Southern Region Copy for Margin Note Annotation (Unmarked copy in A36-00134B)

DRAFT

EVALUATION OF THE FEASIBILITY OF A WATER RECIRCULATION SYSTEM FOR THE RANGEN AQUACULTURE RESEARCH FACILITY.

Brockway Engineering, P.L.L.C.

November 7, 1995

Introduction

The Rangen Aquaculture Research facility is located northeast of Hagerman, Idaho. Water for the facility is drawn from Curren tunnel, a spring issuing from the north face of the Snake River canyon. Three other water users also withdraw water from the tunnel under water rights which are senior to those of Rangen, Inc. Because the rights of Rangen, Inc. are junior to the others, the spring is an unreliable source; fish raceways frequently go unused for lack of water. One option to acquire additional water is to divert water allocated under the senior water rights, use it in the aquaculture facility, and return the flow by pumping back to the Curren tunnel, thereby having no impact on the water rights of the other users. The purpose of this study is to evaluate the feasibility of such a recirculation system.

...ew appropriation ...r "rotation agreement" ...t requiring other ...ilings? Rotation ...ould provide up ...o available flow - or ...ecree amt whichever ...s less.

System layout

A diagram of the Rangen facility is shown in Figure 1. Water is diverted at the tunnel via a concrete headbox and pipe, flows through the facility including three sets

ADM: Send copies to Tim Luke
? Is this proposal going to make better the senior rights water supply to the injuries of downstream users?

of raceways, and returns to a ditch which eventually flows into Billingsley Creek. It is proposed to locate a pumping facility near the point where the ditch crosses the road at the downstream end of the last raceway. This facility would consist of a concrete pump bay, a vertical turbine pump, a flow regulation valve, and a flow measurement device.

The return-flow pipe would be buried in a trench along the road as shown in Figure 1. Two possible paths for the pipe are shown: 1) following the Curren tunnel access road, or 2) following the main road to the toe of the canyon face and going directly up to the tunnel. Both routes are approximately 2600 feet in length. The first route is less steep, but it would be difficult to dig a trench for the pipe since the ground contains much rock. The second route would not require a trench from the toe of the face to the headbox, but placement of a large pipe would be more difficult. In either case, the return-flow pipe would be anchored to the top of the concrete headbox.

Water rights

In addition to water rights for Rangen, Inc., three other users withdraw water under several rights with priority dates ranging from 1884 to 1908. The irrigation and domestic Rangen rights also have early priority dates, but all of Rangen's fish propagation rights have dates much later than these. The water rights from Curren tunnel are listed and described in Table 1.

Table 1. Water users and water rights from the Curren tunnel

Water user	Description of rights	Total rate (cfs)
Crandelmier	5 rights for irrigation and stockwater	8.91
Musser	1 right for irrigation and stockwater	4.10
Candy	2 irrigation rights	0.72
Rangen, Inc.	2 rights for irrigation and domestic	0.14
Rangen, Inc.	2 rights for fish propagation	76.0

The total diversion from the tunnel for irrigation and stockwater uses is 13.94 cfs. Under the proposal examined in this study, this amount (approximately 14 cfs or 6283 gpm) would be diverted from Curren tunnel, used in the aquaculture facility, and pumped back to the headbox, thereby having no impact on downstream water users when the system is in equilibrium. During startup, downstream users could experience momentary fluctuations in flow as the sytem fills.

The Idaho Department of Water Resources (IDWR) has measured the discharge in Curren tunnel for the past two years. These discharges are shown in Figure 2. Minimum flow for the 1993-1995 period was 2.99 cfs in the spring of 1995. The maximum recorded flow was 20.27 cfs in the fall of 1993.

Preliminary selection of pump

The elevation of the Curren tunnel is approximately 3138 feet[1]. The elevation of the ditch at the proposed location of the pumping plant was estimated from a USGS 7.5-minute quadrangle and found to be approximately 3053 feet. The elevation head

[1]Covington, H. R. and J. N. Weaver, "Geologic map and profiles of the north wall of the Snake River canyon," USGS publication, 1989

is therefore equal to 86 feet. The pump must be designed to pump 14 cfs against the total dynamic head (TDH), which equals the elevation head plus the velocity head plus all head losses in the system.

