Annex O

Irrigation Systems Modification Plan

Annex O: Irrigation System Modification Plan

O.1 General

This annex addresses modifications needed to the lower Snake River facilities that withdraw water from the Ice Harbor Reservoir for agricultural uses. Modifications described here are not considered as part of the project implementation costs. The plan and costs were developed for economic evaluations of local, regional, and national impacts.

Irrigation water facilities for agricultural use are concentrated at the Ice Harbor Reservoir. Of the 19 listed pumping stations and associated operators, 12 pumping stations are currently using Snake River water for agricultural purposes. Table O1 provides a summary of pumping plants, operators, pumping capacity, and irrigated area and crops. Note that several facilities are joint use facilities where two or more operators use one plant site.

The area irrigated by the 12 pumping stations totals approximately 15,000 hectares (37,000 acres) of land. Approximately 11 percent of the irrigated acreage is used for fruit trees, 6 percent for grape vineyards, 23 percent for hybrid poplar and cottonwood harvested for pulp for cardboard manufacture, and 46 percent for annual row crops. Approximately 14 percent of the acreage is undefined. A total of 40 percent of the acreage is used for mature tree-like plants that are not capable of surviving a season without irrigation.

The primary assumption on which this irrigation system modification is based is that the current water demand must be met by a replacement system and be operational prior to the initiation of the drawdown of the Ice Harbor Reservoir. The system must function through a full range of river stages without interruption. The design, operation, or scheduled maintenance must address the presence of large quantities of suspended sediment in the water for extended periods of time for several irrigation seasons.

O.2 Alternatives

O.2.1 Existing Systems

There are seven privately-owned irrigation pumping stations on the Ice Harbor Reservoir. These pumping stations range in size from a peak pumping capacity of 0.2 m^3/s (5.6 cfs) to a peak capacity of 7 m^3/s (247 cfs). In general, the existing pumping stations draw water through intake screens in the pool and pump the water uphill to corresponding distribution systems. The majority of the pumps are vertical turbine type with a few centrifugal pumps. Without the pool of water created by the Ice Harbor Dam, the intakes to these pumping stations would be completely out of the water and would be unable to lift water from the new, lower water surface.

O.2.2 Discussion of Alternatives

This study team considered several alternative means of providing water to the irrigators. Those alternatives included: 1) relocating the pumping stations to the new shoreline, 2) adding booster pumping stations to pump water from the new shoreline to the existing pumping stations, and 3) building a single large pumping station and distribution system that would serve all of the irrigators.

Table O1. Pump Station Data

Facility No.	Location	Feature	Existing Pump Data				Pumps
			Type	Total Hp	# Pumps	Existing Head	Peak Req.
IH1	NWNE S18, T9N, R32E RM 12	Pump Sta.	Vertical turbine	2,600	8	360	23,900
IH2	NENE S19, T9N., R32E, RM 11.3	Pump Sta.	Vertical turbine	4,500	5	260	40,000
IH3	SWSW S36, T10N, R32E, RM 16.9	Pump Sta.	Vertical turbine	13,500	11	460	85,000
IH4	SESE S8, T9N., R32E RM 13	Pump Sta.	Vertical Tubine	60	2	260	6,000
IH4A	SESE S8, T9N., R32E RM 13	Pump Sta.	Vertical turbine	1,400	8	250	375
IH5	NENE S19, T9N, R32E RM 12	Pump Sta.	Vertical turbine	4,700	5	260	36,000
IH6	NWNE S9, T9N, R32E RM 14.4	Pump Sta.	Vertical turbine	2,260	8	260	13,000
IH7	NENE S19, T9N, R32E RM 12	Pump Sta.	3 Vertical turbine, 6 centrifugal	4,900	9	260	35,000
IH8	NESE S23, T10N, R32E. RM 19	Pump Sta.	2 Vertical turbine		2	260	42
IH9	SESW S24, T10N, R32E RM	Pump Sta.	Vertical turbine	Same as IH-10			
IH10	SESW S24, T10N, R32E RM	Pump Sta.	Vertical turbine	4,400	8	410	26,000
IH11	SESW S13, T10N, R32E RM 20.4	Pump Sta.	Vertical turbine	3,900	6	310	22,500
IH12	NWNE S18, T9N, R32E RM 12	Pump Sta.	Vertical turbine	included with IH1			
IH13	RM 10.3	Pump Sta.	?	250	2	300	2,500
IH14	SENW S3 T9N, R32E RM 15.3	Pump Sta.	Vertical turbine	450	2	60	3,800
IH15	NENE S8, T10N, R33E RM 23.6	Pump Sta.	Split -case centrifugal	100	1	60	3,800
IH15	NWSE S4, T10N, R32E RM 24.8	Pump Sta.	Split-case centrifugal	150	1	60	1,500
IH16	NENW S24, T9N, R31E, RM 10.3	Pump Sta.	Vertical turbine	300	2	360	2,970

