosion protection and hydropower for the site. Their early 1980's report suggested that a PL-566 erosion protection project would cost about $960,000, and this amount might be credited against the total project cost. Acting primarily on the preliminary indications and cost supplied by the SCS, the Prairie Dog
PROJECT AREA GENERAL MAP

FIGURE

1
Water Supply Company petitioned the Wyoming Water Development Commission in late 1982 to conduct a hydroelectric feasibility study for the proposed project site. In the summer of 1984, the WWDC retained services of the consulting firm of Henningson, Durham and Richardson to complete the study and report its findings to the Commission.

Study Method and Findings

The principle steps completed during the Prairie Dog Level I Hydropower Feasibility Study were:

- Site investigations
- Public Scoping meeting, held in Sheridan, Sept. 28, 1984
- Data acquisition and analysis
- Conceptual development plans
- Break-even analysis
  - current flows and operation
  - prolonged season
  - increased diversion quantity
  - estimated construction and O and M costs
  - PL-566 subsidized construction
- Select best overall plan from cost standpoint
- Market appraisal
- Economic analysis of feasibility
- Prepare report and recommendation
- FERC application for preliminary permit
- Advisability of Level II Study

In completing these steps, four alternative development plans of various penstock lengths, plant capacities, etc. and two operating scenarios (historical flows, increased flows) were investigated. The four alternatives incorporated intake works, penstocks, turbine/generators, interconnections, and tailraces. The costs of the components for each alternative were found to be essentially fixed with the exception of penstock length. Preliminary screening was made on the basis of marginal analysis of head increase per additional unit of penstock length. During this analysis the two intermediate length penstock alternatives were
dropped. The remaining two alternatives incorporated penstock lengths of 1200 ft. (Alternate I) and 5400 ft. (Alternate IV), and net heads of 189 ft. and 381 ft. respectively.

To conduct an economic comparison of the remaining alternatives, a present worth break-even analysis was performed. A 30-year payback period with a 12 percent interest rate was used to estimate what the present (1984) worth of energy would need to be (¢ per kilowatt hour) for the project to at least pay for construction costs. Energy prices were assumed to escalate at an appropriate declining rate. The resulting 1984 energy costs for the two operating plans are given in Table 1.

Table 1 Estimated 1984 Break-Even Prices

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Estimated 1984 Construction Cost</th>
<th>Break-Even Cost (¢/KWH) in 1984</th>
<th>Historic Operation</th>
<th>Modified Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>$1,680,000</td>
<td>6.6</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>$3,280,000</td>
<td>6.4</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>IV Subsidized*</td>
<td>$2,320,000</td>
<td>4.5</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

1Based on average monthly historic diversions.
2Based on a constant 60 cfs for 6 months operation each year.
*This alternative assumes a construction cost subsidized by a $960,000 grant from SCS for erosion protection.

Table 1 shows that current energy prices would need to be 2.5 cents to 6.6 cents per kilowatt hour for any of the options to pay the construction costs alone. Operating costs would also need to be added. The development plan incorporating the 5400 ft. penstock (Alternative IV) has slightly lower break-even energy costs than the plan incorporating the 1200 ft. penstock (Alternative I). The values are too close to clearly claim either as superior. If either a modified operation or a credit for the SCS pipeline project is possible, there is a substantial reduction in the break-even
energy sales prices. Alternative IV was selected as the best proposal because it also provides full erosion protection and improved water quality benefits that could exceed the actual erosion protection project cost.

Selected Project

The selected conceptual project components are shown in Figure 2. The penstock intake would be located approximately 600 feet below the existing Prairie Dog Ditch Diversion. Approximately 5400 feet of buried 36 inch steel penstock would run in a northwesterly direction roughly paralleling Prairie Dog Ditch. A 1644 KW Byron Jackson TKW turbine generator and powerhouse would be located at the end of the valley, approximately 1000 feet east of highway 193, just south of the private access road to the Texaco farm. The power will be stepped up and transmitted approximately 0.4 miles west to an interconnection with the existing MDU 12.5 KV feeder line between Banner and Story. The project would cost $3,376,000 and would produce 6,900,000 KWH of energy each year by operating at a continual flow of 60 cfs for a full six months. The total head would be 420 feet, with a net head of 380 feet.

Feasibility of Selected Project

The final test of project feasibility is assessment of whether markets exist for the energy produced and determination of the project's "ability to pay". A standard measure of the market price for power is the "avoided costs" of the utilities within the project area. These were obtained and found to vary between 1.47¢ per KWH (Montana-Dakota Utilities) and 1.075¢ per KWH (Sheridan-Johnson REA). A direct interconnection could be made with only one of the utilities, Montana-Dakota Utilities (MDU), which owns the
transmission line serving Story. Regardless, neither the 1.47¢ nor 1.075¢ came close to the break-even rates shown earlier (Table 1), and the preliminary results appeared to show the project as infeasible.

The values in Table 1 are based on a 12 percent interest rate (representing private development), a declining energy escalation (initial year 6 percent), zero O & M costs, and a hypothetical operation of 60 cfs for 6 months. Because the Wyoming Farm Loan Board uses lower interest rates (current 8.5 percent for Joint Powers Loans to revenue producing projects), because the actual flows available might exceed the hypothetical case, and because energy may escalate at higher rates, more detailed economic evaluations were deemed necessary.

In regard to the question of available flows, average monthly flows for North and South Piney Creeks were combined with the average historical monthly diversions to the Meade-Coffeen and Piney-Kruse ditches (see Figure 1 for locations) to obtain a reasonable estimate of the potential maximum water available for diversion to the project. These are presented in Table 2, and suggest that substantially greater flows might be available for diversion if legal and other restrictions allowed. Preliminary review of the adjudiated water rights indicate that as much as 120 cfs could be diverted during the irrigation season before any neighboring ditch diversions were able to accumulate significant senior rights to available flows.

