

## MEMORANDUM

December 15, 2003

TO: Kari Dreher  
FROM: Cindy Yenter  
CC: Brian Patton, Jennifer Berkey, Tim Luke  
RE: Water Right Review and Sufficiency of Measuring Devices, Rangen Aquaculture

### Water Rights Review

Rangen, Inc. holds three water rights for fish propagation use at the hatchery and research facility on Billingsley Creek. They are as follows:

36-15501	7/01/1957	1.46 cfs
36-2551	7/13/1962	48.54 cfs (includes 0.1 cfs for domestic use)
36-7694	4/12/1977	<u>26.00 cfs</u>
Total authorized diversion		76.00 cfs

Additionally, Rangen, Inc. holds two earlier water rights for irrigation and domestic uses:

36-134B	10/09/1884	0.09 cfs
36-135A	4/01/1908	<u>0.05 cfs</u>
Total authorized diversion	0.14 cfs	7 acres

According to historical flow data which Rangen submitted, flows at the head of Billingsley Creek have not been available to fully satisfy the most junior right, 36-7694, since October 1972<sup>1</sup>, a period predating the priority of the right. In fact, it is unclear whether diversion and beneficial use have ever actually occurred under right no. 36-7694. Reported average monthly flows during the development period of the water right permit, April 1977 through 1979, never exceeded 50 cfs, the amount of the two earlier rights. The licensing examination from 1979 appears to base the recommendation for an additional 26 cfs diversion rate, on average estimated spring flows of 76 cfs which occurred in October 1972, *five years prior to the filing of the permit*. Even though there may have been some historical basis for the issuance of this license, there is no actual beneficial use documented.

The last year in which flows may have been available to satisfy right no. 36-2551 was during November 1986, when average available flows at the head of Billingsley Creek were estimated

<sup>1</sup> See Rangen's table entitled "Rangen Research Hatchery, total flow measurements". Per Jennifer Berkey's 12-04-03 Memo, most of the Rangen reported diversions reflect total available flows from the source, rather than actual hatchery diversions.

→ or refer to table entitled "Head of Billingsley Creek at Currey Tunnel"

52 cfs Oct 87 also  
42 cfs  
10 cfs

to be above 50 cfs<sup>2</sup>. However, a breakdown of submitted data indicates that Rangen had only diverted a maximum of 40 cfs to hatchery raceways during that same month<sup>3</sup>. It is not clear where the balance of the flows were used. A portion may have been diverted for late-season irrigation under the Musser and Candy rights (at the tunnel pipelines), although an average of greater than 12 cfs was measured over the creek weir during that month. This may indicate a significant bypass of flows around the hatchery.

The largest beneficial-use diversion indicated in post-1981 data occurred during November 1983, when nearly 48 cfs was measured at the large raceways. Prior to 1981, submitted data cannot be parsed to individual measurements, but the estimated total flows in Billingsley Creek exceeded 50 cfs during November in every year from 1966 to 1976, indicating that flows were available at least part of those years, to satisfy right nos. 36-15501 and 36-2551.

Because of a lack of documentation to support historical use of right no. 36-7694, any indication of injury at Rangen should be limited to the documented reduction of available flows to satisfy right no. 36-2551.

**Sufficiency of Measuring Devices**

1. 6" PVC Pipeline from Curren Tunnel

This pipeline has no measuring device. It may be used to divert an unspecified portion of the Rangen fish propagation rights to the hatch house and research lab, and is the sole conveyance for domestic water to the lab, shop, office, and manager's house, as well as irrigation water for 3 to 5 acres of landscaping. Instantaneous flow through the hatch house incubation and rearing tanks may be estimated by determining the number of tanks in operation and applying pre-determined flows per unit, as shown on the attached worksheet. The unit flows were calculated by previous Rangen facility managers, using timed fill tests. All hatch house flows are returned to the Billingsley Creek channel, above the diversion to the lower raceways, and are measured again at the raceways.

Diversions for domestic and irrigation uses are not measured. The hatch house worksheet uses a constant 20 gpm for domestic (including irrigation) uses. This is likely on the high side for winter diversions, and too low for summer when irrigation is occurring. Authorized diversion rate for these uses is 0.14 cfs, from right nos. 36-134B and 36-135A, plus 0.1 cfs as a non-additive element of right no. 36-2551. This is a comparatively small portion of Rangen's total diversions, nevertheless, it is the only consumptive portion.

In July 2001, Tim Luke conducted a measurement certification on the 6" pipeline using a polysonic meter. Concurrently, the hatchery manager estimated flow through the pipeline using the worksheet. On that date, indicated pipeline flow was 18% higher than the standard meter.

<sup>2</sup>See Rangen's table entitled "Rangen Research Hatchery, total flow measurements". Per Jennifer Berkey's 12-04-03 Memo, most of the Rangen reported diversions reflect total available flows from the source, rather than actual hatchery diversions.

<sup>3</sup> See Jennifer Berkey's Excel spreadsheet entitled "~~Rangen Data Max~~", which provides a breakdown of Rangen reported data by point of measurement. Measurements taken in the Large Raceways are most representative of total hatchery diversions.

refer to attachments to 12/11 memo

In March 2002, I conducted the same test, again working with the hatchery manager. On that date, indicated pipeline flow was 9% lower than the standard meter.

There seems to be a great deal of variability in pipeline estimations. Because the majority of the flow returns to the creek to be reused and re-measured, this is probably not of great concern. However, the magnitude of diversions to domestic and irrigation uses is still unknown.

## 2. Rangen Hatchery Raceways

Raceway flows are measured by Rangen personnel over dam boards in the two lowest blocks of raceways ("large" raceways and "CTR" raceways - see facility diagram submitted by Rangen). The CTR raceways are situated downstream from the large raceways. Each block of raceways contains three sets of check dams; heads are collected at the uppermost set of checks in each block. A measurement is also taken over a check dam in the Billingsley Creek channel.

At the time of our visit, Mr. Wayne Courtney (Rangen Inc) indicated that measurements are taken weekly in both the large and the CTR raceways, and the two results averaged for a final flow. Presently, all flows from the large raceways are being sent to the CTR raceways, so these measurements should cross-check.

