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SOURCE Sinkiang Water Conservation Engineering Corps of the Ministry of Water Conservation and the Sinkiang Provincial Water Conservation Bureau.

PRESENT DEVELOPMENT AND FUTURE PLANS FOR THE RED WILD GOOSE LAKE RESERVOIR AND HO-P'ING CANAL PROJECTS

I. INTRODUCTION

[Tables are appended.]

Ti-hua is confronted with an increasing food shortage because of an expanding population and difficulties in obtaining staples from elsewhere. To overcome this dilemma, it is essential to increase the arable acreage of this district by developing its irrigation projects.

If properly regulated, there is a sufficient supply of water in the Urumchi River to meet the demand of the surrounding farmlands. The solution, therefore, is to build a reservoir in the marshland area on the right side of the river, and to utilize the natural terrain of Red Salt Lake (Chiang-yen-ch'ih; Ueda 5985, 14620, 5986). In October 1946 the first step was taken to accomplish this huge task. General Chang-Chih-chun dispatched into Ti-hua area experts from the Sinkiang Provincial Water Conservation Bureau and from the Sinkiang Water Conservation Engineering Corps of the Water Conservation Department.

Subsequently, construction work on the Ho-p'ing (1263, 2899) Canal began in March 1947, with the plan to complete the project by late May of the same year. This canal joins the reservoir with the new agricultural district in the vicinity of Ch'ing-k'o-ta-hu (13095, 4924, 12052, 6362).

Construction work on the Red Wild Goose Lake; (Chiang-yen-ch'ih; 5985, 12957, 5986) Reservoir [The name "Red Salt Lake" was later changed to "Red Wild Goose Lake"] was started in July 1947 and by 9 May 1948 most of the work on the lower sluice gate was completed. This made possible the storage of 18 million cubic meters of water in the reservoir. Thus for the first time, in 1948, water released from the reservoir to supply water to the new irrigation district near Ch'ing-k'o-ta-hu, increasing the rice acreage to 5,000 mou (one mou is

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one-sixth of an acre) and wheat and other cereal acreage to more than 10,000 mou. At the completion of the entire irrigation projects, this total acreage will be increased to 20,000 mou in rice, 40,000 mou in wheat, and 40,000 mou in other cereal fields. The estimated yield per year of grain from this district will then reach 250,000 shih shih (one shih shih is one hectoliter). This will solve most of the food-shortage problems in northern Sinkiang.

Recently, however, construction work on this important irrigation project had to be discontinued because of inflationary prices and sudden stoppage of government grants. As it stands at present, there is no hope for fulfilling the 1949 program for increasing the agricultural acreage. Because of its economic importance, it is hoped that the government will renew the construction grants so that the irrigation projects can be continued and completed at the earliest date.

II. IMPORTANCE OF THE PROJECTS

Until recently, most of the staples needed in Ti-hua were obtained from I-ning district, which had been known as the "Storehouse of Northern Sinkiang." However, the outbreak of the I-li Incident in 1944, and the continual disturbances since, dwindled food production in the I-ning district. Consequently, Ti-hua had to look elsewhere for its food supply. At present, the grain shortage has been alleviated by bringing in grain from various hsiens located west of Lun-t'ai in southern Sinkiang, or from Lan-chou in Kansu Province over the eastern highway.

This method of procuring foodstuff is proving very unsatisfactory and expensive. Exhorbitant prices must be paid for transporting the foodstuff over long and poor transport routes. Besides, only a limited amount could be obtained in this manner. It is also likely that the government will be forced to abandon grants allocated for such a transaction, if the inflationary trend continues. To prepare for such an eventuality, it is essential to complete the irrigation projects at the earliest date.

The first attempt to regulate the water supply in the Ti-hua area was made in 1943. A reservoir was constructed utilizing Red Salt Lake. Because of the extensive nature of this project, it has ended in part failure. If additional construction and repair work is carried out, this reservoir could be made workable. Since the natural terrain surrounding the lake favors such a project, the completed reservoir will become one of the largest of its kind in the Northwest. The reservoir will be capable of storing surplus water from the Urumchi River during autumn and winter and flood water during summer and winter. The water discharged from such a reservoir would supply water to an area twice that of the existing agricultural district.

The agricultural district near Ti-hua is not too fertile. Along Ch'ien-te Hsien, 30 kilometers northwest of Ti-hua in Ch'ing-ko-ta-hu district, is a rich tract of land. The flatness of its terrain makes this district suitable both for grazing and for raising of crops. Attempts were made in 1915 to develop this rich area. Spring water was used to make several thousand mou of barren area productive. Because of lack of spring water, however, the district was not developed completely. When the reservoir work is completed, the entire district could be developed in full. The additional food-producing area will help make Ti-hua self-sufficient. It no longer will be necessary to obtain food elsewhere at exhorbitant prices. Savings on the transport cost alone will more than pay for the entire construction cost of the irrigation projects. Each mou increase in agricultural land in Ti-hua district is worth each 15 - 20 mou increase elsewhere. The completed irrigation projects will give many other tangible and intangible benefits.

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In June 1946, the Water Conservation Bureau was established by the Sinkiang Provincial Government to facilitate the Ti-hua irrigation projects. Also in November of the same year, the Water Conservation Department of the Central Government organized the Sinkiang Water Conservation Engineering Corps to work jointly with the Bureau.

III. PHYSICAL FEATURES OF THE TI-HUA DISTRICT

A. Climate

Ti-hua is about 915 meters above sea level. The temperature in this vicinity remains below zero for 4 - 5 months of the year. In February the temperature drops to the minimum of 34.30 degrees centigrade below zero. The maximum is reached in July when the thermometer registers 41.20 degrees centigarde. The average annual rainfall in this area is approximately 345 millimeters. The maturity period for agricultural crops averages about 180 days.

B. Urumchi River

The water sources of the Urumchi River are located in Wu-k'o-ta-pan (6835, 568, 12052) of the Tien-shan Mountains. The two major water sources are located in the following places:

1. For low-water discharge -- spring waters of southeast Wu-la-pai (5835, 3738, 4139), Shui-hsi-kou (5952, 10820, 6404), Yin-kou (12862, 6404), and Pan-ch'ang-kou (12052, 2990, 6404).

2. For flood-water discharge -- flood waters and melting snow of Kan-ho-tzu (2897, 6045, 2362) and southwestern Nan-shan (1010, 2528).

Water from these sources seldom flows into the Urumchi River because it percolates into the ground before reaching the river, and also because of obstruction from alluvial soil. At normal times, the northern tributary of the Urumchi River flows from the confluence point of the two major water sources into Chiang-shan-tsui (5985, 2528, 1489) and percolates underground when it reaches Ch'ien-te Hsien. This stream reappears above ground in the form of springs in Lao-lung-ho (9250, 14876, 6045) and helps irrigate tens of thousand of mou of rice paddies in Ch'ien-te. During flood periods, however, the northern and southern tributaries join the waters of the Po-k'o-ta-shan (1016, 568, 12052, 2528) and the Shui-mo-kou (5952, 8057, 6404) in the western sector of the old grazing ground. At such times, the total length of the river expands to more than 100 kilometers; the river basin, to about 400 square kilometers. Also, the channel of the river broadens and disperses widely.

The flow of the Urumchi River is not constant. In the hilly, spur section of the Chiang-shan-tsui, in the west of Ti-hua, the flow is regulated by mountain passes and contours of the land. The Ti-hua--I-ning Highway Bridge is located in this hilly sector. The soil in this sector is very alluvial. The river runs down a steep slope which has a gradient of 1 to 2 percent.

C. Volume of Water in Urumchi River

The hydrological conditions of the mountains and valleys in Sinkiang are very similar. The snow on the mountains freezes from October to April every year. The first warm days in May melt the snow on the mountains slopes, and, as summer heat increases, the melting increases rapidly. Thus the streams begin to rise in early spring and continue to rise as the heat increases. The streams reach their highest point in July or August. This condition results in flood, but it lasts only for a short time. From September on, the water starts to

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decrease. Occasionally, during this time of the year, rains cause floods in mountain regions. A careful study of hydrological conditions of the Urumchi River has been made since 1941, but the record is still incomplete. The low-water discharge of this river is 5 cubic meters per second, while the flood-water discharge reaches 200 cubic meters per second. The average low-water discharge is 7 cubic meter per second.

