Appendix F
Costs Estimates for Proposed Facilities

Return to:

*"Northeast Oregon Hatchery Project
Spring Chinook Master Plan"*

The cost estimates for the proposed facilities were taken from Montgomery Watson's Lookingglass Hatchery Review, July 1999.

APPENDIX B
ESTIMATED HATCHERY DEVELOPMENT COSTS
IMNAHA AND LOSTINE SITES

Purpose

The purpose of this appendix is to develop project descriptions and capital cost estimates for stand-alone, spring chinook hatcheries at two sites, Imnaha River and Lostine River, based on several different operating alternatives.

Alternatives

Assumed production for each hatchery site is:

- Lostine: 250,000 smolts at 20/lb.
- Imnaha: 490,000 smolts at 20/lb.

Four alternatives are considered for each hatchery site:

- Early rearing and raceway rearing at conventional densities (DI = 1.00 and 0.17, respectively),
- Early rearing and raceway rearing at NATUREs densities (DI = 0.30 and 0.10, respectively),
- Disinfection of incubator and starting trough water supply,
- Disinfection of incubator, starting trough and raceway water supply.

Site Water Temperature

The starting point for planning these facilities is to develop information on the water supplies. Assuming that the quality and quantity is suited to spring chinook propagation requirements, the focus will be on water temperature.

Temperature summaries for the Imnaha and Lostine sites, as well as Lookingglass Creek, were developed. Methods and data sources were:

- Lookingglass Creek – The source of this data is described in Appendix A. Temperature data from 1993 to 1995 was used and expressed as maximum and average values at 10-day intervals.

- Imnaha – This site has temperature data available from a continuous ten and a half-month period (March 1, 1998 to February 10, 1999) supplied by Nez Perce Tribe. Maximum and average values at 10-day intervals were derived from this data. The missing 3 periods were interpolated.

- Lostine – Summer data was available for four years (1995 through 1998). The period of record for each year does not exactly coincide, however the critical warmer periods were covered. For each day where any data was available either a maximum or an average value was used. Missing data were extrapolated from Lookingglass Creek data to create a full-year record of temperature data. From this data, maximum and average values at 10-day intervals were derived. Actual site temperature data should be used for more detailed planning at this site.

Temperature data was then tabulated and plotted on charts for average and maximum values (Table B-1). Data shown on Table B-1 was used for projecting water and facility requirements in the remainder of this Appendix.

The quality of this temperature data is compromised by the assumptions made as described above. However, compared to the material available in many planning studies, the level of information available is satisfactory for the purposes of planning-level facility descriptions and cost estimates.

Flow Index (FI) Values

The use and derivation of FI values is discussed at length in Appendix A. Separate values were calculated for each site due to differing elevations (Table B-2). These FI values will be used, along with temperature information, to determine the required flows for the Lostine and Imnaha facilities.

In applying these FI values, we have made a conservative assumption. The maximum temperature is used to project flow requirements rather than the average temperature. It is our opinion that the use of average temperatures is suited to defining growth through a cycle. Average temperature is not suited to projecting flow requirements.

Raceway Flow Requirements

Calculated raceway flows through a calendar year as required at Imnaha and Lostine are shown on Tables B-3 and B-4, respectively. For comparison purposes, these two flow profiles are combined with the required Lookingglass Hatchery flows on Table B-5 for units of 100,000 smolts.

Hatchery Flow and Space Requirements

Table B-6 illustrates the calculation of flows and volumes for the Imnaha and Lostine facilities. The basis for each of the values is illustrated in the third column.

Table B-7 illustrates the overlap of flows in the two facilities.

Table B-8 provides a summary of flow and space requirements.

Basis for Estimating Hatchery Capital Costs

The approach used to develop Imnaha and Lostine capital costs is based on a review of the capital costs of hatcheries built in the US for which data is available. These costs are then adjusted as follows for comparability:

- All costs are stated as capital costs with adjustments made to construction costs to reflect engineering, construction administration, inspection, testing and owner overhead and applicable taxes. Typically these adjustments are about 25% of the basic costs.
- Costs are escalated from the date of construction to the year 2000 and an assumed ENR Index of 6000.
- In one instance (Merwin) an ozone system was constructed with the initial facility. To deal with the costs of ozone separately, the ozone system costs were backed out of the Merwin estimate.
- For each facility, the water volume of the raceways and concrete holding ponds was tabulated. In those hatcheries with Rearing Ponds (such as Cowlitz Trout and Merwin) the volume of the rearing pond is adjusted downward by a factor that reflects contemporary criteria for fish density. For example, at Merwin the pond DI was 0.03 and the raceway DI was 0.25. This produces a capacity ratio of 12%, meaning that a 1,000 CF of pond is equivalent to 120 CF of raceway. Applying the DI's to the actual volumes would suggest that the rearing capacity of each is about the same. The ponds were much less costly than the raceways.

The resulting Volume and Cost points (log10) are trended against each other to produce a basis for projecting cost of an "average" facility. This is illustrated on Table B-9.

The formula for cost is:

- **Hatchery Capital Cost = $2,400 x Volume ^ 0.74.**

This information can be used in two ways.

- The trend line can be used directly to predict costs. As indicated on the second chart, most of the data points fall in the 50% +/- range.

  For example a generic hatchery with 30,000 CF in volume should cost $4,930,000 plus or minus 50%.

- The slope of the trend line can be used to extrapolate the actual cost of a particular project to a new project of different size but similar in other aspects.

For example the Methow Hatchery cost $7,550,000 and had a volume of 50,692 CF. A similar hatchery on a similar site with a planned volume of 30,000 CF could be projected to cost $5,120,000 $(((30{,}000/50{,}692))^{.74} * \$7{,}550{,}000 = \$5{,}120{,}000)$.

There are a number of refinements that can be introduced growing out of specific cost elements:

- When a hatchery cannot be sited to have gravity flow, a main intake pump station is required. The added capital cost for a pump installation is relatively small. In a number of hatcheries with pump stations, the identifiable, incremental costs are seldom more than 5% to 8%. The impact is often further reduced by the fact that parts of the intake pump station (screens, head boxes) would be constructed even in a gravity system. There are occasions when the installation of a simple pump station can reduce capital cost compared to a complex gravity system. In consideration of this, capital cost adjustments based purely on the use of pumps is not always justifiable.

- Newer hatcheries, with lower (e.g., NATUREs) rearing densities, may have less mechanical water system components (pump station and piping) per unit of rearing volume than earlier hatcheries with conventional rearing densities. Assuming the water system costs are 15% of the facility and that water system costs are scaled back by a cost exponent of 0.74, then NATUREs facility costs could be reduced 5% for a given rearing volume. Any actual cost savings realized would be site and facilty specific depending on program needs such as chilling requirements.

