The Jacks Creek TMDL

Technical Support Document

With a QAPP Assessment

Bruneau River TMDL Modification – Jacks Creek TMDL
Owyhee County, Idaho

Prepared for
U. S. Environmental Protection Agency – Region 10
U. S. EPA Idaho Operations Office – Boise, Idaho
Idaho Department of Environmental Quality – State Office
Idaho Department of Environmental Quality – Boise
Idaho Department of Environmental Quality – Twin Falls

Prepared by
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Regional Manager - Water Quality Protection
Idaho Department of Environmental Quality
Twin Falls Regional Office
Final: September 4, 2006

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1. Introduction

The Idaho Department of Environmental Quality (DEQ) – Twin Falls Regional Office (TFRO)– provides this technical support document to the Jacks Creek Total Maximum Daily Load (TMDL) Modification of the Bruneau River Watershed Management Plan (or Bruneau River TMDL). This technical support document provides a more in-depth site description of the aquaculture facilities that discharge to Jacks Creek, the sources of wastewater or pollutants that are discharged into Jacks Creek, the artesian geothermal sources to Jacks Creek, and a site characterization of previous investigations conducted in the Jacks Creek drainage. In addition, a summary of field activities and analytical protocols as well as a summary of the quality assurance/quality control that was used in the most current monitoring activity by IDEQ-TFRO in the development of this technical support document.

1.1 Why This Modification is Necessary

A modification to the Bruneau River TMDL is necessary for the Jacks Creek drainage in order to maintain consistency within the aquaculture industry in Idaho for warm water aquaculture. In *The Upper Snake Rock TMDL Modification* (Buhidar 2005), the NPDES limits are preliminarily set at 0.100 mg/L TP for cold water facilities and 0.200 mg/L TP for warm water facilities.

Jacks Creek has two warm water aquaculture facilities that discharge to it; both facilities utilize artesian geothermal wells as their main water source. This same water source is also used as the primary irrigation source for irrigated agricultural croplands during the irrigation season.

To maintain consistency within the aquaculture industry in Idaho, the 0.200 mg/L TP is necessary.

1.2 Requirement for Post-TMDL Evaluation and Analysis

Because of this need for a 0.200 mg/L TP limit, the fish hatchery facilities' owner requested a modification to the Bruneau TMDL to allow for an instream water quality limit based on warm water aquaculture. DEQ took this request under consideration and concluded that a TMDL modification was needed.

DEQ communicated with EPA, and EPA concurred that a modification of the Bruneau TMDL for Jacks Creek was indeed appropriate and necessary. Thus, DEQ conducted a post-TMDL evaluation and analysis of the aquaculture facilities and Jacks Creek to ascertain a more appropriate loading capacity, and subsequent wasteload allocations and load allocations for the affected point and nonpoint source industries, respectively.

1.3 Goals of the Post-TMDL Evaluation and Analysis

Completion of this post-TMDL evaluation and analysis included reviewing and updating site information on Jacks Creek and the aquaculture facilities, executing a site-specific sampling plan, establishing a best management practices plan (BMP Plan) on both aquaculture facilities that describes those actions taken to minimize pollutants to Jacks Creek, conducting the appropriate number of field sampling events, and producing this technical support document that provides justification for a TMDL modification of the Bruneau River TMDL.

The specific goals for this post-TMDL evaluation and analysis were to do the following:

- Collect and analyze samples that sufficiently characterize the sediment (as TSS), phosphorus (as TP), and *Escherichia coli* (as *E. coli*) in Jacks Creek above and below the discharge of the aquaculture facilities.
- Collect and analyze sufficient samples that characterize the TSS and TP from the aquaculture facilities influent and effluent, and recognizing that *E. coli* is not a pollutant-of-concern generated by aquaculture facilities.
- Determine the appropriate wasteload allocation, for both aquaculture facilities, that is not only in line with the existing beneficial uses of Jacks Creek but also consistent with warm water aquaculture limits.
- Provide appropriate TP, TSS, and *E. coli* information, so that a modification to the Bruneau TMDL can be done explicitly on Jacks Creek only, which, in turn, allows for a modification to the NPDES permits for both aquaculture facilities.
- Document any best management practices (BMPs) the aquaculture facilities are presently applying that aid in remediation of the phosphorus load to Jacks Creek. Attempt to do likewise for nonpoint sources.

2. Site Description

The following describes Jacks Creek, the aquaculture facilities on Jacks Creek, stream reaches, sources of wastewater and pollutants, sources of geothermal water, and other site characteristics.

2.1 Jacks Creek

Jacks Creek forms at the confluence of Little Jacks Creek with Big Jacks Creek (Figure 1). At their joining, a hydrologic weir allows irrigation water to be diverted into a canal on the east side; upstream is a USGS gage that has been reading flow information since 1938 (USGS).

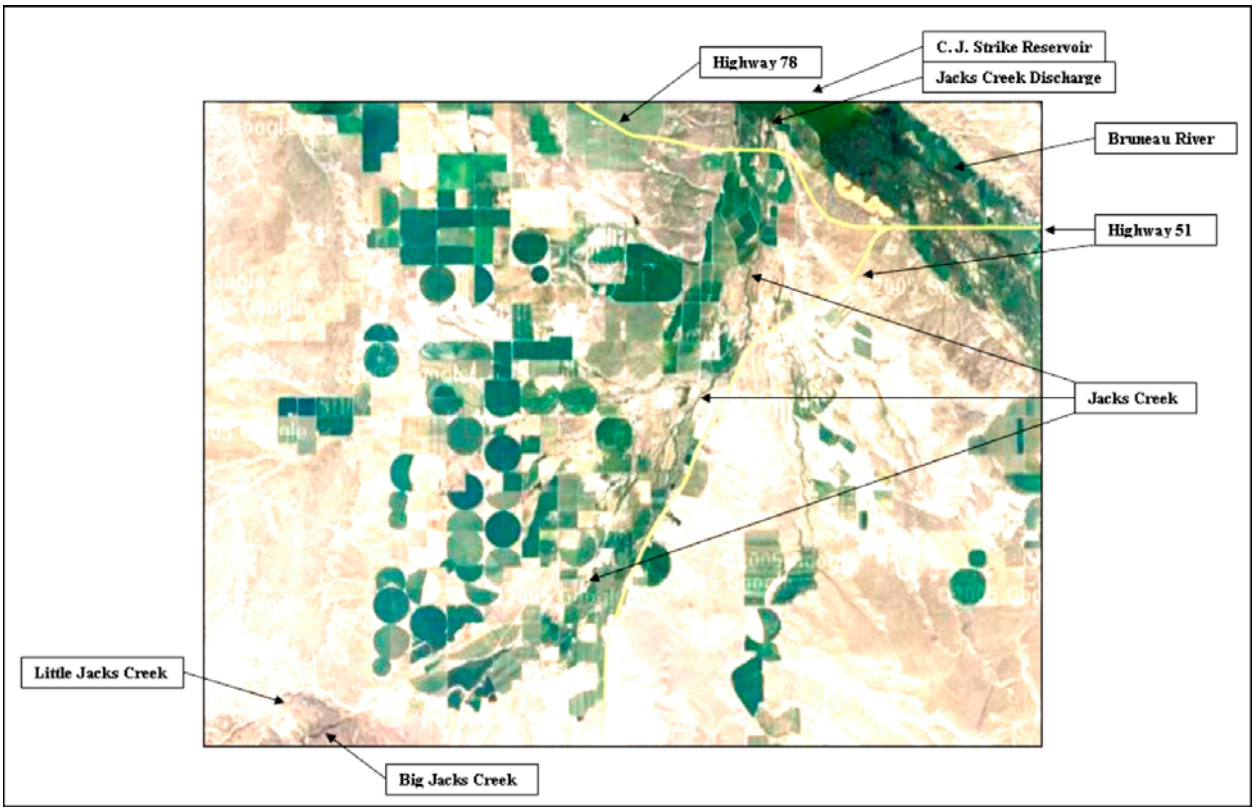


Figure 1. Jacks Creek agricultural drainage area.

Jacks Creek is found within Hydrologic Unit Code (HUC) 17050102 (or the Bruneau River HUC) and is cartographically configured into four assessment units based on Rosgen stream order, as shown in Table 1 (EPA 2005A; EPA 2005B; EPA 2005C; EPA 2005D). It is Assessment Unit ID17050102SW002_05 (as shown in Table 1) that is the assessment unit associated with Jacks Creek.

Table 1. Jacks Creek Assessment Units.

Assessment Unit	Rosgen Stream Order	Water Size	Attainment Status
ID17050102SW002_02	1st and 2nd Order	172.85 miles	Not Assessed
ID17050102SW002_03	3rd Order	11.57 miles	Not Assessed
ID17050102SW002_04	4th Order	8.26 miles	Not Assessed
ID17050102SW002_05	5th Order	12.28 miles	Impaired

Jacks Creek watershed drains approximately 209,265 acres and includes the sub watersheds of Big Jacks Creek, Sugar Creek, Deadman Gulch, and Halfway Gulch. Agriculture accounts for 18,060 acres (9%) of the total (ISCC 2002). The remainder is 87% Bureau of Land Management (BLM) and 4% State of Idaho (Idaho Department of Lands, IDL).

Based on information from local farmers, ranchers, and the Idaho Soil Conservation Commission (ISCC, Bruneau Field Operations Office), water sources available to irrigators in the Jacks Creek drainage include the following:

- Artesian geothermal wells used for agricultural irrigation, aquaculture, and domestic water supply. This is the predominant water supply and source for most of Jacks Creek agriculture.
- Jacks Creek water diverted for agricultural irrigation and stock water. Certainly, this is a major water source but not the most dominant one.
- Bruneau River water diverted for agricultural irrigation and stock water. This encompasses less volume than the water diverted from Jacks Creek.

2.2 Aquaculture Facilities on Jacks Creek

Two aquaculture facilities—the Ace and the Arraina facilities—are located on Jacks Creek. Table 2 provides details of the two facilities requesting modification to their NPDES permit limits based on the Bruneau River TMDL.

Table 2. Specifications of aquaculture facilities on Jacks Creek.

Specifications	Ace Facility	Arraina Facility
Site Name	Ace Development USA, Inc.	Arraina Inc.
Site Address	31194 State Highway 51 Bruneau, ID 83604	31194 State Highway 51 Bruneau, ID 83604
NPDES No.	130123	130122
Location	Owyhee County, Idaho	Owyhee County, Idaho
Latitude	N 42° 49.411′	N 42° 49.840′
Longitude	W 115° 53.724′	W 115° 53.643′
Legal Description	R5E T7S Section 18 of B.M.	R5E T7S Section 8 of B.M.
Type of Facility	Warm Water Aquaculture	Warm Water Aquaculture
Primary Fish Species	Tilapia	Tilapia
Annual Fish Production	350,000 lb	250,000 lb
Primary Water Source	Geothermal Well: 1,800-3,000 GPM	Geothermal Well: 5.5 cfs
Secondary Water Source	None	None
Site Owners/Contacts	Robert C. Williams, 208-845-2487	Robert C. Williams, 208-845-2487
The latitude and longitude values are based on the location of the geothermal wells at both properties. B.M. = Boise Meridian. The Ace facility is considered the headquarters for both the Ace and Arraina facilities. GPM = Gallons Per Minute		

2.2.1 Locations and Descriptions of the Facilities

The Arraina and Ace fish facilities are the only warm water aquaculture facilities in the Jacks Creek watershed. The Arraina facility is located west of Highway 51, southwest of the City of Bruneau and about 4.7 miles after the Highway 51/78 diversion. The Ace facility is located east of Highway 51, about a mile further (Figure 2).

The Arraina facility is located at an elevation of 2,650 feet above sea level; the Ace facility is at 2,653 feet.

Both facilities contain living quarters (mobile homes) for working personnel and management, geothermal artesian wells, and numerous ponds, concrete raceways, and large-volume, circular plastic containers for various species of warm water fish but primarily tilapia.

