KANSAS RIVER PROJECTS

1956 Operations
1957 Outlook

February 1957
INTRODUCTION

This is the fourth Annual Operating Plan regarding irrigation units in the Kansas River Projects area. The scope of the report is limited to irrigation and other functions that are the responsibility of the Bureau of Reclamation. It does not include operational data on flood control which is the responsibility of the Corps of Engineers.

The report is concerned primarily with the Federally constructed irrigation facilities in the Republican, Solomon, and Smoky Hill River drainage areas which were in operation during 1956 or are expected to be in operation during 1957. Chapter I (or the Introduction) of the report is a brief description of the irrigation units in the Kansas River Projects area. Chapter II gives a summary of actual operations during 1956. Chapter III presents operational estimates for 1957. The operational data regarding Harlan County Reservoir, which was constructed and is operated by the Corps of Engineers, has been prepared with the cooperation of the Corps.

1956 OPERATIONS

No shortages of water for irrigation occurred during 1956, although average precipitation over the area was well below normal. Irrigation water was delivered to about 37,840 acres under Bureau-constructed systems. Supplemental water was provided to about 7,350 acres of land served by privately owned and operated pumps and canals. At most of the reservoirs this was the fifth consecutive year of below average inflow. Reservoirs in operation were Bonny, Swanson, Enders, Harry Strunk, Harlan County (operated by the Corps of Engineers), Kirwin, Webster, and Cedar Bluff. Webster Reservoir was placed in operation during May, 1956.

1957 OUTLOOK

It is anticipated that during 1957 approximately 45,700 acres will be irrigated under the Bureau-constructed irrigation systems. If 1957 is a dry year, as much as 17,000 acres under privately owned irrigation systems may wish to obtain supplemental water. All but about 3,000 acres of the 45,700 acres will be in the Republican River drainage. No shortages will develop if normal inflow conditions prevail at all reservoirs; however, an extremely dry year could cause a shortage at Kirwin, and would severely deplete the storage content of Harlan County Reservoir.
Extreme care in the transportation and use of irrigation water may be required during 1957. It is expected that strict state water administration will be needed throughout the system of irrigation units of the Kansas River Projects area if the water supply is going to be conserved for the irrigation systems paying for water delivery services.
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CHAPTER I - INTRODUCTION

Purpose of Report

The purpose of this report is to advise the administrative staff, the water users, state officials, Corps of Engineers, and other interests of the annual operating plan for the irrigation units in the Kansas River Projects area. Included in the report is a brief description of the irrigation units (including Federally constructed canals and the reservoirs providing storage for irrigation purposes), a review of 1956 operations, and the plan of operation for 1957.

Location and Major Features

The Kansas River Projects area is the term used to refer to units of the Kansas River Basin that are a part of the Missouri River Basin Project. This includes multiple-purpose reservoirs which include storage allocations for irrigation and flood control. The irrigation systems for these units are served by dams and reservoirs that have been constructed and are operated by the Bureau of Reclamation or the Corps of Engineers, and canals that have been constructed, or are operated, by the Bureau of Reclamation. The location map of the various units is shown in the general map of the Kansas River Basin (Frontispiece).

Nine reservoirs are now in operation. Seven of these (Bonny, Swanson Lake, Enders, Harry Strunk Lake, Kirwin, Webster, and Cedar Bluff) are operated by the Bureau of Reclamation. Two reservoirs (Harlan County and Kanopolis) are operated by the Corps of Engineers. Kanopolis Reservoir is not being used at present to serve an irrigation unit, therefore, it is not listed with other irrigation facilities referred to in this report.

Storage allocations for the various reservoirs are shown in Table 1 on page 10. Lovewell Dam, which is under construction, will be operated by the Bureau of Reclamation. It may be placed in operation during May, 1957.

Irrigation Districts

Six irrigation districts in the Kansas River Projects area have contracted with the Bureau of Reclamation for construction of irrigation facilities. These are the Frenchman Valley, H. & R.W. (initials for Hitchcock and Red Willow Counties), Frenchman-Cambridge, and Nebraska-Bostwick in the State of Nebraska; and the Kansas-Bostwick and Kirwin Irrigation Districts in the State of Kansas. Also the Almena and Webster Irrigation Districts, in Kansas, are negotiating with the Bureau for such facilities. In addition to these districts, there are other organizations that are showing considerable interest in the development of Bureau-constructed irrigation projects.
CHAPTER II - SUMMARY OF 1956 OPERATIONS

Precipitation

General drought conditions continued throughout the Kansas River Projects area during 1956. The total annual precipitation at the weather stations of the various dams ranged from 46 percent of normal at Trenton Dam to 114 per cent of normal at Enders Dam. Locally, heavy storms in the areas of Enders and Lovewell Dams caused the precipitation totals for the year to be above that at other dams. See Table 2 on page 11.

