BEFORE DEPARTMENT OF WATER RESOURCES

STATE OF IDAHO

IN THE MATTER OF THE MITIGATION PLAN OF THE NORTH SNAKE AND MAGIC VALLEY GROUND WATER DISTRICTS IMPLEMENTED BY APPLICATIONS FOR PERMIT NOS. 02-10405 AND 36-16645 AND APPLICATION FOR TRANSFER NO. 74904 TO PROVIDE REPLACEMENT WATER FOR CLEAR SPRINGS SNAKE RIVER FARM

(Water District Nos. 130 and 140)

DIRECT TESTIMONY OF RAY ELDRIDGE P.E.

SUBMITTED ON BEHALF OF:

NORTH SNAKE GROUND WATER DISTRICT AND MAGIC VALLEY GROUND WATER DISTRICT

December 5, 2008

LIST OF SPONSORED EXHIBITS

DIRECT TESTIMONY OF RAY ELDRIDGE

I. INTRODUCTION

Q. STATE YOUR NAME, BUSINESS ADDRESS AND POSITION.

A. My name is Ray Eldridge. I am a founding partner of Engineering Science Construction, P.C., 200 Norht 4th Street, Suite 300, boise, Idaho 83702.

Q. WHO ARE YOU TESTIFYING FOR?

A. I am testifying as an expert witness on behalf of North Snake and Magic Valley Ground Water Districts which will at times be collectively referred to as the "Ground Water Districts." I began serving as a technical consultant and advisor to the Ground Water Districts in August, 2008.

Q. WHAT IS YOUR AREA OF EXPERTISE?

A. I hold a Masters of Science in Civil and Environmental Engineering from Washington State University. I earned my Bachelor of Science in Civil and Environmental Engineering from Washington State University. I am a licensed professional engineer in Idaho and two other states and have served on the Advisory Board to the Civil and Environmental Engineering Department at Washington State University for seven years. I have over 25 years of experience in the field of hydraulic engineering, fish facilities, water supply, treatment and construction management. My current resume is included at the end of my testimony as Exhibit 4200.

II. DISCUSSION

Q. WHAT WERE YOU ASKED TO EVALUATE IN THIS CASE AND WHAT AREAS DO YOU INTEND ON TESTIFYING ABOUT?

A. I was asked by the Ground Water Districts to analyze mitigation options for the Snake River Farm (SRF) aquaculture operation to off-set 2.66 cubic feet per second (cfs) of water. In my testimony, I will discuss two mitigation options and my bioengineering assessment of Snake River Farms. The first mitigation option involves modification to the existing Snake River Farms infrastructure to allow further and far more effective aeration ("aeration option") and the second mitigation options involves treating and recycling water to the head of the production raceways ("pump back/recycle option").

Q. CAN YOU GENERALLY DESCRIBE THE INFORMATION YOU REVIEWED AND RELIED UPON IN PREPARING YOUR TESTIMONY?

A. Yes. I reviewed most of the pleadings filed in this matter by the parties and the Director's 2008 Order. Also as set forth in the references to Exhibit 401, I have reviewed the Idaho Department of Water Resource's water right records and files relating to Snake River Farms, the agency record as provided by IDWR, documents and information provided by Snake River Farms, and numerous academic and agency reports and studies regarding Snake River Farms and the ESPA. I also reviewed various authoritative written material for my report which are cited in the report.

Q. HAVE YOU INSPECTED THE SNAKE RIVER FARMS FACILITY

A. Yes, on October 22, 2008 I personally visited Snake River Farms and inspected the facility.

Q. DID YOU PREPARE A REPORT THAT CONTAINS YOUR OPINIONS AND CONCLUSIONS?

A. Yes, I prepared a report that is dated November 21, 2008, and marked as Exhibit 4201.

Q. BASED ON YOUR INSPECTION OF THE SNAKE RIVER FARMS FACILITY AND OTHER DOCUMENTATION YOU REVIEWED, CAN YOU DESCRIBE SNAKE RIVER FARMS'CURRENT OPERATION?