D. Soil in the New and Old Irrigation Districts

Like many rivers peculiar to Sinkiang, the Urumchi River's rivulets have a beginning but no end. That is, many of these rivulets disappear underground from percolation. The narrow gorge of the Urumchi River is surrounded on three sides by mountains. After running near the foothills of the Chiang-shan-tsui, the river gradually enters an alluvial plain. Ti-hua is located in the upper reaches of the river. The soil in this vicinity is yellowish and composed mainly of sand and gravel. This type of soil is very permeable. Wheat and bean crops grow fairly well in this type of soil. There is much barren land along the foothills of the mountain. Because of their steep inclines, it is difficult to irrigate the mountains properly. If the irrigation projects are completed, the rich flatland of Ch'ing-k'o-ta-ho will be suitable for growing rice, wheat, and other cereals and grass for grazing purpose.

IV. CONSTRUCTION PLANS

A. New Irrigation District

The projected new irrigation district will include the area west of Chang-shan-tzu (12698, 2528, 2262), east of T'ou-t'un-ho (13346, 2518, 60450), north of the An-ning (2309, 2392) Canal, and south of Kao-chia-hu (13940, 2349, 6362). The total acreage of this district is approximately 200,000 mou. Because of its favorable terrain feature and many springs, the eastern sector of the irrigation district is suitable for rice fields. The low, western sector of Huang-shui (14692, 5952) and Ts'ao-tzu (5274, 2262) are suitable for rotation planting of wheat and other cereal crops. The total arable acreage in the new irrigation district is approximately 100,000 mou, which will be planted in 20,000 mou of rice, 40,000 mou of wheat, and 40,000 mou of other cereal crops. (See Tables 1 and 2.)

B. Water-Storage Plan

The volume of water required annually to supply farms in the irrigation district is estimated as 40,660,000 cubic meters. Actually, 73,188,000 cubic meters of water are needed, since estimated loss of water during transit is about 80 percent of the total water supplied. It is necessary to draw 63,088,000 cubic meters of water directly from the reservoir, not including the 20-day period during the year when the flood water of the Urumchi River is drawn directly by the Ho-p'ing Canal. Again assuming that 20 percent of the reservoir water is lost through evaporation and seepage, the reservoir must be stored with 75,688,000 cubic meters of water. From October to the end of March, when irrigation work is halted, 60,900,000 cubic meters of low-water discharge could be stored. (See Table 3.)

C. Construction Work

The construction work on the irrigation district is divided into two projects, the Red Wild Goose Lake Reservoir and the Ho-p'ing Canal. The construction work on the Red Wild Goose Lake Reservoir is simpler because the reservoir is not situated directly on the main stream of the Urumchi River. There is no fear of its being harrassed by floods. However, because of the reservoir's remoteness from the supply area, there will be a shortage of construction

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materials. Because of this shortage, too elaborate work on the sluice gate is not allowed. This work, however, must be substantial and such problems as the silting-up of the sluice gate must be dealt with properly. Only a limited supply of cement needed for the construction work can be secured from the Yao-chieh Cement Plant in Lan-chou. This cement shortage can be alleviated by a cement substitute made locally. Schemes for control of seepage and erosion should be worked out on the Ho-p'ing Canal, which flows through an arid and hilly sector of the Gobi Desert. It would be ideal if the canal bed were lined with cement mortar, but this is impossible at the present time. Some method of tightening the canal bed to prevent seepage should be worked out until sufficient cement could be obtained later.

V. CONSTRUCTION PROJECTS

A. Red Wild Goose Lake Reservoir

The terrain surrounding Red Salt Lake is ideal for building a reservoir. The northern, southern, and eastern sides of the lake are mountainous, while the western side is open and flat. The western side, therefore, could be utilized to construct a dam, thereby converting the lake into a storage reservoir. In order to make the brackish water of this lake sweet, huge volumes of fresh water from the Urumchi River were drawn into the lake this year (1948). The reservoir project includes construction work on the feed canal, lower sluice gate, lower discharge canal, earthen dam, upper sluice gate, and the upper discharge canal. Details of the construction work on these installations are as follows:

1. Feed Canal

Red Wild Goose Lake Reservoir must depend on the feed canal to draw water from the Urumchi River. The intake-gate opening will be constructed at the entrance point of Yen-erh-wo-hsia (6981, 7043, 8326, 2601) on the right side of the river. The 5,000-meter long feed canal reaches Red Wild Goose Lake by means of an open channel or flume which traverses along the mountain. The discharge of the original construction was only 1.0 cubic meters per second. When the expansion work is completed, it is hoped that the discharge will be increased to 10 cubic meters per second. About 30 meters of the midsection of this canal run along a precarious sector half way up the mountain. This sector of the feed canal must be strengthened with construction of high embankments from the dredged soil of the canal. Bridges and flumes must also be built in this middle section. After crossing the mountain ridge, the canal takes a sudden downward dip toward the reservoir. In order to neutralize this sharp descent, construction of drops is necessary. It has been discovered that if this section is moved southward along the lake at a gradient of .001 percent for about 1,240 meters, it can reach a wide, thick, stone weir from which water may fall into the lake, thus avoiding erosion. With the exception of the first section, if the gradient of the canal bottom is made at about .001 percent, erosion as well as freezing may be avoided. Later, the volume of water will be increased and the current velocity will become greater. If erosion is discovered, slates should be used in paving as a means of protection.

The first section of the feed canal, about 1,100 meters long, is constructed in the river bed and is made entirely of pebbles, which results in a large amount of seepage. To prevent this, it is necessary to line the bottom of the canal with mortar. To eliminate an accumulation of sand and gravel during flood periods, a sand gate is necessary. For protective purposes, drainage embankments should be erected along the river.

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The middle section is open to the effect of wind and snow because it is situated on the slope of the mountain. A wall is necessary to prevent snow from covering the canal. Later, when more money is available, it may be possible to abandon this section and change the line to reach the reservoir via underground methods.

2. Lower Sluice Gate

The original lower sluice gate is situated on a natural earthen dam on the west side of the lake. It is of the folding fan type and is operated by winding steel wires. It is easy for dirt and sand to silt up and obstruct the opening. The original head is only 4 meters, and is already incapable of control. Should the head increase, the dangers can hardly be imagined. It is imperative that a thorough reconstruction be instituted.

After studying local materials, it was decided to use a more reliable cylindrical valve which can be manufactured locally. This valve will make possible the drawing of large quantities of water under a 20-meter head. Enormous water pressure will be used to open and close the valve.

The existing outlet culvert is divided into two sections. The first section passes through beds of hard sandstone. It is a concrete conduit surfaced with 1.5 cubic meters of cement and is 1.1 meters high, 1.0 meter wide, and 70 meters long. The second section of the culvert is a ladderlike wooden conduit. It passes through beds of pebbly soil which has an alkaline content. It is therefore treated to prevent decay from chemical action. This second section is 1.3 meters high, 1.25 meters wide at the top, 1.5 meters wide at the bottom, and 90 meters long. Eventually, the whole culvert will be made larger and will be rebuilt with more permanent materials.

3. Lower Discharge Canal

The lower discharge canal is located near the Urumchi River, approximately 3 kilometers from the reservoir. It is 3,200 kilometers long. It traverses a steep slope. Originally it had a discharge of 0.5 cubic meter per second. Its inclined drop and piers were destroyed. After the slate-lining work in 1946, the discharge was increased to 4 cubic meters per second. This discharge rate will be further increased to 10 cubic meters per second after additional improvements are made.