Streamflow

The year 1956 was the fifth consecutive year of below average inflow at most of the reservoirs. Exhibits 19 through 27 (pages 33 to 41) which plot total annual inflows for the years of inflow record are very indicative of the dry cycle. Table 3 on page 12 shows that the inflows varied from 17 per cent of average at Kirwin Dam (lowest inflow on record) to 121 per cent of average at Lovewell Dam.

Reservoir Operations - 1956

No shortages occurred during 1956 at any of the reservoirs or irrigation units in the Kansas River Projects area. Controlled spills occurred at Bonny and Enders Reservoirs. Reservoir operation hydrographs on which are plotted reservoir content, mean monthly inflow and mean monthly outflow are shown in Exhibits 1 through 9 (Pages 15 to 23). Table 4 on page 13 gives the monthly figures for these values at each reservoir during 1956.

Bonny Reservoir

Controlled spills occurred at Bonny Reservoir in the form of releases through the river outlet in order to keep the reservoir level below the elevation of the spillway outlet. Releases to the Hale Ditch, a privately constructed and operated canal system, were made to satisfy natural flow rights. In addition to this, storage water was released under Warren Act Contracts to supplement the natural flow to the Hale Ditch.

Swanson Lake

Storage in Swanson Lake was more than adequate to satisfy irrigation requirements of the Bartley Canal and demands for storage releases to supplement (under Warren Act Contracts) natural flow water rights of the existing Meeker Canal, Riverside Canal, and various pump irrigators. No spills occurred during 1956. At the end of the calendar year, the reservoir level was at elevation 2741.48 feet. This was about 10.5 feet below the top of the irrigation pool.
Enders Reservoir

Controlled spills through the river outlets occurred at Enders Reservoir during the winter and spring months. Storage releases were made to help meet irrigation requirements of the Bartley Canal in order to reduce the demand on Swanson Lake. Releases of storage water under Warren Act Contracts were made to supplement natural flow rights of pump irrigation in the drainage area of Frenchman Creek.

Harry Strunk Lake

No spills occurred at Harry Strunk Lake during 1956, although at the beginning of the irrigation season the water surface elevation was less than three feet from the top of the irrigation pool. Sufficient storage was available to meet the requirements of the Cambridge Canal and of several pump irrigators under Warren Act Contracts.

Harlan County Reservoir

Carryover storage from the previous year made it possible to meet the 1956 irrigation requirements of land under the Franklin, Naponee, Franklin Pump, Superior, and Courtland Canals. However, the reservoir level was drawn down to elevations 1925.09 feet at the end of October which was almost five feet below the minimum elevation of 1930.0 feet recommended by recreational interests. Also releases were made to meet sanitation requirements below the Superior-Courtland Diversion Dam. Transportation losses of storage water in the reach of the Republican River from Harlan County Dam to the Superior-Courtland Diversion Dam were considerably increased because of unrestricted diversions by numerous pump irrigators.

Kirwin Reservoir

The smallest inflow on record of the North Fork Solomon River above Kirwin Reservoir resulted in very little active storage in the reservoir during 1956. At the end of the calendar year the total storage amounted to only 7,885 acre-feet. No releases were made to the partially constructed Kirwin Canal.

Webster Reservoir

Storage was commenced in Webster Reservoir on May 3, 1956. The inflow was so low that the active irrigation storage in the reservoir at the end of the 1956 calendar year was negligible.

Cedar Bluff Reservoir

No spills occurred at Cedar Bluff Reservoir during 1956. The carryover storage alone was far more than adequate to meet the municipal water supply requirements of 3,750 acre-feet of storage water for the City of Russell, Kansas. Minor releases were made for one irrigation pump about six miles below the dam. There were times when over half of the releases for the Russell municipal water supply pumps (on the Smoky Hill River about 44 miles below Cedar Bluff Dam) were lost in transportation. Some of this loss was the result of depletions by unregulated pump irrigators.
Canal Operations

During 1956 the total diversions by Bureau constructed and operated canals (including the existing Meeker Canal) amounted to 124,405 acre-feet to serve 37,843 acres. This acreage included 5,442 acres in Kansas and 32,421 acres in Nebraska.

