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HANDOUT

FOR

WYOMING WATER DEVELOPMENT COMMISSION

REGARDING

THE LAKE DESMET PROJECT

OCTOBER 5, 1982

TIPTON AND KALMBACH, INC.

ENGINEERS

DENVER, COLORADO
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PART 1 INTRODUCTION

Lake DeSmet Reservoir is situated in Johnson County in northeastern Wyoming on the sloping plains east of the Big Horn Mountains, about six miles north of Buffalo and 30 miles southeast of Sheridan (Figure 1). Originally a small natural body of water situated within an essentially closed basin, Lake DeSmet was first transformed into an operating reservoir more than 50 years ago by constructing a low dam near its northern end and importing water into it through a canal from Piney Creek, a tributary of Clear Creek which in turn flows into the Powder River. Water impounded in this early reservoir was released during the late summer months to provide supplemental water supplies for the irrigation of lands in the lower valleys of Piney and Clear Creeks. More recently, through the construction of the works described in this Report, the capacity of Lake DeSmet Reservoir has been greatly increased and the water supplies that can be stored therein have been augmented by replacing the earlier works which diverted water from Piney Creek, and by the construction of new facilities for importing water from Clear Creek. With the addition of these new works the potential water yield of the project will be increased considerably. Most of the increase in water yield is destined for use in development of the vast coal resources of the area as well as to enhance the dependability of supplies for irrigation and other beneficial purposes.

The project is situated in an area characterized by scant precipitation and wide seasonal variations in temperatures and streamflows. Maximum summer temperatures may approach 100°F in July and August and fall to -20°F to -40°F during the winter. Mean daily temperatures are generally below freezing from December through March. Precipitation in the vicinity of Lake DeSmet averages about 14 inches per year but increases rapidly with elevation over the Big Horn Mountains to the west, probably exceeding 30 inches annually in the high mountain ranges, most of which occurs as snow during the winter months. In this environment, streamflows in Piney and Clear Creeks and their tributaries are quite low during the winter months, but increase rapidly in April and May as snow begins to melt from the higher portions of the watershed. Peak streamflows generally occur during the latter part of May or forepart of June following which the flow drops rapidly to low levels which are sustained through the winter, largely by the
gradual return of water diverted earlier in the summer for irrigation of the valley lands.

All of the base, or dependable, flows of streams in the area are fully appropriated by early direct flow irrigation rights. The only water supplies that are available for storage and subsequent use consist of spring flood flows that are in excess of the requirements of existing irrigation ditches and flows occurring during the winter or non-irrigation season. And as those supplies vary so greatly, both in amount and duration, from year to year a relatively large volume of reservoir storage capacity is required to equate them to a reasonable pattern of water use.

The Lake DeSmet Reservoir Project can be readily reached from Buffalo and Sheridan via Interstate Highway 90 which lies about a mile to the west of the reservoir and by U.S. Highway 25 from Casper 116 miles south of Buffalo. Both Sheridan and Casper are served by scheduled airlines, and an airstrip for small planes exists at Buffalo.

The Burlington Northern Railroad extending from the Pacific Northwest to Omaha and Denver passes through Sheridan and down the valley of Piney Creek, the nearest station in the valley being at Clearmont approximately 20 miles east of Lake DeSmet Reservoir.

Project Features

The Lake DeSmet Project comprises three separate, but interconnected, units, consisting of:

- Lake DeSmet Reservoir,
- The Piney Creek Supply System, and
- The Clear Creek Supply System

The location of the principal components of each of these features are shown on Figure 2 and briefly described below.

Lake DeSmet Reservoir (Figure 3) -- Is a manmade enlargement of a small natural lake created by constructing an earthfill embankment 90 feet in height at the north end of the lake, a similar embankment 50 feet in height at the south end of the lake, and several small dikes of lesser height along the eastern rim of the reservoir. The enlarged
reservoir has an average width of approximately 1 mile and an overall length of approximately 5.5 miles, forming a storage facility with a surface area of nearly 3400 acres and a total capacity of 234,987 acre feet. Of this total capacity, 38,960 acre feet lie below the level of the outlets at the north and south ends of the reservoir. The inverts of the outlets at the north and south ends of the lake are situated at approximately elevation 4545 at which level the surface area of the lake is approximately 1,610 acres. When filled to the level of the crest of the spillway, the water level in the reservoir will be at elevation 4620. Under normal operation, it is unlikely the reservoir would ever be drawn down below about elevation 4555, thus resulting in a maximum fluctuation in water levels of approximately 65 feet corresponding to an operating storage volume of 179,263 acre feet.