4. Earthen Storage Dam

There is a relatively low (about 996 meters high) natural earthen dam on the west side of Red Wild Goose Lake Reservoir. According to plans, the present head of the reservoir will be 1,005 meters high. To prevent water from going over the crest of the dam, 2 meters will be added to the dam, making the standard height of the dam 1,007 meters. The crest of the dam is 6 meters wide. The water slope will be set for 1 to 3 and the surface will be paved with stone blocks to prevent erosion from wave action. The outer slope will be set from 1 to 2 to 1 to 4. The base of the dam will be built with impervious materials. The upstream half of the dam should be rendered impervious by using fine soil, while the downstream half may be built with coaser earth. To prevent seepage, the core wall should be built right up to the rocks. A drainage ditch of stone blocks will be built in the downstream half of the dam. Crushed stones and stone blocks will be used to protect the base of the dam.

5. Upper Sluice Gate

About 500 meters east of the old sluice gate, directly north of the lake, is a stone ridge, the top of which is 1,024 meters high. Along or following the mountain stream, a culvert may be constructed by boring through the precipice. The sluice gate will be relatively secure inside the earthen

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embankment. Therefore, if an upper sluice gate is constructed here on a level with the water head, the burden on the lower sluice gate will be reduced and the security of the reservoir increased. The length of the culvert will be about 150 meters. The maximum sluice discharge is more than 10 cubic meters per second. The cylindrical culvert will be lined with concrete. The gradient of the culvert will be 1/250 percent. At the entrance, a cut-off collar will be built to regulate the flow of water. The rock content of the culvert exit makes possible the use of a cylindrical gate.

6. Upper Discharge Canal

An open channel should be built below the culvert of the upper sluice gate. The channel would be 1,800 meters long and would connect with the old discharge canal. This canal runs on a rather steep slope. To prevent erosion, the canal will be lined throughout with slate. It is estimated that the discharge will be 10 cubic meters per second. The 550-meter-long first section will be excavated to the irregular depth of 3 to 7 meters and will be relatively narrow. Besides this, the cross section of the canal will be paved with impervious material. The gradient of the section of the canal which runs midway along the mountain will generally follow the natural contour of the ground. A wooden flume will be built at 1 plus 760 [sic] where the upper discharge canal must pass through farm ditches. This and the construction of drops will be executed jointly.

B. <u>Ho-p'ing Canal</u>

1. Large Flume Over the Urumchi River

A large flume, 200 meters long, will be built across the Urumchi River connecting the outlet point of the discharge canal with the main canal on the west bank of the river. Temporarily, this large flume will be built of wood, but in the future it will be built over with cement. The foundations of the flume on both sides of the river will be constructed with stone slabs. The foundation on the west bank will also include a construction of a drop. Piers to support the flume will be set at 5-meter intervals and will be buried 4 meters into the ground. A step will be taken to prevent erosion at this point. The river, including its shores, is 500 meters wide here. The current of the river is very swift during the flood periods; therefore, tidal and drainage embankments must be built to regulate the water flow and at the same time prevent widening of the river channel. This embankment work is essential because the length of the flume crossing at this point will be shorter than the width of the river and its shores.

2. Main Canal

The main canal will connect the lower end of the large flume. The 4-kilometer-long head-canal section will run alongside the river in the precipitous sector half way up the mountain. From this point, the canal will extend downward and enter the area behind the new district of Ti-hua. Then the canal will run in a northwesterly direction for 14 kilometers along the Ti-hua--I-li Highway and will reach Hei-shan-t'ou. From Hei-shan-t'ou the canal will take a northerly direction from the highway and will pass through more than 10 kilometers of Gobi Desert and 4 kilometers of productive sector of the An-ning Canal. From there, the canal will finally empty into the irrigation district. The total length of the main canal will be more than 31 kilometers.

The entire canal will be newly dredged except the 11-kilometer middle section, which will be dredged later. This section, which extends from the new district of Ti-hua to Hei-shan-t'ou, will make it possible to utilize temporarily the old Ching-yung Canal to facilitate the early flow of water through the main canal into the irrigation district.

The discharge at the head section will be 10 cubic meters per second and will be gradually reduced to 8 cubic meters in other sections until the end section, where the discharge will become 1.5 to 3 cubic meters per second.

The gradient of the canal will be determined by the terrain features and will range from 6/1,000 to 17/1,000 percent. The slopes of the canal will be built 1 to 1.5 and the canal will be dredged so as to prevent seepage. The dredged earth will be used to build up banks on both sides of the canal. One of the banks will be made wide enough so that an automobile can be driven on top for inspection of the canal. There will be 2 meters of space on both sides of the canal between the canal's edge and the base of each bank. This space will be used in case the canal needs to be expanded or when there is an increase in flood discharge. Trees will be planted along this space.

The canal will be slate-lined to prevent erosion and to make the water flow smoother and faster. Seepage will be further controlled when silt is carried through the canal after the discharge of water. The silt will fill up crevices and will make the canal tighter. When the cement supply is short, this method will do a satisfactory mortaring job in holding the lined slates together.

Seepage is not so extensive in the last section of the main canal. Therefore, the gradient at this section could be made at about 1/1,000 percent and drops could be constructed to prevent erosion.

3. Flood Gate, Sand Gate, and Check Gate

To increase the effectiveness of the irrigation work and to make maximum use of the water in the Urumchi River, the main canal should be capable of drawing flood water directly from the river into the irrigation district. This must be done at the same time the feed canal draws water from the river (at the rate of 10 cubic meters per second) into the reservoir for storage purpose. To accomplish this work, the main canal must have a flood gate, sand gate, and check gate between the tail end of the large flume and the main canal at the western bank of the river. The flood gate will have a discharge of 10 cubic meters per second. The sand gate and check gate will be constructed at the lower end of the flood gate. The sand gate will empty sand and silt from the canal bottom into the Urumchi River. The check gate will control the amount of the clear water coming into the canal.

4. Large Diversion Gate

A large diversion gate will be constructed at the tail section of the main canal. It will be located at the highest point of the irrigation district. This gate will divert water from the main canal into three distributing canals: the eastern, the central, and the western. The gate will have three orifices and the amount of water to be run into distributing canals will be regulated by the raising and lowering of the diversion gate. Eventually the gate will be reconstructed so that it can be operated automatically.

5. Distributing Canals

The irrigation district slants from south to north. The eastern distributing canal will traverse through Ch'ing-k'o-tahu district; the western distributing canal will extend into Huang-shui and Ts'ao-tsu districts; and the central distributing canal will run into the sterile district of Pa-tuan (594, 5792). The 5-kilometer-long eastern distributing canal will be dredged in comparatively high ground along the southeastern sector of Ch'ing-k'o-tahu and will irrigate rice paddies of this district. The head section of this canal will be on a steep slope with a gradient of 1/1,000 percent. Five drops will be constructed here. The other sectors of the eastern canal will have a gradient of 1/3000 percent and will discharge 3 cubic meters per second. The 12-kilometer central distributing canal will extend directly to Kao-chia-hu and will be dredged on the eastern ridge of Pa-tuan. This canal will irrigate barren land east of Pa-tuan, west of Lo-t'o-fang-tzu (13755, 13732, 3646, 2262), and west of Kao-chia-hu. The canal will pass through an extremely hilly sector at a gradient of 1/1,000 percent. Construction of several tens of drops will be necessary. Its discharge rate will be 3 cubic meters per second. The 5-kilometer-long western distributing canal will be dredged through fertile area of Pa-tuan and will irrigate farms in Huang-shui and Ts'ao-tzu. The gradient of the canal will be 1/1,000 percent. The discharge rate will be 4 cubic meters per second.

6. Flumes

When the main and distributing canals pass through an irrigation district, flumes are needed to cross over farm ditches. When one canal intersects another canal on the same level and it is not practicable to carry the first canal over the second, one canal may be carried below grade in a siphon conduit or over the other canal by means of a flume. Flumes will be constructed of wood, while siphon conduits will be made of stones.

7. Drops

Sixteen drops will be constructed in the tail section of the main canal. Each drop will be 2 meters high.