In addition, 726 acre-feet of surplus storage was made available under Warren Act Contracts to 640 acres under the Hale Ditch in Colorado and 717 acre-feet were made available to 5,708 acres of private pump irrigators in the Republican River Basin of Nebraska. Total releases to the Hale Ditch amounted to 4,729 acre-feet for 1,643 acres.

Monthly diversions for each canal are shown in Table 5 on page 14. Total annual diversions for the past few years of record and acres irrigated are shown graphically in Exhibits 10 through 18 (pages 24 to 32).
CHAPTER III - ANNUAL OPERATING PLAN FOR 1957

Insofar as it will be practical to do so, the 1957 plan for operating the irrigation facilities in the Kansas River Projects area will include meeting requirements for recreational and sanitation purposes. In cases of conflict between these interests and those of irrigation, state laws favor irrigation needs.

Water Supply - 1957

The water supply outlook for 1957 indicates that the supply will be adequate to satisfy all irrigation requirements under most probable inflow conditions. If dry conditions prevail, similar to those of 1954 through 1956, there will be shortages in the supply for lands under Kirwin and Lovewell Reservoirs. Carryover storage at other reservoirs will make it possible to meet expected irrigation needs of irrigation units served by them. In the case of Harlan County Reservoir, it is believed that the supply will be adequate for irrigation requirements above Lovewell Reservoir, provided that efficient procedures are followed in the transportation and use of the water supply. Dry conditions would cause the reservoir level at Harlan County to be below the desired minimum level of 1930.0 feet.

The total water supply at each reservoir which will be available to meet demands on the reservoir amounts to the carryover storage from previous years plus the 1957 inflow. The carryover figure is easily determined; however, it is practically impossible to predict future inflows in areas where the major part of the reservoir inflow results from rain flood runoff. For this reason, estimates on future inflows are based upon frequency analysis of runoff records (pages 33-41). The “most probable” inflow was assumed to be that point on the curve where the annual historical inflow was equaled or exceeded 50 per cent of the time. Ten per cent of all the historical annual flows have been less than the selected “reasonable minimum” and 10 per cent have been greater than the selected “reasonable maximum.” The frequency curves are shown in Exhibits 28 through 33 (pages 42 to 47) and the “most probable”, “reasonable minimum”, and “reasonable maximum” values used at each reservoir are shown in Table 3 on page 12. These values are shown graphically on Exhibits 19 through 27 (pages 33 to 41) for ready comparison with historical values.

Reservoir Operations - 1957

Storage limitations at all of the reservoirs for irrigation purposes will be limited to storage below the top of the irrigation pool at each reservoir as indicated in Table 1 on page 10. State laws regulating the use of water will also affect the amount and time of storing streamflows.

During winter months, when it is apparent that a reservoir will spill before the start of the next irrigation season, only that portion of the inflow will be stored continuously as will be required to fill most of the irrigation pool by the first of May. This will avoid extremes in
reservoir releases. Also the reservoir level will be kept lower during winter months when high winds can cause damage to riprap by high wave action. Continuous releases through the river outlet at Bonny Dam during winter months is not desirable because of possible damage to the Hale Ditch outlet pipe by freezing water.

Estimates for the calendar year 1957 showing the probable effects on each reservoir under "most probable", "reasonable minimum", and "reasonable maximum" inflow conditions are shown in Exhibits 1 through 9 (pages 15 to 23).

**Bonny Reservoir**

Carryover storage in Bonny Reservoir will be more than adequate to meet the 1957 irrigation requirements of supplemental storage water by the Hale Ditch. Controlled spills will occur during 1957 even under very low inflow conditions. This can occur as overflow through the gated spillway or by releases through the river outlet. Drawdowns by making releases to the river in advance of anticipated inflow conditions which will cause the irrigation pool to more than fill are also considered controlled spills. It is better to make releases for this purpose when weather conditions are such that river losses in transporting this surplus water to the next downstream reservoir will be at a minimum. During freezing weather conditions, it is not desirable to make releases through the outlet works or over the spillway.