**The Piney Creek Supply System (Figure 11)** -- Consists of a low concrete diversion dam on Piney Creek, at a point approximately one-quarter mile upstream from the Interstate 90 highway bridge, and a concrete-lined tunnel having an internal diameter of 8.58 feet and a total length of 8316 feet, extending from the diversion dam to Lake DeSmet Reservoir. This tunnel is situated deep in the ground (in order to be within a coal bed), nearly 180 feet below the elevation of the diversion dam and the high water level in Lake DeSmet Reservoir. As such, it functions as an inverted siphon. Water flows from Piney Creek into Lake DeSmet Reservoir by gravity under the elevation differential between the diversion dam and the level of water in the reservoir. When the reservoir is drawn down to its minimum level, the tunnel will convey up to about 900 cubic feet per second from Piney Creek into the reservoir. This capacity progressively decreases as the level of water rises in Lake DeSmet, reaching zero when the reservoir is completely filled to elevation 4620 corresponding to the elevation of the spillway on the Piney Creek diversion dam.

**The Clear Creek Supply System (Figure 14)** -- Lifts water from Clear Creek and conveys it for a distance of 6.7 miles into Lake DeSmet Reservoir. Water is diverted from Clear Creek at a low concrete diversion dam and conveyed through a short conduit into the Healy Regulatory Reservoir, an off-channel storage facility.
created by construction of a long earthen dike on the north side of the creek. This reservoir has a surface area of approximately 256 acres and a total storage capacity of 5,140 acre feet. Near the point where water enters the reservoir from Clear Creek, a pumping plant is provided which draws water from Healy Reservoir through six pumps each having a nominal capacity of 33.3 cubic feet per second. Discharge from the pumps is conveyed through the 66-inch diameter Clear Creek-Lake DeSmet Pipeline to the south end of Lake DeSmet Reservoir. The nominal capacity of this pipeline is 200 cubic feet per second; and when Lake DeSmet Reservoir is nearly full and all pumps are operating, the total pump lift is approximately 340 feet.

Other supplies which reach Lake DeSmet Reservoir consist of the runoff from the approximately 40 square mile drainage area tributary to the Lake, most of which originates in the Shell Creek Basin to the west of the Lake. This runoff also includes the return flow from several small ditches which divert water out of the upper basin of Little Piney Creek for irrigation of lands in the Shell Creek Basin, as well as water imported into that basin by the Lake DeSmet (M&M) Ditch which diverts water out of Rock Creek.

Functional Operation

The primary purpose of Lake DeSmet Reservoir and its two water supply systems is to impound storable supplies diverted from the source streams and to regulate those supplies in a fashion such that they can be beneficially used for industrial, irrigation, and other purposes. As noted earlier, during the irrigation season all of the base flows of Piney and Clear Creeks are allocated to irrigation ditches which have senior direct flow rights and hence the first call on the available streamflow. It is only during the latter part of April, in May and in part of June in most years when the natural flow of the streams may exceed the demands of irrigation rights and only flows surplus to such requirements can be diverted into and be impounded in Lake DeSmet Reservoir under its storage rights. The amounts thereof may vary considerably from year to year; and during years of above-normal runoff surplus flows in excess of the capacity of the diversion works may occasionally occur for short periods of time. During the winter, or non-irrigation,
season all of the flow of Piney and Clear Creeks, except for small amounts that are allowed to pass the diversion structures to maintain a live stream, can be diverted into Lake DeSmet Reservoir. Once impounded, the stored supplies will be drawn upon as required to supply the various uses. Most of the water released to supplement streamflows for irrigation use will be released during the period from about mid-July through the end of the irrigation season. Supplies utilized for industrial operations and domestic use will be withdrawn from the reservoir at a more or less constant rate throughout the entire year. The volume of storage in the reservoir will thus fluctuate with the seasons and from year to year. Within any one year, the reservoir will normally be at its highest level at the end of the flood season near the end of May or in June and reach its lowest level near the end of the irrigation season in October.