8. Bridges

It is necessary to construct bridges over various canals in the irrigation district. Highway bridges will be constructed of rock piers and wooden girders. They will be surfaced with crushed stone and will have a loading capacity of 7 metric tons. Cart-road bridges will be of wooden piers and girders. They will be surfaced with crushed stone and will have a loading capacity of 3 metric tons.

9. Diversion Gates for Lateral Canals

Each tail section of the distributing canal will have diversion gate to let out water into various lateral canals. Wooden diversion gates similar in construction to the large diversion gate will be used temporarily.

10. Lateral Canals

Lateral canals will branch out from distributing canals in the main section of the irrigation district. Some lateral canals will be 10 meters while others will be 20 meters long. The discharge rate of each lateral canal will be 1.5 cubic meters per second.

11. Formation of the Irrigation District

In order to facilitate mechanized farming, the irrigation district will be divided into series of rectangular blocks. Each block will be about 300 meters long and about 250 meters wide. Roads and canals will run alongside each of these blocks. Farms will be developed within each of these rectangular blocks.

12. Drainage System

The water table beneath Ch'ing-k'o-ta-hu is high. Except for the brackish sand banks, most of the barren area in the irrigation district could be made arable. Soil could be made fertile if a proper drainage system is put in. Since the irrigation district slopes downward, the drainage system will leach the brackishness from the soil.

If irrigation is carried out too long in one spot, a rise in the water table is to be expected. It is therefore necessary to improve the land by running drainage ditches throughout the district. The drainage system will include small, lateral, and main ditches. The drainage water could be used either to irrigate areas lacking spring water or to irrigate additional farming districts.

VI. ESTIMATES ON LABOR AND MATERIALS

Workers needed for these irrigation projects include coolies, plasterers, stone masons, carpenters, blacksmiths, etc. Military personnel, local Uighurs, and Chinese may be employed as coolie labor. It is difficult to obtain large-scale military labor at present; consequently, the bulk of labor on these projects will continue to come from civilians. Skilled labor is lacking; much of it is concentrated in Ti-hua, where there are many Chinese from the Northeast and Shantung who have lived in the USSR for many years. Their technical skill is excellent, they have great endurance, and can do such work as masonry, plastering, carpentry, concrete mixing, paving, and pitching.

Employment is easy during the winter months when all types of construction work ceases and laborers are idle. At other times, when there are other large construction projects also in progress in the vicinity, employment is difficult. For this reason, cost of labor goes up. If the work area is far from the city, transportation expenses must be assumed. There are in Ti-hua an estimated 300 plasterers, 50 stone masons, 400 carpenters, 200 blacksmiths, and 600 other skilled workers. If more coolie workers are needed, they could be hired from other neighboring hsiens.

There are no large factories in Ti-hua which manufacture construction materials. In these inflationary times, it is most feasible to pay the workers by piece work.

The tools and facilities needed for the projects (except for simple tools and the workers' own tools) will be furnished by the government. Steam shovels could be hired for digging earth during winter and early spring freeze. Pile-driving machines needed for constructing flumes could be made in Ti-hua. The hammer will weigh 800 kilograms and will be operated by means of steel ropes. The top of each pile will be covered with steel caps. The riverbed first should be solidified with pebbles before the piles are driven in.

During winter months, when cement paving and concrete work are necessary, cold-resistant facilities must be provided. Tools and tool sheds must be heated. Stoves must be provided for warming sand, pebbles, and gravel. Water must be heated with specially constructed water heaters. It is necessary to have sufficient working space. The temperature should always be maintained at around 15 degrees centigrade. According to an experiment tried in 1948, in which cold-resistant equipment was used, winter conditions were, at times, better than other seasons.

The materials needed for the projects are: yellow sand and slate, which can be obtained nearby; gravel from the Urumchi River; pebbles from crushed rocks nearby; and stone slabs from an open quarry in T'ou-t'un-ho-shan 40 kilometers away. Lumber, especially white pine, can be obtained from Nan-shan, 80 kilometers from Ti-hua. Cement, besides that obtained from the USSR 4 years ago, can be obtained from the Yao-chieh Cement Factory in Kansu Province. Only a limited amount of cement can be transported from Kansu Province, however. To replenish the shortage, a cement substitute must be made locally. Slate must be transported by trucks from an average distance of 20 kilometers. Blasting powder will be supplied in part by the Sinkiang government. (See Tables 4 to 9.)

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VII. COMPLETED PROJECTS

A. Construction Work in 1947

1. Ho-ping Canal

Construction work on the Ho-p'ing Canal was carried out by coolie labor and by military engineers of the Sinkiang Defense Headquarters. This canal extends from Red Wild Goose Lake Reservoir into the old irrigation district of Ti-hua, crosses the Urumchi River, and runs through 20 kilometers of desert land before reaching the new irrigation district.

Work completed on the Ho-p'ing Canal project as of the end 1947 is as follows:

a. Main Canal

From 10 April to 10 May 1947, approximately 60,000 cubic meters of earth were dug from a 3.7-kilometer-long sector of the main canal. This sector extends from the large flume to the head section of the main canal. From 23 March to 15 April 1947, the sector extending from the top of Hei-shan to the An-ning Canal district was dredged. Ninety-eight thousand cubic meters of earth were removed during this period.

Temporarily, only 50 cubic meters of the canal walls will be slate-lined. Later, when slates can be obtained more readily, the entire lining work will be completed.

b. Distributing Canals

A total of 30 kilometers were dredged in the eastern, western, and central distributing canals between 22 April and mid-May 1947. Fifteen thousand cubic meters of earth were removed.

c. Large Flume Over the Urumchi River

The foundation work on the 200-meter-long, large flume crossing the Urumchi River was started in early March and completed 25 April 1947. Trestle construction and cement pavement of the flume base was completed 10 May. Five-meter-high, 300-meter-long earth embankments were built, using 30,000 cubic meters of dredged earth. This work was completed 20 May.

d. Lateral Canals

In order to serve military reclamation areas, 11,000 cubic meters of earth were dredged from 50 kilometers of lateral canals prior to 10 September 1947. One lateral canal in the eastern and two in the western section were dredged.

2. Red Wild Goose Lake Reservoir

Construction work on the Red Wild Goose Lake Reservoir was started in August 1947. The reservoir project will take little less than 3 years to complete. The earthwork on the upper discharge canal was started on 20 July. The rock-blasting work on the bases of the upper and lower sluice gates was started in early August. This project will require 10,000 cubic meters of slates, 20,000 cubic meters of stone slabs, more than 2,000 tons of locally made substitute cement, several hundreds of tons of regular cement, and several tens of tons of steel materials. Its importance and amount of engineering work far excels that of the Ho-p'ing Canal.

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Construction work on the reservoir continued according to schedule until last August. The original plans had to be altered because a sudden inflationary trend at that time abruptedly raised the construction cost and materials. Besides, as winter set in, cement-pouring work was made very difficult. Construction work on the lower sluice gate and the core wall continued for a while, but other work was suspended to await further granting of government funds.

Some work continued throughout the winter under subzero weather. To attain this difficult task, construction materials were covered. Tool sheds were heated at 15 degrees centigrade. Sand, slabs, slates, and water were warmed before they could be used satisfactorily.

B. Construction Work Previous to Water Discharge (January to 9 May 1948)

In order to meet this year's expansion of the agricultural area, it was planned to complete underwater work on the lower sluice ate and store 14 million cubic meters of Urumchi River water into the reservoir so that water could be discharged onto farm lands by 10 May. Work on the lower discharge continued throughout the winter. Work also continued on the feed canal and the construction of a 55-meter-long wooden flume. By the end of May, one large orifice was repaired and widened, three large culverts were repaired, and snow-removal work inside the canal was completed.

Most of the repair work on the feed canal was completed in March. Consequently, the discharge rate was increased from one cubic meter to 5 cubic meters per second. Eighteen million cubic meters of water were stored in the reservoir before the water discharge date of 9 May. This amount surpassed the projected storage plan up to 9 May by 4 million cubic meters.