**Swanson Lake**

Irrigation releases from Swanson Lake will be used primarily to serve lands under the Meeker, new Upper Meeker, and Bartley Canals; although, if necessary, releases may be made to assist in serving canal systems downstream. No shortages are anticipated during 1957. Surplus storage may be sold under temporary contracts to non-project systems if it is apparent at the beginning of the irrigation season that a sufficient surplus exists. Swanson Lake could spill under inflow conditions of "most probable" or better.

**Enders Reservoir**

Controlled spills will occur at Enders Reservoir during 1957. Some releases will be made to assist in satisfying irrigation requirements of the Meeker and the Bartley Canals, although the total releases at the dam for such purposes probably will not exceed 50 second-feet above that claimed by other water rights to natural flow. Surplus storage may be supplied under temporary "Warren Act" contracts to non-project systems if it is apparent at the beginning of the irrigation season that sufficient surplus exists.

**Harry Strunk Lake**

Harry Strunk Lake will spill or come very close to spilling by the start of the 1957 irrigation season. The main irrigation releases will be to the Cambridge Canal. If sufficient surplus water is available, storage releases may be made under temporary contracts to supplement natural flow rights of pump irrigators in the Medicine Creek watershed.
Harlan County Reservoir

The inflow into Harlan County Reservoir will need to be much above the "most probable condition" to cause the reservoir to spill during 1957. Releases will be made to irrigate land under the Franklin, Naponee, Franklin Pump, Superior, Courtland (Nebraska) and Courtland (Kansas above Lovewell) canals.

If careful use is made of the available water supply, no shortage should occur unless the inflow is less than that of the "reasonable minimum." There may be a shortage in the water that will be needed to fill Lovewell Reservoir to the point where deliveries can be made to that portion of the Courtland Canal now under construction below Lovewell Reservoir. Also there may not be a water supply sufficient to meet any demands above the irrigation requirements of the units in the project areas.

If adequate water is available in Harlan County Reservoir, releases will be made, if required, to assist in filling a portion of Lovewell Reservoir.

Lovewell Reservoir

It is hoped that Lovewell Reservoir, now under construction, will start storing water in May, 1957. Extremely low inflow conditions would make it impossible to fill Lovewell Reservoir to the point where adequate deliveries could be made to the Lower Courtland Canal.

Insofar as possible, all flow of the Republican River at the Superior-Courtland Diversion Dam that is not needed by the Superior Canal, Courtland Canal, or by downstream rights will be diverted into Lovewell Reservoir through the Courtland Canal. It is expected that such diversion will also be made, if necessary, during the non-irrigation season except for the months of January and February.

Kirwin Reservoir

Record low annual inflows into Kirwin Reservoir after the commencing of storage in October 1955 have resulted in practically no active carryover storage for 1957. The outlook for a water supply for that part of the acreage to be irrigated under the Kirwin Canal (now being constructed) is dependent entirely upon 1957 inflows. An inflow equal to a "reasonable minimum" year, or less, would not be adequate to service expected demands. Sales of surplus water under temporary contracts to non-project interests will depend upon future inflow conditions. This will not be possible under "reasonable minimum" inflow conditions.

Webster Reservoir

There was a negligible amount of carryover of active storage in Webster Reservoir at the end of the 1956 calendar year. The canal system for the irrigation unit has not been constructed, therefore, this will not result in shortages for an irrigation project during 1957. It is planned that reservoir releases will be confined to those amounts necessary to meet downstream water rights to natural flow. If spring
and early summer inflows should provide sufficient active storage, water could be sold under temporary contracts to supplement downstream water rights to natural flow.

Cedar Bluff Reservoir

The irrigation system for the Cedar Bluff Unit has not been constructed, so the carryover storage from 1956 is much more than adequate to satisfy expected demands on the reservoir. Water will be available to make storage releases under temporary contracts to the municipal pumping plants for the city of Russell, Kansas, and other rights requiring supplementary storage in addition to natural flows. Inflow in excess of "most probable conditions" will be required to fill the irrigation pool.

Canal Operations - 1957 Estimates

It is expected that a total of approximately 45,700 acres under irrigation units in the Kansas River Projects area will receive irrigation water in 1957. Of this total, 36,600 acres will be in Nebraska and 9,100 acres will be in Kansas. Expected acreages and probable canal diversion requirements under "most probable", "reasonable driest year" and "reasonable wettest year" are shown graphically in Exhibits 10 through 18 (pages 24 to 32). The canal requirements for the values used in each of the three types of years are based on probability curves from data taken from water supply studies.