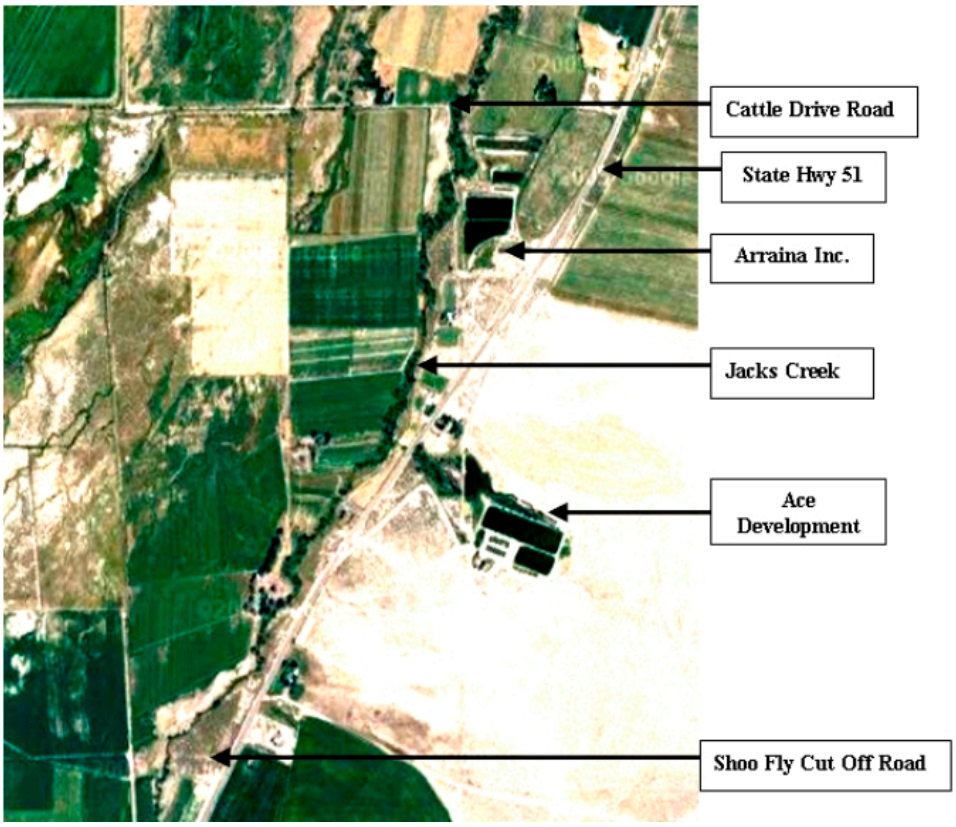


Figure 2. Location of Arraina and Ace facilities on Jacks Creek.

2.2.2 Historical Summary of Facility Operations

Table 3 provides an ownership history and brief summaries of significant activities that have occurred at the site. Prior to 1997 no NPDES permits were issued by EPA for either facility.

Table 3. Historical summary of Ace and Arraina facilities.

Owner/Operator	Dates	Major Activities
Robert C. Williams	April 16, 2004	Ace and Arraina defined as tilapia facilities in the NPDES Notice of Intent (NOI). Ace has 16 twenty-foot concrete raceways and 24 twenty-five foot diameter steel tanks.
Robert C. Williams	April 24, 1997	Arraina defined as tilapia, bass, perch, pacu, and prawns facility in the NPDES NOI. Arraina has 49 raceways, 3 cooling and settling ponds, and two offline settling ponds. Similar fish in Ace as in Arraina.
	1997	Arraina facility modified.
	1991	Ace facility expanded with 8 raceways and 24 tanks.
	1989	Ace facility had offline-settling pond constructed.
	1984-85	Arraina facility builds earthen ponds.
	1970	Ace facility constructed.
NOI = Notice of Intent. NPDES = National Pollutant Discharge Elimination System.		

2.3 Stream Reaches

Jacks Creek may be divided into three stream reaches based on land use:

- The first reach, which begins at the union of Big Jacks Creek and Little Jacks Creek, is approximately 0.2 mile long and is on BLM ground.
- The second reach is approximately 10.5 miles and resides in predominantly private ground; it comprises the agricultural resource of the Jacks Creek drainage.
- The third reach is represented by the last 2.5 miles (through which Jacks Creek flows) and lies in the C. J. Strike Wildlife Management Area (WMA). This WMA is a wetland-marshland area that has a hydrologic discharge connection into the C. J. Strike Reservoir, both as a consequence of the WMA and as a consequence of Jacks Creek. The WMA consists of 8,400 acres that serves as a winter and spring area for migrating and wintering waterfowl (BPA 1986 [p K-6]).

2.4 Sources of Wastewater or Pollutants

Sources of wastewater or pollutants that may discharge into Jacks Creek include the following:

- *Irrigation return drains to Jacks Creek*. These return drains are predominantly irrigation tailwater from various agricultural fields in the Jacks Creek drainage (Campbell 2002 [p 2]). Most of the irrigation water is from irrigated cropland.
- *Livestock activity near or within Jacks Creek*. Livestock activity is a predominant landuse that is characteristic in non-wilderness areas, especially in the vicinity of springs and small reservoirs (Mast and Clow 2000 [p 4]). Since springs and small reservoirs are not significant in the Jacks Creek drainage, cattle activity is confined to within the creek or along the streambanks (Campbell 2002 [p 5]).
- *Septic tank drain fields*. There is no central sewer hookup (to the City of Bruneau) in the Jacks Creek drainage. Sewerage is predominantly septic tank drain fields that are located within the farm sites associated with Jacks Creek.
- *Aquaculture fish facilities*. The Ace and Arraina facilities use geothermal resources and discharge to Jacks Creek, but these facilities utilize approximately 85% of their effluent for cropland irrigation prior to discharge.
- *Waterfowl resting and feeding*. The lower reach of Jacks Creek in the WMA is used extensively by waterfowl for resting and feeding (Campbell 2002 [p 5]). The WMA is a marshland-wetland complex that is part of the migratory flyway zone for resident and migratory waterfowl that belongs to the Owyhee Uplands Ecoregion or "Owyhee Desert" (BLM 1996 [pp 6, 35]). The Idaho Department of Fish and Game (IDFG) has identified the WMA as having degraded water quality from an increased nutrient load from agriculture and food [*fish*] processing. In addition, excess grazing has been identified by IDFG as causing habitat degradation (IDFG 2004 [p 151]).
- *Storm water runoff*. During periods of rainfall or snowfall, storm water runoff within 1,000 feet of the stream may drain into Jacks Creek. The impact to water quality is substantial during these periods, especially if the streambanks are unstable or if runoff from State Highway 51 provides organic pollutants or sediment from the road and its adjacent vicinity.

- *Accidental release from vehicle use of State Highway 51.* Accidental spills or releases into Jacks Creek could occur if vehicle accidents have releases that enter the stream. This may occur along the 5 miles of State Highway 51 that parallel Jacks Creek.

2.4.1 Primary Sources

Based on frequency of occurrence, three of the seven (7) pollutant sources are considered of primary or significant concern:

- Irrigation return drains
- Livestock activity
- Aquaculture fish facilities

2.4.2 Secondary Sources

Of secondary or marginal concern are septic tanks and waterfowl. It is unknown to what degree septic tanks might be a significant contributor to Jacks Creek, but, at present, their impact is considered secondary or marginal.

Waterfowl, although numerous at times, are considered a part of natural background. However, their effects could be subtracted out with a net sample from above and below the area of impact.

2.4.3 Tertiary Sources

Of tertiary, or minor, concern, are storm water runoff and accidental spills/releases.

2.5 Artesian Geothermal Sources

Both the Ace and the Arraina facilities utilize artesian geothermal wells whose effluent is then co-mingled (by approximately 85%) with irrigation water and applied to cropland agriculture. (As discussed in section 2.1, these artesian geothermal sources are also the primary irrigation water source for agriculture.)

2.5.1 Thermal Water Characteristics

Geologically, thermal ground water in the Bruneau-Grand View area occurs under artesian (confined) conditions in both the volcanic rocks and the consolidated and unconsolidated sedimentary rocks. Two general aquifer types exist:

- Volcanic rock aquifers, which include the Banbury Basalt, the ldavada Volcanics, and the rhyolitic and intrusive rocks
- Overlying sedimentary rock aquifers, which generally consist of units of the Idaho and Snake River Groups

Temperatures of water discharged from wells and springs in the area ranged from 9.5°C to 83.0°C. Generally, the temperature of the water obtained from the sedimentary rock aquifers seldom, exceeds 35°C, whereas temperatures from the volcanic rock aquifers ranged from 40.0°C to 83.0°C (Young and Whitehead 1975 [p 31]). The source of heat for the deeply

circulating thermal waters in the Bruneau-Grand View area is believed to be an above-normal geothermal gradient that could be related to a thinning of the earth's upper crust in this area (Young and Whitehead 1975 [p 45]).

Owing to the natural increase of temperature downward in the earth's crust, water in deeper aquifers generally tends to be warmer than that from shallower aquifers. Therefore, and as would be expected, ground water temperatures in the Bruneau-Grand View area increase as wells penetrate into the deeper aquifers.

2.5.2 Recharge Characteristics

Because of its arid climate, recharge to the aquifers underlying the Bruneau-Grand View area probably has its source in precipitation (mostly winter snow) onto the plateau and the mountains to the south and southwest (Young and Whitehead 1975 [p 13]). The ldavada Volcanics aquifer probably underlies most of the Bruneau-Grand View area. It is considered to be the most important aquifer in the area and an aquifer that generally yields large quantities of water to wells. The ldavada Volcanics is also believed to act as the principal conduit that provides recharge to the overlying aquifers (Young and Whitehead 1975 [p 14]).

2.6 Site Characterization

Characterization of the site relative to previous investigations, DEQ site visits, and a summary of site investigation locations is discussed in the following.

2.6.1 Previous Investigations

Prior to 2004, DEQ had visited and monitored Jacks Creek for the development of the Bruneau River TMDL in 1999-2000.

Relative to the NPDES permitted Ace and Arraina facilities, discharge monitoring information has been available since May 2000.

In April 1997, a request was made that DEQ “review the upgrade modernization of this existing facility” for plan and specification approval under Idaho Code §39-118. The existing facility was Arraina, Inc., and DEQ requested modifications to the certification checklist, the best management plan, the waste disposal plan, and the settling pond design. These changes occurred and the approval was granted.

From 1997 through 2000, EPA and DEQ did compliance inspections of both the Arraina and Ace facilities. EPA inspection information is presently not available, but DEQ information is available and is incorporated in the overall database for both facilities.

Concurrent with previous investigations and those of 2004, the investigation of the Ace and Arraina facilities is complete and accurate to the fullest extent possible. A review of this document was conducted with direct input by the facilities’ owner. This, his comments are incorporated into the body of this document.

Of note is the construction of artesian wells in the late 1930s and early 1940s. The Jacks Creek water source, with the exception of the water that comes from Big Jacks Creek and Little Jacks Creek, is primarily from artesian wells. This warm water is used for irrigation and becomes the

principal component of the Jacks Creek drainage once it discharges as tailwater into Jacks Creek. This practice has been on going since the late 1930s for irrigated agriculture.

2.6.2 DEQ Site Visits in 2004

While collecting additional post-TMDL field information and data on Jacks Creek, DEQ visited both facilities on numerous occasions during the winter, spring, summer, and fall of 2004. The owner of the fish hatchery facilities was present on almost all occasions.

With the assistance of the Idaho Association of Soil Conservation Districts (IASCD) and the Idaho Soil Conservation Commission (ISCC) (Duane La Fayette, Water Quality Resource Conservationist), access to private ground on Jacks Creek was obtained during the data collection for this project. In addition, the private landowners provided historical information on Jacks Creek that is also incorporated into this document.

2.6.3 Involved DEQ Personnel

DEQ personnel involved in the Jacks Creek TMDL Technical Support Document and the Bruneau River TMDL Modification include the following:

- *Dr. Balthasar B. Buhidar, Regional Manager*. Water Quality Protection. Principal TMDL writer on the Bruneau River TMDL Modification and the Jacks Creek TMDL Technical Support Document; and DEQ Chemist who assessed, reviewed, and qualified all field and laboratory data. He also participated in the monitoring and conducted the statistical review of the project.
- *Rob Sharpnack, Regional Aquaculture Specialist*. He participated in the monitoring effort on Jacks Creek. Rob was responsible for all of the field instrument calibration, field monitoring of flow, and all ArcView maps. He also provided key insight into warm water aquaculture.
- *Clyde Lay, Senior Water Quality Analyst*. He was the original TMDL writer for the Bruneau River TMDL in which the Jacks Creek TMDL is found as a modification. Clyde's input was used as a primary source for the monitoring plan and for review of the modification document.
- *Don Bledsoe*. Quality Assurance Director. He reviewed the quality control/quality assurance in the Jacks Creek TMDL Technical Support Document.
- *Marti Bridges*. TMDL Program Manager. She reviewed the Bruneau River TMDL Modification prior to submission to EPA as well as the Jacks Creek TMDL Technical Support Document for policy and legal requirements.

2.6.4 Summary of Site Investigation Locations

Based on a review of existing information, areas and features within the site were identified for sample collection by DEQ. In addition, the owner/operator provided additional information that had been collected in conjunction with his NPDES permits for both facilities.

The review identified the following potential sources of water, migration routes, and potential targets:

Potential Sources of Water

- Source of water to Ace facility is a geothermal artesian well built in the 1940s.
- Source of water to Arraina facility is a geothermal artesian well built in the 1940s.
- Jacks Creek water is not a source of water to either facility because Jacks Creek does not have a continuous quantity that can be depended on annually.
- Jacks Creek water source is Big Jacks Creek and Little Jacks Creek. This water generally subs out on BLM ground or evaporates before entering the agricultural zone of Jacks Creek. Only under high flow conditions does water exist from Big Jacks and Little Jacks through the agricultural zone of Jacks Creek and eventually its mouth into the C. J. Strike Reservoir. Based on the period of record (1938-2003), the Big Jacks gage (USGS 13169500) records water volume according to the pattern shown Table 4.