On the day of our investigation, Brian Patton and I took measurements at both the large and CTR raceways. Width of the individual raceway openings, and thus crest length, varied slightly from raceway to raceway. Most checks were not entirely level. We took crest width measurements at each opening, and, using a standard hand-held 3-foot staff gage, took the average of three head readings across each check. Applying the Francis formula for rectangular suppressed weirs, Brian Patton calculated a flow of 18.49 cfs in the large raceways and 18.21 cfs in the CTR raceways. These measurements are representative of the total diverted flow through the facility. We also measured 0.48 cfs over the dam in the creek, using the same techniques. This measurement is representative of the unappropriated flows which bypass all or part of the facility.

There were no hatchery personnel present during our investigation to confirm ~~the~~ either the measurement points or the measurement methods. I made a call to the hatchery and spoke with Lonnie Tate, who confirmed that all measurements are made at the first set of checks in each block. Mr. Tate indicated that heads were read at the middle of the crest, with a 2" wide metal ruler rather than a standard staff gage. Measurements taken by hatchery personnel on November 24, the day before our visit, indicated flows of 16.6 cfs in the large raceways and 15.9 cfs in the CTR raceways. These flows are as related to me by Mr. Tate, and are not documented. They are 10% to 12% lower than the flows we measured the next day. The chances of actual inflows changing 2 cfs over a 24-hour period is possible but not probable. Mr. Tate confirmed that no operational changes were made within the hatchery during that period. Mr. Tate also confirms that Rangen is still using some form of averaging between the large and CTR raceways and the creek dam flow, to derive flows for reporting purposes.

Brian Patton applied the Francis formula individually to each set of data we collected, but Rangen uses weir discharge tables calculated with fixed 44 inch (for large raceway) or 58 inch (for CTR raceway) openings. In the large raceway measurement section, crest lengths ranged from 43.44 to 44.04 inches. In the CTR block, crest lengths ranged from 58.32 inches to 58.8 inches. To test the sufficiency of the fixed-length discharge tables, I applied our head measurements to the Rangen tables, and calculated total flows of at 18.55 cfs for the large

raceways and 18.03 for CTR raceways, a difference of less than 1% in each case, from the flows derived from the sum of independent equations.

Rangen's measurement methodology also passes a sufficiency test, as the 10% difference in measurements found is not greater than the range of accuracy expected for open-channel measurements under these conditions. The most likely cause of the discrepancy between our measurement and the hatchery's measurement is error due to the use of a metal ruler to measure head. Without actually observing the hatchery staff's measurement techniques, I suspect that the head readings taken are probably more indicative of crest drawdown rather than actual head over the check. This would result in a lower head reading and a lower total flow.

It seems reasonable to conclude that, while Rangen's measuring techniques for the hatchery raceways may not be absolutely correct, they are fairly consistent, and are resulting in reported measurements which are no more than about 10% lower than actual flows. However, the reported measurements continue to be measurements of available flow, which usually includes at least some bypass flow, and not actual diverted flow.

To: Tim Luke  
Cc: Cindy Yenter, Brian Patton  
From: Jennifer Berkey *JB*  
Date: December 4, 2003  
Re: Review of Rangen Hatchery data

As you requested, I have reviewed the data submitted for the Rangen Research Hatchery (Rangen) by May, Sudweeks & Browning, LLP (May), via correspondence dated November 21, 2003. The submittal includes the following:

1. A table of monthly average flow measurements from 1966 to 2003, which is titled "Rangen Research Hatchery, total flow measurements"
2. A chart of yearly average flow from 1966 to 1991, titled "Water Flow Measurements, Head of Billingsley Creek"
3. A table of monthly average flow from 1966 to 1991, titled "Head of Billingsley Creek at Curran Tunnel"
4. Copies of handwritten records of weekly flow measurements recorded between 1966 and 2003
5. A sketch of the hatchery facilities

Rangen has also reported weekly diversion data to IDWR on an annual basis for the years of 1995 through 2002. These data have been entered into the IDWR database SW36DATA.mdb. Data are reported for two diversions, which are denoted as 410089 "Rangen Hatchery/Billingsley Ck Head", and 410041 "Rangen Pipe from Curran Tunnel". As part of this review I have compared these data to the recent submittal.

The handwritten weekly flow records indicate that Rangen measures flow at the following three locations, which are shown on the sketch included in the submittal. Measurement methods are not documented.

- A. Large raceways
- B. CTR raceways
- C. Dam on Billingsley Creek

Based on the sketch and discussions with Cindy Yenter and Brian Patton, who recently conducted a detailed site visit, the measurements collected at the dam on Billingsley Creek could potentially include bypass flows not diverted by Rangen, spring inflow downstream of Rangen's lower diversion, irrigation return flows, and discharge from the raceways when they are drained for maintenance. According to Brian Patton, most of the flow at the dam in Billingsley Creek during the November 25, 2003 site visit was the result of spring inflow downstream of Rangen's lower diversion. Leakage around the check structure at Rangen's lower diversion and leakage from the raceway drainage pipes contributed a very small amount to the flow in the creek.

Comparison of the handwritten records with the data in SWDATA.mdb, indicates that the diversion data submitted by Rangen for diversion 410089 is the sum of the CTR raceway

measurement and the measurement at the dam on Billingsley Creek. Therefore, these data appear to include water that was not diverted or put to beneficial use by Rangen.

Diversion 410041 is not addressed in the recent submittal. Based on discussion with Cindy Yenter, diversion 410041 includes water measured in the pipeline at the laboratory and an estimate of Rangen's irrigation water, which is diverted through the same pipeline, but rediverted before the point of measurement. Rangen's water rights authorized irrigation of 7 acres. Rangen has not included the data reported for 410041 in the monthly averages reported in the recent submittal because some of the water (the water used in the laboratory) flows into the lower raceways and is measured again at the large and CTR raceways. It should be noted that water used by Rangen for irrigation or domestic purposes is not included in the data recently submitted by May.

The table titled "Rangen Research Hatchery, total flow measurements" has a descriptive note indicating that the monthly average flows are also the sum of the CTR raceway measurement and the dam measurement. Review of the handwritten records indicates that this is true for the 1997 and 1999 through 2003 data. The data presented in this table for other years were calculated using other measurements, and include an estimate of water diverted from Curren Tunnel by irrigators. Documentation of the method used to estimate the irrigation diversions was not provided. Note that the data presented for 1966 through 1991 are identical to Rangen's total spring flow data presented in the table titled "Head of Billingsley Creek at Curren Tunnel. The following table summarizes my findings regarding the methods used to calculate the monthly average flows.