In addition to the above acreages, it may be possible to deliver surplus storage water under temporary contracts to non-project irrigation systems.

Some of the irrigation Districts in the Kansas River Projects area will start operating parts of the canal systems for the first time in 1957. Prior to this time, during the period of canal construction, all canal operation and maintenance was performed by the Bureau of Reclamation. Since the canal operations may vary according to the irrigation district under which they will be operated, the canal operations for 1957 are discussed under the various district headings.

Frenchman Valley Irrigation District

The Culbertson Canal and diversion dam will be operated by the Frenchman Valley Irrigation District. Rehabilitation of the canal has been started by the Bureau of Reclamation, therefore, the Bureau will maintain the diversion dam and main canal during 1957.

H. & R.W. Irrigation District

The Bureau of Reclamation has contracted with the H. & R.W. Irrigation District to enlarge and extend the Culbertson Canal, operated by the Frenchman Valley Irrigation District, to serve a new irrigation unit. Work on this system will not be far enough advanced to serve any lands in the H. & R.W. District in 1957.
Frenchman-Cambridge Irrigation District

In 1957 the Frenchman-Cambridge Irrigation District will take over both operation and maintenance of the Bartley and Cambridge Canals (including the Bartley and Cambridge Diversion Dams) which are described as Block I of their system. The Bureau of Reclamation operated and maintained these canals during the construction period. The Bureau of Reclamation will operate and maintain the Meeker Canal (including the diversion dam) and the new Upper Meeker Canal. These will not be turned over to the District until more of the canal system in the Meeker-Driftwood Unit is completed. See location map.

Nebraska-Bostwick Irrigation District

The 1957 irrigation season will be the first year for the Nebraska-Bostwick Irrigation District to operate any of their canal systems. These will include the Franklin, Naponee, Franklin Pump, Superior Canals, and the Courtland Canal laterals (including farm deliveries from the main canal). During the construction period, water deliveries were made by personnel of the Bureau of Reclamation. The Bureau of Reclamation will maintain these canals and their laterals for another year, but after 1957 it is expected that the district will assume this responsibility, too.

The only parts of the Nebraska-Bostwick Canal system that will not be operated by the district in 1957 are the Superior-Courtland Diversion Dam and the main Courtland Canal between the diversion dam and the Nebraska-Kansas state line. These will be operated and maintained by the Bureau of Reclamation in 1957 (and possibly 1958) because they are also integral parts of the Kansas-Bostwick irrigation system now under construction.

Kansas-Bostwick Irrigation District

The Kansas-Bostwick Irrigation District will assume for the first time, part of the operating responsibilities in 1957. They will operate the laterals and farm turnouts served by the Courtland Canal between the Nebraska-Kansas state line and Lovewell Reservoir. The laterals will be maintained by the Bureau of Reclamation in 1957, but it is expected that the district will do this in 1958. For the next year or two, the Bureau will make deliveries to and maintain the main Courtland Canal.

It is possible that work on the Courtland Canal below Lovewell Reservoir may be completed enough to serve a very small area in 1957. However, if this is done, the operation and maintenance will be performed by the Bureau of Reclamation.

Kirwin Irrigation District

The Kirwin Canal will still be under construction during 1957, therefore, any operation and maintenance performed will be done by the Bureau of Reclamation.
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Includes space for sediment storage.

Irrigation season for 1956 was May 1 to Oct. 15. The net acre-feet shown is active irrigation storage.

Elevation at outlet to Franklin Canal.

Elevation at outlet to lower Courtland Canal. Need Elev. 1571.7 (18,800 A.F.) to supply full canal capacity.

Closure is expected in Spring of 1957.

Storage commenced on May 3, 1956.
<table>
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<tr>
<th></th>
<th>Bonny</th>
<th>Trenton (Swanson L.)</th>
<th>Enders</th>
<th>Medicine Cr. (H. Strunk L.)</th>
<th>Harlan County</th>
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<td>% of</td>
<td>% of</td>
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<tr>
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<tr>
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<tr>
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<td>1.09</td>
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<td>T</td>
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<td>.02</td>
<td>.12</td>
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<td></td>
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<td>4%</td>
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<tr>
<td>Jan.-Dec.</td>
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<td>64%</td>
<td>61%</td>
<td>69%</td>
<td>48%</td>
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</tr>
<tr>
<td>May-Oct.</td>
<td>18.81</td>
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<tr>
<td></td>
<td>101%</td>
<td>74%</td>
<td>86%</td>
<td>55%</td>
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</table>

1/ Inclusive.