A. Yes. Currently, Snake River Farms uses 16 rearing raceways, along with research raceways and brood stock holding raceways. Snake River Farms employs what is referred to as serial reuse, or the delivery of water from one rearing unit to another. Serial reuse is practiced in two ways at Snake River Farms. The first type of reuse practiced at Snake River Farms involves first pass (spring source) water that is delivered to the research raceways and brood stock holding raceways which is directed, after use, to the main rearing raceways where it is used as sole source flow to some raceways and mixed with first pass (spring source) water in other raceways; this occurs throughout production raceways No. 1-14. Similarly, the hatch house is provided first pass water, which after its use in the hatch house, is delivered to production raceways 15 and 16. In both cases described above, the serial reuse water is not treated in any way before it is reused.

The second type of serial reuse practiced at Snake River Farms is between successive levels in a raceway. In this case, water from an upper raceway flows by gravity to a lower raceway. This is practiced in all 16 rearing raceways at Snake River Farms. The serial reuse in the Snake River Farms rearing raceways provides three passive, though critical, treatment processes. These include aeration, solids removal and nitrification. The aeration occurs in the 4 ft drops between units where dissolved oxygen, consumed by fish in the upper unit, is added as the water plunges to the lower unit. Solids removal occurs throughout the raceways where much of the uneaten feed, feces and wind blown material settles in the bottom of each unit. Nitrification occurs within the raceways where a small fraction of the ammonia produced by fish is biologically converted to nitrite and ultimately nitrate on the walls and other surfaces of the raceways.

Q. WAS THE FACT THAT SNAKE RIVER FARMS CURRENTLY PRACTICES REUSE IMPORTANT TO YOUR OPINIONS?

A. Yes. The extensive practice of serial reuse at Snake River Farms is fundamental to this discussion. If disease concerns were high at the facility, it would not be prudent or even possible to practice serial reuse, especially with 40% of the water supply reused between the brood stock and research raceways and the main production raceways. While diseases occur in virtually all hatcheries, they appear to be at a manageable level at Snake River Farms. This suggests that a properly designed and operated recirculation system or other water treatment can be expected to meet with success at Snake River Farms.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS REGARDING THE AERATION OPTION OF MITIGATION.

A. Based on my analysis, I have reached the following conclusions regarding the aeration option for mitigation:

Since the Snake River Farms is an oxygen limited system, improvement of the existing aeration within the raceways will have the same effect as more water, which is to maintain or increase fish production.

In the existing Snake River Farms operation, 2.66 cfs entering the facility as first pass spring water can be expected to have a dissolved oxygen level of 9.1 mg/l, of which 4.1 mg/l are available to fish (this assumes a minimum DO level of 5 mg/l as noted in Table 2.2). If the water is passed over four drops within the existing rearing units and each drop adds 1.82 mg/l of DO (the average of the data presented in Table 2.3), the total DO contribution is:

DO Contribution = 4.1 mg/l + 4(1.82 mg/l) = 11.38 mg/l.

The DO concentration of 11.38 mg/l can be converted to lbs/day for a flow rate of 2.66 cfs; this yields 163 lbs/day of oxygen. In other words, the oxygen benefit to the Snake River Farms from 2.66 cfs of spring water is equal to 163 lbs/day of oxygen.

By carrying the Snake River Farms' existing operating scenario forward, (i.e. aeration within raceways to achieve needed dissolved oxygen levels) the 163 lbs/day of dissolved oxygen can be provided by improving the performance of aeration at the existing four drops in the raceways. There are several techniques that can be used to improve the aeration performance. One option is a three stage air-water contactor that can be installed at each of the four existing raceway drops that will achieve roughly 88% of dissolved oxygen saturation.

A three stage air-water contactor can be expected to achieve DO levels of 8.0 mg/l below each drop. This is an increase of approximately 0.6 mg/l over the best performance measured in the existing system as shown on Table 2.3 (exhibit 4204). If we assume that one raceway is modified and the flow to each raceway is 5.72 cfs (91.5 cfs / 16 raceways), the additional 0.6 mg/l of DO transferred is equal to 18.5 lbs/day. By these calculations, if nine raceways were converted, a total of 166 lbs/day of oxygen would be added to the Snake River Farms, which is greater than the 163 lbs/day required, as noted above.

It is important to note that the analysis presented above is conservative. The conservatism is in the assumption that the existing system operates according to the best performance measured on October 22, 2008 in raceway No. 7. In reality, the existing system's actual performance is likely lower and better represented by the average performance measured on October 22, 2008.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS REGARDING THE PUMP BACK/RECYCLE OPTION OF MITIGATION.