System curves were developed and are shown in Figure 3 for a range of pipe sizes from 20 inches to 30 inches. The design flow will be 14 cfs, which is the maximum flow that will be returned to the headbox. However, the actual flow may vary, depending on the discharge of the Curren tunnel. A pump which delivers a range of flow from 10 cfs to 14 cfs (4488 gpm to 6283 gpm) against a sufficient TDH the while maintaining reasonable efficiency is the Ingersoll-Dresser 18NKH. The pump curves for this unit are shown in Figure 4.

what Happens when spring flow is minimal? ei 2.99 cfs)

This pump with a 250-horsepower motor and a 10-foot column will cost approximately $21,750 installed, as quoted by Layne Pump of Twin Falls, Idaho.

Selection of pipe size

The cost of pumping is directly related to the TDH which must be overcome. For a given flow, a larger pipe results in lower water velocity and less head loss due to friction, and therefore less pumping cost. However, larger pipe costs more. The optimal pipe size may be found by expressing the tradeoff between pipe cost and pumping cost in economic terms. For a range of pipe sizes, the pumping cost per year was found assuming an average electricity cost of $.035 per kilowatt-hour. This average price considers the monthly demand charge, which is based on the power rating of the pump, and the usage charge per kilowatt-hour. Prices for steel pipe and installation were quoted by Farmore Co. of Jerome, Idaho and are given in Table 2.

Table 2. Cost of steel pipe.

Pipe diameter	Cost per foot
20"	$16.50
24"	$20.50
26"	$23.50
36"	$47.00

It was assumed that the same pump is appropriate over the range of pipe sizes examined, so that the cost of the motor and pump does not vary with pipe size. A comparison of the system curves in Figure 3 with the pump curves in Figure 4 suggests that this is a reasonable assumption. It was also assumed that the cost of excavation and pipe installation does not vary with pipe size.

Because the yearly electricity cost is an amortized cost, the present value was calculated assuming a project life of 20 years with a minimum acceptable rate of return of 10%. This amount was then added to the cost of the pipe, which is already a present value, to yield a total present value (see Figure 5). The pipe size which minimizes the total present value 26 inches. A very large pipe is selected by this procedure because when pumping continuously, the present value calculation is very sensitive to pumping cost, which is a function of head loss and thus the size of the pipe. If a 24-inch pipe is chosen rather than a 26-inch, the initial cost of the pipe would decrease to $53,300 from $61,100 but the annual pumping cost would increase to $46,500 from $45,300. Given than this is a relatively small increase in pumping cost, and because a 24-inch pipe is easier to handle and may be more readily available, it may be a better choice.

Allowance for system down time

Water recirculated by the pumping plant would be used for fish propagation. Raceways require continuous replenishment with fresh water. Any occurrence which interrupts this flow of water would be devastating to the fish in the raceways and would result in a significant monetary loss. Interruption of the flow could be caused by a power outage, a malfunction of the pump or motor, or a break in the return-flow pipe. A pipe break is unlikely unless the pipe were defective or a weld was improperly performed. However, the first two scenarios are not only probable but a certainty if the pump is run continuously. As protection, a redundant system could be built (two pumps of equal size) and a 440-volt, 3-phase generator could be installed for use during power outages. Neither of these has been included in the cost estimate for this study.

Cost estimation

Initial cost estimates for the components of the system and installation are presented in Table 3. Excavation costs assume a 3-foot wide by 4-foot deep trench for the pipeline. The pipeline price was quoted by Farmore Co. in Jerome, Idaho for steel pipe with a wall thickness of 0.281". Installation of the pipeline involves placement of the pipe and welding of the sections, both of which could be performed by Farmore. Prices for the pump and motor and the electrical panel were quoted by Layne Pump of Twin Falls, Idaho and include installation. A flow meter would be required on the pipeline to measure the return flow to Curren tunnel. An in-pipe impeller-type meter may be obtained for approximately $900 including installation from Farm Irrigation systems of Twin Falls, Idaho. The flow should also be measured in the ditch at the end of the last raceway to ensure that water is not deprived of downstream users who have senior water rights. This cost is not included in the estimate.