2/ Records at Burr Oak, Kansas for 1956.
### TABLE 3

**INFLOW INTO RESERVOIRS - 1956 RECORDS, 1957 ESTIMATES**

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Actual</th>
<th>Adjusted</th>
<th>Percent of Average</th>
<th>Average for Period of Record</th>
<th>1957 Estimates</th>
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<tr>
<td></td>
<td>1,000 Acre-Feet (Except Col. 4)</td>
<td></td>
<td></td>
<td>1956 Records</td>
<td><strong>1957 Estimatess</strong></td>
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<td>86.5</td>
<td>66%</td>
<td>131.5</td>
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<td>Lovewell 3/</td>
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<td>33.9</td>
<td>121%</td>
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<td>Kirwin</td>
<td>9.1</td>
<td>9.1</td>
<td>17%</td>
<td>54.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Webster</td>
<td>9.5 4/</td>
<td>9.5 4/</td>
<td>19%</td>
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<td>Cedar Bluff</td>
<td>28.1</td>
<td>28.1</td>
<td>46%</td>
<td>60.6</td>
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</tbody>
</table>

1/ Actual records plus upstream depletions caused by reservoirs and canals in Missouri Basin Projects.

2/ Values determined from inflow frequency curve. A value of 90% on curve = reasonable minimum conditions, 50% = most probable conditions, and 10% = reasonable maximum conditions.

3/ No storage during 1956. Expect storage to commence about May 1, 1957.