A Based on my analysis, I have reached the following conclusions regarding the pump back/recycle option for mitigation:

This option involves diverting flow from existing single pass raceway effluent and treatment of that effluent before delivery to the head of three or more of the production raceways. This option is shown schematically in Figure 3.1 (Exhibit 4205). A total flow of 2.66 cfs would be diverted from one or more of the existing 16 raceways. That flow would run by gravity to a combination rotating drum filter/sump. The drum filter would be fitted with a 20 micron screen and self-backwashing capability. The drum filter housing would be extended beyond traditional models and serve as a pumping wet well. A duplex pumping station would move water through a pressurized ultraviolet light (UV) disinfection chamber and a packed column aerator. The water would then flow by gravity to two or more raceways.

This option varies significantly from the aeration option described in the previous section. The treatment and recycle system adds solids removal, pumping and UV disinfection; the packed column/aeration process serves the same function as the air-water contactors in the previous option. The drum filter/solids removal process works together with the UV process to prevent "masking" of pathogens from the UV light. The UV process would be sized to inactivate target pathogens with a goal of 2-logs of removal.

The proposed flow schematic does not include the traditional aquaculture reuse process of nitrification. This process is not required here since the amount of recirculation flow is small - less than 15% if the recirculated water is divided between three raceways. As a result, un-ionized ammonia will not build up to levels of concern.

While the proposed flow schematic for this option is far more complex than the aeration option, it is simple when compared to most recirculating aquaculture systems, and can be expected to be operated with few problems.

Q. WHAT ARE THE COSTS ASSOCIATED WITH THE AERATION OPTION AND THE PUMP BACK/RECYCLE OPTION?

A. The Aeration Option will cost approximately $240,000; this includes design and system installation of improved aeration in nine of the production raceways. The Recycle Option will cost approximately $730,000; this includes design and system installation for a 2.66 cfs system.

Q. IN REACHING YOUR CONCLUSIONS ABOUT THE TWO MITIGATION PLANS DISCUSSED ABOVE, DID YOU ANALYZE WATER QUALITY ISSUES?

A. Yes, a bioengineering analysis was performed for the existing SFR based on the available data. The analysis has four goals. 1) Determine the resulting water quality of the current rearing program. 2) Compare the existing rearing programs water quality to accepted industry standards. 3) Determine the carrying capacity at the current flow rate. 4) Determine the required water quality of a treated/recirculated flow stream.

In the process of rearing, fish take in food (from feed) and dissolved oxygen from water. They in-turn add weight and produce solids, ammonia and carbon dioxide. The amount of feed and oxygen consumed is a function of type, size and weight of fish as well as water temperature, rearing conditions, feed composition, fish health and production scheduling. Production of solids, ammonia and carbon dioxide can generally be correlated to feed for a specific species. The following table lists bioengineering criteria used in the analysis of Snake River Farms.

Feeding – Using a feed conversion ratio (FC) of 1.1 and 3,700,000 lbs/yr of production from Snake River Farms, the annual feed is calculated to be 4,070,000 lbs (1.1 x 3,700,000 lbs/yr). Assuming a flat feeding rate throughout the year, this would represent 11,150 lbs/day of feed. Recognizing that feeding is not uniform throughout the year, the maximum month feeding rate 416,000 lbs/mo from Snake

River Farms' 2004 NPDES Permit[1] application is used. This yields a maximum feeding rate (F) of 13,675 lbs/day (416,000 lbs/mo/30.42 days/mo).

Ammonia Production – Using the ammonia production relationship from Table 2.2, the total ammonia as nitrogen (TAN) is calculated as:

$$TAN = 0.03 \times F$$

or,

$$TAN = 410 \text{ lbs/day}$$

Converting TAN into a concentration by using the flow of 91.5 cfs, the TAN is calculated to be 0.83 mg/l. This calculation is higher than the grab sample taken on 10/22/08 which measured 0.52 mg/l TAN and the three samples reported by Snake River Farms for TAN in 2001 which varied from 0.41 to 0.60 mg/l of TAN. By comparison to other data, the calculated TAN value of 0.83 mg/l is a conservative estimate.