- Many newer hatcheries are installing ozone disinfection for some or all of their flow capacity. The capital cost of these installations is significant. Table B-10 presents a cost curve developed from estimates for units from 500 gpm to 5,000 gpm. These costs are based on Ozone gas/UV systems that are especially suited to very cold climates. If UV were replaced with air strippers suited to warmer climates, the cost could be reduced from 5% to 10%. Cost includes a metal building and all mechanical systems. No pump station is assumed. LOX (Liquid Oxygen) will be used from leased tanks.

- The formula for cost is Ozone Capital Costs = $26,562 x Flow Capacity ^ 0.54, where capacity is expressed in gpm.

Capital Cost of Alternatives

Table B-11 illustrates estimates for the various alternatives, a summary is provided below:

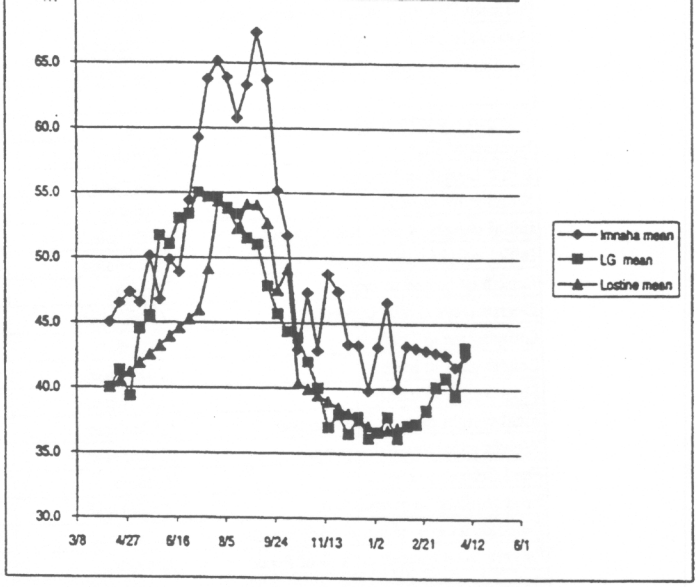
Alternative Features	Imnaha	Lostine
Conventional Density/Minimal Ozone	$ 5,770,000	$ 3,670,000
Conventional Density/Maximum Ozone	$ 7,390,000	$ 4,700,000
NATUREs Density/Minimal Ozone	$ 7,450,000	$ 4,740,000
NATUREs Density/Maximum Ozone	$ 9,080,000	$ 5,770,000

The hatchery costs are based on the cost curve of Table B-9. Another approach, extrapolating from Merwin, produces a value within 7% for the "Conventional Density/Maximum Ozone" alternative.

Preliminary Facility Sizing

Table B-12 provides preliminary planning facility sizing for the various options.

5/30	46.8	51.7	43.2
6/9	49.8	51.0	43.9
6/19	48.9	53.0	44.6
6/29	54.4	53.3	45.3
7/9	59.3	55.0	45.9
7/19	63.8	54.7	49.1
7/29	65.2	54.7	54.3
8/8	63.9	53.8	53.8
8/18	60.8	53.3	52.2
8/28	63.3	51.5	54.1
9/7	67.3	51.0	54.1
9/17	63.7	47.8	52.7
9/27	55.2	45.7	47.5
10/7	51.7	44.3	49.1
10/17	43.0	43.8	40.4
10/27	47.3	42.0	39.9
11/6	42.9	40.0	39.5
11/16	48.8	37.0	39.0
11/26	47.4	38.0	38.5
12/6	43.4	36.5	38.1
12/16	43.3	37.8	37.6
12/26	39.8	36.2	37.1
1/5	43.2	36.7	36.7
1/15	46.6	37.8	36.8
1/25	40.0	36.2	37.0
2/4	43.3	37.2	37.2
2/14	43.1	37.3	37.3
2/24	42.9	38.3	38.3
3/6	42.8	40.2	40.2
3/16	42.6	40.8	40.8
3/26	41.7	39.5	39.5
4/5	42.6	43.2	43.2



	Imnaha-max.	LG-Max.	Lostine-Max.
7/9	62.2	65	47.8
7/19	68.0	66	51.7
7/29	68.6	65	58.2
8/8	68.6	64	58.9
8/18	66.0	62	65.3
8/28	69.2	61	59.8
9/7	71.8	58	61.2
9/17	68.0	55	61.2
9/27	59.7	53	52.2
10/7	56.0	49	55.0
10/17	44.9	48	43.6