From 20 March to 30 April, one section of the feed canal was dug by 400 men dispatched by the Sinkiang Defense Headquarters. The depth of the canal varied from 2 to 5 meters. More than 22,000 cubic meters of earth were dug and the excavated earth was used to strengthen the base of the left bank of the canal. The completion of this mountainous sector of the feed canal made possible the release of water on 9 May.

The Ho-p'ing Canal project proceeded simultaneously. Construction of the flood, sand, and check gates went on as scheduled. The flood gate was completed in July 1947. The work on sand and check gates began on 1 April and was completed by 15 June.

Last year, the head section of the main canal was damaged because of erosion. From 8 March to 6 May, the accumulated earth inside the canal had to be removed and part of the banks had to be lined with slates to prevent further erosion. Slate-lining work continued even after the water-release date.

The 11-kilometer middle section of the main canal, located 3.75 kilometers from the large flume, and running from Ho-tien-chieh in Ti-hua to Hei-shan-t'ou, was to have been dredged. However, the work was discontinued because of lack of funds. In its place the existing old canal had to be dredged and lined. This work began in mid-March and was completed in early May.

The volume of water in the new canal section below Hei-shan-t'ou had to be increased by additional paving work. A 2-kilometer section below this new canal section was damaged by erosion last year. This section was subsequently relined with slates. Fifty drops were constructed in this sector. The construction of large drops in the 5-kilometer lower section of the main canal was completed by 4 May. The volume of water discharged this year was more than twice that of last year. Erosion and silting have not yet occurred. There is also very little seepage at present. (See Table 10.)

VII. PLANS FOR INCOMPLETE PROJECTS

A. First Construction Period

During this period, the arable acreage will be increased to 40,000 mou by 1949, including 10,000 mou each in rice and wheat and 20,000 in other cereal fields. Twenty-five million cubic meters of water will be needed to supply this total acreage. The water head must be raised to 998 meters in the reservoir. To accomplish this, the following work must be completed:

1. Head Feed Canal, Red Wild Goose Lake Reservoir (sluice walls, intake gate, and sand gate)

The head canal section requires construction of sluice walls, an intake gate, and a sand gate to facilitate drawing of water into the reservoir. The intake gate will control the volume of water flowing into the canal. The sand gate eliminates sand and stone during periods of flood. The sand gate will be constructed one kilometer below the head canal and will also be used for letting out water.

2. Feed Canal, Red Wild Goose Lake Reservoir (outlet gate)

The middle section of the feed canal is situated on the slope of the mountain. Too much snow or too much water in this section could destroy the entire feed canal. It is therefore necessary to construct a check gate on a rock foundation and also an outlet gate for further protection.

3. Expansion of the Lower Discharge Canal, Red Wild Goose Lake Reservoir

The discharge (even after repair work) of the old lower discharge canal will be 3 cubic meters per second. The banks must be widened and further lining must be carried out to increase the discharge.

4. Construction Work on the Upper Sluice Gate, Red Wild Goose Lake Reservoir

The lower sluice gate must be constructed inside an earthen dam and must run underneath the old wooden culvert. The wooden culvert must be built over with stones before the lower sluice gate can be depended upon to discharge water. The upper sluice gate will be sturdy, since it must be bored through a ridge of granite rock. When the water gauge in the reservoir becomes too high, both the upper and the lower sluice gates will be depended upon to discharge water. To prevent damage to the sluice walls and the outlet gate, additional lining must be carried out.

5. Construction Work on the Earthen Storage Dam, Red Wild Goose Lake Reservoir

The earthen storage dam must be 1,000 meters high to store a 998-meter head of water inside the reservoir. This construction work must be completed before the water-storage period starts again. The slope must be paved up to the water head to prevent erosion.

6. Eleven-kilometer Section of the Main Canal, Ho-p'ing Canal

The remaining work on the 11-kilometer section of the main canal must be completed. If the repaired, old canal proves unsatisfactory, a new canal must be dredged in this section. Construction of bridges and flumes will also be necessary.

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B. Second Construction Period

During this period, the acreage will be increased to 70,000 mou by 1950, including 15,000 in rice, 20,000 in wheat, and 40,000 in other fields. The reservoir capacity must be raised to 40 million cubic meters. The gauge height must be raised to 1,003 meters. Construction work allotted for completion during this period is as follows:

1. Feed Canal Red Wild Goose Lake Reservoir (continual expansion work)

There still remains a 600-meter section in the head canal which must be completed. Earthwork, mortaring work, and lining work must be carried out previous to the water-storage period. Four drainage embankments are to be strengthened to prevent flood water from damaging the canal. The canal must be expanded to raise the intake discharge to 10 cubic meters per second. The wooden flume in the hilly section must be rebuilt with stones. Bridges must be rebuilt also.

2. Lower Discharge Canal Red Wild Goose Lake Reservoir (expansion work)

The heightening and widening of the lower discharge canal must be completed in order to increase the discharge to 10 cubic meters per second.

3. Lower Sluice Gate Red Wild Goose Lake Reservoir (culvert construction)

The old wooden culvert below the sluice gate must be reconstructed with more permanent materials. Cement-mortared stone blocks will be used.

4. Completion of the Upper Sluice Gate, Red Wild Goose Lake Reservoir

Some construction work remains to be done on the sluice gate. Other work to be completed during the second period includes the stonework on the head section of the upper discharge canal, lining of the canal, and construction of the inclined drop.

5. Completion of Earthen Dam, Red Wild Goose Lake Reservoir

Since the water head in the reservoir will be raised to 1,005 meters, the height of the dam must be elevated to 1,007 meters. Lining work on both slopes, and stonework on the spillway orifice, must be completed during this period.

6. Completion of the Main Canal, Ho-p'ing Canal

One half of the lining work remains on the main canal. It should be completed before the date of water discharge. The work on the diversion gate should be completed during the second construction period.

7. Completion of the Distributing Canals, Ho-p'ing Canal

Sectors in the central and eastern distributing canals still are incomplete. These will be completed during the second period.

C. Third Construction Period

All the remaining construction work will be completed during this period. Incomplete sectors of the distributing and lateral canals will be completed during this period. Outlet gates and farm ditches will also be constructed alongside the rectangular blocks, series of which form a large irrigation district. Drainage ditches will be dug to complete the entire irrigation projects.

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IX. BENEFITS FROM THE IRRIGATION PROJECTS

Following are some of the benefits which could be derived from the completed irrigation projects:

The irrigation district will be capable of yielding approximately 250,000 shih shih of grain per year. This yield could be further increased after work is carried out to prevent seepage.

The food shortage in the Ti-hua district will end. There will be no need to obtain foodstuff from elsewhere at exhorbitant costs.

Grain yields and savings made by not having to import food will pay the entire cost of the irrigation projects. Based on 4,500,000 yuan, which is the transport cost per shih shih between A-[illegible]'o-su to Ti-hua as of July 1948, the Sinkiang government could save, in the first year alone, approximately 1,125,000,000,000 yuan in Sinkiang currency. Assuming that 100,000 mou could be planted with cereal crops, and estimating the yield per mou of rice as 3 shih, that of wheat as 1.5 shih, and other cereals as 3.5 shih, the earnings from the total yield in the first year would amount to 740 trillion yuan, or equivalent to 150 percent of the total engineering cost of the irrigation projects.