Year	Calculation of reported flow	Reported flow represents
1997 and 1999-2003	CTR + dam	Raceway use plus undiverted bypass flow in creek
1998	CTR + dam + "estimated farmers"	Estimate of total spring flow
11/1993-12/1996	(Large raceway + CTR + dam)/2 + "estimated farmers"	Estimate of total spring flow minus half of the undiverted bypass flow in creek
1/1992-12/1993	(Large raceway + CTR)/2 + "estimated farmers"	Estimate of total spring flow minus undiverted bypass flow in creek
1984-1991	(Large raceway + CTR)/2 + dam + "estimated farmers"	Estimate of total spring flow
1981-1983	(Large raceway + CTR)/2 + "fishout/creek" + "estimated farmers"	Estimate of total spring flow
1966-1980	Documentation is not sufficient to determine where measurements were made. Estimated irrigation use was added to the monthly average measurements.	Estimate of total spring flow

Comparison of the 1997 and 1999 through 2003 monthly average flow data with the monthly average flow data generated by SW36DATA.mdb shows that, although the same weekly flow measurements were used, the monthly averages are different. This is because Rangen calculated the monthly flow measurements by giving equal weight to

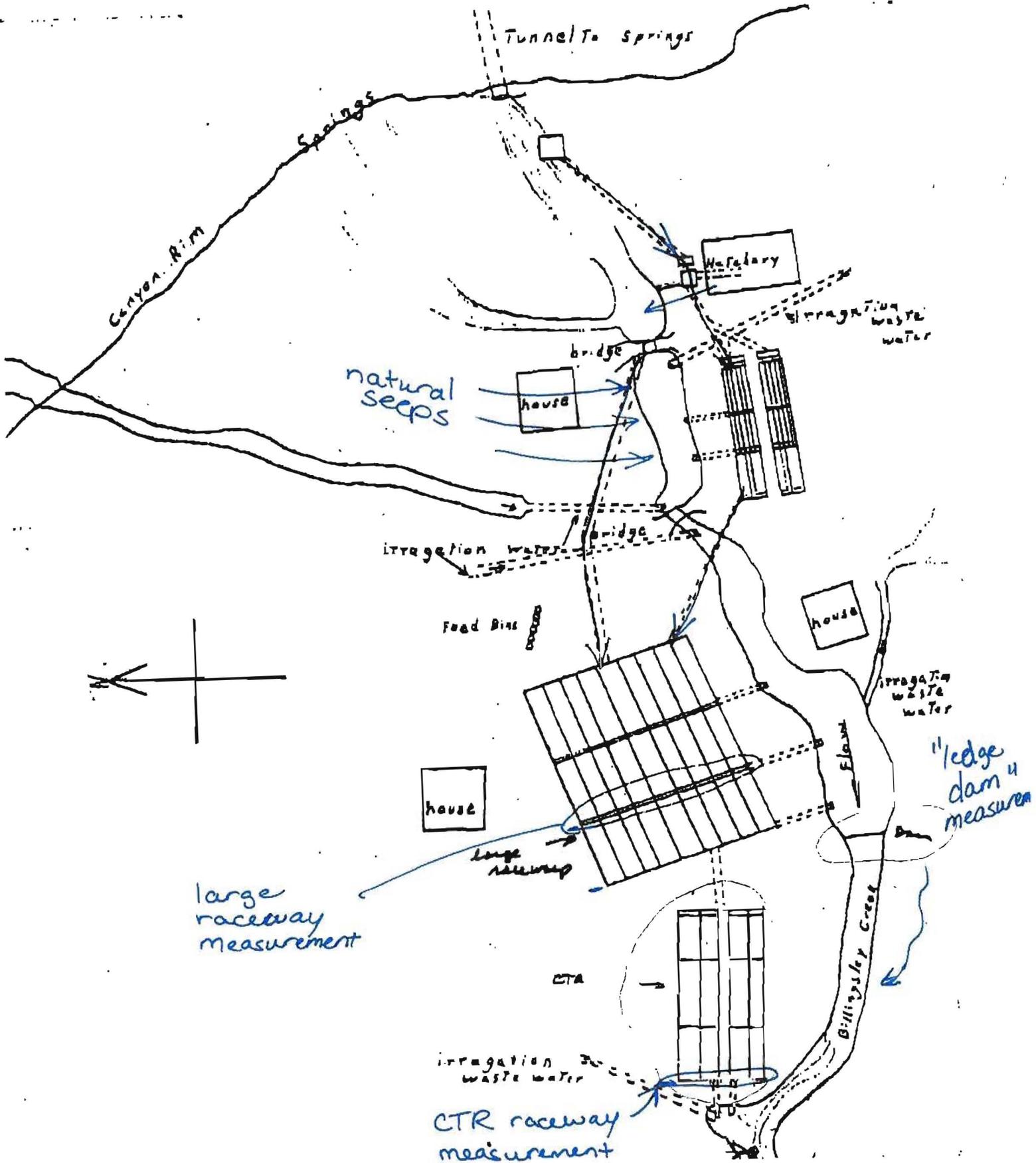
each measurement collected during that month, while each measurement was assigned to a seven day period in SW36DATA.mdb.

Because the data reported in the table "Rangen Research Hatchery, total flow measurements" do not represent the same parameters each years, this table cannot be used to evaluate Rangen's historical water use. Using the handwritten weekly records, it would be possible to derive a table of average monthly raceway flows that would more closely represent Rangen's historical use between 1981 and 2003. Some data gaps and errors would likely occur in this analysis because some of the handwritten records are not legible. The data sheets for years prior to 1981 are not sufficient to derive monthly raceway data.

#### Recommendations:

1. The data monthly average data submitted in the table "Rangen Research Hatchery, total flow measurements" do not represent Rangen's diversion and beneficial use of water and are not consistent in the parameters they represent.
2. If average monthly raceways flows and/or average monthly creek bypass flows would be useful in the evaluation of Rangen's call, we can derive them for 1981 to 2003 from the weekly handwritten records. This will involve a large amount of data entry or hand calculation, so I would like feedback on whether or not these data would be useful before proceeding.
3. The data Rangen has submitted for annual reporting (diversion 410089) appears to include undiverted bypass flow in Billingsley Creek, in addition to their diversions to the raceways. We should consider revising the data in SW36DATA.mdb using the weekly raceway measurements (with a note that this data overlaps with some of the water diverted at 410041). We should also consider giving Rangen more specific guidelines for measurement and reporting.

Hagerman I. Id.