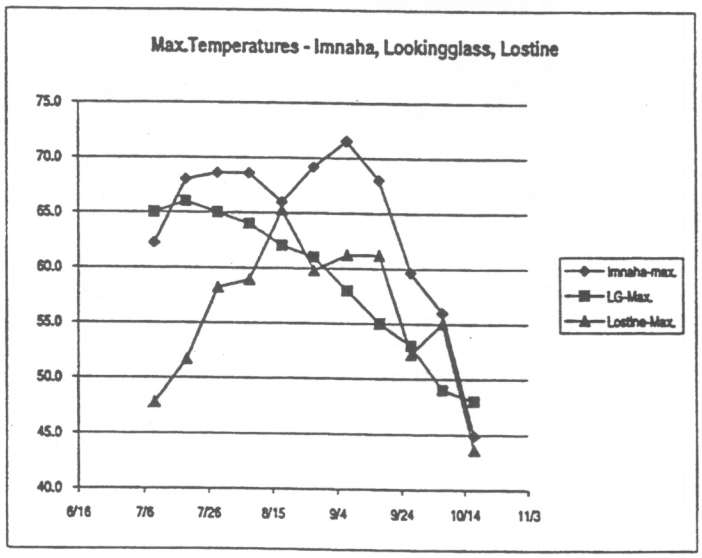


Table B-2 Calculated Flow Indices for 3 Sites

Available Oxygen		Imnaha	Lookingglass	Lostine	
Critical Temp.°F	Given	65.0	65.0	65.0	
Critical Temp.°C	Calculated	18.3	18.3	18.3	
Sea Level Oxygen Saturation-mg/l	Calculated	9.39	9.39	9.39	
Site Elevation in feet	Given	1,600	2,500	3,700	
Site Barometric Pres.mmHg	Calculated	719	697	669	
Vapor Pressure	Calculated	15.79	15.79	15.79	
Site-Oxygen Sat-mg/l	Calculated	8.87	8.60	8.24	
Inflow DO as % Saturation	Criteria	95%	95%	95%	
Inflow DO - mg/l	Calculated	8.43	8.17	7.83	
Partial Pressure-mm HG	Criteria	90	90	90	
Bunsen Coefficient-(L/L-atm)	Calculated	.03208	.03208	.03208	
Effluent DO-mg/l @ Given Partial Pres.	Calculated	5.43	5.43	5.43	
Available Oxygen - mg/l	Calculated	3.00	2.74	2.40	
Available Oxygen - lbs/day in 1 gpm	Calculated	0.04	0.03	0.03	
Oxygen Consumption					
Number of Fish	Criteria	1,000	1,000	1,000	
Initial Length in inches	Criteria	4.0	4.0	4.0	
K factor for chinook	Criteria	0.0002959	0.0002959	0.0002959	
Initial weight of each fish - pounds	Calculated	0.0189	0.0189	0.0189	
Initial weight fish - pounds	Calculated	18.94	18.94	18.94	
Length of period in days	Criteria	1.0	1.0	1.0	
Degree Days (DfD) in period	Calculated	33.0	33.0	33.0	
Growth rate in DfD/inch	Criteria	1000	1000	1000	
Length gain in inches	Calculated	0.033	0.033	0.033	
Final length in inches	Calculated	4.033	4.033	4.033	
Final weight of each fish - pounds	Calculated	0.0194	0.0194	0.0194	
Weight gain each fish - pounds	Calculated	0.00047	0.00047	0.00047	
Feed Conversion Ratio	Criteria	1.50	1.50	1.50	
Feed required in pounds/fish	Calculated	0.00071	0.00071	0.00071	
Feed/day as a % of initial body weight	Calculated	3.74%	3.74%	3.74%	
Oxygen consumption as a % of Feed	Criteria	25.0%	25.0%	25.0%	
Oxygen consumption/day as a % of Wt	Calculated	0.94%	0.94%	0.94%	
Oxygen consumption/day in pounds	Calculated	0.18	0.18	0.18	
Required Flow					
Required flow in gpm	Calculated	4.92	5.39	6.15	
Required flow in lbs/gpm	Calculated	3.85	3.51	3.08	
Flow Index	Calculated	0.96	0.88	0.77	
Tabulated FI Values					
	From Above				
	Source	Imnaha	Lookingglass	Lostine	
	SGR DfD/inch	1,000	1,000	1,000	
	40°F	5.65	5.17	4.56	
	45°F	3.23	2.95	2.60	
	50°F	2.17	1.98	1.74	
	55°F	1.58	1.45	1.27	
	60°F	1.21	1.11	0.97	
	65°F	0.96	0.88	0.77	
	70°F	0.78	0.71	0.62	
	75°F	0.65	0.59	0.52	
	80°F	0.55	0.50	0.43	
FI Formulas for 3 sites (by Curve Fit Program)					
Imnaha =	-0.0001704*T^3+0.033503*T^2-2.2344*T+51.449				
Lookingglass =	-0.0001585*T^3+0.03106*T^2-2.0642*T+47.384				
Lostine =	-0.0001415*T^3+0.02771*T^2-1.8407*T+42.1989				

Table B-3 Imnaha

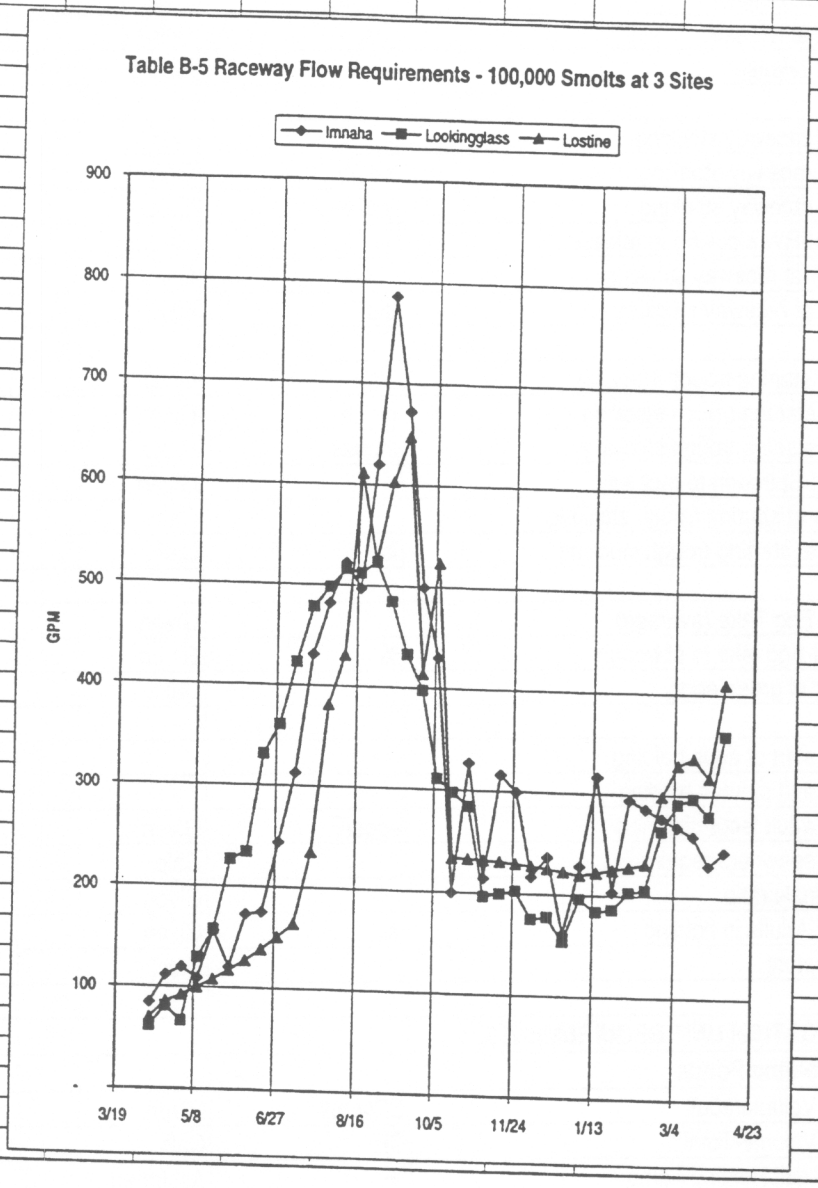
Flow Requirements for 100,000 Smolts Based on Conv.=1.5 SGR = 1000