Table 4. Big Jacks water gage seasonal patterns.

Quarter	Months	Dry	Wet	Dominant Condition
Spring	Mar-May	43.8%	56.2%	Wet (56.2% > 43.8%)
Summer	Jun-Aug	62.0%	38.0%	Dry (62.0% > 38.0%)
Fall	Sep-Nov	67.7%	32.3%	Dry (67.7% > 32.3%)
Winter	Dec-Feb	68.7%	31.3%	Dry (68.7% > 31.3%)
Overall	Annual	60.6%	39.4%	Dry (60.6% > 39.4%)

- The major source of water to Jacks Creek in the agricultural zone is irrigation water that comes from geothermal artesian wells. Most water along Jacks Creek during the spring and summer comes from irrigation tailwater sources, which originally comes from the artesian geothermal wells.

> *Note*: Based on the discharge pattern of Big Jacks Creek into Jacks Creek, it may be wrongly concluded that Jacks Creek is an intermittent rather than ephemeral stream. See section 6.4, Reasonable Assurance in Beneficial Use Attainment, page 42, for more.

Migration Routes

- The Ace facility discharges to a settling pond and then directly to Jacks Creek.
- The Arraina facility discharges to a settling pond and then directly to Jacks Creek.
- All farms along Jacks Creek discharge directly to Jacks Creek through their irrigation tailwater. It is estimated that 100% of the farm water that discharges to Jacks Creek is from artesian wells that are near the stream or that originate from as far as 4 miles away.
- Subsurface percolation along the corridor of Jacks Creek is principally impeded by saline alkali conditions due to a relatively high water table that permeates the salts upward towards the surface. As a consequence, vegetation along the corridor is principally greasewood.
- Jacks Creek water from the agricultural zone discharges into a wetland-marshland area prior to discharging into the C. J. Strike Reservoir. The wetland-marshland functions as a filter for any pollutants that are picked up from agriculture and the fish farm facilities.

Potential Targets

Pollutants into Jacks Creek come from the following:

- Agricultural sources that discharge their irrigation tailwater into the system.
- The Ace and Arraina fish hatchery facilities. However, as noted in section 2.4, at least 85% of their effluent is used for cropland irrigation.
- Surface runoff due to storm water discharges. These events have the tendency to cause a "flushing" condition under certain circumstances, but unless these particularly high flow storm events occur, little flushing occurs in Jacks Creek.

3. Summary of Field Activities and Analytical Protocol

Field activities and analytical protocols used for sampling for the TMDL modification of Jacks Creek are described in section A-1 of Appendix A, including the following:

- Sampling for surface soils
- Subsurface stream sediments
- Ground water artesian well water
- Surface water and flow measurements
- NPDES fish hatchery influent/effluent
- Analytical protocols and procedures
- Global positioning system
- Investigation-derived waste

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4. Summary of Quality Assurance / Quality Control

Quality assurance/quality control (QA/QC) measures of the used in the Jacks Creek TMDL modification are described in the sections A-2 through A-10 of Appendix A, including the following:

- Data quality objectives (DQOs)
- QA/QC samples
- Project-specific DQOs for precision, accuracy, completeness, representativeness, and comparability,
- NPDES influent/effluent data DQOs
- Conclusions derived about the DQOs.

Section A-11 provides a summary of QA/QC measures.

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5. Results

Results from the sampling for this technical support document are reported in the following, including evaluation criteria, surface water quality results, substrate streambed results, artesian well water quality results, surface soil results, fish hatchery influent/effluent results and proposed reductions, and the habitat assessment of the Jacks Creek channel.

5.1 Evaluation Criteria Results

Results presented in this document show all parameters detected above laboratory detection limits. No qualifications were required by the DEQ Chemist for any parameters. In addition, the DEQ Chemist assessed the criteria for all the data analyzed by the various laboratories and determined the following:

- Analytical protocols and procedures for the field parameters of the ground water and surface water samples (as described in Table 26, page 57) were met for all parameters. No qualifications of the data were required.
- Analytical protocols and procedures for laboratory parameters of ground water and surface water samples (as described in Table 27, page 58) were met for all parameters. No qualifications of the data were required.
- Analytical protocols and procedures for laboratory parameters of surface soils and substrate sediment samples (as described in Table 28, page 58) were met for all parameters. No qualifications of the data were required.

5.2 Surface Water Quality Results

DEQ surface water quality monitoring was conducted more extensively during the irrigation season, from March to September 2004, for flow (Q), TSS, TP, Total Coliform, *E. coli*, temperature, dissolved oxygen, specific conductivity, pH, total dissolved solids, turbidity, chlorophyll-a, and dissolved oxygen % saturation.

Coordination with ISCC and private landowners allowed for additional monitoring, from December 2001 through January 2004, for Q, TSS, TP, Total Coliform, and *E. coli*, providing additional data for analysis.

Table 5 summarizes the Q and laboratory parameters and describes existing conditions on Jacks Creek.

Table 5. Summary of mean flow and mean laboratory parameters of sampling locations (2001-2004).

Monitoring Location	Mean Q cfs (2004)	Mean TSS mg/L (2001-2004)	Mean TP mg/L (2001-2004)	Mean Total Coliform CFU/100 mL (2001-2004)	Mean *E. coli* CFU/100 mL (2001-2004)
7-Wetland	12.58 a	9.2 a	0.300 a	8,984 a	448 a
7-Main	13.00 a	81.4 b	0.241 a	29,867 ab	2,454 b
6-Highway 78	9.81 ab	66.2 b	0.258 ab	41,438 bc	3,542 bc
5-Davis	6.11 bc	27.1 c	0.199 ac	9,608 ad	180 a
4-Cattle Drive	5.41 c	31.4 c	0.202 ac	15,600 abde	728 ab
3-Selman	0.79 d	20.5 c	0.179 ac	10,327 ade	420 a
2-Shoo Fly	0.30 de	26.3 ac	0.211 abc	7,970 de	660 ab
1-Vaught	0.41 ef	70.3 abc	0.274 abc	138,000 abce	10,725 abc
0-USGS Weir	0.00 f	-	-	-	-
Little Jacks	0.00 f	-	-	-	-
Big Jacks	0.00 f	-	-	-	-
Big JacksC 1967-1995	0.07-229.55D (114.77)	4.7E	0.170F	-	189G
OVERALL SUMMARY STATISTICS					
N	100	115	115	104	104
Mean (2001-2004)	4.40	41.5	0.233	32,724	2,395
Min	0.00	9.2	0.179	7,970	180
Max	13.00	81.4	0.300	138,000	10,725
95th Percentile	12.79A/ 12.85B	77.5	0.291	104,203	8,211
70th Percentile	9.81H	68.7	0.268	36,810	3,107
SD	3.44	26.8	0.109	30,250	3,386
CV %	59.7%	96.8%	45.7%	91.2%	141.4%

Q = Flow. TSS = Total Suspended Sediment. TP = Total Phosphorus. cfs = cubic feet per second. mg/L = milligram per liter. cfu = colony forming unit. E. coli = Escherichia coli.
Alphabetical letters in small caps (a – e) is a designation indicating No Significance in the mean value with other values of the same alphabetical letter; that is, the values with the same alphabetical letter are statistically the same. Significance was established using a standard t-Test based on unpaired values, 2-tailed test, with heterodescacity.
Alphabetical letters in large caps (A-H) are footnotes.
A: 12.79 cfs is the 95th Percentile for all of the mean values from the monitoring sites including the zero values for 2004.
B: 12.85 cfs is the 95th Percentile for all of the mean values from the monitoring sites excluding the zero values for 2004.
C: Big Jacks Creek historical flow information from 1967-1995 is from Mast and Clow (2000).
D: 0.07-229.55 cfs is equivalent to the range in flow from 1967 to 1995. Flow in parenthesis (114.77 cfs) equates to the mid-range value of the range in flow from 1967 to 1995.
E: TSS value estimated by the algorithm TSS = (NTU – 6.8447)/1.1939, which is derived from the 2004 monitoring average values per site and applied on the Big Jacks Creek data for TDS, which was determined by the reverse algorithm in Table 4, footnote D.
F: TP value estimated by the algorithm TP = (-0.00002 x TSS2) + (0.0026 x TSS) + 0.1581, r2 = 0.6075, which is derived from the 2004 monitoring average values per site and applied on the Big Jacks Creek data for TSS (See Table 3, footnote E).
G: ECOLI value estimated by the algorithm ECOLI = (-0.3444 x TSS2) + (60.584 x TSS) – 88.195, r2 = 0.2685, which is derived from the 2004 monitoring average values per site and applied on the Big Jacks Creek data for TSS (See Table 3, footnote E).
H: 9.81 cfs is the 70th Percentile of all of the mean values from the monitoring sites including the zero values for 2004. This does NOT represent the statistically 70th Percentile flow that eventually discharges into the C. J. Strike Reservoir. The 70th Percentile flow of sites 7-Wetland and 7-Main (or 17.49 cfs) is a more accurate representation of such flows.

5.2.1 Flow

Flow from Little Jacks Creek and Big Jacks Creek was insufficient to go past the USGS Weir (Site 0) during the 2004 monitoring season. Discussion with various farmers and ISCC personnel indicated that spring runoff did indeed occur and passed the 0-USGS Weir site during the month of March—earlier than when sampling occurred.

The spring runoff event happened during a three-day period but left the three channels (Little Jacks, Big Jacks, and upper Jacks Creeks) as ephemeral waterbodies. Therefore, flows during the irrigation season were generally derived from the artesian geothermal wells beginning on private land adjacent to Jacks Creek (starting with Site 1-Vaught).

This continued through each sampling site (2-Shoo Fly through 7-Main). Once entering the wetland area (7-Wetland), the wetland either absorbs water from Jacks Creek or else diffuses water into Jacks Creek before discharging into C. J. Strike Reservoir.

> *Note*: 12.58 cfs at 7-Wetland is < 13.00 cfs at 7-Main. Statistically, 12.58 cfs is approximately equivalent to 13.00 cfs based on a standard t-test.

The wildlife management area (where 7-Wetland exists) functions as a sink for sediment (Table 10: 9.2 mg/L TSS is < 81.4 mg/L TSS and statistically different) and bacteria (Table 3: 448 cfu/100 mL *E. coli* is < 2,454 cfu/100 mL *E. coli* and statistically different) before the discharge from Jacks Creek into the C. J. Strike Reservoir. Phosphorus remains relatively unchanged since 0.300 mg/L TP at 7-Wetland is statistically similar or equivalent to 0.241 mg/L TP at 7-Main.

Of interest is the historical flow information on Big Jacks Creek (1967-1995; from Mast and Clow 2000). This historical flow indicates a range from 0.07 cfs to 229.55 cfs, or a mid-range value of 114.77 cfs, which is indicative of variable stream flow fluctuations due to storm water events. These high flow fluctuations (or high flow pulses as a consequence of storm events) are characteristic of Big Jacks Creek as a natural variant stream (relative to flow) past the spring baseflow area in the stream channel, which is eventually lost to evaporation or subbing out within the alluvium of the stream.

5.2.2 Total Suspended Sediment (TSS)

TSS mean values range from 9.2 to 81.4 mg/L, with an overall mean of 41.5 mg/L. The monitoring sites that show values less than the previous site are due to slow moving water and the dropout of suspended sediment into the substrate.

Figure 3 summarizes the polynomial regression analysis of the TSS against the river mile (RM) monitoring site, which has a strong regression (r^2 = -0.8233). Of interest is the TSS value for Big Jacks Creek, which is an estimated value derived from the 2004 monitoring data and applied to the association (or relationship) between TSS and NTU. The estimated TSS value in Big Jacks Creek is much lower than the values shown for Jacks Creek.