JB

To: Karl Dreher

Cc: Glen Saxton, Gary Spackman, Tim Luke, Cindy Yenter, Brian Patton

From: Jennifer Berkey JB

Date: December 11, 2003

Re: Review of Rangen Hatchery Data

The handwritten historic data submitted for the Rangen Research Hatchery (Rangen) by May, Sudweeks & Browning, LLP (May), via correspondence dated November 21, 2003, have been data entered in electronic format and re-evaluated.

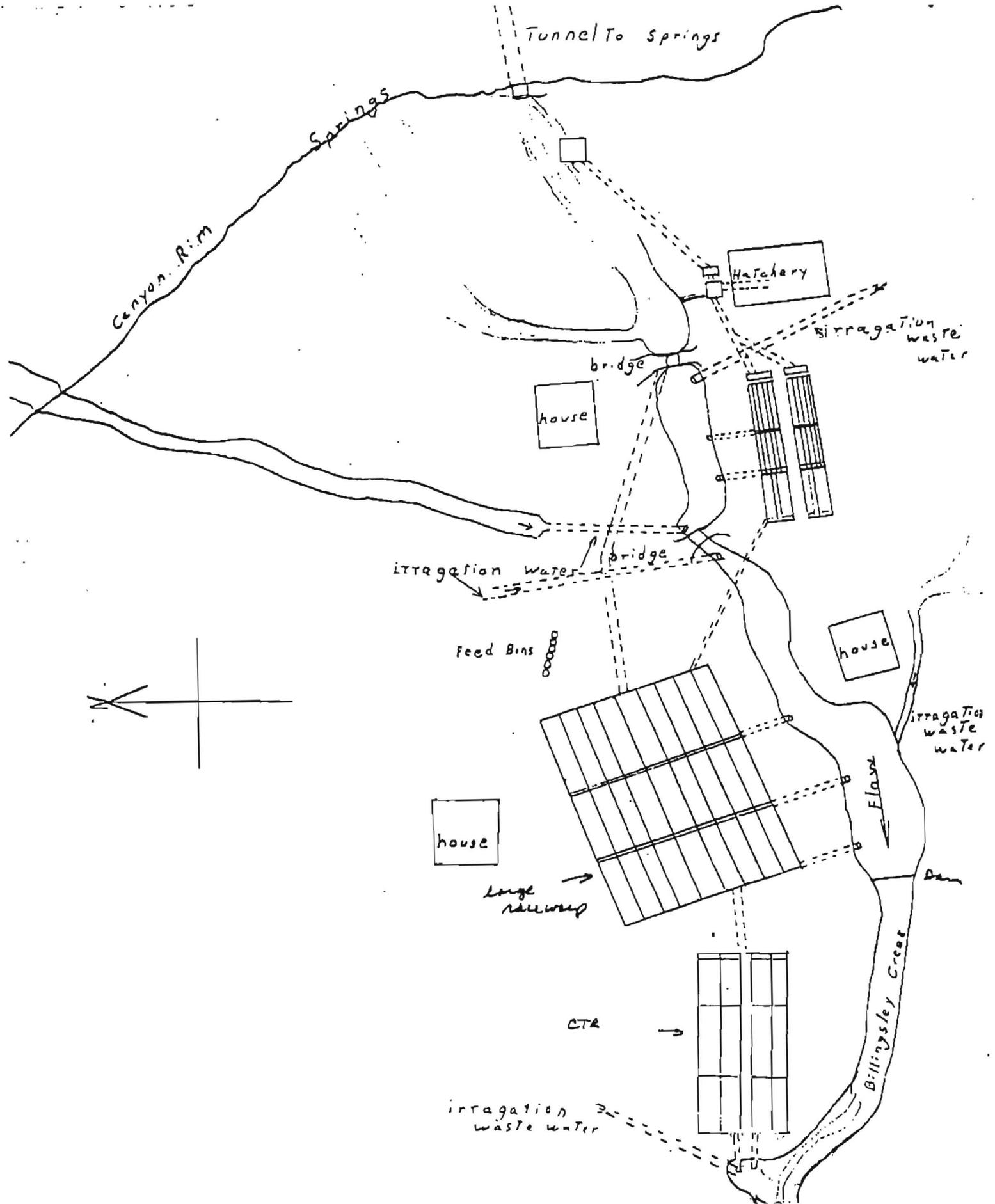
It appears that the measurements submitted for the "Large" raceways are the best available record of beneficial use by Rangen. This is based on the sketch provided by Rangen, observations made by Cindy Yenter during a November 25, 2003 site visit, and comparison of the measurements submitted for the "Large" raceways, "CTR" raceways, and the "dam" on Billingsley Creek. The Billingsley Creek dam measurements could potentially include spring inflow downstream of Rangen's lower diversion, irrigation return flows, bypass flows not diverted by Rangen and/or water diverted to the upper raceways or the "Large" raceways that was discharged into the creek rather than the "CTR" raceways. The "CTR" raceway measurements may or may not include all of the water used in the "Large" raceways, depending on the hatchery's operating conditions. The "Large" raceway measurement likely includes most of the water diverted through the upper and "Large" raceways.

Rangen's domestic and irrigation use, which are diverted from the PVC pipe in Curren Tunnel, are not measured and are not included in this analysis. The flow rate for domestic and irrigation use authorized by water rights 36-2551, 36-134B, and 36-135A totals 0.24 cfs, and is small compared to the raceway measurements.

Data submitted by Rangen for years prior to 1981 were not sufficient to document the amount of water diverted to the hatchery raceways. The documentation submitted for 1966 through 1974 consists of a summary of George Lemmon's measurements of Curren Spring. The documentation submitted for 1975 through 1980 has three columns of flow rate values that are labeled "mo/l/s", "H2O avail", and "total H2O avail". Without further explanation from Rangen of what these values represent, these data cannot be used in this analysis.

Data from 1981 through 2003 were included in this analysis. Tables and charts summarizing the monthly average and monthly maximum flow rates measured by Rangen are attached. The average flow rates diverted during recent years were compared to the five-year average flow rate diverted between 1981 and 1985. This analysis indicates that from January to October 2003, the average diversion rate was 45% of the 1981-1985 rate. From 2001 to 2003, the average diversion rate was 48% of the 1981-1985 rate. Comparison of better water years indicates that during the five-year period from 1996 to 2000, the average diversion rate was 83% of the 1981-1985 rate. During the two-year period from 1997 to 1998, the average diversion rate was 93% of the 1981-1996 rate.

Hagerman Ida.