<table>
<thead>
<tr>
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<th></th>
<th></th>
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<td>1.8</td>
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<td>0.8</td>
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<td>1.5</td>
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<td>2.4</td>
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<td>7.9</td>
<td>7.7</td>
<td>8.1</td>
<td>10.4</td>
<td>9.6</td>
<td>8.5</td>
<td>8.2</td>
<td>7.2</td>
<td>7.2</td>
<td>-</td>
</tr>
<tr>
<td><strong>Webster-Inflow</strong></td>
<td>-</td>
<td>0.4</td>
<td>0.7</td>
<td>1.2</td>
<td>0.9</td>
<td>0.7</td>
<td>6.7</td>
<td>4.6</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9.5</td>
</tr>
<tr>
<td><strong>Outflow</strong></td>
<td>Storage started 5-3-55</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Content at End of Mo.</strong></td>
<td>5.4</td>
<td>1.1</td>
<td>3.1</td>
<td>3.2</td>
<td>2.6</td>
<td>2.4</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>-</td>
</tr>
<tr>
<td><strong>Cedar Bluff-Inflow</strong></td>
<td>-</td>
<td>0</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>9.7</td>
<td>3.3</td>
<td>13.5</td>
<td>0</td>
<td>0</td>
<td>1.3</td>
<td>0.1</td>
<td>0</td>
<td>28.1</td>
</tr>
<tr>
<td><strong>Outflow</strong></td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.4</td>
<td>1.1</td>
<td>0.7</td>
<td>1.3</td>
<td>1.3</td>
<td>0.7</td>
<td>0.7</td>
<td>0</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Content at End of Mo.</strong></td>
<td>127.0</td>
<td>127.3</td>
<td>128.1</td>
<td>127.3</td>
<td>125.4</td>
<td>126.7</td>
<td>126.0</td>
<td>143.2</td>
<td>149.7</td>
<td>121.9</td>
<td>121.9</td>
<td>121.1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Irrigation Facilities</td>
<td>Acres Irrigated</td>
<td>April</td>
<td>May</td>
<td>June</td>
<td>July</td>
<td>August</td>
<td>Sept.</td>
<td>Oct.</td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------</td>
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<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planned 1/ 1956</td>
<td>2/ Canal not constructed or operated by Bureau of Reclamation. Values include natural flow and Warren Act deliveries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meeker Canal</td>
<td>3,058</td>
<td>0</td>
<td>1,872</td>
<td>2,016</td>
<td>3,219</td>
<td>2,902</td>
<td>2,491</td>
<td>1,238</td>
<td>14,830</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Bartley Canal</td>
<td>7,000</td>
<td>4,736</td>
<td>0</td>
<td>631</td>
<td>1,002</td>
<td>4,034</td>
<td>2,541</td>
<td>910</td>
<td>9,489</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cambridge Canal</td>
<td>15,600</td>
<td>10,463</td>
<td>0</td>
<td>2,870</td>
<td>5,336</td>
<td>11,712</td>
<td>8,028</td>
<td>4,040</td>
<td>33,892</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Franklin Canal</td>
<td>13,794</td>
<td>6,054</td>
<td>210</td>
<td>2,599</td>
<td>5,808</td>
<td>5,288</td>
<td>6,478</td>
<td>2,162</td>
<td>21,251</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napanee Canal</td>
<td>1,696</td>
<td>762</td>
<td>0</td>
<td>75</td>
<td>117</td>
<td>954</td>
<td>722</td>
<td>175</td>
<td>2,431</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Franklin Pump Canal</td>
<td>2,070</td>
<td>1,419</td>
<td>0</td>
<td>414</td>
<td>377</td>
<td>1,329</td>
<td>1,266</td>
<td>361</td>
<td>3,707</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior Canal</td>
<td>7,491</td>
<td>4,612</td>
<td>230</td>
<td>1,242</td>
<td>930</td>
<td>3,616</td>
<td>5,919</td>
<td>1,291</td>
<td>13,192</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Courtland Canal</td>
<td>2,949</td>
<td>1,317</td>
<td>181</td>
<td>1,242</td>
<td>990</td>
<td>1,333</td>
<td>1,682</td>
<td>505</td>
<td>6,141</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Nebraska</td>
<td>15,270</td>
<td>5,422</td>
<td>0</td>
<td>2,420</td>
<td>3,140</td>
<td>4,670</td>
<td>7,180</td>
<td>2,730</td>
<td>20,860</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Kansas above Lovewell</td>
<td>65,870</td>
<td>37,843</td>
<td>621</td>
<td>13,965</td>
<td>17,808</td>
<td>36,205</td>
<td>36,978</td>
<td>14,665</td>
<td>4,763</td>
<td>124,405</td>
<td></td>
<td></td>
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<tr>
<td>Total for USBR Operated</td>
<td></td>
<td>6,310</td>
<td>0</td>
<td>53</td>
<td>18</td>
<td>338</td>
<td>374</td>
<td>228</td>
<td>1,040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warren Act (Nebraska)</td>
<td></td>
<td>640</td>
<td>0</td>
<td>141</td>
<td>346</td>
<td>23</td>
<td>39</td>
<td>177</td>
<td>726</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Warren Act (Colorado)</td>
<td></td>
<td>6,950</td>
<td>0</td>
<td>194</td>
<td>364</td>
<td>361</td>
<td>413</td>
<td>403</td>
<td>1,766</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warren Act (Total)</td>
<td></td>
<td>1,643</td>
<td>88</td>
<td>1,080</td>
<td>671</td>
<td>1,269</td>
<td>632</td>
<td>507</td>
<td>4,729</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

1/ Planned acreage as of January 1, 1957.
2/ Canal not constructed or operated by Bureau of Reclamation. Values include natural flow and Warren Act deliveries.
ENDERS RESERVOIR
OPERATION HYDROGRAPHS

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool

Top Dead Storage


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 3

(Estimated)
HARRY STRUNK LAKE
OPERATION HYDROGRAPHS

ESTIMATED


Reservoir Content
1000 A.F.

100
80
60
40
20
0

Top Irrigation Pool

Top Dead Storage

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Inflow
Outflow

Mean Monthly Flow
100 C.F.S.


(Estimated)
HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Exhibit 5


Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

(HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS

(Estimated)

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Reservoir Content
1000 A.F.
LOVEWELL RESERVOIR
OPERATION HYDROGRAPHS

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Reservoir Content
1000 A.F.

Mean Monthly Flow
100 C.F.S.

Inflow
Outflow

Top Irrigation Pool
Top Dead Storage
KIRWIN RESERVOIR
OPERATION HYDROGRAPHS

- Actual or estimate under most probable inflow conditions
- Estimate under reasonable minimum inflow conditions
- Estimate under reasonable maximum inflow conditions

Reservoir Content
1000 A.F.

Top Irrigation Pool

Top Dead Storage

Mean Monthly Flow
100 C.F.S.