The following table shows the estimated first-year earnings from different cereal crops:

Cereal crop	Acreage (in 1,000 mou)	Yield per Mou (in shih)	Total Annual Yield (in 1,000 shih)	Value per Shih (in 1 million	Total Value Sinkiang dollars)
Rice	20	3.0	60	6.0	360,000
Wheat	40	1.5	60	3.3	198,000
Others	40	3.5	140	1.3	182,000
Total	100				740,000

Table 1. Estimated Monthly Duty of Water Required by Farms Supplied by the Ho-p'ing Canal

Crop	Acreage (in 1,000 mou)	Water Required	Apr	May	Jun	Jul	Aug	Sep	Total	Remarks
Rice	20	Depth (cm)	--	25	30	30	20	--	105	Fields irrigated to depth of 25 cm from mid-May. 10 cm added every 10 days from June. Water supply shut off after mid-August. Harvest in late August.
		Vol (1,000 cu m)	--	3,300	4,000	4,000	2,700	--	14,000	
Spring wheat	20	Depth	12	12	12	12	--	--	48	Irrigated from mid-March. 8 cm added every 20 days beginning April. Harvest in July.
		Vol	1,600	1,600	1,600	1,600	--	--	6,400	
Winter wheat	20	Depth	12	12	10	--		8	42	Irrigated to depth of 8 cm from mid-August to mid-September. Seed sown immediately after. 8 cm added every 20 days beginning April. Harvest in July.
		Vol	1,600	1,600	1,333	--		1,067	5,600	
Other cereals	40	Depth	--	--	15	15	15	10	55	Irrigated to depth of 15 cm beginning mid-June. Seed sown immediately after. 10 cm added every 20 days beginning July. Harvest in early October.
		Vol	--	--	4,000	4,000	4,000	2,660	14,660	

NOTE: Irrigation water shut off from October to March inclusive.

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Table 2. Estimated Monthly Loss of Water While in Transit Through Ho-p'ing Canal to the Agricultural Area

		Apr	May	Jun	Jul	Aug	Sep	Total
Duty of water required for farms	Vol (1,000 cu m)	3,200.00	6,500	10,933	7,600	9,233	3,194	40,666
	Discharge (cu m/sec)	1.23	2.50	4.20	3.69	2.78	1.23	--
Loss of water in transit	Vol	2,560	5,200	8,746	7,680	5,786	2,555	32,588
	Discharge	0.98	2.00	3.36	2.96	2.23	0.98	--
Water supplied	Vol	5,760	11,700	19,679	17,280	13,019	5,749	93,188
	Discharge	2.22	4.50	7.56	6.65	5.01	2.21	--

NOTE: Irrigation water shut off from October to March inclusive.

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Table 3. Estimated Monthly Volume of Water Stored, Discharged, and Lost (Red Wild Goose Lake Reservoir)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Remarks
Urumchi R (mean discharge in cu m/sec)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	10	15	15	6	-	-
Water used by existing farms and mills on both sides of Urumchi R (cu m/sec)	1.5	1.5	1.5	1.5	1.5	1.5	2.5	6	7	8	8	6	-	Mills use water from Oct to Mar inclusive.
Discharge used for storage (cu m/sec)	3.5	3.5	3.5	3.5	3.5	3.5	2.5	--	5	8	8	-	-	Estimated loss of water in transit from feed canal to reservoir is 0.5 cu m/sec.
Volume of water stored (1,000 cu m)	9,070	9,070	9,070	9,070	9,070	9,070	6,480	-	2,160	8,295	8,295	--	79,650	Reservoir flooded 5 days in Jun, 12 days in Jul, and 12 days in Aug.
Volume of water discharged (in 1,000 cu m)	-	-	-	-	-	-	5,760	11,700	19,679	11,520	8,679	5,749	63,088	Canals draw water directly from Urumchi R for a 10-day period in Jul and a 10-day period in Aug; 5,760,000 cu m in Jul and 4,340,000 cu m in Aug

Table 3. (Contd)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Remarks
Volume of water lost through evaporation and seepage (in 1,000 cu m)	400	600	800	1,000	1,400	1,900	1,900	1,500	900	900	900	400	12,600	Volume of water lost is approximately 20 percent of the total volume of water discharged annually
Actual volume of water in reservoir (in 1,000 cu m)	8,670	17,140	25,410	33,480	41,150	48,320	47,140	33,940	15,520	11,395	10,111	3,962	-	-
Gauge height of reservoir (in meters)	991	995	998	1,001	1,003	1,005	1,005	1,001	994	993	992	989	-	-

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Table 4. Estimated Number of Workers Required for the Red Wild Goose Lake Reservoir Project

Type of Work	No of Workers
Earthwork	371,950
Stonework	2,820
Dry masonry	12,787
Rock-blasting	31,500
Large puddling and plastering	9,933
Small " " "	19,817
Timbering	8,884
Ironwork	1,200
Twig-matting	360
Miscellaneous	1,420
Total	460,671

Table 5. Estimated Number of Workers Required for the Ho-p'ing Canal Project

Type of Work	No of Workers
Earthwork	496,166
Stonework	1,640
Dry masonry	30,990
Pile-driving	2,756
Large puddling and plastering	4,486
Small " " "	8,972
Timbering	25,874
Ironwork (meshwork)	1,750
Twig-matting	280
Miscellaneous	560
Total	573,474

Table 6. Estimated Number of Workers Required for Construction Work on the Red Wild Goose Lake Reservoir Project

Engineering Work	Type of Work	No of Workers
Feed Canal		
Expansion work: earth excavation	Earthwork	38,000
Expansion work: rock pitching	Dry masonry	5,500
Reconstruction of tail canal	Earthwork	9,333
Reconstruction of bridges and flumes	Carpentry work	460
	Earthwork	120
	Ironwork	60
Reconstruction of head canal	Earthwork	11,972
	Dry masonry	1,950
Repair of drainage embankments	Earthwork	120
	Twig-matting	360
Total		69,875

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Table 6. (Contd)

Engineering Work	Type of Work	No of Workers
Upper and Lower Sluice Gates		
Expansion of lower discharge canal: earth excavation	Earthwork	35,710
Expansion of lower discharge canal: rock-pitching work	Dry masonry	1,667
Upper discharge canal: earth excavation	Earthwork	52,531
Upper discharge canal: rock removal	Rock-blasting	26,090
Upper discharge canal: rock-pitching work	Dry masonry	3,670
Lower sluice gate: culvert reconstruction	Timbering	7,000
	Large puddling and plastering	1,142
	Small puddling and plastering	2,284
	Earthwork	1,600
	Stonework	700
Upper sluice gate: tunnel construction	Rock-blasting	4,810
	Large puddling and plastering	936
	Small puddling and plastering	1,872
	Timbering	324
	Miscellaneous	300
Lower sluice gate construction	Rock-blasting	600
	Stonework	600
	Large puddling and plastering	1,595
	Small puddling and plastering	2,966
	Timbering	420
	Ironwork	540
	Miscellaneous	400
Upper sluice gate construction	Stonework	800
	Large puddling and plastering	3,110
	Small puddling and plastering	6,395
	Timbering	460
	Ironwork	600
	Miscellaneous	400
Upper discharge canal: inclined drop construction	Earthwork	320
	Timbering	220
	Stonework	720
	Large puddling and plastering	274
	Small puddling and plastering	548
Total		161,604
Earthen Dam		
Earth excavation	Earthwork	217,444
Rock-pitching work for core wall	Earthwork	4,800
	Large puddling and plastering	1,600

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Table 6. (Contd)

Engineering Work	Type of Work	No of Workers
Rock-pitching work for core wall (Contd)	Small puddling and plastering	3,200
	Miscellaneous	160
Rock-pitching work to water head	Large puddling and plastering	1,276
	Small puddling and plastering	2,552
	Miscellaneous	160
Total		231,192
Grand total		462,671

Table 7. Estimated Number of Workers Required for Construction on the Ho-p'ing Canal Project

Engineering Work	Type of Work	No of Workers
Main Canal		
Earth excavation	Earthwork	309,679
Rock-pitching work	Dry masonry	30,630
Concrete paving of canan bottom	Earthwork	43,040
Mortar-pouring work	Earthwork	47,250
Large flume construction over Urumchi R	Earthwork	240
	Stonework	200
	Pile-driving	1,200
	Timbering	4,200
	Large puddling and plastering	810
	Small puddling and plastering	1,620
	Ironwork	640
	Miscellaneous	120
Flood-control work for Urumchi R	Earthwork	2,300
	Pile-driving	800
	Timbering	50
	Twig-matting	200
	Dry masonry	360
	Miscellaneous	80
Sand-gate construction	Earthwork	2,300
	Stonework	360
	Large puddling and plastering	265
	Small puddling and plastering	530
	Timbering	24
	Miscellaneous	240
Flood-gate construction	Earthwork	600
	Stonework	360
	Timbering	40
	Large puddling and plastering	730
	Small puddling and plastering	460
	Timbering	40
	Twig-matting	80
	Miscellaneous	120