Studies that have been made of the operation of the Lake DeSmet Reservoir disclose that apart from the seasonal regulation of supplies, the reservoir may be called upon to supply projected demands during prolonged periods of drought which may be of up to 8 to 10 years in duration. As there is no practical way in which the occurrence of extended drought periods can be predicted in advance, all water that is storable under the Lake DeSmet storage rights will normally be impounded in order to maintain the reservoir at the highest feasible storage level.

History

Originally, Lake DeSmet was a small body of water occupying a natural depression within an essentially closed basin, it being conjectured that this depression originally formed as a result of burning of the underlying coal beds. In its natural state, most of the runoff from the relatively small area tributary to the lake was evaporated from the lake's surface. As a result, at the time the first pioneers entered the area in the 1860's, the lake was a brackish body of water.

More than fifty years ago the lake was converted into an off-channel reservoir by constructing a low earthen dam near the north end of the basin and an intake canal through which water could be diverted from Piney Creek into the lake. Beginning in 1954, the Reynolds Mining Corporation of Richmond, Virginia became interested in this area
because of the availability of water in close proximity to vast sub-bituminous coal resources and acquired the reservoir and surrounding lands as well as stock in the Lake DeSmet Reservoir Company which controlled the reservoir storage rights. Soon thereafter it embarked on a program of acquisition of additional lands and an extensive drilling program to explore the extent of the coal resource. In 1958, the dam at the north end of the lake was raised to permit storage of water up to elevation 4573 which provided an operating storage capacity above the level of the outlet in the dam of 55,129 acre feet. Since it was first transformed into an operating reservoir, a portion of the supplies stored therein from Piney Creek have been released during the late summer months to provide supplemental water for irrigation of lands downstream of the reservoir on Piney and Clear Creeks. With the importation of fresh water supplies from Piney Creek, and their subsequent release, the quality of the water in the lake has continually improved; and for a number of years, has supported rainbow trout and other fresh water fish species.

In the process of acquiring lands, the Reynolds Mining Corporation also acquired, both directly and indirectly, an interest in a great variety of water rights. These comprised in addition to the storage rights in Lake DeSmet Reservoir, direct flow rights attached to lands that are irrigated with water from various streams in the area, rights to the use of direct flow and storage water by virtue of ownership of shares in ditch and reservoir companies, and a number of water right applications and permits primarily for storage of water in other reservoirs which at the time of their acquisition had not been constructed. From the outset, the Corporation recognized that a dependable water supply would be required in order to develop the coal resources it controlled; and in 1967, it called upon Tipton and Kalmbach, Inc. to, among other things, devise certain improvements to the then existing water supply facilities and to assist it in formulating a long-range plan of water development.

The first stage program, the initial planning for which was undertaken in 1967, embodied rehabilitating the then existing storage and supply facilities. That work included the replacement of the old dam at the north end of the lake (which had developed serious leakage problems) with a new dam across a narrow point in the valley about 2,000 feet to the north of the former site. This new dam accommodated raising the water level in the reservoir from elevation 4573 to 4580 to provide a total operating storage
capacity of 72,867 acre feet. The first-stage program also included the construction of a new diversion dam on Piney Creek and the Lake DeSmet Intake Tunnel for conveying water diverted from that creek into the reservoir. When those works were completed in May of 1971, the old Lake DeSmet Intake (Leiter) Ditch, which had been costly to maintain and difficult to operate during the winter, was abandoned.

During the time the first-stage works were being constructed, a number of alternative plans of developing the other storage filings and permits owned by the Corporation were considered. It was found that the most attractive plan would embody the transfer of a number of undeveloped storage rights (most of which pertained to storage sites on Clear Creek and its tributaries) to an enlarged Lake DeSmet Reservoir and construction of facilities to convey water from Clear Creek into that reservoir. As this scheme, which subsequently became known as the Master Water Plan, involved the transfer in place of storage of a number of individual storage permits, a public hearing on the matter was held by the State Engineer in accord with provisions of Wyoming Water Law, following which the scheme of integrating essentially all of the undeveloped storage permits into Lake DeSmet Reservoir was approved in August of 1970.