**Ranget Hatchery near Hagerman, Idaho**  
**Average flow rate measured at the "Large Raceway"**

Notes:

1. Data were provided by Ranget Hatchery on November 21, 2003.
2. Data were entered from copies of handwritten logs. Some data were not legible and was not included in this analysis.
3. Because the day of measurement was not provided for some measurements, the monthly average flow rate was calculated based on a simple average of measurements reported during that month.
4. The average flow rate for the year was calculated using a simple average of the monthly averages.
5. NM = not measured

Year	Average flow rate for year (cfs)											
	1	2	3	4	5	6	7	8	9	10	11	12
1981	25.75	27.06	24.94	19.62	18.37	17.31	17.73	NM	32.58	NM	37.07	37.75
1982	28.42	26.89	25.33	22.66	15.59	17.61	19.51	28.68	36.76	43.47	44.65	NM
1983	32.70	32.79	29.85	27.30	21.80	21.73	24.10	32.98	38.64	47.97	45.88	NM
1984	36.07	37.11	36.48	32.63	24.38	27.57	NM	37.57	35.43	42.40	NM	41.63
1985	31.19	32.65	NM	30.02	23.45	23.15	22.59	32.40	38.69	40.58	NM	38.08
1986	32.14	33.22	31.35	25.27	24.23	23.68	28.30	38.56	NM	40.32	39.60	42.75
1987	30.07	40.22	34.51	33.61	25.62	27.28	25.69	32.77	36.43	40.96	38.52	47.86
1988	27.48	33.51	29.68	28.04	18.66	21.01	19.09	23.32	31.29	38.72	NM	32.68
1989	23.83	27.53	25.20	22.43	14.94	15.60	18.38	26.14	NM	36.05	NM	34.90
1990	25.06	30.63	29.85	18.62	15.95	18.08	19.53	20.71	NM	38.99	NM	32.08
1991	20.34	27.87	25.90	15.95	13.51	13.78	19.90	18.11	28.97	NM	NM	NM
1992	16.05	22.89	19.12	14.85	11.34	11.47	13.98	14.82	17.30	22.08	20.14	18.68
1993	18.59	18.52	17.12	15.90	11.09	12.22	12.69	16.23	21.98	22.05	29.76	23.33
1994	20.01	23.11	16.50	14.28	15.41	13.39	13.83	16.75	23.98	29.01	27.17	23.55
1995	20.03	19.96	18.22	17.26	14.00	15.06	12.87	15.52	23.31	29.38	30.19	26.89
1996	23.41	23.83	21.66	19.55	18.68	16.14	18.14	20.33	28.57	33.54	32.70	30.61
1997	28.28	27.64	25.37	23.00	20.80	22.56	22.22	25.05	32.36	40.24	36.83	36.30
1998	29.18	32.68	31.72	27.88	23.59	26.46	19.73	20.81	30.28	40.26	39.06	36.62
1999	24.58	30.29	27.11	24.99	21.63	22.95	17.76	17.53	23.31	27.88	31.86	29.20
2000	22.07	27.47	24.45	19.02	16.96	14.94	14.60	17.38	23.08	29.15	29.36	25.10
2001	17.33	23.43	18.10	17.35	13.52	12.23	11.86	12.55	17.28	21.30	23.09	19.02
2002	14.03	16.44	14.59	13.99	10.87	10.19	9.58	10.00	11.32	19.72	19.60	17.88
2003	12.83	13.80	12.91	12.52	11.21	11.21	10.29	13.53	13.80	17.13		
1981-1985	30.50	32.62	31.30	28.90	20.28	21.48	20.96	32.90	38.66	43.60	42.52	36.79
1986-1990	29.32	33.02	30.11	27.68	18.86	21.12	22.40	27.90	33.67	39.01	38.11	36.83
1991-1995	19.18	21.86	21.14	19.37	13.07	13.18	13.43	16.25	22.91	28.12	28.81	23.11
1996-2000	25.50	28.38	25.94	24.43	19.66	20.64	18.09	20.26	27.12	34.21	34.33	31.58
2001-2003	14.73	18.42	15.69	14.52	11.87	11.21	10.62	11.02	14.13	19.38	21.34	18.35

Ratio 2003/1981-1985

Ratio 2001-2003/1981-1985

Ratio 1996-2000/1981-1985

Ratio 1997-1988/1981-1985

Ratio 1999-2000/1981-1985

Ratio 2001-2003/1981-1985

Ratio 1996-2000/1981-1985

Ratio 1997-1988/1981-1985

**Rangen Hatchery near Hagerman, Idaho**  
**Average flow rate measured at the "CTR Raceway"**

**Notes:**

1. Data were provided by Rangen Hatchery on November 21, 2003.
2. Data were entered from copies of handwritten logs. Some data were not legible and was not included in this analysis.
3. Because the day of measurement was not provided for some measurements, the monthly average flow rate was calculated based on a simple average of measurements reported during that month.
4. The average flow rate for the year was calculated using a simple average of the monthly averages.
5. NM = not measured