Alternatives 1 and 2

Alternatives 1 and 2 were not examined in detail for several reasons. After drawdown, the water surface elevation and water depth would vary considerably for unregulated flow conditions in the river. Water surface fluctuations between the mean low water elevation and the 100-year flood range from 3 meters

(9 feet) to 5 meters (15 feet). Because of these fluctuations in water surface elevation, it would be reasonable to use submersible inline turbine pumps for this application. Passive intake screens, installed on the pump suction piping to prevent both passage of debris and harm to fish would need to be located properly to maintain adequate submergence during low flow conditions. An air-burst back-flush cleaning system would be needed for each submerged screen.

The majority of this stretch of the river has a rather wide, flat bottom with substantial silt, sand, and gravel deposits. It is possible that, as material in the river erodes and deposits, serious problems would occur with this type of pumping arrangement. The river may meander, affecting the availability of water for pumping. Deposited material could reduce intake screen submergence or could cover and plug the screens. Erosion could undermine the pumps, piping, and intake screens, affecting the structural integrity of the system. The submerged equipment would be susceptible to damage due to impact from debris. This type of system, regardless of the sediment concerns, would be difficult to operate and maintain. Finally, in addition to the questionable reliability, installing this type of system prior to or during drawdown would be difficult and costly.

Alternative 3

After considering the alternatives, the study team focused on building one large pumping station and distribution system. The team selected this alternative because it avoided many of the problems associated with the other alternatives. In the vicinity of existing pumping plant IH11, the river is narrow and is contained within steep basalt walls. A review of pre-dam river profiles shows the water to be deep in this stretch of the river during minimal flow conditions. This site lends itself well to installation of a large pumping station. Adequate depth is maintained over the pump bowls even at low flows. The rock channel would minimize erosion, and the higher velocities in this narrow stretch would prevent accumulation of silt, sand, and gravel. The steep walls of the channel enable conventional vertical turbine pumps to be used instead of submersibles.

Providing one large pumping plant to serve all irrigators also has advantages with respect to implementation. The majority of the work on the pumping plant and pipeline could be accomplished prior to drawdown. Connecting the new pipeline system to existing irrigation plants may be accomplished in the off-season prior to drawdown.

Sediment Concerns

It is anticipated that the silt and sand that has accumulated in the reservoirs behind the dams would be eroded and entrained by the faster moving river flows during and after drawdown. It may take several years for this material to be depleted. In addition approximately 3 to 4 million cubic yards of sediments are added to the system from the Snake and Clearwater Rivers. This poses a significant problem for all water supplies that rely upon the river as a source. Excessive quantities of silt and sand would cause damage to pumps, valves, sprinklers, and other components. Intakes would have to be kept clean and clear. Sand particles are heavy enough that most can be kept out of well-designed pumping systems. The silt, however, may remain suspended for long periods of time, even if pumped into large settling ponds. Removal of suspended particles from the pumped water supply could be accomplished by flocculents, but a chemical treatment plant to treat up to 19 m^3/s (680 cfs) would be impractical to construct and operate. The most practical means of handling sand and silt is to use large settling ponds. Settling ponds would help remove sand passed-on from the pumping plant at the river as well as some of the suspended silt. No data are available to quantify the expected sediment load in the river. The extent of required settling facilities is pure speculation at this point and will need to be addressed in detail in future design efforts.