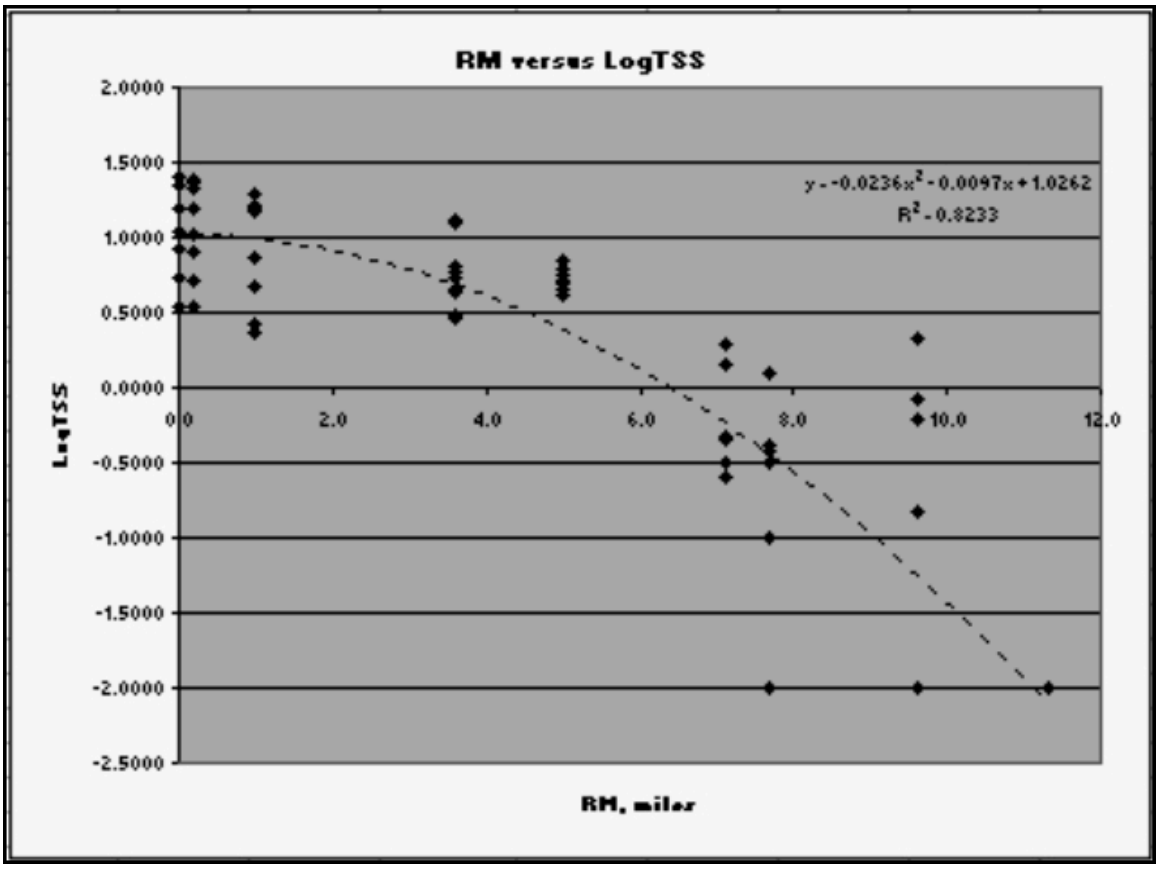


Figure 3. RM versus LogTSS on Jacks Creek 2004 Monitoring.

5.2.3 Total Phosphorus (TP)

TP mean values range from 0.179 to 0.300 mg/L TP, with an overall mean of 0.233 mg/L. Like TSS, the monitoring locations that show values less than the previous site are possibly due to the slow moving water and the tendency for the TP to attenuate with the TSS that is dropping out into the substrate.

Figure 4 summarizes the polynomial regression analysis of TP against the river mile (RM) monitoring site, which has a weak regression (r^2 = -0.1412). Of interest is the TP value for Big Jacks Creek, which is an estimated value derived from the 2004 monitoring data and applied to the association (or relationship) between TSS and TP. The estimated TP value in Big Jacks Creek is much lower than the values shown for Jacks Creek.

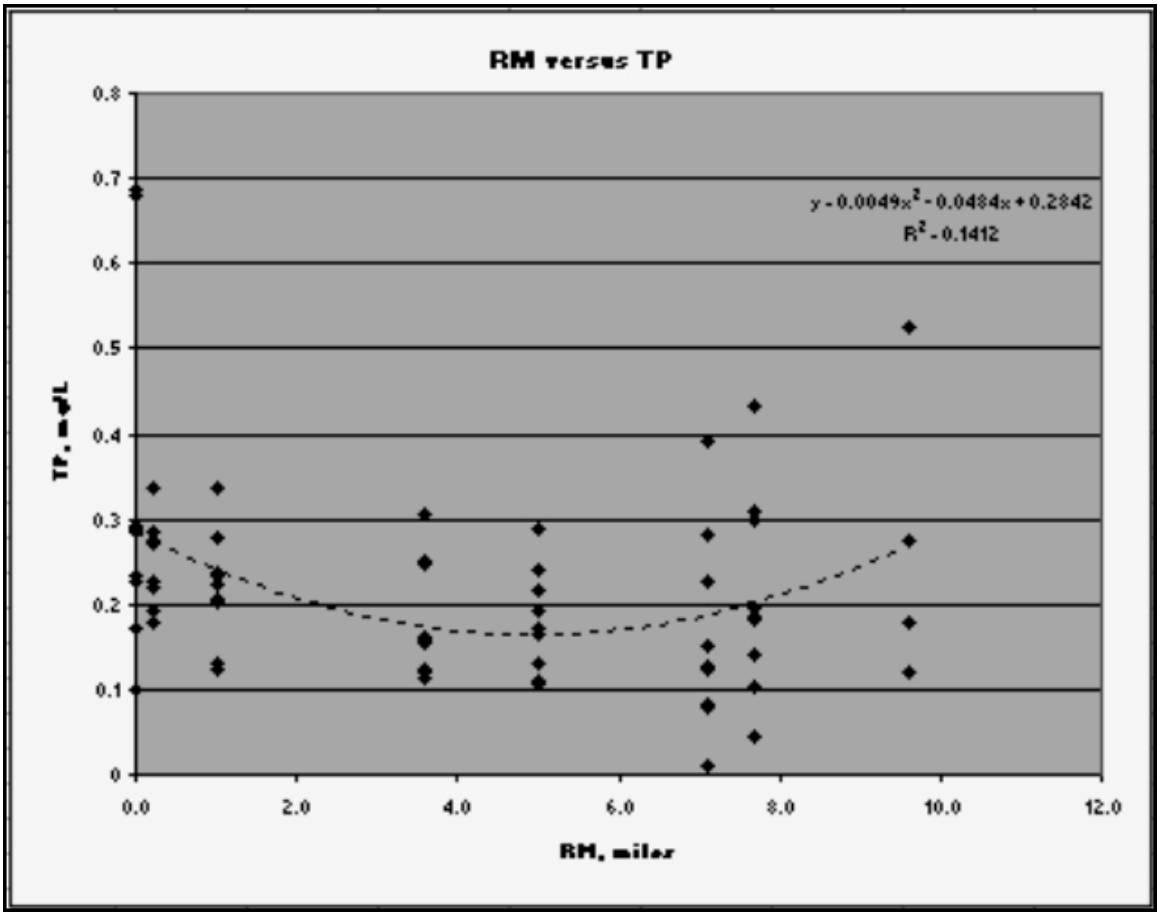


Figure 4. RM versus TP on Jacks Creek 2004 Monitoring.

5.2.4 Total Coliform

Total Coliform mean values range from 5,753 to 240,000 cfu/100 mL, with an overall mean of 32,724 cfu/100 mL. Like TSS, the monitoring location sites that show values less than the previous site are possibly due to the slow moving water and the tendency for the bacteria to attenuate with the TSS that is dropping out into the substrate.

Figure 5 summarizes the polynomial regression analysis of the Total Coliform against the river mile (RM) monitoring site, which has a weak regression (r^2 = -0.2605). As shown in Figure 5, the Total Coliform bacteria starts high at Site 1-Vaught; then decreases through Jacks Creek; and finally shows a marginal increase at Site 7-Main with a decrease in Site 7-Wetland.

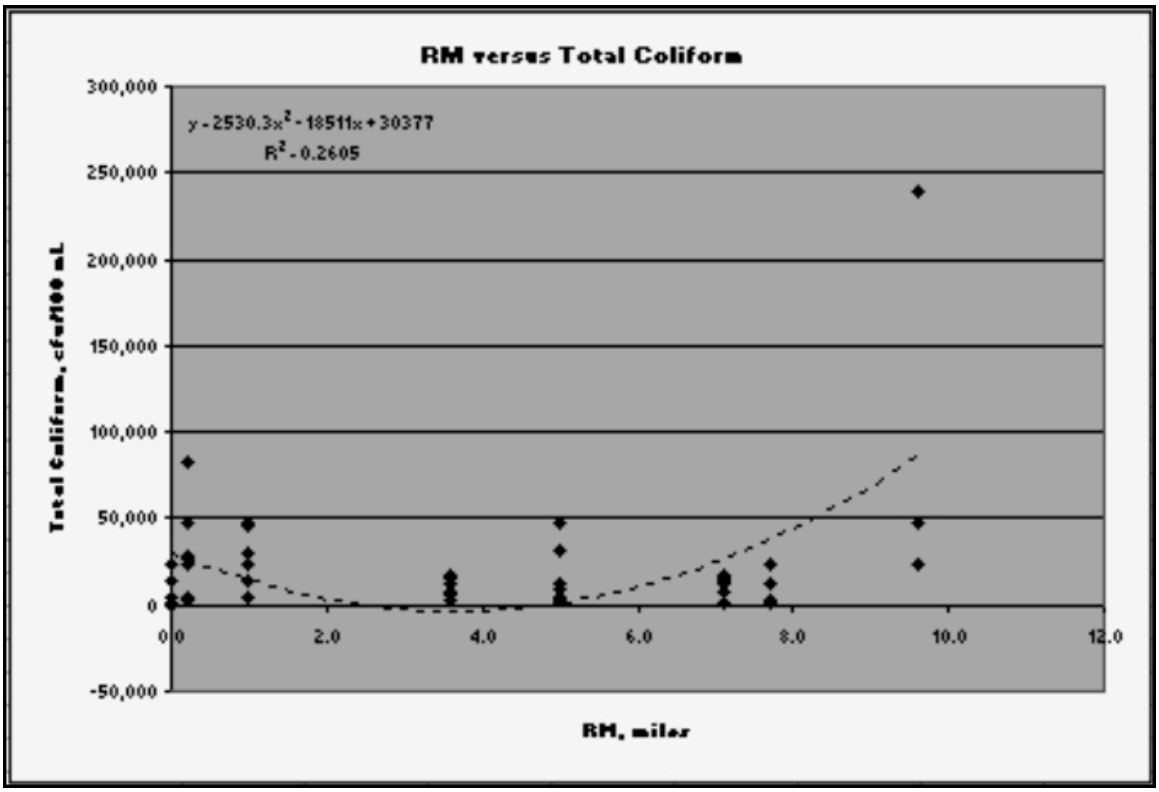


Figure 5. RM versus Total Coliform on Jacks Creek 2004 Monitoring.

5.2.5 *Escherichia coli*

Escherichia coli mean values range from 180 to 10,725 cfu/100 mL, with an overall mean of 2,395 cfu/100 mL. Like TSS, the monitoring location sites that show values less than the previous site are possibly due to the slow moving water and the tendency for the bacteria to attenuate with the TSS that is dropping out into the substrate.

Figure 6 summarizes the polynomial regression analysis of the Total Coliform against the river mile (RM) monitoring site, which has a weak regression (r^2 = -0.1530). Of interest is the *E. coli* value for Big Jacks Creek, which is an estimated value derived from the 2004 monitoring data and applied to the association (or relationship) between TSS and *E. coli*. The estimated *E. coli* value in Big Jacks Creek is similar the values shown for Jacks Creek at the 5-Davis monitoring site (which is the site where best management practices have been applied).