The necessary field investigations and preparation of plans for the second-stage development were well underway in December 1973 when Texaco Inc. entered into an agreement with the Reynolds Mining Corporation to purchase substantially all of the properties, including the water supply facilities and water rights, then owned by Reynolds. Under that agreement, the Reynolds Mining Corporation retained approximately 3,000 acres of land and a 15 percent interest in the water supplies that would be available for new uses upon completion of the Master Plan works. Construction of the works embodied in the second-stage program commenced in September, 1974 and were substantially completed by the end of 1976. These works included the enlargement of the north dam and construction of new dams and dikes at the south and along the eastern rim of Lake DeSmet Reservoir to accommodate a 40-foot raise in its high water level to elevation 4620; and construction of the Clear Creek Supply System, including a diversion dam on Clear Creek, the Healy regulatory reservoir, a pumping plant, and the Clear Creek - Lake DeSmet Pipeline.
In accord with requirements of State Law, all of the plans and specifications covering the construction of the water supply facilities embodied in the Master Water Plan were submitted to, and approved by, the Office of the State Engineer of Wyoming.

**Construction Cost**

The total "direct cost" of construction of the water supply works embodied in the Master Water Plan is estimated to be in the order of $29,200,000. This total represents only direct payments to construction contractors and suppliers of equipment in completing the specific works embodied in the first and second-stage construction programs. It does not include the cost of engineering services involved in the planning, design and supervision of construction of the works, administrative and engineering costs incurred by the Owners during the time the works were under construction, the cost of land, easements, legal fees, and other similar corollary costs that are allocable to the water supply project nor does it include any of the original costs of acquisition of the properties and water rights concerned. Table 1 indicates a summary of the cost of the principal features embodied in each of the two stages of the construction program.

Because of the general increase in construction costs that have taken place during recent years, the present day replacement cost of the water supply features of the Lake DeSmet Project would be considerably more than the amounts indicated in Table 1.
Table 1

Summary of Direct Construction Cost of the Lake DeSmet Project

<table>
<thead>
<tr>
<th>Stage</th>
<th>Feature and Works</th>
<th>Construction Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Lake DeSmet Reservoir:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>North Dam (including outlet works and spillway)</td>
<td>$1,189,718</td>
</tr>
<tr>
<td></td>
<td>Piney Creek Supply System:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piney Creek Diversion Works</td>
<td>571,605</td>
</tr>
<tr>
<td></td>
<td>Lake DeSmet Intake Tunnel</td>
<td>2,714,539</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Subtotal - First Stage</strong></td>
</tr>
<tr>
<td>Second</td>
<td>Lake DeSmet Reservoir:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>North Dam (including outlet works)</td>
<td>3,465,106</td>
</tr>
<tr>
<td></td>
<td>South Dike (including inlet-outlet works)</td>
<td>3,869,062</td>
</tr>
<tr>
<td></td>
<td>East Abutment Cutoff</td>
<td>2,218,348</td>
</tr>
<tr>
<td></td>
<td>East Dikes (including auxiliary spillway)</td>
<td>300,778</td>
</tr>
<tr>
<td></td>
<td>Service Spillway</td>
<td>537,614</td>
</tr>
<tr>
<td></td>
<td>Clear Creek Supply System:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clear Creek Diversion Works</td>
<td>1,368,949</td>
</tr>
<tr>
<td></td>
<td>Healy Regulatory Reservoir</td>
<td>3,251,765</td>
</tr>
<tr>
<td></td>
<td>Pumping Plant</td>
<td>2,850,414</td>
</tr>
<tr>
<td></td>
<td>Clear Creek - Lake DeSmet Pipeline</td>
<td>6,866,196</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Subtotal - Second Stage</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total Construction Cost</strong></td>
</tr>
</tbody>
</table>
LEGEND