Year	Average flow rate for year (cfs)	Average flow rate for month (cfs)											
		1	2	3	4	5	6	7	8	9	10	11	12
1981	27.29	NM	28.83	27.54	21.63	17.64	18.28	NM	21.59	32.20	34.91	38.21	32.09
1982	28.75	28.03	26.94	26.67	21.60	15.94	14.90	17.09	26.51	38.97	41.42	47.34	39.86
1983	31.35	34.92	30.12	27.84	26.28	20.14	20.31	24.37	32.85	39.84	NM	43.97	44.48
1984	34.07	36.80	37.13	33.41	29.41	23.60	27.01	NM	38.13	35.22	40.79	NM	41.15
1985	31.80	NM	29.45	29.60	28.93	22.00	23.59	22.53	29.28	40.77	41.66	41.61	40.48
1986	32.51	34.34	32.95	28.34	24.33	23.15	22.26	28.70	33.05	41.14	40.78	38.57	41.96
1987	31.83	40.45	35.30	31.06	25.48	20.78	24.70	25.29	33.03	32.39	36.92	36.90	36.64
1988	26.79	34.88	30.71	27.25	23.71	18.12	21.06	19.83	24.56	29.49	34.57	NM	30.49
1989	24.33	27.28	23.10	19.72	18.09	12.58	14.35	18.02	26.38	27.38	37.63	36.24	33.23
1990	26.42	32.39	26.16	26.33	19.60	16.31	18.80	18.83	21.47	NM	38.03	35.61	34.13
1991	20.51	28.02	27.20	27.30	14.97	14.59	12.76	12.90	20.20	26.05	NM	NM	NM
1992	17.04	NM	23.06	18.88	14.38	11.22	11.47	14.20	14.90	17.29	22.50	20.37	19.20
1993	17.78	17.12	16.88	15.23	13.71	10.75	12.07	12.49	15.75	21.20	26.07	29.68	22.38
1994	19.46	22.08	20.08	17.84	12.90	14.87	13.27	13.36	15.71	23.07	28.38	27.29	24.59
1995	19.65	21.30	18.53	18.12	17.20	13.39	14.20	13.76	15.23	21.03	28.52	29.87	28.16
1996	21.67	23.46	20.99	23.82	19.65	16.92	14.91	13.94	17.54	24.93	28.53	29.85	27.73
1997	27.20	26.59	25.35	25.21	22.42	20.48	21.94	21.70	23.75	29.52	36.85	37.66	34.90
1998	28.28	32.38	30.88	27.85	23.51	21.98	25.76	19.49	20.83	28.54	36.82	38.93	34.41
1999	24.38	32.83	28.25	26.30	21.44	21.16	20.87	17.53	17.82	22.91	24.77	29.54	26.11
2000	22.37	27.91	26.34	26.67	16.98	15.81	15.81	14.81	17.58	22.39	26.34	28.99	25.42
2001	18.04	24.02	19.66	19.06	18.28	13.83	11.12	11.35	11.69	13.54	14.80	17.49	17.83
2002	13.51	15.80	14.31	14.12	13.03	11.08	10.11	9.27	9.60	12.80	16.33	18.20	17.45
2003	12.73	14.86	13.69	12.57	11.37	11.52	11.43	10.47	10.82	13.57	18.95		
1981-1985	30.66	33.26	30.49	28.01	25.57	19.86	20.82	21.33	29.27	37.40	39.70	42.78	36.57
1986-1990	28.38	33.87	30.24	26.54	21.78	18.19	20.23	22.13	27.88	32.60	37.59	36.83	35.89
1991-1995	18.88	22.38	21.15	19.47	14.84	12.90	12.75	13.06	16.36	21.73	25.37	26.75	23.08
1986-2000	24.78	28.83	26.36	25.17	21.44	19.50	19.88	17.49	19.50	25.66	30.86	32.35	30.31
2001-2003	14.39	18.23	15.89	15.25	14.23	12.17	10.89	10.38	10.70	13.30	18.03	17.84	17.54

Ranget Hatchery near Hagerman, Idaho  
Average flow rate measured at the Billingsley Creek check structure

Notes:

1. Data were provided by Ranget Hatchery on November 21, 2003.
2. Data were entered from copies of handwritten logs. Some data were not legible and was not included in this analysis.
3. Because the day of measurement was not provided for some measurements, the monthly average flow rate was calculated based on a simple average of measurements reported during that month.
4. The average flow rate for the year was calculated using a simple average of the monthly averages.
5. NM = not measured

Year	Average flow rate for year (cfs)	Average flow rate for month (cfs)											
		1	2	3	4	5	6	7	8	9	10	11	12
1981	2.17	1.19	2.02	2.91	2.27	1.98	1.89	1.19	2.32	2.03	4.20	2.31	2.03
1982	2.34	2.42	2.98	3.73	2.21	1.39	0.87	2.82	1.72	2.52	3.65	1.83	NM
1983	2.13	1.83	1.84	2.15	1.78	1.70	0.99	2.51	1.99	1.56	3.97	3.83	2.25
1984	4.58	4.34	3.33	3.66	5.45	3.95	3.69	NM	4.25	4.98	NM	NM	7.12
1985	5.35	NM	NM	3.00	2.81	NM	3.06	3.06	8.51	8.84	7.88	NM	NM
1986	6.37	4.05	4.45	5.77	4.05	4.45	3.48	3.48	5.20	NM	12.30	12.60	8.60
1987	5.10	3.80	4.45	3.07	2.51	2.68	3.80	3.80	3.67	7.67	10.01	8.62	4.58
1988	4.04	3.85	3.48	3.18	3.24	3.12	2.16	2.28	2.28	5.67	7.85	NM	7.33
1989	4.83	8.97	7.10	6.93	3.32	3.32	2.65	2.82	2.82	NM	5.29	NM	4.31
1990	3.07	2.71	2.26	2.54	2.84	1.75	3.48	3.48	2.43	NM	4.68	NM	4.58
1991	2.51	2.82	3.20	2.05	3.48	3.26	2.24	1.85	NM	1.85	NM	NM	NM
1992	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
1993	4.88	NM	NM	NM	NM	NM	NM	NM	NM	NM	8.14	2.93	3.56
1994	2.85	3.31	3.37	1.65	2.40	2.03	1.56	2.06	2.06	3.23	4.37	3.22	3.48
1995	2.97	3.80	4.18	2.87	1.98	2.05	1.33	1.80	1.80	3.10	3.88	3.63	3.85
1996	3.66	3.50	3.94	2.91	2.57	2.57	3.25	3.25	3.20	4.07	5.81	8.12	8.01
1997	4.68	5.30	4.57	3.81	3.50	4.18	3.72	4.27	4.27	5.42	6.37	5.70	4.88
1998	4.53	3.88	2.75	3.26	4.18	4.17	3.65	4.21	4.21	5.03	4.49	4.94	4.28
1999	4.48	3.87	4.40	4.27	3.26	3.26	2.47	3.26	3.26	7.37	8.50	NM	4.08
2000	4.20	3.75	2.86	3.22	4.52	4.46	4.46	2.51	3.55	4.68	5.98	4.96	4.04
2001	4.21	2.85	4.54	2.98	2.61	1.89	4.32	4.32	3.08	4.69	7.87	7.70	4.15
2002	2.84	4.14	4.11	3.68	1.58	1.58	1.55	1.43	1.43	1.54	4.54	2.87	1.45
2003	1.33	1.74	1.38	1.64	1.27	1.16	1.14	1.20	1.20	1.35	1.35		
1981-1985	3.31	2.59	2.59	2.94	2.36	1.76	2.22	2.22	3.28	3.88	5.00	2.92	3.85
1986-1990	4.68	4.23	4.25	3.69	3.27	3.45	3.11	3.28	3.28	8.67	8.02	11.11	5.32
1991-1995	3.30	3.31	2.75	2.77	2.46	2.11	1.51	1.83	1.83	2.73	5.46	3.33	3.83
1996-2000	4.21	3.88	3.72	3.31	3.68	3.79	3.08	3.63	3.63	5.31	6.48	5.43	4.85
2001-2003	2.73	2.94	2.78	2.89	1.82	1.48	2.34	1.90	1.90	2.53	4.62	3.29	2.80