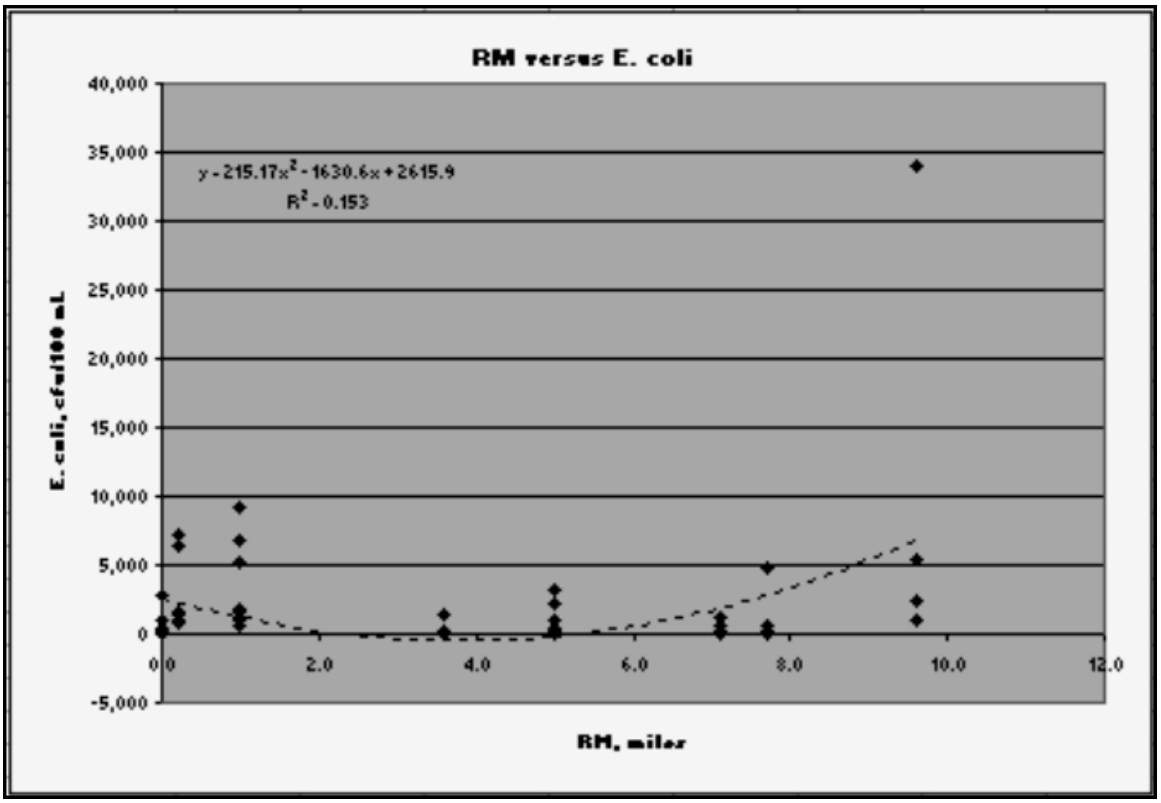


Figure 6. RM versus Escherichia coli on Jacks Creek 2004 Monitoring.

Table 6 summarizes results for the standard field parameters analyzed with the multi-probe Hydrolab/Quanta instrument:

- temperature (TEM), dissolved oxygen (DO)
- specific conductivity (SC)
- pH
- total dissolved solids (TDS)
- turbidity (TURB)
- chlorophyll-a (CHLOR)
- dissolved oxygen % saturation (DO% SAT)

Salinity was recorded using the Quanta instrument, but not reported.

Table 6. Mean values of field parameters from monitoring locations (2001-2004).

Monitoring Site	TEM °C	DO mg/L	SC µmhos/cm	pH SU	TDS g/L	TURB NTU	CHLOR mg/L	DO% SAT
7-Wetland	15.21	5.50	1211.4	7.39	0.7713	25.3	3.5	52.2
7-Main	16.05	9.99	1545.3	7.51	0.9674	59.8	2.7	96.9
6-Highway 78	15.87	11.62	1538.3	7.80	0.9614	40.1	3.6	116.7
5-Davis	18.81	10.20	599.3	8.07	0.3640	26.1	3.6	110.2
4-Cattle Drive	18.50	9.70	622.3	7.85	0.3886	19.2	5.6	100.5
3-Selman	16.15	10.23	1007.1	7.70	0.6295	39.1	2.4	104.0
2-Shoo Fly	16.67	8.65	598.9	7.41	0.3678	33.1	5.7	82.2
1-Vaught	24.93	6.93	332.2	8.28	0.2001	124.7	4.4	85.2
0-USGS Weir	-	-	-	-	-	-	-	-
Little Jacks	-	-	-	-	-	-	-	-
Big Jacks	-	-	-	-	-	-	-	-
Big JacksA 1967-1995	-	-	5.2B	5.6B	0.0003C	12.5D	-	-
OVERALL SUMMARY STATISTICS								
N	70	70	70	70	70	70	70	70
Mean	17.20	9.17	977.9	7.71	0.6108	39.6	3.9	93.1
Min	8.28	0.61	261.5	6.46	0.1600	0.0	0.0	3.0
Max	32.81	16.66	2105.0	8.76	1.3500	271.6	30.6	176.2
95th PercentileE	24.47	13.57	1894.6	8.62	1.2151	116.5	10.9	152.3
70th PercentileF	19.46	10.62	1211.5	7.82	0.7592	42.9	4.5	104.8
SD	5.00	3.12	495.0	0.47	0.3202	49.8	4.6	33.6
CV %	29.1%	34.0%	50.6%	6.1%	52.4%	125.9%	117.4%	36.1%

TEM = Temperature. DO = Dissolved Oxygen. SC = Specific Conductivity. SU = Standard Units. TDS = Total Dissolved Solids. TURB = Turbidity. NTU = Nephelometric Turbidity Units. CHLOR = Chlorophyll. DO% SAT = Dissolved Oxygen % Saturation. Alphabetical letters in large caps (A-F) are footnotes.

A: Big Jacks Creek historical information from 1967-1995 is from Mast and Clow (2000).

B: Values for SC and pH are volume-weighted mean concentrations.

C: TDS value estimated by the algorithm TDS = (0.0006 x SC) 0.0105, r2 = 0.9996, which is derived from the 2004 monitoring average values per site and applied on the Big Jacks Creek data for SC to determine TDS.

D: NTU value estimated by the algorithm NTU = (34.819 x TDS) + 12.537, r2 = 0.4946, which is derived from the 2004 monitoring average values per site and applied on the Big Jacks Creek data for TDS, which was determined by the algorithm in C.

E: The 95th Percentile represents the values for the 2004 monitoring season.

F: The 70th Percentile represents the values for the 2004 monitoring season.

An immediate observation is that the 7-Wetland location filters SC, TDS and TURB, when compared to the 7-Main site, prior to discharge into the C. J. Strike Reservoir. It also reduces the TEM, DO, pH and DO% SAT values, while CHLOR essentially remains unchanged (2.7 mg/L CHLOR ≅ 3.5 mg/L CHLOR).

A more detailed discussion of the results for each of the field parameters is presented in the following:

- *Temperatur*e. Instantaneous temperature readings are highest in the 1-Vaught site—ranging from 15.87 to 18.81°C for 2-Shoo Fly through 7-Main—but are slightly dissipated for 7-Wetland site (5.2% reduction in temperature). The higher temperature readings correlate to the artesian geothermal well sources that discharge into Jacks Creek as irrigation tailwater during the irrigation season.

  Meeting temperature standards for cold water aquatic life are impractical because, historically, the only water in Jacks Creek after the spring melt is the water from the artesian geothermal wells. In those high flow years when flows from Little Jacks Creek or Big Jacks Creek is prolonged past the spring runoff (as spring freshet), temperature readings may be lowered; but high flow years are not the normal flows in Jacks Creek.

  In effect, Little Jacks Creek and Big Jacks Creek are hydrologic ephemeral streams, responding directly to storm events or spring melt. (Note that Big Jacks Creek has headwater springs as the source water, but the water flow subs out in the channel due to high rates of evaporation and infiltration into the valley alluvium prior to the USGS gage [Mast and Clow 2000].)

  Consequently, beneficial uses for Jacks Creek are best defined under a modified water regime and not a cold water regime.

- *Dissolved Oxygen (DO) and DO % Saturation*. Instantaneous DO readings range from 6.93 to 11.62 mg/L, or an average of 9.62 mg/L for 1-Vaught to 7-Main. 7-Wetland has a value of 5.50 mg/L. Average reduction in DO in the wetland coming in from Jacks Creek is 42.8%, which is characteristic of organic, wetland soils. In addition, DO% saturation ranges from 82.2% to 116.7%, or an average of 99.4% for 1-Vaught to 7-Main. For 7-Wetland, DO% saturation is 52.2%, or reduced by 47.5% prior to discharge into C. J. Strike Reservoir.

- *Specific Conductivity (SC)*. SC ranges from 332.2 µmhos/cm (1-Vaught) to 1545.3 µmhos/cm (7-Main), or an increase of 4.65 times from upstream to downstream. SC concentration increasing upstream to downstream indicates more soluble salts are being introduced into Jacks Creek by agricultural dischargers. At 7-Wetland, there is a 21.6% reduction in SC prior to discharge into C. J. Strike Reservoir.

- *pH*. The pH ranges from 7.41 to 8.28 for 1-Vaught to 7-Main. Once the water gets to 7-Wetland, pH tends to drop (pH 7.39) as a direct characteristic of the wetland. In fact, the range of pH values in 7-Wetland site ranged from 6.99 to 7.99, with the majority of the values being less than 7.50.

- *Total Dissolved Solids (TDS)*. TDS ranges from 0.2001 g/L at 1-Vaught to 0.9674 g/L at 7-Main, or an increase of 4.83 times upstream to downstream. TDS concentration increases upstream to downstream indicate that dissolved solids are being introduced by agricultural

dischargers. At 7-Wetland site, there is a 20.3% reduction in TDS prior to discharge into C. J. Strike Reservoir.

- *Turbidity (NTU)*. NTU ranges from 19.2 to 124.7 NTU, or an average of 47.1, for 1-Vaught to 6-Highway 78. Based on field investigations of each monitoring site (during the 2004 monitoring season) and their water sources, the range in NTU is due, in part, to application of agricultural best management practices by the private landowners. In general, NTU values < 30.0 NTU (such as at 4-Cattle Drive and 5-Daves) are a direct result of practices that reduce erosion and sedimentation from farmlands. Unfortunately, that is not the situation above and below these areas. For 7-Main and 7-Wetland, NTU ranges from 25.3 to 59.8 NTU, or an average of 42.6. The average NTU reduction into the wetland area is 9.6% prior to discharge into C. J. Strike Reservoir.
- *Chlorophyll-a (CHLOR)*. CHLOR, as a measure of primary productivity, has values that are all less than 10.0 mg/L. The range in values is from 2.4 to 5.7 for 1-Vaught to 6-Highway 78, or an average of 4.2 mg/L. For 7-Main and 7-Wetland, CHLOR ranges from 2.7 to 3.5 mg/L, or an average of 3.1 mg/L. Average CHLOR reduction into the wetland area is 26.2% (3.1 / 4.2 x 100%) prior to discharge into C. J. Strike Reservoir.

5.3 Substrate Streambed Results

Substrate streambed results, using the monitoring locations discussed, are summarized in Table 39, page 67. These results were compared to Big Jacks Creek USGS gage. In addition, a sample collected just below the irrigation weir represents the "headwaters" to Jacks Creek.

Little Jacks Creek was not sampled as it provides very little water to Jacks Creek in comparison to Big Jacks. The sample below the weir and the sample on Big Jacks Creek served as background samples. Samples 1 through 7-W are directly influenced by agricultural activities.

Average values for samples 1 through 7-W versus the two background samples are summarized in Table 7.

Table 7. Average substrate streambed values for locations 1 – 7-W compared to background samples.

Analyte	Location 1-7-W	Background
pH, SU	7.26	7.80
OM % (Organic Matter)	1.71	0.60
Lime %	1.34	0.60
Texture	Loamy Sand	Loam
Sand %	78.8	38.5
Silt %	16.9	49.6
Clay %	4.3	11.9
Total P, ppm	868.4	563.0
Background		
Olsen P, ppm	10.3	9.0
Water P, ppm	6.9	4.0

The values indicate several features about the streambed substrates of Jacks Creek:

- Substrate pH indicates that the background mean sample is slightly alkaline (pH 7.80), whereas the sample mean influenced by irrigated agricultural runoff is near-neutral (pH 7.26).
- Organic matter of the substrates indicates that the background samples contain 64.9% less organic matter than the samples influenced by irrigated agricultural runoff.
- Excess lime content of the substrates indicates that the background samples contain 55.2% less lime than the samples influenced by irrigated agricultural runoff.
- Texture of the substrates indicates that the background samples are of a loam condition whereas the samples influenced by irrigated agriculture are of a loamy sand condition. This is demonstrated by sand content, which is two times greater in the irrigated agricultural samples than the background samples. Silt and clay contents are 65.9% less and 63.9% less, respectively, in the agricultural samples.
- Total mineral and organic phosphorus content is 35.2% lower, the Olsen P is 10.0% lower, and the water-soluble P is 42.0% lower in background samples compared to the irrigated agricultural samples of locations 1-7-W. This increase in the irrigated agricultural samples cannot be solely attributed to the artesian well water sources, which are shown in the next section to contribute a minimal amount of phosphorus to the system.

One additional component that needs to be considered and researched is the effects of artesian well temperature (29.91-37.72°C; see Table 40, page 68) on the streambed substrate of Jacks Creek. The higher temperature of the artesian water could potentially extract the insoluble phosphorus from the substrate and render it soluble in the stream water. This extraction effect was not considered in this TMDL modification due to project resource constraints.

5.4 Artesian Well Water Quality Results

A number of artesian well sites were sampled above and below the fish facilities to ascertain the general water-quality condition of temperature and total phosphorus. In addition, the USGS-Boise office has collected artesian well information from additional sites along Jacks Creek (USGS 1970). The results are summarized in Table 40, page 68.

5.4.1 Temperature

The temperature data indicate unequal variances because 1.17 (the variance of temperature for wells below the fish hatcheries) is much smaller than 11.70 (the variance of temperature for wells above the fish hatcheries).