O.3 Selected Configuration

O.3.1 General Discussion

The selected primary irrigation system is a pressure supply system that withdraws water from one river location and supplies all the distribution systems. An optional feature is to construct a reservoir for sediment and surge control with a main pumping plant and make appropriate modifications to the river intake plant.

The primary irrigation system consists of five main components: 1) a pumping plant at the river, 2) a piping system, 3) connections to existing irrigation systems, 4) secondary pumping plants, and 5) a control system. The plant at the river lifts to the piping system. At plants IH3 and IH6, the new pipeline crosses the path of the existing irrigation pipelines at an elevation considerably higher than and distant from the existing pumping plants. Instead of extending a branch from the new pipeline down to the existing pumping plants and pumping the water back up to the branch elevation, it makes more sense to abandon the existing pumping plant and construct new secondary plants near the intersection between the new and existing pipelines. A control system would be needed to coordinate pumping activities. Float switches would be needed to start and stop the pumps at the river as the water surface in the settling pond fluctuates. Pressure switches or interlocking relays would be needed to coordinate the main pumps with system demand and the start-up or stopping of pumps at the various irrigation plants.

The optional reservoir requires the addition of four main components: 1) a large settling reservoir, 2) a main pumping plant, 3) reconfigured pumps at the river intake plant, and 4) additional supply piping to the reservoir and additional discharge piping from the reservoir. The plant at the river would lift the river water up to the settling reservoir while the main pumping plant would pump from the settling pond into the piping system.

The pumps in the system must be sized to deliver the quantities of water needed by each irrigator. The size of the motors on the pumps is related to the volume of water being pumped, elevation changes, flow losses in the piping system, and the desired pressure at the ends of the pipe branches. Pipe size can greatly influence flow losses in the system and, thus, the size of the motors needed on the pumps. Large-diameter pipe is desired to reduce motor sizes and power consumption. On the other hand, smaller-diameter piping is desirable to reduce pipe costs for such a long, extensive pipeline. In selecting pipe size and motor size and in determining the number of pumps to use, overall project cost and practicality were considered by thus study team, but only at a cursory level. If the decision is made to drawdown the reservoirs and a pumping system similar to that described below is to be pursued, the cost ramifications should be more carefully reviewed.

O.3.2 Primary Irrigation System

Primary River Pumping Station Description

The intake structure would be divided into five bays or sumps and would have a large horizontal deck upon which the pump motors would be mounted. The peak capacity of the pumping plant is estimated be 7 m^3/s (850 cfs). This peak capacity is 25 percent greater than the 19 m^3/s (680 cfs) peak irrigation demand in order to provide additional capacity to compensate for pumps that are out of service.

Immediately behind the trash racks, bulk-head slots would be placed to allow each bay to be dewatered when needed for maintenance. Behind the bulkhead slots, vertical traveling debris screens would be installed. The screens would have openings no greater than 2 millimeters (0.08 inches), as required to control entrance flow velocities for fish. The river-facing surface of the screen would travel upwards, carrying any debris attached to the screen surface to the top of the structure. A water spray system within the screen assembly would clean debris from the screen near the top of the structure. A wetted debris channel within the structure deck would convey debris washed from the screen back to the river.