Date	Maximun Temp.	Average Temp	Days In Period	D/D	Gain In " Period @ 2188	Length in "	Weight each fish lbs	Fish Count 0.9988	Fish Weight lbs	SGR1000 FI Max.Temp	SGR1000 lbs/gpm	SGR1000 gpm	
4/10	48.2	45.0				2.62	0.0053	104,417	556	2.51	6.56	85	
4/20	51.3	46.5	10	138	0.06	2.68	0.0057	104,292	596	1.99	5.34	112	
4/30	51.6	47.3	10	149	0.07	2.75	0.0062	104,167	642	1.95	5.37	119	
5/10	49.6	46.5	10	149	0.07	2.82	0.0066	104,042	690	2.25	6.36	109	
5/20	54.1	50.1	10	163	0.07	2.89	0.0072	103,917	745	1.65	4.77	156	
5/30	49.6	46.8	10	164	0.08	2.97	0.0077	103,792	804	2.25	6.69	120	
6/9	54.1	49.8	10	163	0.07	3.04	0.0083	103,667	865	1.65	5.02	172	
6/19	53.5	48.9	10	173	0.08	3.12	0.0090	103,543	933	1.71	5.34	175	
6/29	58.2	54.4	10	196	0.09	3.21	0.0098	103,419	1,014	1.30	4.16	244	
7/9	62.2	59.3	10	248	0.11	3.33	0.0109	103,295	1,124	1.08	3.60	313	
7/19	68.0	63.8	10	295	0.13	3.46	0.0123	103,171	1,265	0.85	2.94	431	
7/29	68.6	65.2	10	325	0.15	3.61	0.0139	103,047	1,433	0.82	2.97	482	
8/8	68.6	63.9	10	325	0.15	3.76	0.0157	102,923	1,616	0.82	3.10	522	
8/18	66.0	60.8	10	303	0.14	3.90	0.0175	102,800	1,799	0.93	3.62	497	
8/28	69.2	63.3	10	300	0.14	4.03	0.0194	102,676	1,994	0.80	3.22	620	
9/7	71.6	67.3	10	333	0.15	4.19	0.0217	102,553	2,226	0.68	2.83	786	<MAX.
9/17	68.0	63.7	10	335	0.15	4.34	0.0242	102,430	2,476	0.85	3.68	673	
9/27	59.7	55.2	10	274	0.13	4.46	0.0263	102,307	2,694	1.21	5.40	499	
10/7	56.0	51.7	10	215	0.10	4.56	0.0281	102,184	2,872	1.46	6.68	430	
10/17	44.9	43.0	10	153	0.07	4.63	0.0294	102,062	3,003	3.25	15.04	200	
10/27	51.0	47.3	10	132	0.06	4.69	0.0306	101,939	3,117	2.03	9.54	327	
11/6	45.2	42.9	10	131	0.06	4.75	0.0318	101,817	3,234	3.18	15.11	214	
11/16	49.9	48.8	10	138	0.06	4.82	0.0330	101,695	3,361	2.21	10.63	316	
11/26	48.8	47.4	10	161	0.07	4.89	0.0346	101,573	3,513	2.40	11.73	299	
12/6	44.3	43.4	10	134	0.06	4.95	0.0359	101,451	3,642	3.39	16.81	217	
12/16	45.2	43.3	10	113	0.05	5.00	0.0370	101,329	3,753	3.18	15.90	236	
12/26	40.1	39.8	10	96	0.04	5.05	0.0380	101,208	3,848	4.73	23.88	161	
1/5	44.3	43.2	10	95	0.04	5.09	0.0390	101,086	3,944	3.39	17.28	228	
1/15	48.2	46.6	10	129	0.06	5.15	0.0404	100,965	4,077	2.51	12.90	316	
1/25	42.4	40.0	10	113	0.05	5.20	0.0416	100,844	4,196	3.96	20.62	204	
2/4	46.8	43.3	10	97	0.04	5.24	0.0427	100,723	4,299	2.79	14.62	294	
2/14	46.2	43.1	10	112	0.05	5.30	0.0439	100,602	4,421	2.93	15.50	285	
2/24	45.6	42.9	10	110	0.05	5.35	0.0452	100,481	4,543	3.08	16.44	276	
3/6	44.9	42.8	10	109	0.05	5.40	0.0465	100,361	4,665	3.23	17.43	268	
3/16	44.3	42.6	10	107	0.05	5.44	0.0478	100,240	4,787	3.39	18.48	259	
3/26	42.6	41.7	10	101	0.05	5.49	0.0490	100,120	4,904	3.88	21.29	230	
4/5	43.2	42.6	8	81	0.04	5.53	0.0500	100,000	4,998	3.71	20.51	244	

Table B-4 Lostine
Flow Requirements for 100,000 Smolts Based on Conv=1.5
SGR = 1000

Date	Maximun Temp.	Average Temp	Days in Period	DfD	Gain in " Period @ 1367	Length in "	Weight each fish lbs	Fish Count 0.9988	Fish Weight lbs	SGR1000 FI @ Max.Temp	SGR1000 lbs/gpm	SGR1000 gpm	
4/10	43.0	40.0				2.62	0.0053	104,417	556	3.03	7.95	70	
4/20	45.0	40.5	10	83	0.06	2.68	0.0057	104,292	594	2.59	6.93	86	
4/30	45.3	41.2	10	88	0.06	2.75	0.0061	104,167	638	2.52	6.91	92	
5/10	45.7	41.9	10	95	0.07	2.81	0.0066	104,042	686	2.45	6.89	100	
5/20	46.0	42.5	10	102	0.07	2.89	0.0071	103,917	742	2.38	6.88	108	
5/30	46.4	43.2	10	109	0.08	2.97	0.0077	103,792	804	2.32	6.88	117	
6/9	46.7	43.9	10	116	0.08	3.05	0.0084	103,667	873	2.25	6.88	127	
6/19	47.1	44.6	10	122	0.09	3.14	0.0092	103,543	951	2.19	6.90	138	
6/29	47.4	45.3	10	129	0.09	3.24	0.0100	103,419	1,038	2.14	6.91	150	
7/9	47.8	45.9	10	136	0.10	3.34	0.0110	103,295	1,135	2.08	6.94	164	
7/19	51.7	49.1	10	155	0.11	3.45	0.0122	103,171	1,254	1.55	5.35	234	
7/29	58.2	54.3	10	197	0.14	3.59	0.0137	103,047	1,416	1.03	3.72	381	
8/8	58.9	53.8	10	221	0.16	3.76	0.0157	102,923	1,614	1.00	3.75	431	
8/18	65.3	52.2	10	210	0.15	3.91	0.0177	102,800	1,818	0.76	2.97	611	
8/28	59.8	54.1	10	212	0.15	4.06	0.0199	102,676	2,040	0.96	3.89	524	
9/7	61.2	54.1	10	221	0.16	4.23	0.0223	102,553	2,291	0.90	3.80	603	
9/17	61.2	52.7	10	214	0.16	4.38	0.0249	102,430	2,551	0.90	3.94	648	<MAX
9/27	52.2	47.5	10	181	0.13	4.51	0.0272	102,307	2,786	1.49	6.73	414	
10/7	55.0	49.1	10	163	0.12	4.63	0.0295	102,184	3,009	1.24	5.74	524	
10/17	43.6	40.4	10	128	0.09	4.73	0.0313	102,062	3,191	2.89	13.68	233	
10/27	43.3	39.9	10	82	0.06	4.79	0.0325	101,939	3,310	2.97	14.22	233	
11/6	42.9	39.5	10	77	0.06	4.84	0.0336	101,817	3,423	3.05	14.76	232	
11/16	42.6	39.0	10	72	0.05	4.90	0.0347	101,695	3,533	3.13	15.32	231	
11/26	42.3	38.5	10	68	0.05	4.95	0.0358	101,573	3,636	3.21	15.88	229	
12/6	42.0	38.1	10	63	0.05	4.99	0.0368	101,451	3,734	3.29	16.44	227	
12/16	41.6	37.6	10	58	0.04	5.03	0.0378	101,329	3,826	3.38	17.02	225	
12/26	41.3	37.1	10	54	0.04	5.07	0.0387	101,208	3,912	3.47	17.60	222	
1/5	41.0	36.7	10	49	0.04	5.11	0.0395	101,086	3,990	3.56	18.18	219	
1/15	41.0	36.8	10	48	0.03	5.14	0.0403	100,965	4,068	3.56	18.31	222	
1/25	41.0	37.0	10	49	0.04	5.18	0.0411	100,844	4,148	3.56	18.43	225	
2/4	41.0	37.2	10	51	0.04	5.22	0.0420	100,723	4,233	3.56	18.57	228	
2/14	41.0	37.3	10	53	0.04	5.26	0.0430	100,602	4,322	3.56	18.70	231	
2/24	44.0	38.3	10	58	0.04	5.30	0.0440	100,481	4,423	2.80	14.84	298	
3/6	45.0	40.2	10	73	0.05	5.35	0.0454	100,361	4,552	2.59	13.84	329	
3/16	45.0	40.8	10	85	0.06	5.41	0.0470	100,240	4,707	2.59	14.00	336	
3/26	44.0	39.5	10	82	0.06	5.47	0.0485	100,120	4,858	2.80	15.33	317	
4/5	47.0	43.2	8	75	0.05	5.53	0.0500	100,000	4,999	2.21	12.20	410	