**Rangen Hatchery near Hagerman, Idaho**  
**Maximum flow rate measured at the "Large Raceway"**

**Notes:**

1. Data were provided by Rangen Hatchery on November 21, 2003.
2. Data were entered from copies of handwritten logs. Some data were not legible and was not included in this analysis.
3. NM = not measured

Year	Maximum flow rate for year (cfs)												
	1	2	3	4	5	6	7	8	9	10	11	12	
1981	38.09	29.75	27.06	26.16	23.73	16.42	18.14	17.73	NM	36.90	NM	38.09	34.30
1982	44.65	29.22	26.97	25.93	23.76	17.74	17.61	19.52	31.12	39.12	44.38	44.65	NM
1983	47.97	36.77	33.42	33.35	29.58	23.86	21.73	28.20	35.43	42.54	47.97	45.88	NM
1984	42.70	37.46	37.11	36.05	32.63	26.35	29.74	NM	37.57	35.43	42.70	NM	41.63
1985	40.58	NM	32.65	NM	30.71	24.30	23.16	23.47	32.40	38.88	40.58	NM	36.98
1986	44.50	33.22	31.29	29.72	27.84	24.23	28.10	28.30	40.61	NM	40.64	39.60	44.50
1987	42.32	40.22	36.35	33.90	25.46	21.74	27.26	28.29	35.62	38.24	41.69	40.78	42.32
1988	39.51	34.30	29.68	30.38	27.26	19.68	24.20	20.08	23.32	36.42	39.51	NM	33.16
1989	36.90	27.53	28.80	22.62	18.91	16.00	15.80	18.38	27.07	NM	38.9	NM	34.97
1990	38.99	32.89	29.85	25.20	22.18	15.95	18.98	19.53	23.86	NM	38.99	NM	32.08
1991	32.46	28.51	25.90	25.10	17.52	13.51	14.03	15.10	19.80	32.46	NM	NM	NM
1992	23.86	NM	23.64	23.86	15.99	11.73	11.69	15.63	15.32	19.65	22.08	20.23	18.81
1993	32.76	17.34	17.54	16.58	15.08	11.76	14.29	15.61	18.99	27.44	32.76	31.41	23.92
1994	29.72	23.92	21.38	19.32	16.89	17.36	15.88	14.08	19.64	26.17	29.72	28.60	24.86
1995	31.33	20.70	19.26	18.16	16.32	15.36	15.24	15.01	17.69	24.24	31.04	31.33	28.55
1996	33.88	25.76	21.87	21.51	20.76	20.62	18.33	18.77	22.20	28.21	33.96	33.14	31.74
1997	40.33	28.12	26.72	25.49	25.16	23.57	23.27	24.21	26.22	34.72	40.33	39.47	36.13
1998	41.08	33.53	31.76	29.16	25.61	25.75	27.27	21.16	22.65	36.31	41.08	40.39	39.72
1999	32.20	30.40	29.29	27.28	22.40	22.40	30.30	18.59	18.56	29.44	31.06	32.20	30.07
2000	31.69	28.30	25.56	24.32	21.64	18.88	15.57	17.62	19.86	24.51	30.45	31.69	27.02
2001	27.16	27.05	18.87	18.49	18.18	14.93	13.12	12.95	13.64	18.99	23.23	27.16	20.13
2002	20.59	17.21	15.36	14.80	17.37	11.99	10.60	9.99	10.60	11.85	20.59	20.49	18.56
2003	18.58	16.17	14.29	13.28	12.41	11.32	11.23	10.66	11.36	15.24	18.58		
1981-1985	47.97	37.46	37.11	36.05	32.63	26.35	29.74	28.20	37.57	42.54	47.97	45.88	41.63
1986-1990	44.50	40.22	36.35	33.90	27.84	24.23	27.26	28.30	40.61	38.24	41.69	40.78	44.50
1991-1995	32.76	28.51	25.90	25.10	18.32	17.38	16.24	15.63	19.80	32.46	32.76	31.41	28.55
1996-2000	41.08	33.53	31.76	29.16	25.61	25.75	30.30	24.21	26.22	36.31	41.08	40.39	39.72
2001-2003	27.16	27.05	18.87	18.49	18.18	14.93	13.12	12.95	13.64	18.99	23.23	27.16	20.13

Rangen Hatchery near Hagerman, Idaho  
 Maximum flow rate measured at the "CTR Raceway"

Notes:

1. Data were provided by Rangen Hatchery on November 21, 2003.
2. Data were entered from copies of handwritten logs. Some data were not legible and was not included in this analysis.
3. NM = not measured