Vertical turbine pump motors would be secured to the deck above each bay, the pump columns extending down into the sump. The pumps would be divided among the five bays. Each bay would have three 1,500- hp pumps and two 600-hp pumps. Valves would be installed on the discharge of each pump to allow the pump to be isolated from the system for maintenance. The valves would be automatically controlled to open slowly after pump start and close slowly prior to pump shutdown in order to control water hammer and surging. Discharge from each pump would manifold to the connection with the main pipeline. A mobile crane could be used to remove and install pump and system components on an as-needed basis. Sand and silt that accumulates in the pump sumps would be conveyed to one end of the sump and pumped out for disposal. Electrical switchgear would be located at deck level. Pumps would be operated in stages as needed to control pressure and flow. Start-up of the private irrigation pumps that are supplied by this pump station would need to be coordinated to keep demand fluctuations at an acceptable level.

Secondary Pumping Plants

The secondary pumping systems would be comprised of covered slabs with canned vertical turbine pumps. Power supply, switchgear, and control systems would be required. The study team assumed that twelve 1,000-hp pumps would be required for the plant that would replace pump station IH3 and four 400-hp pumps would be required for the plant that would replace pump station IH6. The pump suction piping for both of these plants would be plumbed directly to the new water supply pipe with the discharge plumbed into the existing irrigation piping.

Pipeline Description

In general, the proposed pipeline would follow the south shore of the Snake River. The study team assumed that epoxy-lined and polyethylene-coated steel pipe, conforming to American Water Works Association (AWWA) C200, would be used with 18-meter (60-foot) pipe lengths and weld bell ends. At the river pumping station, the discharge piping from the pumps would manifold into the main pipeline. For a 2-meters-per-second (m/s) (6-feet-per-second [ft/s]) target flow velocity in the pipe, 4-meter (12-foot) diameter pipe would be needed close to the pumping station. The remainder of the pipeline was sized based upon an 2-m/s (6-ft/s) flow velocity, with pipe size reducing as flow is withdrawn to the various existing pumping plants. Pipe wall thickness was based upon internal pressure and external loading. External loads were calculated assuming the following: 1) the piping would be buried with a cover of 3 feet; HS-20 highway loading might be realized; and pipe bedding and compaction would achieve a soil modulus of at least 7 by 10^5 Pascal (Pa) (1,000 pounds per square inch [psi].

The pipeline from the river would begin at the pump station near river kilometer 32 (river mile 20), proceeding downstream approximately 1,585 meters (5,200 feet) to the branch to IH11. The pipe to IH11 would be 1,067 millimeters (42 inches) in diameter and would cross the river along the river bottom. The length of this branch was estimated to be 823 meters (2,700 feet) to cross to Emma Lake and an additional 1,372 meters (4,500 feet) to IH11. The pipe to IH11 would need to be excavated in the river channel and covered with rock.

The pipeline serving the remaining stations would begin at 3,048 millimeters (120 inches) in diameter. Near IH9, the pipeline pipe would cross a ravine. This crossing may be achieved by suspending the pipeline above the ravine on piers or excavating and covering the pipe in the ravine bottom. The branch to IH9 is estimated to be 30 meters (100 feet) long and would be 914-millimeter (36-inch) diameter pipe. From the IH9 branch, the main line would reduce to 2,743 millimeters (108 inches) in diameter and continue along the river bank side of the railroad tracks towards IH3, a length of 3,810 meters (12,500 feet). Near river kilometer 28.0 (river mile 17.4) and prior to IH9, the bank of the railroad extends all the way to the river. At this location, complete excavation and burial of the pipe may be impractical. The study team assumed that partial excavation would occur and that cover and rip-rap would be provided along this 305-meter (1,000-foot) stretch of the line.

Near river kilometer 27.7 (river mile 17.2), again prior to IH9, the main line would cross beneath the railroad tracks to the south side. The study team assumed that, for this crossing and all subsequent railroad and highway crossings, the main line would pass through a vented casing that extends beyond the limits of the crossing. A 61-meter (200-foot) long, 1,829-millimeter (72-inch) diameter branch would feed water to a secondary pump station for IH3.