Date	gpm Imnaha	gpm Lookingglass	gpm Lostine
4/10	85	61	70
4/20	112	81	86
4/30	119	67	92
5/10	109	129	100
5/20	156	157	108
5/30	120	226	117
6/9	172	233	127
6/19	175	331	138
6/29	244	360	150
7/9	313	423	164
7/19	431	478	234
7/29	482	498	381
8/8	522	516	431
8/18	497	512	611
8/28	620	524	524
9/7	786	485	603
9/17	673	433	648
9/27	499	398	414
10/7	430	311	524
10/17	200	298	233
10/27	327	284	233
11/6	214	196	232
11/16	316	200	231
11/26	299	202	229
12/6	217	175	227
12/16	236	177	225
12/26	161	154	222
1/5	228	196	219
1/15	316	184	222
1/25	204	186	225
2/4	294	203	228
2/14	285	206	231
2/24	276	264	298
3/6	268	290	329
3/16	259	296	336
3/26	230	279	317
4/5	244	359	410



Site			Imnaha	Lostine
Elevation	Ft	Given	1,600	3,700
Species		Given	Spring Chinook.	Spring Chinook.
Production number	no.	Given	490,000	250,000
Size at release	no./lb	Given	20	20
Length at release	inches	Calc.	5.53	5.53
Weight at release	lbs	Calc.	24,500	12,500
Date at release		Given	4/6/02	4/6/02
Date of raceway stocking		Given	4/14/01	4/14/01
Size at raceway stocking	no./lb	Given	200	200
Size at raceway stocking	inches	Calc.	2.62	2.62
Survival-RW stocking to release	%	Given	96%	96%
Number at raceway stocking		Calc.	510,417	260,417
Weight at raceway stocking	lbs	Calc.	2,552	1,302
Date of starting trough stocking		Given	12/26/00	12/26/00
Size at starting trough stocking	no./lb	Given	1200	1200
Size at starting trough stocking	inches	Calc.	1.41	1.41
Survival-St.trough to raceway		Given	95%	95%
Number at starting trough stocking		Calc.	537,281	274,123
Weight at starting trough stocking	lbs	Calc.	448	228
Date of Egg Take (average)		Given	8/18/00	8/18/00
Survival-Egg take to st.trough	%	Given	88%	88%
Number of green eggs		Calc.	610,546	311,503
Date of start of adult holding			7/1/00	7/1/00
Date of end of adult holding			9/15/00	9/15/00
Female adult fecundity (net)	eggs/F.	Given	4,400	4,400
Female spawners required		Calc.	139	71
Male/female ratio		Given	1.00	1.00
Survival-Adults in holding	%	Given	95%	95%
Adult capture		Calc.	293	150
PROPAGATION UNIT REQUIREMENTS				
Adult Holding Ponds				
Holding Volume/adult	CF/adult	Given	8	8
Holding Volume-Total	CF	Calc.	2,344	1,200
Critical Adult Holding Temp	°F	Assumed	71.6	65.3
Flow requirement	gpm/adult	Given	2.1	1.8
Flow requirement	gpm	Calc.	609	265
Detention time	minutes	Calc.	29	34
Redundancy in Holding units	ea.	Given	1	1
Required Number of Holding Units	ea.	T&E	4	4
Required Holding Volume each unit	CF	Calc.	781	400
Required Flow each	gpm/ea	Calc.	203	88

Required Flow Total	gpm	Calc.	813	353
			Imnaha	Lostine
Incubator Stacks				
Incubator trays required/female	ea.	Given	1.0	1.0
Usable incubators/stack	ea.	Given	7.0	7.0
Stack use efficiency	%	Table 10, p.48	77%	71%
Required Number of stacks	ea.	Calc.	26	15
Required Flow	gpm/stack	Given	5.0	5.0
Required Flow Total	gpm	Calc.	130	75
Starting Trough Volume-Normal Density				
Density Index		Given	1.00	1.00
Density at end of cycle	lbs/CF	Calc.	2.62	2.62
Required Volume at end of cycle	CF	Calc.	974	497
Volume per starting trough	CF	Given	63	44
Required starting troughs	CF	Calc.	16	12
Starting Trough Volume-Nature Density				
Density Index		Given	0.30	0.30
Density at end of cycle	lbs/CF	Calc.	0.79	0.79
Required Volume at end of cycle	CF	Calc.	3,247	1,657
Volume per starting trough	CF	Given	104	70
Required starting troughs	CF	Calc.	32	24
Raceway Volume-Normal Density				
Density Index		Given	0.17	0.17
Density at end of cycle	lbs/CF	Calc.	0.94	0.94
Required Volume at end of cycle	CF	Calc.	26,073	13,302
Volume per raceway	CF	Given	2,250	1,800
Required raceways	CF	Calc.	12	8
Raceway Volume-Natural Density				
Density Index		Given	0.10	0.10
Density at end of cycle	lbs/CF	Calc.	0.55	0.55
Required Volume at end of cycle	CF	Calc.	44,323	22,614
Volume per raceway	CF	Given	2,800	2,000
Required raceways	CF	Calc.	16	12
Starting Trough Flows				
Maximum Required Flow/100,000 smolts	gpm	Estimated	85	70
Maximum Required Flow	gpm	Calculated	417	175
Detention Time-Normal Density	minutes	Calculated	17	21
Detention Time-Natural Density	minutes	Calculated	58	71
Raceway Flows				
Maximum Required Flow/100,000 smolts	gpm	Estimated	786	648
Maximum Required Flow	gpm	Calculated	3,851	1,620
Detention Time-Normal Density	minutes	Calculated	51	61
Detention Time-Natural Density	minutes	Calculated	86	104