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Table 7. (Contd)

Engineering Work	Type of Work	No of Workers
Bridge construction	Timbering	840
	Pile-driving	440
	Large puddling and plastering	40
	Small puddling and plastering	80
	Earthwork	4,400
	Ironwork	300
Flume construction	Earthwork	220
	Timbering	270
	Large puddling and plastering	207
	Small puddling and plastering	414
Drop construction	Timbering	1,560
	Large puddling and plastering	54
	Small puddling and plastering	108
	Earthwork	1,600
Large diversion gate construction	Earthwork	600
	Stonework	720
	Timbering	60
	Large puddling and plastering	752
	Small puddling and plastering	1,504
Total		474,397
Distributing Canals		
Earth excavation	Earthwork	35,897
Diversion gate construction	Timbering	160
	Earthwork	320
	Large puddling and plastering	120
	Small puddling and plastering	240
	Ironwork	60
Flume construction	Timbering	1,200
	Earthwork	400
	Large puddling and plastering	66
	Small puddling and plastering	132
Bridge construction	Timbering	650
	Earthwork	1,300
	Large puddling and plastering	66
	Small puddling and plastering	132
	Ironwork	350
	Pile-driving	156
Drop construction	Timbering	1,380
	Large puddling and plastering	76
	Small puddling and plastering	152

Table 7. (Contd)

Engineering Work	Type of work	No of Workers
Drop construction (Contd)	Earthwork	22,000
Total		45,007
Lateral Canals		
Earth excavation	Earthwork	27,670
Bridge construction	Earthwork	4,000
	Timbering	920
	Large puddling and plastering	100
	Small puddling and plastering	200
	Ironwork	400
	Pile-driving	160
Flume construction	Timbering	120
	Earthwork	300
Drop construction	Timbering	14,400
	Large puddling and plastering	1,200
	Small puddling and plastering	2,400
	Earthwork	1,200
Total		63,070
Grand total		582,474

Table 8. Estimated Amount of Construction Materials Required for the Red Wild Goose Lake Reservoir Project

Material	Measurement per Unit (in cm)	Amt
Stone slabs	20x30x100	13,822 slabs
	20x30x60	13,[illegible]2 "
Slates	--	19,520 cu
Wooden girders	30(dia)x700	2,130 girders
	25(dia)x700	60 "
	20(dia)x700	220 "
Wooden crossbeams	15(dia)x700	60 beams
4"x8" lumber	10x20x380	70 pieces
3"x6" scantlings	7x15x380	4,850 "
2" scantlings	5x15x380	1,950 "
1" strips	2x15x380	850 "
Cement (from Yung-teng Hsien, Kansu Prov)	--	350 tons
Substitute cement (made locally)	--	2,500 "
Sand	--	2,800 cu m
Cast-iron waste	--	60 tons
Wrought iron	--	18 "
Steel nails	--	500 kg
Twigs	--	100 carloads
Gravel	--	2,500 cu m

Table 9. Estimated Amount of Construction Materials Required for the Ho-p'ing Canal Project

Material	Measurement per Unit (in cm)	Amt
Stone slabs	30x50x100	1,400 slabs
"	20x30x100	6,400 "
"	20x30x60	6,400 "
Slates	--	50,260 cu m
Wooden girders	30(dia)x700	400 girders
"	20(dia)x700	2,123 "
"	25(dia)x700	160 "
Wooden crossbeams	15(dia)x700	3,876 beams
"	10(dia)x700	1,554 "
4"x8" lumber	10x20x380	66 pieces
3"x6" scantlings	7x15x380	2,260 "
2" scantlings	5x15x380	17,830 "
Cement	--	50 tons
Substitute cement	--	600 "
Wrought iron	--	2,600 kg
Steel nails	--	2,200 kg
Sand	--	2,100 cu m
Hemp cord	--	500 kg
Twigs	--	240 carloads
Lead wire	--	200 kg

Table 10. Completed Construction Work on the Red Wild Goose Lake Reservoir and the Ho-p'ing Canal

(As of 1 June 1948)

Red Wild Goose Lake Reservoir

Engineering Work	Amount Completed
Feed Canal	
Expansion work: earth excavation	22,000 cu m
Reconstruction work on canal head: earth excavation	9,333 cu m
Reconstruction work on canal tail: earth excavation	6,371 cu m
Lower Sluice Gate	
Concrete paving of well	759 cu m
Gate construction	200 cu m
Temporary earthen storage dam construction	2,000 cu m
Upper Sluice Gate	
Tunnel opening work: rock removal	81 m

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Table 10. (Contd)

Engineering Work	Amount Completed
Upper Discharge Canal	
Earth excavation	34,131 cu m
Rock removal	12,042 cu m
Slate lining of the canal bottom	170 cu m
Bridge construction	2 bridges
Earthen Dam	
Slate lining of core wall	919 cu m
Ho-p'ing Canal	
Main Canal	
Earth excavation	209,679 cu m
Paving	12,000 cu m
Concrete pouring	4,000 cu m
Large flume construction over Urumchi R	1 flume
Flood-control work on Urumchi R	560 m
Flood gate construction	1 gate
Sand gate and check gate construction	1 gate
Bridge construction	8 bridges
Flume construction	4 flumes
Drop construction	16 drops
Rock-pitched drop construction	50 drops
Diversion gate construction	1 gate
Distributing Canals	
Earth excavation	71,693 cu m
Flume construction	17 flumes
Bridge construction	8 bridges
Drop construction	5 drops
Lateral Canals	
Earth excavation	10,706 cu m
Drop construction	15 drops

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Table 11. Estimated Cost of the Red Wild Goose Lake and the Ho-p'ing Canal Projects

Engineering Work	Cost	Remarks
Incomplete work on the Red Wild Goose Lake Reservoir	272,979,680,000	Equivalent to 1,364,898,400,000 CNC yuan, 454,966.13 gold yuan notes, or 113,741.53 US dollars
Incomplete work on the Ho-p'ing Canal	253,598,400,000	Equivalent to 1,267,992,000,000 CNC yuan, 422,664 gold yuan notes, or 105,666 US dollars
Total	526,578,080,000	Equivalent to 2,632,890,400,000 CNC yuan, 877,630.13 gold yuan note, or 219,407.53 US dollars

Table 12. Estimated Cost of Work to be Completed on the Red Wild Goose Lake Reservoir

Compiled 15 August 1948

(Cost per unit and total cost in one million Sinkiang yuan)

Engineering Work	Amt and Unit	Cost per Unit	Total Cost
Feed Canal			23,080
Canal head: conduit walls, intake gate, and sand gate construction	1 canal head	6,000	6,000
Canal expansion: earth excavation	15,000 cu m	0.32	4,800
Canal expansion: paving	2,340 cu m	2	4,680
Reinforcement of drainage embankments	4 embankments	400	1,600
Check gate and outlet gate construction	2 gates	2,400	4,800
Bridge repair and rebuilding	3 bridges	400	1,200
Lower Sluice Gate			34,400
Expansion of lower discharge canal: earth excavation	20,000 cu m	0.32	6,400
Expansion of lower discharge canal: paving	2,000 cu m	2	4,000
Lower sluice gate: culvert construction	600 cu m	40	24,000
Upper Sluice Gate			118,792
Well construction	1,313 cu m	40	52,520
Gate construction	1 gate	12,000	12,000
Tunnel intake orifice paving	800 cu m	40	32,000
Upper discharge canal: earth excavation	14,600 cu m	0.32	4,672
Upper discharge canal: rock removal	1,000 cu m	6.4	6,400
Upper discharge canal: paving	4,400 cu m	2	8,800
Upper discharge canal: inclined drop construction	1 inclined drop	2,400	2,400

Table 12. (Contd)

Engineering Work	Amt and Unit	Cost per Unit	Total Cost
Earthen Dam			96,707.68
Clay excavation	86,978 cu m	0.56	48,707.68
Slate lining up to dam's water head	2,000 cu m	20	40,000
Paving work, up to dam's water head	3,000 cu m	2	6,000
Filter gallery: rock removal	500 cu m	4	2,000
Grand total			272,979.68

NOTE: The cost per unit in this table is based on commodity prices as of mid-August 1948 in Ti-hua. The grand total cost of 272,979,680,000 Sinkiang yuan is equivalent to 1,364,898,400,000 CNC yuan, 454,966.13 gold yuan notes, or 113,741.53 US dollars.