After the branch to IH3, the main line would reduce to 2,286 millimeters (90 inches) in diameter and extend up the mild slope to the top of the bluff above the river over a length of 4,511 meters (14,800 feet) to the IH6 branch. The 762-millimeter (30-inch) diameter, 123-meter (400-foot) long branch to the IH6 system would feed a secondary pumping plant.

After the IH6 branch, the 2,469-m (8,100-foot) main line would remain 2,286 millimeters (90 inches) in diameter and would continue along the bluff, angling down toward the river and the IH4 plant. The 30-m (100-foot) long, 762-millimeter (30-inch) diameter branch to IH4 need not cross under the tracks because the main portion of the IH4 plant is south of the tracks.

After branching to IH4, the main line would reduce to 2,134-millimeter (84-inch) diameter pipe and would continue 1,067 meters (3,500 feet) to the IH1/IH12 branch. Shortly after the IH4 branch and prior to the IH1/IH12 branch, the main line would again cross under the railroad tracks. The 1,372-meter (4,500-foot) long, 914-millimeter (36-inch) diameter IH1/IH12 branch would extend across the river bottom and discharge into the north shore bay in which the IH1/IH12 plant is installed. The study team assumed that this bay would be sealed to act as a reservoir for the IH1/IH12 plant, although it may prove to be more cost effective to extend the piping all the way to the pumping plant and manifold the supply directly to the pumps.

After the IH1/IH12 branch, the main line would reduce to 1,981 millimeters (78 inches) in diameter and continue 701 meters (2,300 feet) to its termination at the IH2/IH5/IH7 plant. The majority of the IH2/IH5/IH7 branch would parallel existing gravel and paved roadways, having to cross a paved roadway at one location. Buried utilities would likely be encountered along the route of the IH2/IH5/IH7 branch.

Pipeline Specials

Two of the existing pumping plants, IH6 and IH4, are multi-pump configurations. These plants use small pumps at the river to lift water to main pumping plants that are a short distance further up the shore. The piping from the small plant is plumbed directly into the suction piping of the main plant. This type of arrangement is proposed for connecting the new water supply to each of the affected pumping plants, plants IH6 and IH3 excluded. For plant IH4, the small plant at the river would be abandoned and the existing manifold at the main plant would be connected to the new branch pipe. For plants IH11, IH9, IH1/IH12, and IH2/IH5/IH7, manifolds need to be constructed and installed to connect each pump to the branch piping. The study team assumed that the manifolds would be simple horizontal pipes with vertical branches extending up to and connecting with the bottom of each pump. Some structural modifications would be needed for the plants that need manifolds. Typical structural modifications would include boring through concrete walls in the existing sumps and providing supports for the manifolds.

In the branch piping near each existing plant and each secondary, an isolation valve would be required to allow the plant to be isolated from the supply system as needed for plant maintenance. The valves would need to be the slow opening and closing type to prevent surging. The study team assumed that manual valve operators would be provided. The team also assumed that a flow meter would be needed in each pipe branch in order to monitor water consumption.

At each branch pipe and at each significant change in direction, the piping would need to be constrained against thrust. The team assumed that concrete thrust blocks would be used to accomplish this. At the new pumping plant near river kilometer 32 (river mile 20), the main line would need to be constrained along the entire length of the intake structure due to the thrust generated by flow from the pump manifolds.

At all high points, large air release/vacuum valves (ARVs) would be required. The ARVs need to be sized to suit the pipe and flow. It is anticipated that at least six locations would require ARVs.

At all low points, drain valves and drain discharge piping would be required to allow the pipeline to be drained. It is anticipated that at least six 610-millimeter (24-inch) diameter drain valves and piping and at least four 305-millimeter (12-inch) diameter drain valves and piping would be required.

O.3.3 Optional Reservoir

The sediment concentration in the river is difficult to determine. The ability of the irrigation system to handle high volumes of sediment in the supply water is questionable. Ideally, a holding pond sized to detain the water for a sufficient time to allow settling of suspended solids is desired. A reservoir to provide a significant detention time for peak flows of 19 m^3/s (680 cfs) would be sizeable. The study team estimated that a reservoir of approximately 396 m^3 (14,000 acre-feet) would be required. This assumes an active storage volume of 50 percent and a detention time of 5 days. More detailed evaluation of sediment characteristics may indicate that more advanced water treatment is necessary to remove sediments from the water.