Table B-7 Imnaha/Lostine Flow Cycles

Detail calculations								
Lostine Flows	Holding	Incubation	St.Trought	Raceways		Totals Min.Ozone	Totals Max.Ozone	Totals Total Flow
1/1/00			175	1,620		175	1,795	1,795
1/15/00			175	1,620		175	1,795	1,795
1/29/00			175	1,620		175	1,795	1,795
2/12/00			175	1,620		175	1,795	1,795
2/26/00			175	1,620		175	1,795	1,795
3/11/00			175	1,620		175	1,795	1,795
3/25/00			175	1,620		175	1,795	1,795
4/8/00			175	1,620		175	1,795	1,795
4/22/00				1,620		-	1,620	1,620
5/6/00				1,620		-	1,620	1,620
5/20/00				1,620		-	1,620	1,620
6/3/00				1,620		-	1,620	1,620
6/17/00				1,620		-	1,620	1,620
7/1/00	397			1,620		-	1,620	2,017
7/15/00	397			1,620		-	1,620	2,017
7/29/00	397			1,620		-	1,620	2,017
8/12/00	397	75		1,620		75	1,695	2,092
8/26/00	397	75		1,620		75	1,695	2,092
9/9/00	397	75		1,620		75	1,695	2,092
9/23/00	397	75		1,620		75	1,695	2,092
10/7/00		75		1,620		75	1,695	1,695
10/21/00		75		1,620		75	1,695	1,695
11/4/00		75		1,620		75	1,695	1,695
11/18/00		75		1,620		75	1,695	1,695
12/2/00		75		1,620		75	1,695	1,695
12/16/00		75	175	1,620		250	1,870	1,870
12/30/00		75	175	1,620		250	1,870	1,870
						250	1,870	2,092
Imnaha	Holding	Incubation	St.Trought	Raceways		Totals Min.Ozone	Totals Max.Ozone	Totals Total Flow
1/1/00			130	3,851		130	3,981	3,981
1/15/00			130	3,851		130	3,981	3,981
1/29/00			130	3,851		130	3,981	3,981
2/12/00			130	3,851		130	3,981	3,981
2/26/00			130	3,851		130	3,981	3,981
3/11/00			130	3,851		130	3,981	3,981
3/25/00			130	3,851		130	3,981	3,981
4/8/00			-	3,851		-	3,851	3,851
4/22/00				3,851		-	3,851	3,851
5/6/00				3,851		-	3,851	3,851
5/20/00				3,851		-	3,851	3,851
6/3/00				3,851		-	3,851	3,851
6/17/00				3,851		-	3,851	3,851
7/1/00	813			3,851		-	3,851	4,664
7/15/00	813			3,851		-	3,851	4,664
7/29/00	813			3,851		-	3,851	4,664
8/12/00	813	130		3,851		130	3,981	4,794
8/26/00	813	130		3,851		130	3,981	4,794
9/9/00	813	130		3,851		130	3,981	4,794
9/23/00	813	130		3,851		130	3,981	4,794
10/7/00		130		3,851		130	3,981	3,981
10/21/00		130		3,851		130	3,981	3,981
11/4/00		130		3,851		130	3,981	3,981
11/18/00		130		3,851		130	3,981	3,981
12/2/00		130		3,851		130	3,981	3,981
12/16/00		130	417	3,851		547	4,398	4,398
12/30/00		130	417	3,851		547	4,398	4,398
						547	4,398	4,794

Table B-8 Imnaha/Lostine
Summary Rearing and Holding

Facility		Imnaha	Lostine
FLOWS REQUIRED FOR SPECIFIC UNITS			
Incubators	gpm	130	75
Starting Troughs	gpm	417	175
Raceways	gpm	3,851	1,620
Holding Ponds	gpm	813	397
OVERALL FLOW REQUIREMENTS			
Facility Design Flow	gpm	5,000	2,250
Required Ozonation - Incubators and Starting Troughs	gpm	600	300
Required Ozonation - RW's, Incubators and Starting Tr.	gpm	4,400	2,000
REARING UNIT REQUIREMENTS-Normal Density			
Incubator Stacks	ea.	28	16
Starting Trough Volume ea.	CF	63	44
Starting Troughs	ea.	16	12
Raceway Volume ea.	CF	2,250	1,800
Raceways	ea.	12	8
Holding Pond Volume ea.	CF	750	400
Holding Ponds	ea.	4	4
Total Raceway and Holding Volume	CF	30,000	16,000
REARING UNIT REQUIREMENTS-Natural Density			
Incubator Stacks (7 Trays)	ea.	28	16
Starting Trough Volume ea.	CF	104	70
Starting Troughs	ea.	32	24
Raceway Volume ea.	CF	2,800	2,000
Raceways	ea.	16	12
Holding Pond Volume ea.	CF	750	400
Holding Ponds	ea.	4	4
Total Raceway and Holding Volume	CF	47,800	25,600

REARING VOLUME CALCULATION									
	Raceway	Rearing P.	Capy Ratio	Adjusted Rearing					
Facility	Volume-CF	Volume-CF	Pond/RW	Volume-CF					
Mossyrock	19,844			19,844					
Bayfield	33,000			33,000					
Columbia Basin	40,600			40,600					
Merwin/wo Ozone	20,828	183,200	12%	42,812					
Methow	38,400	73,750	17%	50,692					
Humptulips	76,800	153,600	17%	102,400					
Makah	110,000			110,000					
NY Salmon	110,000			110,000					
Soleduck	87,000	154,600	17%	112,767					
Warm Springs, O	116,000			116,000					
Platte	205,000			205,000					
Rathbun	210,000			210,000					
Cowlitz Trout	142,686	2,700,000	8%	358,686					
Cowlitz Salmon	645,760			645,760					
REARING VOLUME vs CAPITAL COSTS		Computed	Trended						
	Adjusted	Capital Costs	Capital Costs						
	Rearing	Year 2000	Year 2000						
	Volume-CF	ENR=6000	ENR=6000	-50%	+50%				
Mossyrock	19,844	$ 2,896,552	$ 3,634,602	$ 1,817,301	$ 5,451,903				
Bayfield	33,000	$ 8,068,966	$ 5,295,556	$ 2,647,778	$ 7,943,334				
Columbia Basin	40,600	$ 3,662,069	$ 6,173,344	$ 3,086,672	$ 9,260,017				
Merwin w/o Ozone	42,812	$ 8,170,568	$ 6,420,513	$ 3,210,256	$ 9,630,769				
Methow	50,692	$ 9,226,806	$ 7,275,524	$ 3,637,762	$ 10,913,287				
Humptulips	102,400	$ 7,551,724	$ 12,241,460	$ 6,120,730	$ 18,362,190				
Makah	110,000	$ 20,275,862	$ 12,907,491	$ 6,453,745	$ 19,361,236				
NY Salmon	110,000	$ 21,517,241	$ 12,907,491	$ 6,453,745	$ 19,361,236				
Soleduck	112,767	$ 6,827,586	$ 13,146,949	$ 6,573,475	$ 19,720,424				
Warm Springs, O	116,000	$ 17,379,310	$ 13,424,872	$ 6,712,436	$ 20,137,308				
Platte	205,000	$ 26,068,966	$ 20,460,163	$ 10,230,082	$ 30,690,245				
Rathbun	210,000	$ 16,551,724	$ 20,828,285	$ 10,414,143	$ 31,242,428				
Cowlitz Trout w/o Ozone	358,686	$ 23,586,207	$ 30,952,798	$ 15,476,399	$ 46,429,197				
Cowlitz Salmon	645,760	$ 53,937,931	$ 47,825,981	$ 23,912,990	$ 71,738,971				
HATCHERIES WITH OZONE SYSTEMS									
Merwin with Ozone	42,812	$ 10,321,350	3,000	gpm of 5,000 gpm flow is treated					
Cowlitz Trout with Ozone	358,686	$ 26,666,207	9,000	gpm of 20,000 gpm flow is treated					