Table 13. Estimated Cost of Work to be Completed on the Ho-p'ing Canal

Compiled 15 August 1948

(Cost per unit and total cost in one million Sinkiang yuan)

Engineering Work	Amt and Unit	Cost per Unit	Total Cost
Main Canal			154,995.2
Large flume: painting	1 flume	4,800	4,800
New section of the main canal at Ho-t'ien Street, Ti-hua: earth excavation	100,000 cu m	0.32	32,000
Additional paving work	30,561 cu m	3.2	97,795.2
Flood-control work on Urumchi R	500 m	12	6,000
Bridge construction over new section of the main canal at Ho-t'ien St Ti-hua	14 bridges	600	8,400
Flume construction over new section of the main canal at Ho-t'ien St Ti-hua	5 flumes	400	2,000
Construction of large diversion gate	1 gate	4,000	4,000
Distributing Canals			16,080
Diversion gate construction	2 gates	1,200	2,400
Flume construction	23 flumes	320	7,360
Bridge construction	5 bridges	400	2,000
Drop construction	18 drops	240	4,320

RESTRICTED

Table 13. (Contd)

Engineering Work	Amt and Unit	Cost per Unit	Total Cost
Lateral Canals			82,523.2
Earth excavation	64,63[illegible] cu m	0.32	20,683.2
Bridge construction	20 bridges	320	6,400
Flume construction	6 flumes	240	1,440
Drop construction	225 drops	240	54,000
Grand total			253,598.4

NOTE: The cost per unit in this table is based on commodity prices as of mid August 1948 in Ti-hua. The grand total cost of 253,598,400,000 Sinkiang yuan is equivalent to 1,267,992,000,000 CNC yuan, 422,644 gold yuan notes, or 105,666 US dollars.

RESTRICTED

Table 14. Estimated Cost of Work to be Completed on the Red Wild Goose Lake Reservoir

Compiled 15 August 1948

(Cost per unit and total cost in one million Sinkiang yuan)

Engineering Work	1st Period Amt and Unit	1st Period Cost per Unit	1st Period Total Cost	2d Period Amt and Unit	2d Period Cost per Unit	2d Period Total Cost
Feed Canal	-	-	14,000	-	-	9,080
Canal head: conduit walls, intake gate and sand gate construction	1 canal head	6,000	6,000	-	-	-
Canal expansion: earth excavation	10,000 cu m	0.32	3,200	5,000 cu m	0.32	1,600
Canal expansion: paving	-	-	-	2,340 cu m	2	4,680
Reinforcement of drainage embankments	-	-	-	4 embankments	400	1,600
Check gate and outlet gate construction	2 gates	2,400	4,800	-	-	-
Bridges repairing and rebuilding works	-	-	-	3 bridges	400	1,200
Lower Sluice Gate	-	-	2,600	-	-	31,800
Expansion of lower discharge canal: earth excavation	5,000 cu m	0.32	1,600	15,000 cu m	0.32	4,800
Expansion of lower discharge canal: paving	500 cu m	2	1,000	1,500 cu m	2	3,000
Lower (sluice) gate: culvert construction	-	-	-	600 cu m	40	24,000

Table 14. (Contd)

Engineering Work	1st Period Amt and Unit	1st Period Cost per Unit	1st Period Total Cost	2d Period Amt and Unit	2d Period Cost per Unit	2d Period Total Cost
Upper (sluice) Gate	-	-	95,592	-	-	23,000
Well construction	1,313 cu m	40	52,520	-	-	-
Gate construction	-	-	-	1 gate	12,000	12,000
Tunnel and intake orifice paving	800 cu m	40	32,000	-	-	-
Upper discharge canal: earth excavation	14,600 cu m	0.32	4,672	-	-	-
Upper discharge canal: rock removal	1,000 cu m	6.4	6,400	-	-	-
Upper discharge canal: paving	-	-	-	4,400 cu m	2	8,800
Upper discharge canal: inclined construction	-	-	-	1 inclined drop	2,400	2,400
Earthen Dam	-	-	39,400	-	-	57,307.68
Clay excavation	40,000 cu m	0.56	22,400	46,978 cu m	0.56	26,307.68
Slate lining, up to dam's water head	800 cu m	20	16,000	1,200 cu m	20	24,000
Paving work, up to dam's water head	500 cu m	2	1,000	2,500 cu m	2	5,000
Filter gallery: rock removal	-	-	-	500 cu m	4	2,000
Total			151,592			121,387.68

NOTE: The grand-total cost of 272,979,680,000 Sinkiang yuan equals 1,364,898,400,000 CNC yuan, 454,966,13 gold yuan notes, or 113,411,33 US dollars

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Table 15. Estimated Cost of Work to be Completed on the Ho-p'ing Canal

(Cost per unit and total cost in one million Sinkiang yuan)

Engineering Work	1st Period Amt and Unit	1st Period Cost per Unit	1st Period Total Cost	2d Period Amt and Unit	2d Period Cost per Unit	2d Period Total Cost	3d Period Amt and Unit	3d Period Cost per Unit	3d Period Total Cost
Main Canal :			75,200	-	-	79,795.2	-	-	-
Large flume: painting	1 flume	4,800	4,800	-	-	-	-	-	-
New section of the main canal at Ho-t'ien St, Ti-hua: earth excavation	100,000 cu m	0.32	32,000	-	-	-	-	-	-
Additional paving work	10,000 cu m	3.2	32,000	20,561 cu m	3.2	65,795.2	-	-	-
Flood-control work on Urumchi R	-	-	-	500 m	12	6,000	-	-	-
Bridges construction over new section of the main canal at Ho-t'ien St, Ti-hua	4 bridges	600	2,400	10 bridges	6,000	6,000	-	-	-
Flume construction over new section of the main canal at Ho-t'ien St, Ti-hua	-	-	-	5 flumes	400	2,000	-	-	-
Construction of large diversion gate	1 gate	4,000	4,000	-	-	-	-	-	-
Distributing Canals			4,320			7,360			44,000
Diversion gates construction	-	-	-	2 gates	1,200	2,400	-	-	-
Flume construction	-	-	-	13 flumes	320	4,160	10 flumes	320	3,200
Bridge construction	-	-	-	2 bridges	400	800	3 bridges	400	1,200
Drop construction	18 drops	240	4,320	-	-	-	-	-	-

Table 15. (Contd)

Engineering Work	1st Period Amt and Unit	1st Period Cost per Unit	1st Period Total Cost	2d Period Amt and Unit	2d Period Cost per Unit	2d Period Total Cost	3d Period Amt and Unit	3d Period Cost per Unit	3d Period Total Cost
Lateral Canals	-	-	-	-	-	19,200	-	-	63,323.2
Earth excavation	-	-	-	-	-	-	64,635 cu m	0.32	20,683.2
Bridge construction	-	-	-	-	-	-	20 bridges	320	6,400
Flume construction	-	-	-	-	-	-	6 flumes	240.8	1,440
Drop construction	-	-	-	80 drops	240	19,200	145 drops	240	34,800
Total			79,520			166,335.2			67,723.2

NOTE: The grand-total cost for the three periods is 253,598,400,000 Sinkiang yuan, which is equivalent to 1,267,992,000,000 CNC yuan, 422,664 gold yuan notes, or 105,666 US dollars

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