This study team assumed that the area just to the east of the river intake would be the site of the proposed reservoir. The reservoir would be excavated and enclosed using earthen dikes. The reservoir area would be lined with a geomembrane liner to prevent excessive seepage of the stored water. The liner would be subsequently covered with a protective layer of fine-grained material. More detailed evaluations and reconfiguring of the intake and irrigation system may allow advantageous use of existing topographic features to better site a reservoir.

In order to incorporate an in-line reservoir, the river intake would be reconfigured so that each bay would have three 2,500-hp pumps. This horsepower is based upon the settling reservoir having a mean water surface elevation of 213.4 meters (700 feet). At the river pumping station, the discharge piping from the pumps would manifold into the main pipeline that feeds the settling reservoir. The pipeline from the river begins at the pump station near river kilometer 32 (river mile 20), angling up the hill approximately 671 meters (2,200 feet) and discharging into the settling reservoir above.

To provide a range of flows between partial and full irrigation demand, numerous pumps at the main pumping station would be required. The study team selected an arrangement of 15 250-hp pumps and 10 150-hp pumps. For 18 meters (60 feet) of head, the 250-hp pumps would each provide 51 m^3/m (13,440 gpm), and the 150-hp pumps would each provide 25 m^3/m (6,720 gpm). The head required of these pumps is small because the settling pond elevation is equivalent to the highest anticipated elevation of the pipeline. The 18 meters (60 feet) of design head assures at least 6 meters (20 feet) of surplus head that exist along the entire length of the pipeline. The study team assumed that canned vertical turbine pumps would be used in order to take advantage of the greater efficiencies possible with this type of pump. The pumps would be supported from a slab with water reaching the pump intakes through buried piping that extends out into the settling pond.

It should also be noted that the use of variable frequency driven pumps to reduce the number of pumps needed to cover a broad range of demand is another alternative that could be very advantageous and should be examined in more detail if the drawdown proceeds.

Debris would inevitably be encountered in the settling reservoir. If the debris were sucked into the pumps, damage could occur. Therefore, the study team assumed that intake screens would be required. Manual cleaning of the intake screens should suffice since debris loads should not be heavy. Power supply, switchgear, and control systems would be required. A roof with removable sections for pump access should be provided to shelter the pumps from the elements and allow pump maintenance.