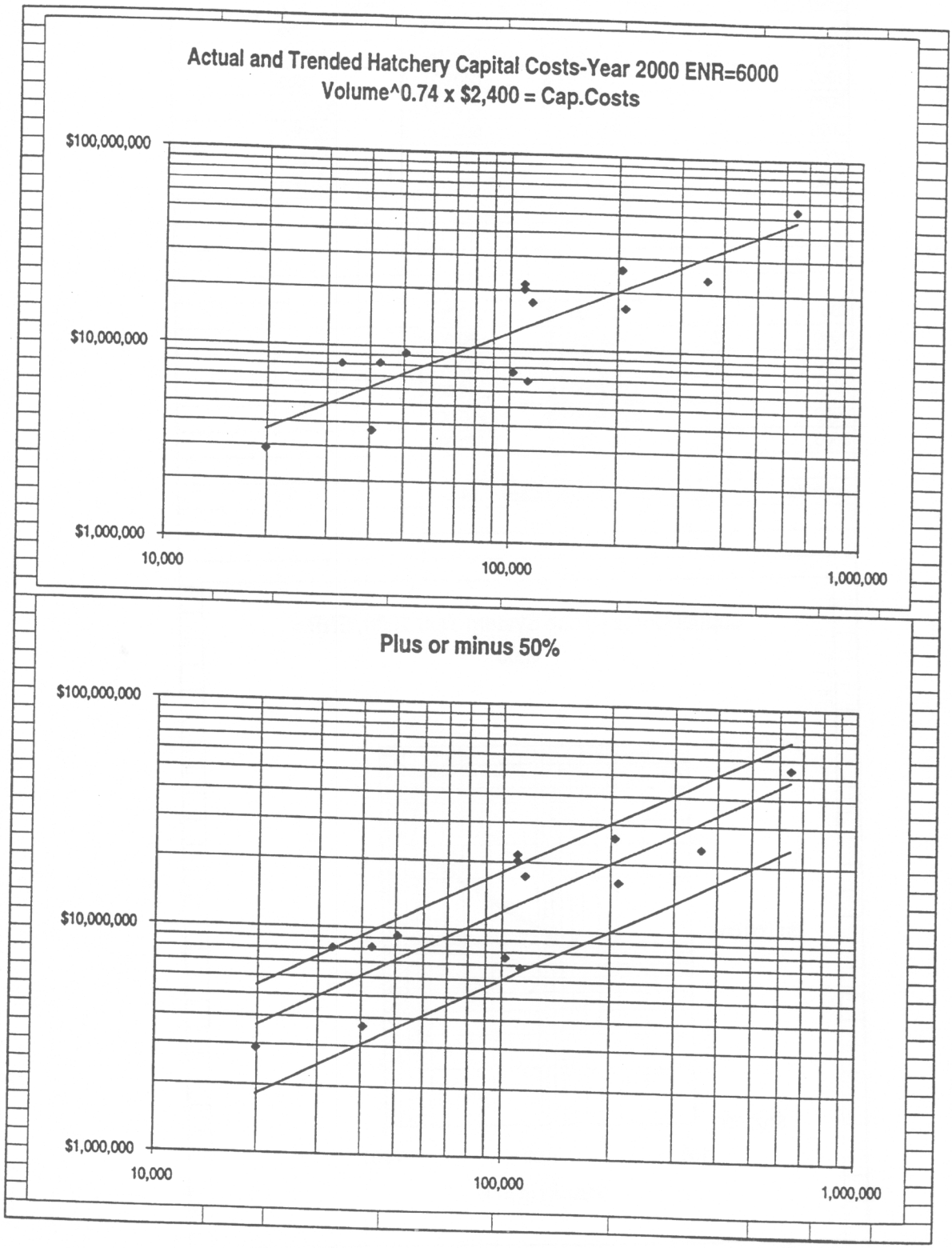

Actual and Trended Hatchery Capital Costs-Year 2000 ENR=6000
Volume^0.74 x $2,400 = Cap.Costs
$100,000,000
$10,000,000
$1,000,000
10,000
100,000
1,000,000
Plus or minus 50%
$100,000,000
$10,000,000
$1,000,000
10,000
100,000
1,000,000

Table B-10 Ozone System Capital Costs Curve

Capy-GPM	Con.C.w/Contr.OH&P	w/Design Contenge	Cap.C.w/engr &OH
		20%	25%
500	$ 500,000	$ 600,000	$ 750,000
1000	$ 700,000	$ 840,000	$ 1,050,000
2000	$ 1,000,000	$ 1,200,000	$ 1,500,000
3000	$ 1,300,000	$ 1,560,000	$ 1,950,000
4000	$ 1,500,000	$ 1,800,000	$ 2,250,000
5000	$ 1,700,000	$ 2,040,000	$ 2,550,000
	Estimate	Trend	
500	$ 750,000	$ 740,000	
1000	$ 1,050,000	$ 1,060,000	
2000	$ 1,500,000	$ 1,550,000	
3000	$ 1,950,000	$ 1,930,000	
4000	$ 2,250,000	$ 2,250,000	
5000	$ 2,550,000	$ 2,530,000	
Formula	**Capital Cost = $26,562 x Capy ^ .54**		