- Clear Creek Drainage Basin
- Stream Gaging Stations
- Texaco Inc. Properties

FIGURE 1
LAKE DE SMET PROJECT
LOCATION MAP
LAKE DESMET PROJECT:
1 LOCATION MAP
2 GENERAL PLAN

LAKE DESMET RESERVOIR:
3 LOCATION OF PRINCIPAL FEATURES
4 NORTH DAM
5 SOUTH DIKE
6 EAST ABUTMENT CUTOFF
7 EAST DIKES AND AUXILIARY SPILLWAY
8 SPILLWAY
9 NORTH DAM-OUTLET WORKS
10 SOUTH DIKE-INLET-OUTLET WORKS

LAKE DE SMET SUPPLY SYSTEM:
11 PLAN AND PROFILE
12 DIVERSION DAM
13 LAKE DESMET INTAKE TUNNEL
14 PRINCIPAL FEATURES
15 DIVERSION WORKS
16 HEALY RESERVOIR
17 PUMPING PLANT-PLANS
18 PUMPING PLANT-SECTIONS
19 SWITCHYARD
20 CLEAR CREEK-LAKE DESMET PIPELINE

REFERENCE FIGURES
LAKE DE SMET PROJECT:
1 LOCATION MAP
2 GENERAL PLAN

LAKE DESMET RESERVOIR:
3 LOCATION OF PRINCIPAL FEATURES
4 NORTH DAM
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18 PUMPING PLANT-SECTIONS
19 SWITCHYARD
20 CLEAR CREEK-LAKE DESMET PIPELINE

FIGURE 2
LAKE DE SMET PROJECT
GENERAL PLAN

SCALE
1 2 MILES

Boundary of Texaco's properties
FIGURE 3
LAKE DE SMET RESERVOIR
LOCATION OF PRINCIPAL FEATURES
**Figure 4**
Lake De Smet Reservoir
North Dam

**Sections and Details**

- **Section A-A**: West Abutment Cutoff
- **Section B-B**: Sandstone and concrete backfill
- **Section C-C**: Shale or coal, first stage dam, outlet works, embankment zones

**Profile**

- Original ground surface along axis
- Second stage dam (EL 4630.0
- Crest of first stage dam
- Outlet works
- Bottom of cutoff trench (to coal or shale)
- First stage dam

**Embankment Zones**

1. Selected impervious materials compacted to 6-inch layers
2. Selected sand and gravel materials compacted to 12-inch layers
3. Random fill composed predominantly of cinder materials compacted to 12-inch layers

**Notes**

- **Control House**
- **Parshall Flume**
- **Access Road**
- **To Pinyon Creek**
COUNTY ROAD

EMBANKMENT ZONES

1. Selected impervious materials compacted to 6-inch layers.
2. Selected sand and gravel materials compacted to 12-inch layers.
3. Random fill composed predominantly of clinker materials compacted to 12-inch layers.

FIGURE 5
LAKE DESMET RESERVOIR
SOUTH DIKE
PLAN

SOUTH DIKE
(SEE FIGURE 5)

LAKE DE SMET
RESERVOIR
(HWL EL 4620)

INLET-OUTLET WORKS
(SEE FIGURE 10)

CLEAR CREEK
PIPELINE
(SEE FIGURE 20)

EAST ABUTMENT CUTOFF

SCALE
0 400 800 1200 FEET

4760

4720

PL

Original ground surface

Crest EL 4630

H WL EL 4630

Bottom of cutoff trench

Top of protective blanket

Coal or shale

Slurry trench

Clinker

Coal or shale

Top of protective blanket

Slurry trench

Clinker formations

Top of protective blanket EL 4570 Z

Clinker formations

Top of protective blanket EL 4570 Z

Coal or shale

Embankment zones:

1. Selected impervious materials compacted to 6-inch layers.
2. Random fill composed predominantly of clinker materials compacted to 12-inch layers.
3. Hard clinker materials placed without special compaction.

FIGURE 6
LAKE DE SMET RESERVOIR
EAST ABUTMENT CUTOFF
(SLURRY TRENCH)

SECTION D-D
STA 78+00 Z TO STA 91+00 Z

SECTION C-C
STA 74+00 Z TO STA 78+00 Z

SECTION A-A
STA 51+00 Z TO STA 64+00 Z

SECTION B-B
STA 64+00 Z TO STA 74+00 Z

ft. H.