The motor requires a 440-volt, 3-phase supply of electricity. According to Mr. Greg Evans of Idaho Power, the nearest 440-volt tap is approximately 1050 feet from the pumping plant location. The cost to tap this line and supply power to the pump house would be approximately $1875 plus $7.00 per foot, for a total of $9,267. Idaho Power gives a $30 per horsepower discount for large users, which would bring the cost down to $1767 for a 250 horsepower pump. However, Mr. Evans cautioned that this discount may not be available next year due to changes in the regulatory environment of utilities.

Including other costs for concrete, a pre-fabricated pump house, miscellaneous metal fabrication for an expansion fitting and other incidental work, plus a 10% margin for unexpected costs, the total initial cost for the system installation is estimated to be $116,300.

Annual pumping costs were estimated to be $0.035 per kilowatt-hour on average, which includes both demand and usage costs as discussed previously. Assuming 14 cfs (6283 gpm) were pumped continuously, the annual pumping cost would be $45,300 with a 26-inch pipe and $46,500 with a 24-inch pipe. One option to reduce pumping cost is to operate the recirculation system only during the irrigation season when the other water users were withdrawing significant flow. With a 180-day growing season from April 15 to October 15, the annual pumping cost would be $22,300 with a 26-inch pipe and $22,900 with a 24-inch pipe.

Conclusions

The analysis of the proposed recirulation system for Rangen, Inc. shows that it is a feasible solution with significant annual cost. Even though the arrangement may be feasible, a proposition such as this would require the approval of each of the involved water users with senior rights and of the Idaho Department of Water Resources (IDWR).

Table 3. Estimate of initial cost.

Item	Description	Cost	Vendor
Excavation	1200 cu yds @ $5/yd	$6,000	Loosli Excavating
Pipeline	2600 ft, 26" @ $23.50/ft	$61,100	Farmore
Pipeline installation	Placement & welding	$5,200	Farmore
Pump & motor	250 Hp, 6200 gpm pump, installed	$21,750	Layne Pump
Electrical panel	All options	$5,000	Layne Pump
Panel installation	Installation by qualified electrical contractor	$1,000	Shotwell
Power supply	440-volt, 3-phase tap, 1050-ft run, minus credit	$1,767	Idaho Power
Flow meter	Grainland impeller w/totalizer, installed	$900	Farm Irrigation Systems
Check valve	Needed to prevent backflow after system shutdown	$1000	Farmore
Butterfly valve	Needed to regulate the flow rate	$1000	Farmore
Pump bay & pad	5 cu yd concrete @ $200 / yd in place	$1,000	Triple-C or equivalent
Pump house	Pre-fab metal pump house 8'x8'	$1,500	Petersen Brothers
Metal fabrication	Pipe expansion, misc. brackets & fittings	$500	Langdon or equivalent
	SUBTOTAL	$107,717	
	10% Contingency	$10,572	
	TOTAL INITIAL COST	$118,289	