A t-test of two-sample means (assuming unequal variances) was performed. The t-statistic that was determined (-7.82) was less than the P-value (1.94) at the p=0.05 level, which indicates that the means are not different but are essentially similar or equivalent. Therefore, it may be concluded, based on temperature alone, that the temperature of the artesian samples above and below the fish facilities are essentially similar or equivalent (based on the number of samples collected). Thus, the mean temperature (34.68°C) for the wells below the fish hatcheries is equivalent to the mean temperature (34.43°C) for the wells above the fish hatcheries.

5.4.2 TP

TP data indicates equal variances because 0.000 (the variance of TP for wells below the fish hatcheries) is equal to 0.000 (the variance of TP for wells above the fish hatcheries); or the variances are small enough that equal variances can be assumed.

A t-test of two-sample means assuming equal variances was performed. The t-statistic determined (-7.65) was less than the P-value (1.81) at the p=0.05 level, which indicates that the means are not different but are essentially similar or equivalent. Therefore, it may be concluded that the TP of the artesian samples above the fish facilities versus the TP of the artesian samples below the fish facilities are essentially similar or equivalent (based on the number of samples collected). Thus, the mean TP (0.017 mg/L) for the wells below the fish hatcheries is equivalent to the mean TP (0.017 mg/L) for the wells above the fish hatcheries.

5.4.3 Conclusions

Based on the temperature and TP artesian geothermal well samples above and below the fish facilities, it may reasonably be concluded that the artesian water source appears to be from one similar source since the temperature and TP are similar or equivalent. So the mean concentration of TP (0.017 mg/L) translates into 0.04624 lb TP/acre-foot of water applied or 1.419×10^{-7} lb TP/gallon. (One-acre foot of water is enough water to cover one acre of land one foot deep.)

Therefore, the amount of TP applied from the artesian source is very small and insufficient to account for the TP concentration that exists in the Jacks Creek water during the irrigation season. The only other source of water is from irrigation that enters Jacks Creek as tailwater at various locations from the number of irrigated agricultural farms.

5.5 Surface Soil Results

Table 41, page 69, summarizes the laboratory analysis of the only surface soil sample (0-3") collected from the Jacks Creek drainage along the uplands portion within 100 feet of the stream.

No crops are grown in this soil because of the visible saline-alkali conditions that exist. Crops are grown only in those areas where this soil type is not present or where the soil has been drained of tabled water due to the marshland type conditions.

Table 41 shows that this loamy-sandy soil to be similar to a mud flat (Saltic Fluvisol) with sand content of 72-85%, silt content of 11-25%, and clay content of 3-4%. Additionally, it is also similar to a marshland with clay content of 2-6%, an organic matter content of 0.5-10%, and a lime content of 3-8%.

In particular, at the wetland-marshland location (7-Wetland) near the mouth, surface soil conditions are quite visible and indicative of a salty, high-mineral soil. This soil shows signs of a high water table with salt permeating to the surface as white sodium chloride. Potential natural vegetation in these alkaline foothills is predominantly sagebrush (*Artemisia*) steppe, inland saltgrass (*Distichlis spicata*), saltbush (*Atriplex*) community, desert seepweed (*Suaeda suffrutescens*), and greasewood (*Sarcobatus vermiculatus*).

5.6 Fish Hatchery Influent/Effluent Results and Proposed Reductions

Table 38, page 67, summarizes the fish hatchery influent/effluent results from the discharge monitoring reports (DMRs) for their NPDES permits. Net values are modified to reflect the average conditions summarized in the influent and effluent results. Consequently, we may describe the following load characteristics (as existing conditions) from the various parameters (i.e. TSS, TP and *E. coli*) along with the proposed TMDL reductions:

- *Flow.* Flow decreases in both facilities prior to discharge. Table 8 summarizes the decrease: 1.1 cfs for Arraina and 1.0 cfs for Ace Development:

Table 8. Flow decrease for Arraina and Ace prior to discharge.

Facility Name	Influent Flow (cfs)	Effluent Flow (cfs)	ExistingNet Flow (cfs)
Arraina	5.5	4.4	1.1
Ace Development	3.7	2.7	1.0
Total	9.2	7.1	2.1

- *Temperature*. Water temperature decreases in both facilities prior to discharge of their effluent. Table 8 summarizes this apparent temperature decrease as a net 8.00 °C for Arraina and a net 11.92 °C for Ace Development:

Table 9. Temperature decrease for Arraina and Ace prior to discharge.

Facility Name	Influent °C	Effluent °C	ExistingNet °C
Arraina	36.00	28.00	8.00
Ace Development	37.47	25.55	11.92
Mean	36.74	26.78	9.96

- *Total Phosphorus*. Total phosphorus (TP) increases in both facilities' effluent prior to discharge. Table 10 summarizes this net increase in TP as 0.223 mg/L for Arraina and 0.331 mg/L for Ace Development.

Table 10. Total phosphorus concentration increase for Arraina and Ace prior to discharge.

Facility Name	Influent TP (mg/L)	Effluent TP (mg/L)	Existing Net TP (mg/L)
Arraina	0.012	0.235	0.223
Ace Development	0.020	0.351	0.331
Mean	0.016	0.293	0.277

The estimated existing net load for both facilities is shown in Table 11.

Table 11. Total phosphorus concentration net load for Arraina and Ace.

Facility Name	Net TP (mg/L)	Effluent Flow (cfs)	Existing Net TP Load (lb/day)
Arraina	0.223	4.4	5.3
Ace Development	0.331	2.7	4.8
Total		7.1	10.1
Arraina Influent TP = 0.012 mg/L TP (from Table 10) x 4.4 cfs x 5.4 = 0.29 lb/day TP. Effluent TP = 0.235 mg/L TP (from Table 10) x 4.4 cfs x 5.4 = 5.58 lb/day TP. Ace Development Influent TP = 0.020 mg/L TP (from Table 10) x 2.7 cfs x 5.4 = 0.29 lb/day TP. Effluent TP = 0.351 mg/L TP (from Table 10) x 2.7 cfs x 5.4 = 5.12 lb/day TP. Arraina Influent + Ace Development Influent = 0.29 + 0.29 = 0.58 lb/day TP			

Based on a concentration net TP target of 0.200 mg/L for a warm water fishery, Table 12 shows the estimated reductions per facility needed to achieve the target net TP load.

Table 12. Arraina and Ace TP reductions needed to achieve target net TP load.

Facility Name	Net TP Target (mg/L)	Effluent Target Net Flow (cfs)	Effluent Target Net TP Load (lb/day)	Net TP Load Reduction (%)
Arraina	0.200	4.4	4.8	9.4
Ace Development	0.200	2.7	2.9	39.6
Total		7.1	7.7	
Arraina TP Net Load: 0.200 mg/L TP x 4.4 cfs x 5.4 = 4.75 lb/day TP = 4.8 lb/day TP Ace TP Net Load: 0.200 mg/L TP x 2.7 cfs x 5.4 = 2.92 lb/day TP = 2.9 lb/day TP				

- *Total Suspended Sediment*. Total suspended sediment (TSS) increases in both facilities' effluent prior to discharge. Table 13 summarizes this increase as net 16.6 mg/L for Arraina and 25.6 mg/L for Ace Development.

Table 13. Total suspended sediment increase for Arraina and Ace prior to discharge.

Facility Name	Influent TSS (mg/L)	Effluent TSS (mg/L)	Existing Net TSS (mg/L)
Arraina	1.1	17.7	16.6
Ace Development	1.0	26.6	25.6
Total	1.05	22.15	21.1

The estimated net load for both facilities is shown in Table 14.

Table 14. Net suspended sediment load for Arraina and Ace.

Facility Name	Net TSS (mg/L)	Effluent Flow (cfs)	Existing Net TSS Load (lb/day)
Arraina	16.6	4.4	394.4
Ace Development	25.6	2.7	373.2
Total	-	7.1	767.2
Arraina TSS Load: 16.6 mg/L TSS x 4.4 cfs x 5.4 = 394.4 lb/day. The influent TSS load (based on 4.4 cfs) = 1.1 mg/L TSS (from Table 13) x 4.4 cfs x 5.4 = 26.1 lb/day TSS. The effluent TSS load (based on 4.4 cfs) = 17.7 mg/L TSS (from Table 13) x 4.4 cfs x 5.4 = 420.6 lb/day TSS. Ace TSS Load: 25.6 mg/L TSS x 2.7 cfs x 5.4 = 373.2. The influent TSS load (based on 2.7 cfs) = 1.0 mg/L TSS (from Table 13) x 2.7 cfs x 5.4 = 14.6 lb/day TSS. The effluent TSS load (based on 2.7 cfs) = 26.6 mg/L TSS (from Table 13) x 2.7 cfs x 5.4 = 387.8 lb/day TSS.			

Based on a concentration net TSS target of 15.0 mg/L for a warm water fishery, Table 15 shows the estimated reductions per facility, from the existing net TSS load, to achieve the target net TSS load. The effluent flow is based on 4.4 cfs for Arraina and 2.7 cfs for Ace Development.

Table 15. Estimated net TSS load reductions needed for Arraina and Ace to achieve target TSS.

Facility Name	Existing Net TSS Load (lb/day)	Net TSS Target (mg/L)	Target TSS Load (lb/day)	Net TSS Load Reduction (%)
Arraina	394.4	15.0	356.4	9.6
Ace Development	373.2	15.0	218.7	41.4
Total	767.2	15.0	575.1	25.0

- *Total Ammonia Nitrogen*. Total ammonia nitrogen (TAN) increases in both facilities' effluent prior to discharge. Table 16 summarizes this increase as net 0.325 mg/L for Arraina and 0.586 mg/L for Ace Development.

Table 16. Net increase in total ammonia nitrogen for Arraina and Ace prior to discharge.

Facility Name	Influent TAN Concentration (mg/L)	Effluent TAN Concentration (mg/L)	Existing Net TAN Concentration (mg/L)
Arraina	0.025	0.350	0.325
Ace Development	0.031	0.617	0.586
Total	0.028	0.484	0.456

The estimated net load for both facilities is shown in Table 17.

Table 17. Estimated net total ammonia nitrogen load for Arraina and Ace.

Facility Name	Net TAN (mg/L)	Effluent Flow (cfs)	Existing Net TAN Load (lb/day)
Arraina	0.325	4.4	7.72
Ace Development	0.586	2.7	8.54
Total		7.1	16.26

No TAN reductions are proposed at this time through the TMDL process.

- *Total Nitrate + Nitrite*. Total nitrate + nitrite (NOX) increases by the time the facilities discharge their effluent. Table 18 summarizes this increase as net 0.040 mg/L for Arraina and 0.043 mg/L for Ace Development.

Table 18. Total nitrate + nitrite increase for Arraina and Ace prior to discharge.

Facility Name	Influent NOX (mg/L)	Effluent NOX (mg/L)	Existing Net NOX (mg/L)
Arraina	0.240	0.280	0.040
Ace Development	0.253	0.296	0.043
Mean	0.247	0.288	0.042

The estimated net load for both facilities is shown in Table 19.

Table 19. Estimated net nitrate + nitrite load for Arraina and Ace.

Facility Name	Net NOX (mg/L)	Effluent Flow (cfs)	Existing Net NOX Load (lb/day)
Arraina	0.040	4.4	0.95
Ace Development	0.043	2.7	0.63
Total		7.1	1.58

No NOX reductions are proposed at this time through the TMDL process.

- *Total Kjeldahl Nitrogen*. Total Kjeldahl nitrogen (TKN) increases by the time the facilities discharge their effluent. Table 20 summarizes this increase as net 1.005 mg/L for Arraina and 1.301 mg/L for Ace Development.

Table 20. Total Kjeldahl nitrogen increase for Arraina and Ace prior to discharge.

Facility Name	Influent TKN Concentration (mg/L)	Effluent TKN Concentration (mg/L)	Existing Net TKN Concentration (mg/L)
Arraina	0.039	1.044	1.005
Ace Development	0.049	1.350	1.301
Total	0.044	1.197	1.153

The estimated net load for both facilities is shown in Table 21.

Table 21. Estimated net total Kjeldahl nitrogen load for Arraina and Ace.

Facility Name	Net TKN (mg/L)	Effluent Flow (cfs)	ExistingNet TKN Load (lb/day)
Arraina	1.005	4.4	23.88
Ace Development	1.301	2.7	18.97
Total		7.1	42.85

No TKN reductions are proposed at this time through the TMDL process.

5.7 Habitat Assessment of Jacks Creek Corridor

On May 18, 2004 a generalized habitat assessment was performed, as a reconnaissance overview, on the riparian and stream channel of the Jacks Creek corridor. The generalized habitat assessment included embeddedness, fishery presence and major riparian zone plants.

This assessment is only representative of a one-time site visit event and does not purport to represent seasonal considerations. However, during the water quality monitoring events at these same sites, fishery presence, embeddedness, and riparian zone vegetation were reviewed.