Year	Maximum flow rate for year (cfs)	Maximum flow rate for month (cfs)											
		1	2	3	4	5	6	7	8	9	10	11	12
1981	39.36	NM	30.60	30.97	22.02	18.12	19.93	NM	21.59	37.08	34.91	39.36	35.79
1982	47.34	29.01	27.82	26.90	24.59	18.07	14.95	17.50	30.40	40.31	41.80	47.34	39.66
1983	44.48	38.85	30.34	29.71	28.04	22.47	21.36	29.51	35.93	42.65	NM	43.97	44.48
1984	43.20	38.30	38.75	33.41	29.59	25.39	30.61	NM	36.13	35.22	43.20	NM	41.15
1985	41.66	NM	29.45	28.60	29.55	23.34	23.59	23.36	29.26	40.77	41.66	41.61	40.46
1986	44.30	34.34	32.95	28.34	25.57	24.20	22.69	28.70	37.28	41.14	41.15	39.63	44.30
1987	40.45	40.45	37.47	31.06	28.92	21.21	27.55	27.11	35.55	36.78	36.92	38.92	39.81
1988	37.01	37.01	30.88	27.88	25.62	19.36	24.00	21.08	25.66	34.06	34.87	NM	30.77
1989	39.70	27.28	24.76	20.54	17.89	12.64	14.84	18.02	27.25	27.38	39.70	36.24	33.44
1990	38.03	34.12	30.32	26.60	22.21	16.31	18.80	19.54	24.43	NM	38.03	35.61	34.13
1991	30.90	29.34	27.20	27.30	14.87	14.59	13.50	12.50	21.57	30.90	NM	NM	NM
1992	24.62	NM	24.62	22.16	16.53	11.57	11.57	15.91	15.50	19.69	22.50	21.10	19.85
1993	30.73	17.28	17.41	15.86	15.16	11.19	15.02	15.45	18.10	26.28	27.05	30.73	23.72
1994	29.03	23.72	20.57	18.50	18.06	15.17	17.00	13.90	17.95	24.33	29.03	28.89	25.46
1995	30.88	22.42	18.70	19.20	18.28	14.43	15.05	14.55	16.99	23.53	30.74	30.88	27.84
1996	30.08	24.72	21.03	21.17	21.12	18.69	16.42	15.69	20.40	27.58	29.94	30.08	28.20
1997	37.89	27.78	25.70	25.77	24.19	23.04	22.63	23.89	25.69	33.53	37.35	37.89	36.61
1998	37.81	33.25	31.39	29.51	24.78	25.79	26.65	21.06	22.85	34.16	37.18	37.81	36.17
1999	32.98	32.98	29.93	29.21	23.73	23.73	22.63	18.30	18.82	27.84	28.58	31.77	29.74
2000	31.49	28.27	27.12	27.12	22.61	18.86	17.00	18.55	19.60	23.47	29.07	31.49	26.81
2001	24.77	24.77	21.49	19.63	19.58	15.74	12.95	12.23	12.37	14.76	15.21	20.22	18.23
2002	18.87	16.33	14.99	14.44	13.85	11.66	10.41	9.45	10.00	15.23	18.20	18.87	17.86
2003	17.82	15.48	14.53	13.21	11.83	11.79	11.85	10.81	11.23	15.06	17.82		
1981-1985	47.34	38.65	38.75	33.41	29.59	25.39	30.61	29.51	36.13	42.65	43.20	47.34	44.48
1986-1990	44.30	40.45	37.47	31.06	28.92	24.20	27.55	28.70	37.28	41.14	41.15	39.63	44.30
1991-1995	30.90	29.34	27.20	27.30	18.28	15.17	17.00	15.91	21.57	30.90	30.74	30.88	27.84
1996-2000	37.89	33.25	31.39	29.51	24.78	25.79	26.65	23.89	25.69	34.16	37.35	37.89	36.61
2001-2003	24.77	24.77	21.49	19.63	19.58	15.74	12.95	12.23	12.37	15.23	18.20	20.22	18.23

Rangen Hatchery near Hagerman, Idaho

Maximum flow rate measured at Billingsley Creek check structure

Notes:

1. Data were provided by Rangen Hatchery on November 21, 2003.
2. Data were entered from copies of handwritten logs. Some data were not legible and was not included in this analysis.
3. NM = not measured

Year	Maximum flow rate for year (cfs)	Maximum flow rate for month (cfs)											
		1	2	3	4	5	6	7	8	9	10	11	12
1981	4.20	1.19	2.99	3.08	2.77	2.20	2.25	1.19	2.32	2.41	4.20	3.25	2.08
1982	4.49	2.55	3.66	3.91	2.90	1.55	0.67	2.78	2.25	2.67	4.49	1.63	NM
1983	3.97	1.72	2.25	2.67	1.78	1.92	0.99	3.90	1.89	1.64	3.97	3.63	2.25
1984	7.12	4.80	4.18	4.32	5.77	5.63	3.69	NM	4.25	4.98	NM	NM	7.12
1985	8.84	NM	NM	NM	3.00	3.12	NM	3.12	6.51	8.84	7.88	NM	NM
1986	12.60	4.05	4.45	6.97	5.77	4.05	5.42	3.48	6.07	NM	12.30	12.60	9.14
1987	11.16	3.80	5.42	NM	3.60	2.76	2.88	3.80	4.58	11.16	10.01	11.16	4.58
1988	8.33	4.05	3.48	3.48	3.48	3.00	3.48	2.26	2.26	8.33	8.33	NM	8.00
1989	7.68	6.97	7.68	6.97	4.05	5.25	3.93	2.65	3.48	NM	6.97	NM	6.36
1990	4.68	2.76	2.26	2.54	3.24	1.75	3.48	3.48	2.43	NM	4.68	NM	4.58
1991	3.48	2.88	3.00	2.05	3.48	3.00	2.43	1.65	NM	1.95	NM	NM	NM
1992	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
1993	8.54	NM	NM	NM	NM	NM	NM	NM	NM	NM	8.54	3.80	3.63
1994	4.45	3.67	4.45	3.80	3.24	3.42	2.50	1.65	2.65	4.32	4.45	3.54	3.80
1995	4.72	4.58	4.72	3.36	3.36	2.76	2.60	1.46	2.71	3.93	4.18	4.18	4.05
1996	6.51	3.80	4.99	3.48	3.11	3.12	3.18	3.54	4.05	4.92	5.92	6.21	6.51
1997	6.59	6.00	5.77	5.13	4.25	3.67	4.45	3.86	4.32	5.85	6.59	6.21	5.20
1998	6.07	4.25	2.94	4.11	4.79	4.51	4.99	4.25	4.32	5.56	4.72	6.07	4.45
1999	11.72	3.80	4.59	4.59	3.69	3.94	3.82	2.98	4.33	11.72	10.98	NM	4.59
2000	9.76	4.07	3.45	3.57	2.75	7.87	8.98	2.64	4.59	5.47	9.76	5.41	4.20
2001	10.80	4.07	4.86	4.59	3.21	4.31	2.43	7.11	3.82	5.33	10.80	9.26	4.59
2002	7.87	4.59	4.59	3.45	7.87	1.81	1.72	1.62	1.73	1.91	7.79	3.10	1.91
2003	2.01	2.01	1.62	1.35	1.62	1.35	1.35	1.35	1.26	1.91	1.44	1.44	NM
1981-1985	8.84	4.80	4.18	4.32	5.77	5.63	3.69	3.90	6.51	8.84	7.88	3.63	7.12
1986-1990	12.60	6.97	7.68	6.97	5.77	5.25	5.42	3.80	6.07	11.16	12.30	12.60	9.14
1991-1995	8.54	4.58	4.72	3.80	3.48	3.42	2.60	1.65	2.71	4.32	8.54	4.18	4.05
1996-2000	11.72	6.00	5.77	5.13	4.79	7.87	8.98	4.25	4.59	11.72	10.98	6.21	6.51
2001-2003	10.80	4.59	4.86	4.59	7.87	4.31	2.43	7.11	3.82	5.33	10.80	9.26	4.59

## Rangen Hatchery Yearly Average Flow Rates