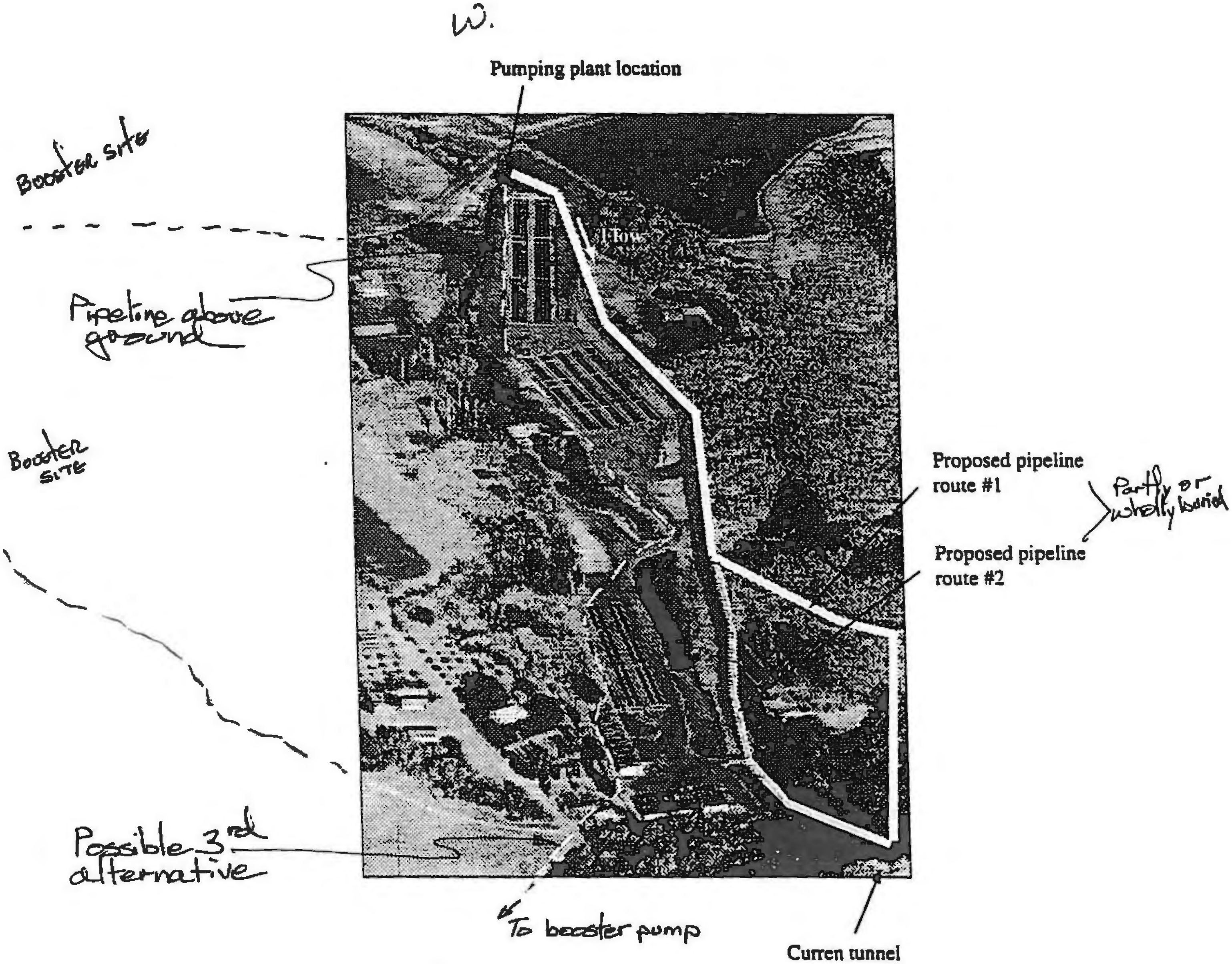


Figure 1. An aerial photo of the Rangen, Inc. facility with the proposed layout of the water recirculation system superimposed. The locations of the pumping plant and pipeline are shown.

Potential injury to junior priority irrigators if up to 14 cfs is pumped back to pipelines (i.e. flows that ordinarily not be available to Crandlemire, Candy, Musser).