Table 22 summarizes the assessment of Jacks Creek and indicates that warm water fish is the predominant species although some site locations are devoid of any fish. In addition, the streambed throughout the length of Jacks Creek is 80-100% embedded due to the presence of fine sediments made up primarily of silt and sand.

Table 22. Generalized habitat assessment of Jacks Creek Corridor.

Location	Site	Main substrate	Fish Present	Major Riparian Zone Plants
7-Wetland	# 1	95-100% Embedded	Carp	Greasewood, milkweed, rabbitbrush, reeds, rushes, russian olive, sagebrush, salt brush, saltgrass, willows
7-Main	# 2	95-100% Embedded	Carp	Greasewood, milkweed, rabbitbrush, reeds, rushes, russian olive, sagebrush, salt brush, saltgrass, willows
6-Hwy 78	# 3	95-100% Embedded	Carp	Algae, cattails, duck weed, elm trees, greasewood, macrophytes, sagebrush, russian olive, wild rose, willows
5-Davis	# 4	95-100% Embedded	Carp, tilapia	Algae, duck weed, greasewood, macrophytes, reed canary grass, sagebrush, salt brush, rabbitbrush, willows
4-Cattle	# 5	95-100% Embedded	Carp, tilapia	Algae, cattails, duck weed, macrophytes, reed canary grass, stinging nettle, wild rose, willows
3-Selman	# 6	95-100% Embedded	Carp	Algae, duck weed, elm trees, poison ivy, reed canary grass, macrophytes, stinging nettle, wild rose, willows
2-Shoo Fly	# 7	90-95% Embedded	None	Algae, cattails, duck weed, macrophytes, reed canary grass, willows
1-Vaught	# 8	90-95% Embedded	None	Algae, duckweed, elm trees, macrophytes, poison ivy, reed canary grass, stinging nettles, willows
USGS Weir	# 9	85-90% Embedded	None	Rabbitbrush, sagebrush
Big Jacks	#10	80-85% Embedded	None	Rabbitbrush, sagebrush
Little Jacks	#11	80-85% Embedded	None	Rabbitbrush, sagebrush
Embeddedness: Substrate embeddedness is quantified as the percent of individual cobbles buried in fine sediments. In the case of Jacks Creek, the stream substrate is predominately silt/clay and sand in the BURP sites #1 through # 8. The sites # 9 and #11 have a higher degree of cobbles present in the substrate and are predominantly embedded in silt/clay and sand fractions.				

Table 22 also describes the major riparian zone vegetation and includes greasewood in combination with rabbitbrush and sagebrush (although the sagebrush species grows beyond the edges of the greasewood community along the Jacks Creek stream corridor). This vegetation is typical of the sagebrush steppe desert area of southern Idaho, which is part of the Great Basin Desert (Figure 7). Sagebrush steppe is dominated by species and sub species of sagebrush. Other associated brush species can include rabbitbrush, greasewood, and saltbush.

The sagebrush steppe is a cold desert, characterized by cold winters and hot summers. Snow is a common sight in the winter, and moisture is limited to about 4 to 12 inches a year. This desert covers much of southern Idaho, much of Nevada and Utah, northeastern California, southeastern Oregon and western Wyoming (IDFG 2005 and Wicklow-Howard 1994). Some of the areas of

sagebrush steppe habitat have been converted to farmland (Wicklow-Howard 1994) as in the case of the Jacks Creek area.

Plant communities found in sagebrush steppe include the following:

- *Green Rabbitbrush, Horsebrush, Purple Sage Mosaic*. The mosaic found in the Jacks Creek area is typical of green rabbitbrush, horsebrush, and purple sage; but it is also typical of the salt desert shrub mosaic. Green rabbitbrush mosaic lies between 2,200 and 4,500 feet and receives about 7 to 10 inches of precipitation a year. Any of these three communities (green rabbitbrush, horsebrush, or purple sage) can commonly be found on old lakebeds. Each has an affinity to sand. Green rabbitbrush, horsebrush, and purple sage are neighboring communities found within the salt desert shrub mosaic. Most of the smaller plants and grasses associated with the salt desert bush mosaic are generally found here as well.
- *Salt Desert Shrub Mosaic*. This plant community lies between 2,200 and 2,800 feet and receives 7 to 10 inches of moisture a year. It includes the shrubs shadscale, winterfat, fourwing and Nuttall saltbush, and greasewood. The grasses that usually accompany these shrubs include Sandberg bluegrass and Bottlebrush squirreltail. The dominant shrubs occur in a complex mixture, or mosaic, in very dry areas, usually on lava plateaus. Plants are distributed by soil type and texture, available moisture, and landforms.



Figure 7. Sagebrush Steppe within Great Basin Desert.
(Source: http://www.idahoptv.org/dialogue4kids/season3/desert/facts.html.)

6. Migration/Exposure Pathways, Best Management Practices, and Reasonable Assurance

This section describes the migration or exposure pathways for ground water and surface water relative to pollutants entering these systems. The main purpose of this section is to identify and describe the various sources of surface water anthropogenic pollutants that are likely to enter and degrade Jacks Creek.

This assessment was done to verify the pollution soures identified earlier in section 2.4, *Sources of Wastewater or Pollutants*, page 7, and was independent of the TMDL assessment of 2000 but supplants many of the conclusions described therein.

6.1 Ground Water Migration Pathway

The Grand View-Bruneau Ground Water Management Area is located in north-central Owyhee County, south of the Snake River. The management area was designated on October 29, 1982, due to increased and projected increases in ground water withdrawal and declines in spring flows from the geothermal aquifer system. Since designation, the only new ground water diversions have been for domestic use. The IDWR has also worked with well owners to eliminate leakage or unrestricted flow.

A management plan has not been developed nor has an advisory committee been formed. See Figure 8 for an illustration of the Grand View-Bruneau Ground Water Management Area.

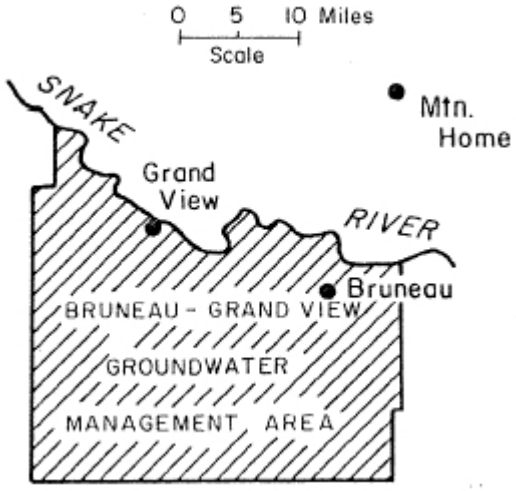


Figure 8. Grand View-Bruneau Ground Water Management Area.

The impact of ground water development on spring flows has been studied by various researchers because of the listing of the Bruneau Hot Springs snail as an Endangered Species in 1993. The snail's dependency on hot springs for its habitat has resulted in studies to evaluate the impact of ground water pumping on spring discharges.

6.2 Surface Water Migration Pathway

Based on the 2004 monitoring of Jacks Creek, surface water pollutants enter Jacks Creek through one or all of the following:

- *Row-crop cultivation*. Production and transport of sediment to Jacks Creek appears to be greatest from associated row crops and other cultivated fields. It is uncertain what percentage of the total sediment comes from row-crop cultivation, but a large amount is delivered during the irrigation season. Straight furrow fields with up-and-down slopes in rolling terrain result in inevitable loss of soil and eroding sediment—particularly in those fields where the tail portion of the rows demonstrates the results of erosion from the associated field. In addition, cultivation of row crops too close to the streambanks of Jacks Creek has removed protective vegetation, leading to streambank destabilization and sedimentation.
- *Livestock grazing*. Historical and current livestock grazing show impacts to Jacks Creek via streambank destabilization and vegetation denuding. Not all of Jacks Creek is affected by livestock grazing, but grazing impacts are visible on both sides of the stream in certain sections. Incision of streambanks is present due to livestock overuse of stream riparian areas, leading to stream-channel sedimentation caused by soil erosion. Evidence of past livestock grazing in indicated in the degradation of riparian-stream habitats, which show increased fine sediment generation due to channel widening, slowed water and shallowed channels, sediment entrainment from slumping streambanks, and increased deposition on the streambed.
- *Storm water events*. Jacks Creek experiences a spring thaw during March-April, causing high flows and some flooding, depending on the flows. Generally, the thaw is short-lived (less than a week), but during the event the riparian areas that have been denuded by overgrazing demonstrate erosion from the streambanks and the channel itself. Flash floods due to unexpected storms during the summer months provide additional erosion to the already agricultural erosion as a consequence of row-crop cultivation or livestock grazing.
- *Stream channelization*. Jacks Creek, as it exists today, has areas of stream channelization and channel straightening, possibly as short-term solutions to flooding of agricultural fields or due to historical cultural requirements that the stream be straightened and narrowed. In many sections, the stream channel appears and functions like an agricultural ditch, steepening the gradient and raising the water velocity, which accelerates erosion of the streambed through incision of the channel. This type of streambank erosion delivers heavy sedimentation into the receiving stream.
- *Floodplain erosion*. As described in S*urface Soil Samples* (page 55) and *Surface Soil Sample* (page 68), a white alkali crust is characteristic of the Jacks Creek floodplain, which is indicative of a high water table. This is especially true as of the 7-Wetland monitoring location. A major source of sediment into Jacks Creek is that portion of the cultivated floodplain from which eroded sediment is transported to the stream by flooding, especially under storm conditions. Very few of the associated fields along Jacks Creek employ buffer strips between the fields and the stream, so floodplain erosion occurs more easily and directed. Lateral (streambank) erosion of the Jacks Creek drainage is the major form of soil removal from its floodplain.
- *Artesian geothermal warm water erosion*. Because of the influence from the artesian geothermal sources during the irrigation season, streambank erosion is a major cause of sediment production in warm water streams like Jacks Creek (Waters 1995 [p 47]). Generally, warm water streambank erosion is linked to agriculture; this is especially true of Jacks Creek, which is a susceptible stream on a floodplain historically attractive to settlement

and agriculture, loss of riparian zones due to intense cultivation, and trampling by livestock. Since Jacks Creek is characteristic of a warm water stream, it tends to be typical of many warm water streams, thus being muddied with silt or sand bottoms originating from associated fields (Waters 1995 [p 85]).

- *Point source dischargers*. The only point sources on Jacks Creek are the Ace Development and Arraina Inc. facilities; both facilities discharge to Jacks Creek, but a major portion of their effluent (about 85%) is utilized for cropland irrigation. The primary pollutants-of-concern include TSS and TP. The pathogen *E. coli* is not considered a pollutant coming from the fish hatcheries because the fish raised are not warm-blooded animals. However, the cattle defecation found along the creek is the primary source of bacteria to Jacks Creek.
- *Septic system drain fields*. Private homes, ranches, and farms along Jacks Creek are all affiliated with septic systems since there is no hookup to central sewerage with the City of Bruneau. Jacks Creek residents are outside the city limits and are not hooked up to city services.

  Relative to monitoring, sampling for DNA analysis of bacteria to ascertain human islets was not conducted because of resource constraints. Instantaneous *E. coli* readings, however, indicate warm-blooded animals as the source, but it is uncertain if septic system failure is a component of the pollutant sources, or, if indeed, there has been or presently is failure in any of the septic systems.
- *Waterfowl flyway zone*. The C. J. Strike Wildlife Management Area (WMA) borders the C. J. Strike Reservoir of the Snake River, and includes portions of Owyhee County south of the river and Elmore County to the north. Jacks Creek discharges into C. J. Strike Reservoir through the WMA.

  The 7-Wetland monitoring site is in the WMA (although private property exists within the WMA). Figure 9 indicates the portion of the WMA that has Jacks Creek discharging into the reservoir.