Un-ionized Ammonia, or NH_3, is the toxic form of ammonia. The production can be calculated from TAN as a function of water temperature and pH. Using a leaving pH value of 7.7 and a water temperature of 58 deg. F, a TAN of 0.83 mg/l yields an un-ionized ammonia of 0.011 mg/l. This is below the maximum NH_3 concentration listed in Table 2.2.

Carbon Dioxide is calculated using the constant in Table 2.2 as:

$$CO_2 = 0.28 \times F$$

or,

$$CO_2 = 3{,}829 \text{ lbs/day}$$

Converting lbs/day of CO_2 at a flow rate of 91.5 cfs, CO_2 is calculated to be 7.8 mg/l. This is below the maximum CO_2 concentration listed in Table 2.2.

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[1] Clear Springs Foods NPDES General Permit Application for Snake River Farm, April 19, 2004.

Dissolved Oxygen consumption is calculated using the constant in Table 2.2 as:

DO = 0.25 x F

or,

DO = 3,419 lbs/day

Converting lbs/day of DO consumption at a flow rate of 91.5 cfs, DO is calculated to be 6.9 mg/l. If it is assumed that the incoming dissolved oxygen is 9.1 mg/l at Snake River Farms, this would produce a leaving DO of 2.2 mg/l (9.1 mg/l - 6.9 mg/l) at the end of the final rearing unit. This value is well below the target minimum DO of 5.0 mg/l listed in Table 2.2, suggesting that the facility is oxygen limited at a production of 3,700,000 lbs/year. What actually occurs at Snake River Farms is that the serial reuse operation provides aeration between steps in a line of raceways. On October 22, 2008, dissolved oxygen was measured along a line of raceways at the Snake River Farms. The results are presented in Table 2.3. Table 2.3 shows that over the five steps of Snake River Farms raceway No.7 a total of 9.76 mg/l of dissolved oxygen was consumed; this is roughly 40% more than the amount the facility would use on average (as calculated above). Table 2.3 also shows that the aeration between each drop in the raceway adds between 1.55 and 2.18 mg/l of DO. It is important to note that the data presented above is not exhaustive and far more study would be necessary to truly characterize the oxygen consumption of the Snake River Farms. It does, however, strongly suggest that the serial reuse at the Snake River Farms is necessary to overcome an oxygen limited system. It also suggests that the aeration provided within the raceways is effective and capable of satisfying the oxygen demands of the program.

Q. WHAT ARE YOUR BIOENGINEERING OPINIONS AND CONCLUSIONS?

A. The following conclusions are drawn from the data and analysis presented above.

1. The Snake River Farms is an oxygen limited operation and that limitation is overcome by aeration within the serial reuse system.

2. Un-ionized ammonia is not a limiting factor at an annual production rate of 3,700,000 lbs/yr and a water flow rate of 91.5 cfs. Production could be increased by approximately 10% or water flow decreased by 10% before un-ionized ammonia becomes a limiting factor.

3. Carbon dioxide is not a limiting factor at an annul production rate of 3,700,000 lbs/yr and a water flow rate of 91.5 cfs. Production could be increased by approximately 20% or water flow decreased by 20% before carbon dioxide becomes a limiting factor.

4. Disease problems at the facility do not appear to be a significant operational issue, as evidenced by the on-going reuse operation.

Q. WHAT INFORMATION DID YOU REVIEW TO MAKE YOUR BIOENGINEERING ASSESSMENT?

A. The information presented in the bioengineering assessment portion of my report is based on data gathered during a site visit to Snake River Farms on October 22, 2008, field and laboratory water quality analyses, public records, limited information provided during discovery, and professional journal articles, technical reports and books related to aquaculture. It is important to note that certain records requested by Racine Olson Nye Budge & Bailey, Chartered as a part of discovery process were not produced by Snake River Farms. As a result, certain assumptions were necessarily made in this assessment. If Snake River Farms produces the requested data in the future, those assumptions can be replaced with hard data and a more accurate bioengineering assessment can be made.

Table 2.1 (exhibit 4202) presents key operations criteria for the Snake River Farms aquaculture facility. These criteria form the foundation of our understanding of the operation and the resulting mitigation options and recommendations.