Figure 2. Measured discharge of Curren tunnel

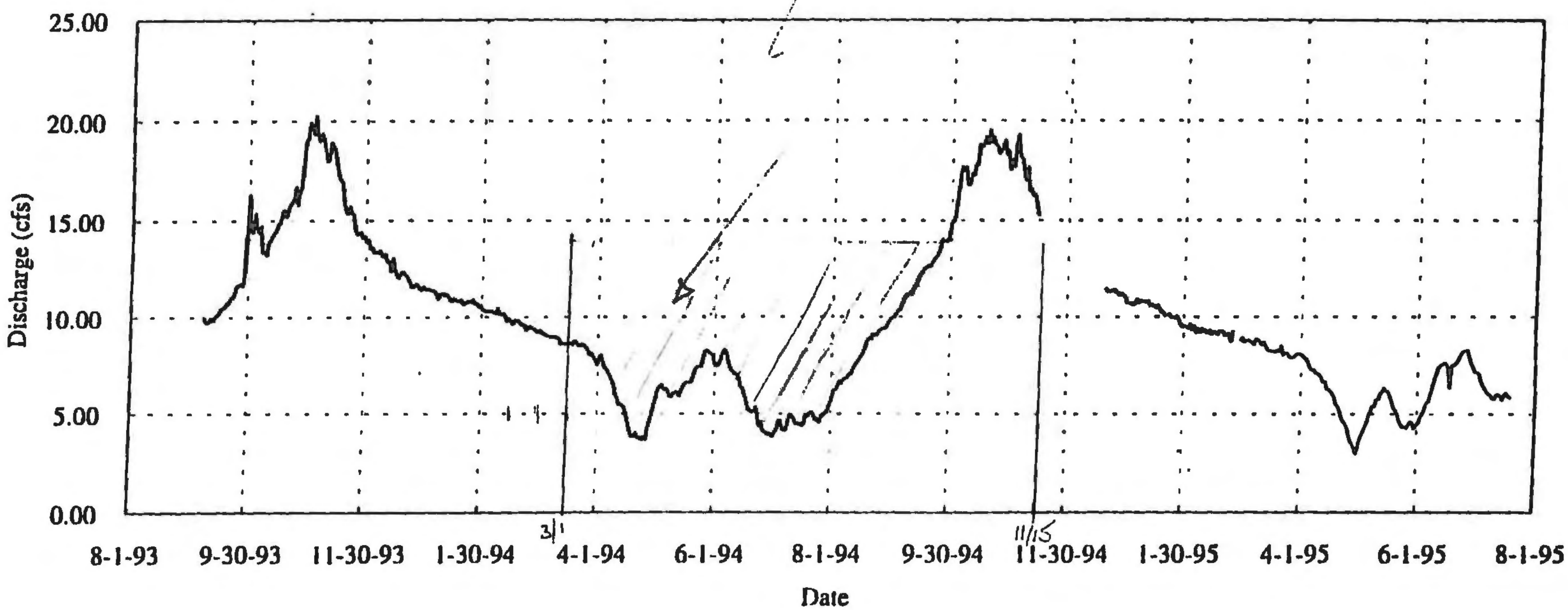
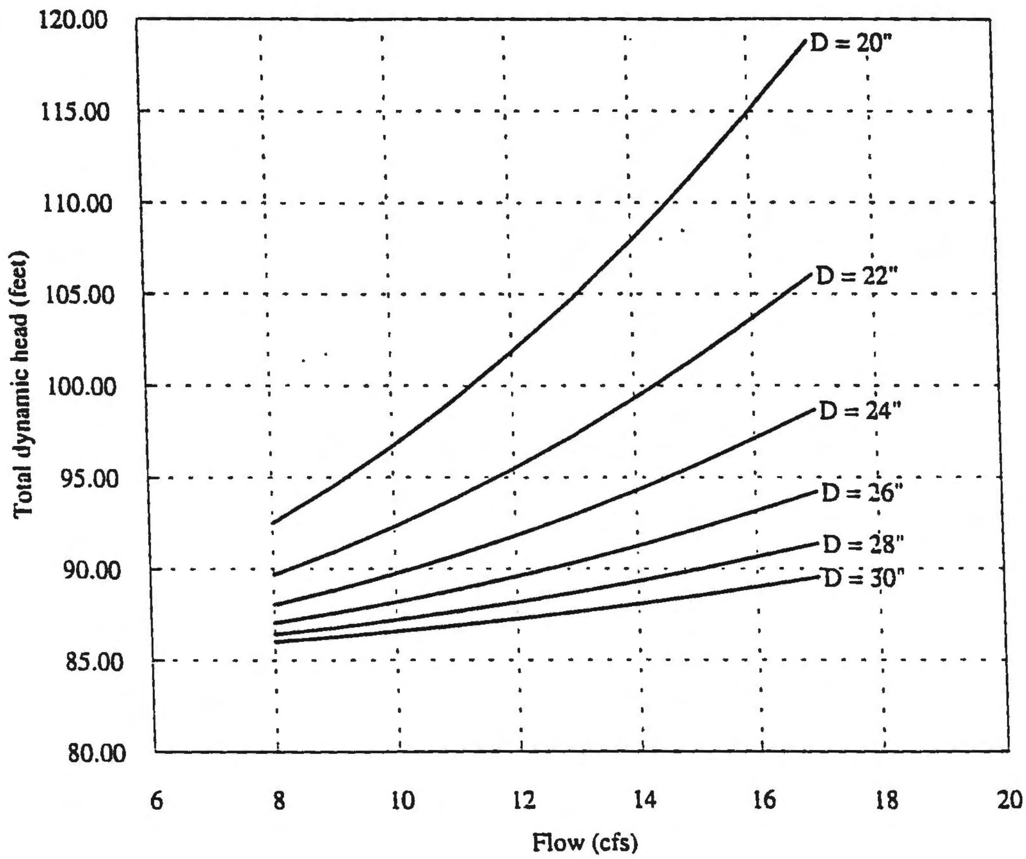