Exhibit 7
WEBSTER RESERVOIR
OPERATION HYDROGRAPHS

Actual or estimate under most probable inflow conditions
Estimate under reasonable minimum inflow conditions
Estimate under reasonable maximum inflow conditions

Top Irrigation Pool
Top Dead Storage

Mean Monthly Flow
1000 C.F.S.

Reservoir Content
1000 A.F.

Exhibit 8
---13,000 A.F (Reasonable Driest Yr.)
---9,000 A.F (Most Probable Yr.)
---5200 A.F (Reasonable Wettest Yr.)

- 5,000 Ac.
Franklin Canal Diversions and Acres Irrigated

- 24,400 A.F. (Reasonable Driest Yr.)
- 16,200 A.F. (Most Probable Yr.)
- 8200 A.F. (Reasonable Wettest Yr.)
- 6600 Ac.
- 3000 A.F. (Reasonable Driest Yr.)
- 2000 A.F. (Most Probable Yr.)
- 1000 A.F. (Reasonable Wettest Yr.)
- 900 Ac.
ACRE-FEET DIVERTED OR ACRES IRRIGATED (Thousands)

- 5200 A.F. (Reasonable Driest Yr.)
- 3400 A.F. (Most Probable Yr.)
- 1800 A.F. (Reasonable Wettest Yr.)
- 1550 A.c. (Estimated)

FRANKLIN PUMP CANAL DIVERSEIONS AND ACRES IRRIGATED
- 14,000 A.F. (Reasonable Driest Yr.)
- 10,100 A.F. (Most Probable Yr.)
- 4,900 A.F. (Reasonable Wettest Yr.)
- 4,700 Ac.
TOTAL DIVERSIONS LESS FLOW AT NEBR-KAN. STATE LINE

- 6200 A.F (Reasonable Driest Yr.)
- 4480 A.F (Most Probable Yr.)
- 2160 A.F (Reasonable Wettest Yr.)
- 1500 A.c. (Estimated)
24,800 A.F (Reasonable Driest Yr.)

17,920 A.F (Most Probable Yr.)

8640 A.F (Reasonable Wettest Yr.)

6000 Ac.

COURTLAND CANAL DIVERGIONS AND ACRES IRRIGATED IN KANSAS ABOVE LOVELL

(ESTIMATED)
ANNUAL INFLOW—SWANSON LAKE

Acre-Feet (Thousands)

Historical Records
Records Adjusted for Upstream Storage and Use.

5-Year Running Average (Adjusted)

Average 131.5

CALENDAR YEARS

Exhibit 20
ANNUAL INFLOW - HARLAN COUNTY RESERVOIR

Historical Records
Records adjusted for Upstream Storage and Use.

5-Year Running Average (Adjusted)

Average 487.0

Exhibit 23
ANNUAL INFLOW - LOVEWELL RESERVOIR
(WHITE ROCK CREEK)

Acre-Feet
(Thousands)

130
100
90
80
70
60
50
40
30
20
10
0

1929 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

CALENDAR YEARS

Acre-Feet
(Thousands)

130
100
90
80
70
60
50
40
30
20
10
0

Average
27.5

5-Year Running Average

Exhibit 2.4
ANNUAL INFLOW - KIRWIN RESERVOIR

Acre Feet (Thousands)

280
200
180
160
140
120
100
80
60
40
20
0

1920 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

CALENDAR YEARS

Acre Feet (Thousands)

280
200
180
160
140
120
100
80
60
40
20
0

Average

5 Year Running Average

Exhibit 25
ANNUAL INFLOW—CEDAR BLUFF RESERVOIR

Year Running Average

400
380
360
340
320
220
200
180
160
140
120
100
80
60
40
20
0

ANNUAL INFLOW—CEDAR BLUFF RESERVOIR

Acre Feet
(Thousands)

Acre Feet
(Thousands)

1919 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

CALENDAR YEARS

Average 60.6

5 Year Running Average

Exhibit 27
INFLOW FREQUENCY CURVES

ACRE FEET
(Thousands)

ACRE FEET
(Thousands)

HARRY STRUNK LAKE
(1925-55)

BONNY RESERVOIR
(1929-55)

Exhibit 28
INFLOW FREQUENCY CURVES

HARLAN COUNTY RESERVOIR
(1929-1955)
INFLOW FREQUENCY CURVES

CEDAR BLUFF RESERVOIR (1919-55)