Based on these observations, a value higher than the 60 cfs assumed for the modified operation in Table 1 may be available and legal. If the entire storage of Kearney Lake could be used to supplement the low flows of April and October (see Table 2), as much as 100 cfs over a 7 month period, or more
Table 2. Mean Annual Water Available for Diversion
Based on Historical Diversions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr</td>
<td>27.5</td>
<td>0</td>
<td>0</td>
<td>25.0</td>
<td>52.5</td>
<td>-</td>
</tr>
<tr>
<td>May</td>
<td>165.2</td>
<td>3.9</td>
<td>2.5</td>
<td>98.2</td>
<td>257.0</td>
<td>15.6</td>
</tr>
<tr>
<td>Jun</td>
<td>183.3</td>
<td>17.9</td>
<td>13.0</td>
<td>333.2</td>
<td>485.6</td>
<td>40.0</td>
</tr>
<tr>
<td>Jul</td>
<td>39.9</td>
<td>- 21.1</td>
<td>- 20.1</td>
<td>+ 202.8</td>
<td>= 201.1</td>
<td>50.5</td>
</tr>
<tr>
<td>Aug</td>
<td>16.0</td>
<td>22.8</td>
<td>17.7</td>
<td>142.2</td>
<td>117.7</td>
<td>51.9</td>
</tr>
<tr>
<td>Sep</td>
<td>14.0</td>
<td>14.6</td>
<td>9.0</td>
<td>92.8</td>
<td>83.2</td>
<td>35.4</td>
</tr>
<tr>
<td>Oct</td>
<td>11.3</td>
<td>0</td>
<td>0</td>
<td>32.7</td>
<td>44.0</td>
<td>-</td>
</tr>
</tbody>
</table>

For shorter periods, could be available for diversion and hydropower generation (assuming the ditch channel could safely carry this amount). A discharge of 100 cfs for 7 months will provide 2741 KW of power and generate 13,373,750 KWH of energy. This is about twice the energy of the earlier proposal (60 cfs, 6 months), but would increase construction costs from $3.3 million to $4.6 million, which is a 39 percent cost increase.

With regard to energy escalation, MDU predicts that the current avoided costs will increase 12 percent in 1985 and 6 percent thereafter until 1991 when their contract with Pacific Power and Light expires. This is a slightly different pattern than that used in preparing Table 1. In addition, operating and maintenance costs will occur and should not be neglected as with Table 1. Using all these changes, the actual present worth of construction costs, operation and maintenance, and energy values were determined and are summarized in Table 3. Break-even prices in Table 1 were not calculated because the 1984 market price of 1.47¢ is known and should be used for economic evaluations. The two interest rates, 12 percent
Table 3. Estimated Project Construction Costs, Operation and Maintenance Costs, and Energy Present Value*

<table>
<thead>
<tr>
<th>Plant Size (MW)</th>
<th>Estimated Construction Cost</th>
<th>0 and M Present Value</th>
<th>Energy Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>8.5% 12%</td>
<td>8.5% 12%</td>
</tr>
<tr>
<td>1.6</td>
<td>$3,377,000</td>
<td>$743,700  $500,200</td>
<td>$2,230,000 $1,558,000</td>
</tr>
<tr>
<td>2.7</td>
<td>$4,609,700</td>
<td>$1,047,500 $733,600</td>
<td>$4,322,000 $3,020,000</td>
</tr>
</tbody>
</table>

*Energy values were projected using 1.47¢ per KWH in 1984, a 12 percent increase in 1985, a 6 percent increase in 1986, and continued escalation but at a declining rate thereafter.

...and 8.5 percent, reflect reasonable values for private and public development, respectively.

Table 3 shows that the estimated construction plus O & M present costs for the 1.6 MW and 2.7 MW plants exceed the present value of energy in all cases. Thus, none of the attempts to find a feasible project were successful. In fact, the analysis shows that even with the most optimistic estimates of water availabilities, the project would not return the invested capital (even if O & M costs were dropped). If the cost of the erosion protection project ($960,000) were credited to the estimated project cost for either the 1.6 or 2.7 MW plants, the remaining cost plus present worth of O & M still exceeds projected energy values. For these reasons, it is concluded that hydroelectric energy development at the site is currently infeasible, regardless of whether or not an erosion control project is constructed.

Conclusion and Recommendations

The conclusion of this study is that hydropower development at the Prairie Dog Ditch site in Story, Wyoming is infeasible for both the current...
irrigation diversion pattern and for any "improved" operation considered.

The most significant reasons for the infeasible finding are:

- Low market value for energy of 1.47¢ per KWH.
- "Best Plan" would require energy sales price of 3.6¢ per KWH to pay construction costs.
- No capacity payment would be allowed because the peak demand season is winter.
- 5-7 month operating season is too short.
- Variability of available flow restricts plant size.
- Low flow capacity in system would limit additional diversions.
- Costs exceed energy values for all alternatives.

Three of these factors contributed most to the unfavorable economic assessment of the project. The primary flaw is that only very low power purchase rates could be identified within the project area. Second, very large revisions in stored and diverted flows would be required to increase the project flows, energy production and revenues. Increasing the discharge through the turbine will produce more energy but will also result in higher initial project costs, which manage to always stay ahead of the present worth of energy produced. Third, the short annual operating period (6 to 7 months) results in a substantial capital investment generating no revenues for much of the year.

It is recommended that the Wyoming Water Development Commission drop the site from further consideration for hydropower development until such time that energy purchase prices rise above production costs. It is further recommended that the state, SCS, and owners pursue possible cooperatives or cost-sharing aproaches for alleviating the severe erosion and water quality problems.