Figure 3. System curves for several pipe diameters



CGB 11-12-95

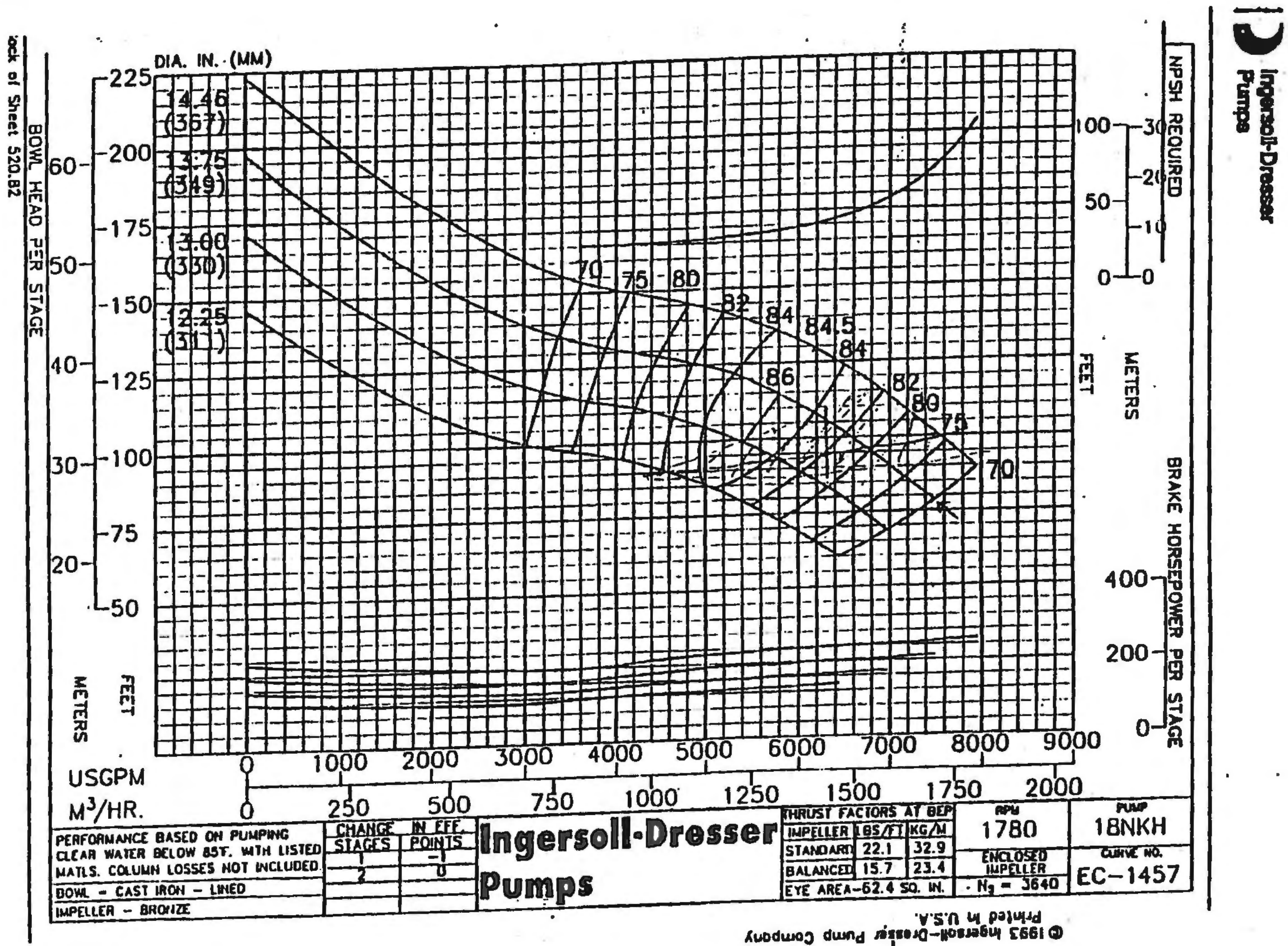


Figure 4. Pump curves for the Ingersoll-Dresser 18NKH

Figure 5. Pipe size selection by minimizing the present value of total cost