12/.

Figure 6
LAKE DE SMET RESERVOIR
EAST ABUTMENT CUTOFF
(SLURRY TRENCH)
SITE PLAN

SITE PLAN

DIKE A
DIKE B
DIKE C

DIKE B

AUXILIARY SPILLWAY

EAST DIKES - TYPICAL SECTIONS

EMBANKMENT ZONES

1. Selected impervious materials compacted to 6-inch layers.
2. Selected sand and gravel materials compacted to 12-inch layers.
3. Random fill composed predominantly of cinder materials compacted to 12-inch layers.
4. Hard cinder materials placed without special compaction.

DIKE "A"

DIKE "C"

DIKE "B"

STATIONS

PROFILE

AUXILIARY SPILLWAY CHANNEL

FIGURE 7

LAKE DESMET RESERVOIR
EAST DIKES
AND
AUXILIARY SPILLWAY
NOTE
See Figure 7 for location of service spillway and description of embankment zones.

FIGURE 8
LAKE DESMET RESERVOIR
SERVICE SPILLWAY
(AND DIKE)
GENERAL PLAN

DIVERSION DAM
LITTLE PINERY
TRANSFER DITCH
RECTIFIED CHANNEL
INTAKE SHAFT

SCALE
0 800 1600 FEET

PROFILE

LAKE DE SMET: INTAKE TUNNEL

TUNNEL STATIONS

PROFILE

DIVERSION DAM
Spillway crest
EI 4435.00
Flow
EI 4434.5
Outlet shaft
EI 4450.00
Unwatering gate
EI 4445.5
Natural ground surface
EI 4465.64
NORTH DAM
M.W.L. EI 4420

FIGURE II
PINEY CREEK SUPPLY SYSTEM
GENERAL PLAN AND PROFILE
PIEVEY CREEK SUPPLY SYSTEM
LAKE DE SMET INTAKE TUNNEL

FIGURE 13

PINEY CREEK SUPPLY SYSTEM
LAKE DE SMET INTAKE TUNNEL
FIGURE 15
CLEAR CREEK SUPPLY SYSTEM
DIVERSION WORKS
CLEAR CREEK SUPPLY SYSTEM
PUMPING PLANT
(PLANS)

NOTE
See Figure 18 for Sections and Table of pumping equipment.
ISOMETRIC VIEW

DETAIL A
H.V. SWITCH OPERATING HANDLE

ELEVATION A-A
(69KV/460V POWER TRANSFORMER)

ELEVATION B-B
(OUTDOOR SWITCHING CABINET)

PLAN

Power bus from Transformer

BAY 1

BAY 2

BAY 3

BAY 4

Power bus to Pumping Plant

Bus duct from Transformer

Bus duct to Control Equipment

Power driven roof vent

Doors

Windows

Station service dis-connect

Fuse refill container

Weatherproof toggle switches

Weatherproof duplex outlet

BAY-2

BAY-3

BAY-4

FIGURE 19
CLEAR CREEK SUPPLY SYSTEM
PUMPING PLANT
SWITCHYARD
Figure 20
CLEAR CREEK SUPPLY SYSTEM
CLEAR CREEK-LAKE DE SMET PIPELINE

APPROXIMATE HYDRAULIC GRADIENTS

6 UNITS - LAKE DE SMET RESERVOIR AT EL 4820 (1,192 CF/S)
6 UNITS - LAKE DE SMET RESERVOIR < EL 4590 (100,000 CF/S)
6 UNITS - LAKE DE SMET RESERVOIR > EL 4590 (10,000 CF/S)

6' I.D. Reinforced Concrete Pressure Pipe
6' 1/2" Concrete Pipe
73' I.D. Pipe Drop
57' I.D. Pipe Drop

Profile of Surge Tank (rotated 90°)
Profile of Surge Tank

PLAN
SCALE

ELEVATION

PROFILE
STATION

FIGURE 20
CLEAR CREEK SUPPLY SYSTEM
CLEAR CREEK-LAKE DE SMET PIPELINE