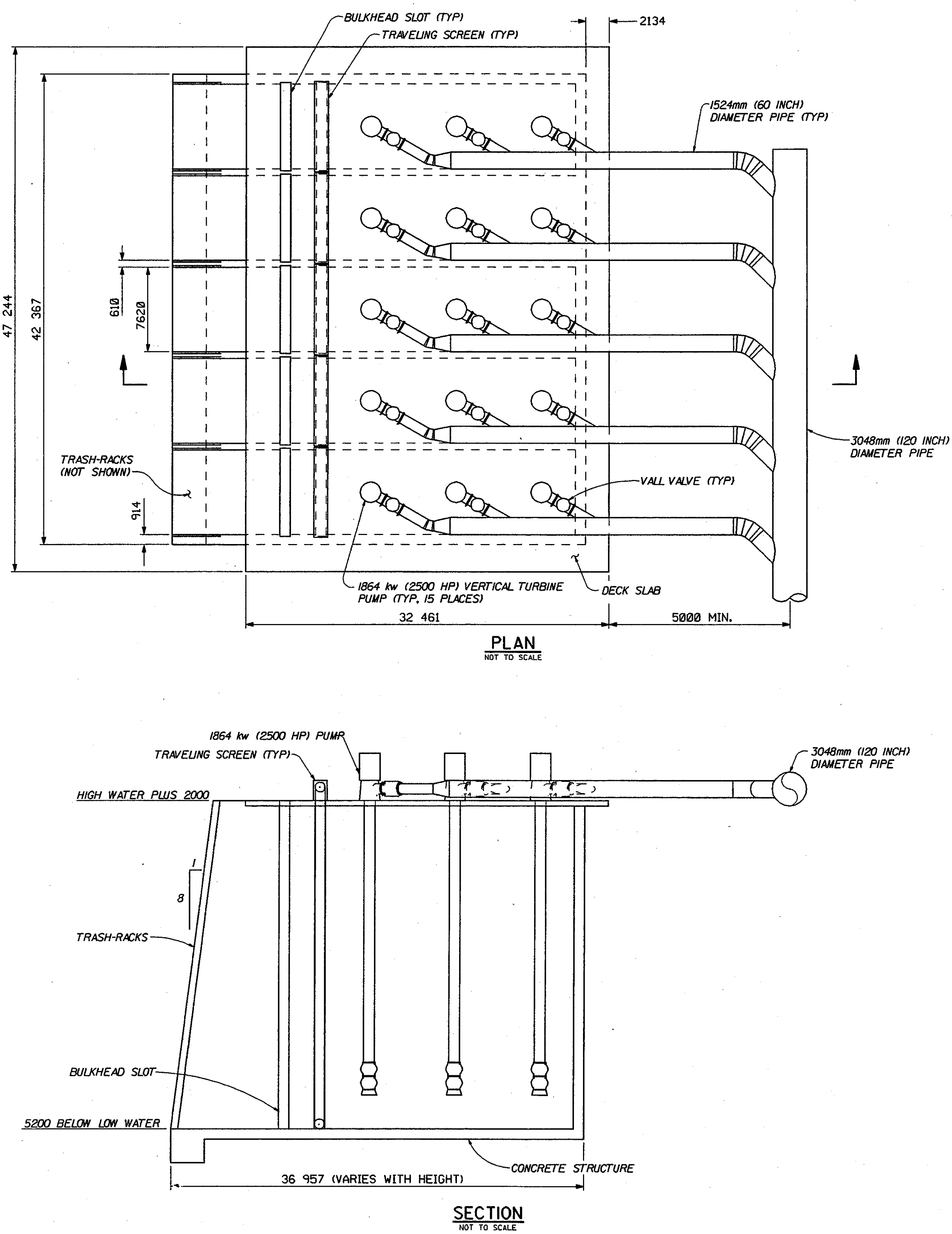
A single pipeline would discharge water from the settling pond to the branch near plant IH11. The 1,067-millimeter (42-inch) line would then branch to IH11 across the river, and the mainline would continue on to serve the remaining plants

O.3.4 Maintenance Requirements

The extent of increased maintenance activity to treat sediment related problems is not known. Certainly replacement of the wear parts of the pumps, valves, sprinklers, and filters would initially be at a high frequency. Even in later years a higher frequency of parts replacement could be expected with the river in its natural state.

O.4 Schedule

Construction activities for this system must be completed by January of the year in which drawdown occurs. Each irrigator must start the irrigation season on the new system. Drawdown begins in early August of that year, the period of peak water demand. In order of accomplish this, construction of the river intake, the pipeline, and the optional reservoir must commence 24 to 36 months in advance of the January completion date.



SHEET MAIN SCALE:

US Army Corps of Engineers
Walla Walla District

LOWER SNAKE RIVER JUVENILE SALMON MIGRATION FEASIBILITY STUDY
24 CMS (850 CFS) PUMPING PLANT
IRRIGATION SUPPLY

Figure: 01

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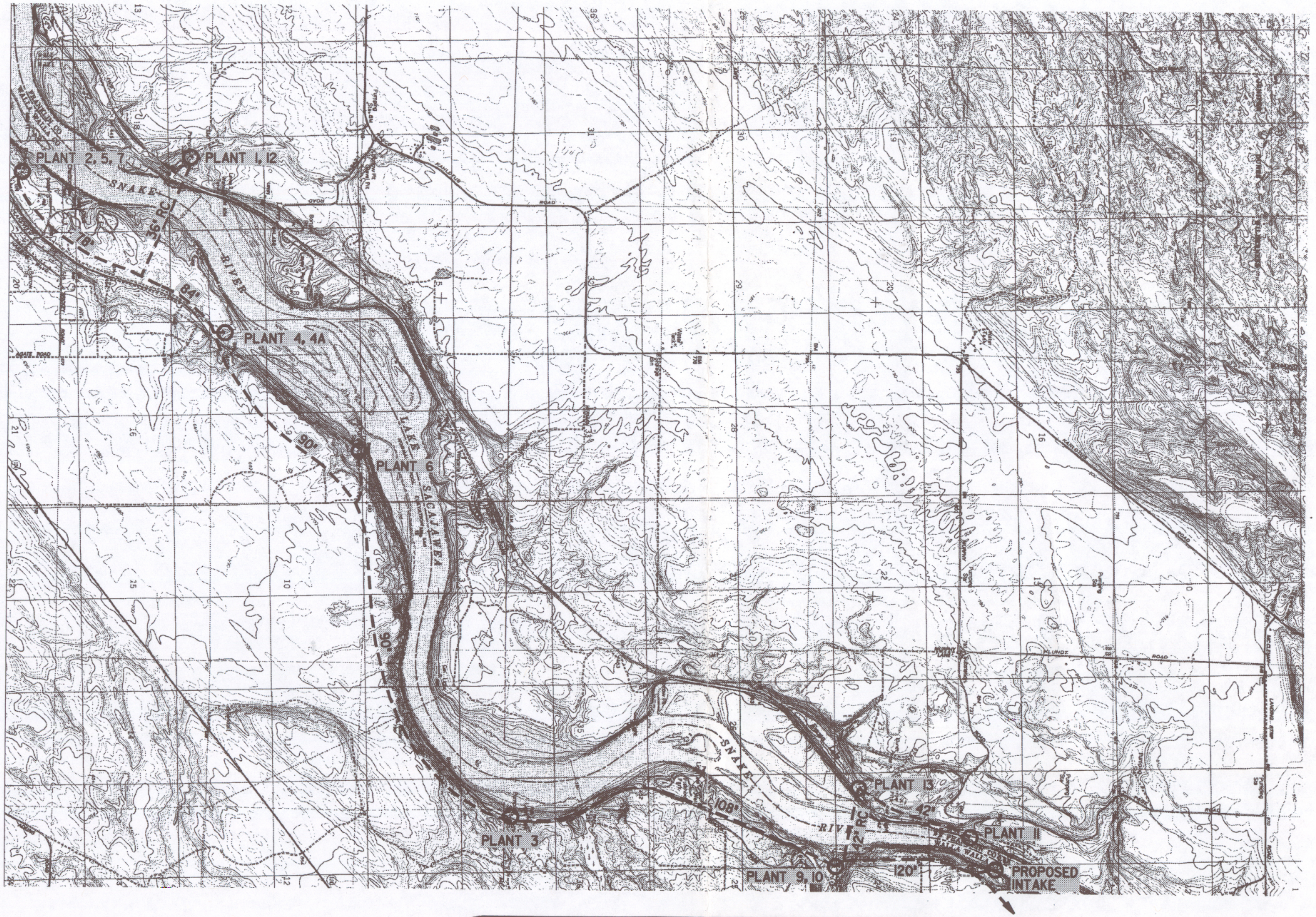

US Army Corps of Engineers Walla Walla District

SCALE IN FEET

4000' 0 4000'

LOWER SNAKE RIVER JUVENILE SALMON MIGRATION FEASIBILITY STUDY

PIPELINE ROUTING MAP

GRID NORTH

LAMBERT WASH. SOUTH

Figure: 02

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