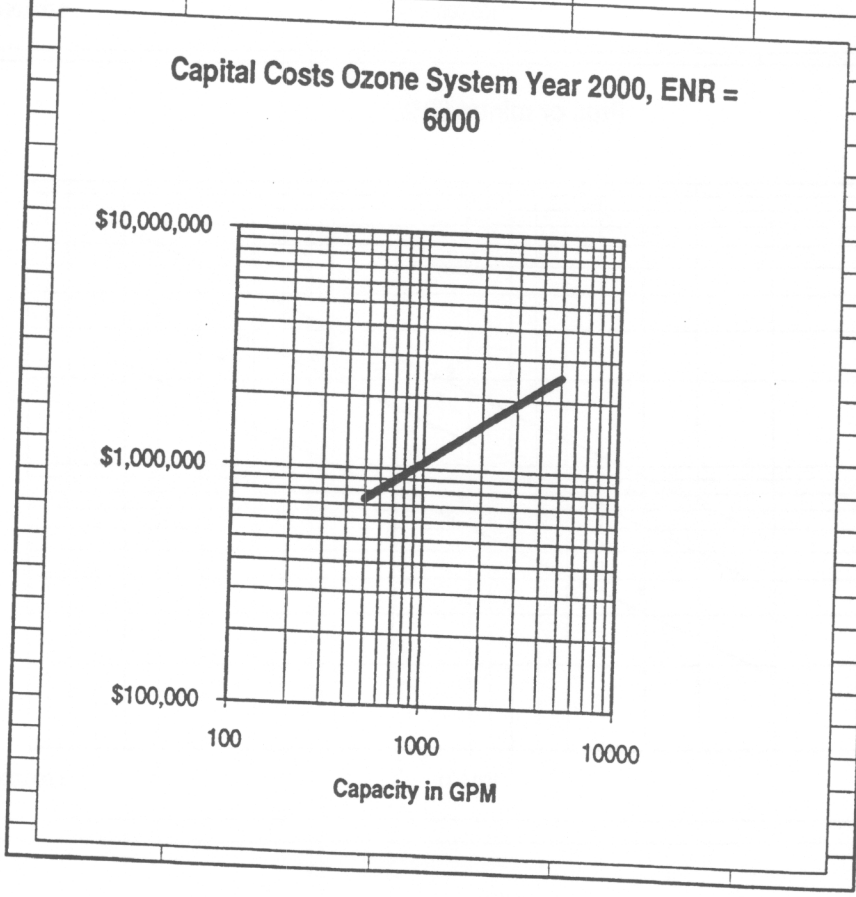


Table B-11 Imnaha/Lostine
Cost of Alternatives

	Imnaha	Lostine
Hatchery Capital Costs Based on Rearing Volume		
Normal Density-Total Raceway and Holding Volume-CF	30,000	16,000
Related Capital Costs	$ 4,934,930	$ 3,099,274
NATURE Density-Total Raceway and Holding Volume-CF	47,800	25,600
Base Value	$ 6,966,071	$ 4,388,426
Deduction for NATURE	$ 348,304	$ 219,421
Related Capital Costs	$ 6,617,767	$ 4,169,005
Ozonation Costs Based on Design Flow in GPM		
Required Ozonation - Incubators and Starting Troughs-GPM	600	300
Related Capital Costs	$ 840,354	$ 577,971
Required Ozonation - RW's, Incubators and Starting Tr.-GPM	4,400	2,000
Related Capital Costs	$ 2,464,480	$ 1,609,967
Total Costs Based on Hatchery and Ozone Costs	Imnaha	Lostine
Normal Density/Minimal Ozone	$ 5,770,000	$ 3,670,000
Normal Density/Maximum Ozone	$ 7,390,000	$ 4,700,000
NATURE Density/Minimal Ozone	$ 7,450,000	$ 4,740,000
NATURE Density/Maximum Ozone	$ 9,080,000	$ 5,770,000
Total Costs based on an Extrapolation of the Merwin Hatchery with Ozone		
Escalated Cost of Merwin	$ 10,321,350	$ 10,321,350
Volume of Merwin in CF	42,812	42,812
Volume of this Facility (Normal Density)	30,000	16,000
Escalator Factor (based on 74% exponent)	77%	48%
Extrapolated Cap. Cost - Normal Density/Maximum Ozone	$ 7,933,188	$ 4,982,265
Comparison of two estimates	93%	94%

Facility		Imnaha	Lostine
FLOWS REQUIRED FOR SPECIFIC UNITS			
Incubators	gpm	130	75
Starting Troughs	gpm	417	175
Raceways	gpm	3,851	1,620
Holding Ponds	gpm	813	397
OVERALL FLOW REQUIREMENTS			
Facility Design Flow	gpm	5,000	2,250
Required Ozonation - Incubators and Starting Troughs	gpm	600	300
Required Ozonation - RW's, Incubators and Starting Tr.	gpm	4,400	2,000
REARING UNIT REQUIREMENTS-Conventional Density			
Incubator Stacks (7 Trays)	ea.	28	16
Starting Trough Volume ea.	CF	63	44
Starting Troughs	ea.	16	12
Starting Troughs-width	ft	2.67	2.67
Starting Troughs-depth	ft	1.50	1.42
Starting Troughs-length	ft	16.00	12.00
Raceway Volume ea.	CF	2,250	1,800
Raceways	ea.	12	8
Rectangular Raceway-width	ft	10.00	10.00
Rectangular Raceway-depth	ft	2.33	2.33
Rectangular Raceway-length	ft	100.00	80.00
Circular Raceway-depth	ft	2.25	2.25
Circular Raceway-diameter	ft	36.00	32.00
Holding Pond Volume ea.	CF	750	400
Holding Ponds	ea.	4	4
Rectangular Holding Pond-width	ft	8.00	8.00
Rectangular Holding Pond-depth	ft	3.00	3.00
Rectangular Holding Pond-length	ft	32.00	20.00
Circular Holding Pond-depth	ft	2.75	2.75
Circular Holding Pond-diameter	ft	20.00	14.00
REARING UNIT REQUIREMENTS-"NATUREs" Density			
Incubator Stacks (7 Trays)	ea.	28	16
Starting Trough Volume ea.	CF	104	70
Starting Troughs	ea.	32	24
Starting Troughs-width	ft	2.67	2.67
Starting Troughs-depth	ft	2.00	1.67
Starting Troughs-length	ft	20.00	16.00
Raceway Volume ea.	CF	2,800	2,000
Raceways	ea.	16	12
Rectangular Raceway-width	ft	12.00	12.00
Rectangular Raceway-depth	ft	2.42	2.42
Rectangular Raceway-length	ft	100.00	72.00
Circular Raceway-depth	ft	2.25	2.25
Circular Raceway-diameter	ft	40.00	34.00
Holding Pond Volume ea.	CF	750	400
Holding Ponds	ea.	4	4
Rectangular Holding Pond-width	ft	8.00	8.00
Rectangular Holding Pond-depth	ft	3.00	3.00
Rectangular Holding Pond-length	ft	32.00	20.00
Circular Holding Pond-depth	ft	2.75	2.75
Circular Holding Pond-diameter	ft	20.00	14.00