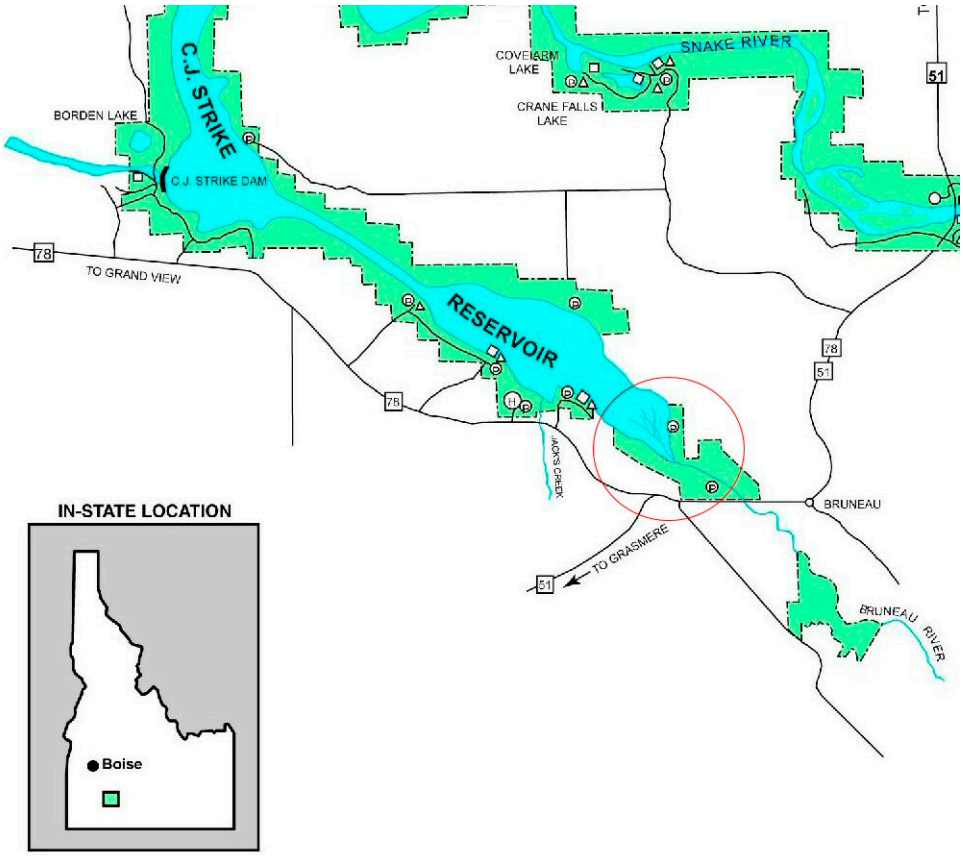


Figure 9. C. J. Strike Wildlife Management Area – Jacks Creek Discharge
(Source: http://www.fishandgame.idaho.gov/cms/wildlife/wma/cj/)

The WMA is a major waterfowl production and wintering area. During the winter, between 30,000 and 90,000 ducks, mostly mallards and other "puddle ducks," are counted, along with 5,000 to 12,000 Canada geese. The largest numbers of waterfowl usually arrive in November and leave by the first part of February.

Muskrat, beaver, raccoon and mink are found in habitats associated with ponds, rivers, and the reservoir. Mule deer, white-tailed deer, California quail, chukars, gray partridge, common snipe and mourning doves are found on the WMA, as are a variety of nongame wildlife, including bald eagles, red-winged blackbirds, shorebirds, swans and pelicans.

The influence of the WMA on Jacks Creek is mostly from November to February, when waterfowl are greatest, but its effect on the water quality of Jacks Creek is unknown and probably minimal since the WMA does not discharge into Jacks Creek but vice versa.

The sampling conducted in 2004 centered on the March to September period and specifically stayed outside of the November to February period when waterfowl are present.

- *Accidental release via State Highway 51*. Although no accidental spills or releases were noted from State Highway 51 during 2004 monitoring, the potential does exist that Jacks Creek would be the receiving stream under such conditions.

6.3 Best Management Practices Plan(s) for Fish Facilities

Incorporated into this TMDL modification is a Best Management Practices Plan (BMP Plan) that provides reasonable assurance that TP and TSS pollution of Jacks Creek will be minimized. This plan is based on targets of net 0.200 mg/L TP and net 15.0 mg/L TSS. Table 23 summarizes the BMP Plan for both the Ace and Arraina fish facilities.

Table 23. BMP Plan Elements for Ace and Arraina Fish Facilities.

BMP Plan Application	Ace	Arraina
Tanks		
Self-cleaning center drain per tank that removes solid waste to the settling pond.	X	
Constructed above ground level to prevent storm water runoff & windblown dirt from entering.	X	
O2 injection to maintain high O2 to break down organic material.	X	X
Raceways		
Quiescent zone to collect solid waste.	X	X
Quiescent zone cleaned monthly to remove solids through a pipe connected to the OLSP.	X	X
Water in OLSP is contained and naturally percolates into the ground.	X	X
Fish in quiescent zone are removed immediately.	X	X
Constructed above ground level to prevent storm water runoff & windblown dirt from entering.	X	X
Raceway drops 3 ½' into canal to settling pond to maximize DO levels for reuse for irrigation.	X	X
Feeding		
Feed is 1% P as sinking & floating pellet.	X	X
Demand feeders, 1 per tank & 1 per raceway & adjusted to farm conditions.	X	X
Feed used within manufacturer's expiration date.	X	X
Feed is screened to separate fines.	X	X
Demand feeders have wind shields to prevent undesired feed release.	X	X
Fish are fed 6 days per week.	X	X
Employee Education		
Employees trained to observe fish behavior.	X	X
Hatchery		
Water from vats drains back into the brood ponds.	X	
All drained water for the hatchery flows back into the settling pond and recycled.	X	
Mortality		
Disposal in earthen pit located more than 200' from any surface water & 0.25 mile from any well.	X	X
Mortality pit is covered with a layer of dirt to prevent flies, odor, and vector attractors.	X	X
When a mortality pit is full, 2' from the top, it is covered with dirt and a new pit is dug.	X	X
Therapeutants		
No therapeutants are used.	X	X
Disposal		
Sludge from OLSP is recycled to nearby fields as land application.	X	X
Water Source		
Geothermal water pumped into cooling ponds.	X	X
Cooling pond water is mixed with well water for fish culturing.	X	X
Mixed cooling water is used for irrigation.	X	X
No surface water is used.	X	X

BMP = Best Management Practice. OLSP = Offline Settling Pond. DO = Dissolved Oxygen. This table was reviewed and corrected by the facility owner and operator.

6.4 Reasonable Assurance in Beneficial Use Attainment

The Bruneau TMDL sets instream targets for TSS, TP, and *E. coli* for beneficial use attainment based on the loading capacity of Jacks Creek discharging into the C. J. Strike Reservoir (Lay 2000 [pp 101-102]). These targets are based on three primary considerations:

- *"Gold Book" Water Quality Target*. Jacks Creek discharges to the C. J. Strike Reservoir through the C. J. Strike Wildlife Management Area. The application of a 0.050 mg/L TP instream target was based on EPA's "Gold Book" value for a free-flowing stream discharging into a reservoir or lake (EPA 1986 [Phosphate Phosphorus Section, PB-263943]; see Lay 2000 [p 91, §3.1.1, Nutrients]). Relative to ambient water quality conditions, a review of EPA's nutrient recommendations for Idaho in Ecoregion III (Ecoregion ID 12 – Snake River Basin) indicates a TP value of 0.022 mg/L (with a turbidity value of 1.8 NTU) (EPA 2000C [pp 8, 16]). The selection of 0.050 mg/L was done prior to 2000 (when the TMDL was approved by EPA) and thus did not necessarily consider the suggested nutrient criteria for this stream.
- *Default Designated Beneficial Uses*. Jacks Creek is an undesignated stream relative to its beneficial uses. Therefore, the default designation in the State of Idaho is a cold water aquatic life designation. (See Lay 2000.)
- *Nutrient Limitation*. Phosphorus has been referred to as a "limiting" nutrient, and in freshwater phosphorus is more limiting than nitrogen (Moss 1988 [p 170]; Boyd 1990 [p110]; Johnson and Stickney 1989 [p 156]). As such, "phosphorus is often the limiting nutrient for plant growth in freshwater environments" (Johnson and Stickney 1989 [p 177]). Macrophytes in particular have increased growth with increasing concentrations of nitrogen and phosphorus, but this growth has its limitations based on turbidity and water clarity (Boyd 1990 [p 112]). Relative to algal physiology, phosphorus is of particular interest because, in general, "phosphorus is the least abundant element of the major nutrients required for algal growth in a large majority of fresh waters" (Wetzel 1983 [p 275]).

  In Jacks Creek, phosphorus is an excess nutrient (along with sediment and bacteria). As shown in Table 37, page 66, TP averages 0.285 mg/L (2001-2004), which is considered an excess concentration when compared to an instream value of 0.100 mg/L for free-flowing streams; and much more of an excess concentration when compared to an instream value of 0.050 mg/L for free-flowing streams discharging into reservoirs or lakes (EPA 1986 Phosphorus Section).

6.4.1 Why Jacks Creek Should Have a Modified Aquatic Life Designation

However, there are several reasons why Jacks Creek should have a modified aquatic life designation, as defined in IDAPA §58.01.02.100 rather than the default cold water designation. Those reasons include the following:

Limitations in the "Gold Book" Standard

The application of the Gold Book standard (the 0.050 mg/L TP) is primarily for the "control" of eutrophication. No distinctions or considerations are made relative to cold water versus warm water, so it must be assumed that the "control" for eutrophication is applicable to cold water AND warm water environments.

However, as stipulated in the introduction to the Gold Book, "These criteria are not rules and they do not have regulatory impact" (EPA 1986 [To Interested Parties]). The 0.050 mg/L TP criterion is an expression of "scientific data and guidance of the environmental effects of pollutants which can be useful to derive regulatory requirements based on considerations of water quality impacts" (EPA 1986 [To Interested Parties]).

To that end, the Gold Book criterion is used "to prevent the development of biological nuisances and to control accelerated or cultural eutrophication" (EPA 1986 [Phosphate Phosphorus Section, PB-263943]). However, "generally, it is recognized that phosphorus is not the sole cause of eutrophication…" (EPA 1986 [Phosphorus Section]). Frequently, "it is the key element of all of the elements required by freshwater plants, and generally, it is present in the least amount relative to need.

Therefore, an increase in phosphorus allows use of other already present nutrients for plant growth (EPA 1986 [Phosphorus Section]).

In addition, a review of EPA's suggested nutrient criteria was considered (as 0.022 mg/L TP with a turbidity value of 1.8 NTU) for Ecoregion III (Ecoregion ID 12 – Snake River Basin; see EPA 2000C [pp 8, 16]) but this was discarded since Jacks Creek has not had functional ambient water quality conditions (cold water aquatic life) since prior to November 28, 1975 (as defined for existing beneficial uses; see IDAPA §58.01.02.003.37). As such, the Gold Book standard and EPA's suggested nutrient criteria are inappropriate for Jacks Creek based on its existing beneficial use.

Hydrologic Characteristics

The hydrologic characteristics of Jacks Creek define it primarily as an ephemeral stream since Big Jacks Creek water (with Little Jacks Creek) is considered the only water source (inclusive of storm water) to Jacks Creek.

As discussed in section 2.6.4, *Summary of Site Investigation Locations*, page 10, the water from Big Jacks Creek and Little Jacks Creek subs out on BLM ground before entering the agricultural private land zone of Jacks Creek. It is only when high water flow conditions exist (principally due to a higher than average snowmelt) that this water reaches the entire length of Jacks Creek until to C. J. Strike Reservoir.

Based on the USGS period of record (1938-2003), the Big Jacks gage (USGS 13169500) indicates "wet" conditions 39.4% of the time on average and "dry" conditions 60.6% of the time on average.

Jacks Creek, however, is not necessarily characterized by a predominant absence of water dependent plants, indistinct banks, or an inability to support aquatic animal communities (even seasonally) as most descriptions are used to describe ephemeral drainages. "Ephemeral streams generally occur in the upper reaches of a watershed and flow after heavy rains, snow melt, or when soils are saturated" (IDNR 2005). In the case of Jacks Creek, the ephemeral condition occurs from just upstream of the confluence of Little Jacks Creek with Big Jacks Creek to downstream of the mouth where it discharges into C. J. Strike Reservoir.

Therefore and based on 40 CFR 131.10, the default cold water designation of Jacks Creek is inappropriate due to its hydrologic characteristics. As a consequence, the natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the beneficial uses

of Jacks Creek, unless this hydrologic condition was in some way compensated by the discharge of sufficient volume of effluent discharges (from all sources) without violating State water conservation requirements to enable beneficial uses to be met. In addition and as a historical condition since before November 28, 1975, human caused conditions or sources of pollution prevent the attainment of the beneficial uses and cannot be remedied or would cause more environmental damage to correct than to leave in place.

Artesian Geothermal Wells and Existing Beneficial Use

Jacks Creek drainage is characterized by artesian geothermal wells as previously discussed in section 2.5, Artesian Geothermal Sources, page 8. Because of the average 60.6% "dry" condition in Jacks Creek, construction of artesian wells commenced in the late 1930s and early 1940s.

Consequently, 60.6% of time, Jacks Creek is a modified stream because of the artesian geothermal influence. And, as expressly defined in IDAPA §58.01.02.003.37, this condition is an existing beneficial use (i.e., warm water aquatic life) since it was "actually attained in waters on or after November 28, 1975, whether or not they are designated for those waters" in DEQ's rules and regulations.

Existing beneficial use commenced prior to November 28, 1975 and has been on-going after November 28, 1975. Consequently, the existing beneficial use is warm water aquatic life since the water quality is "appropriate for the protection and maintenance of a viable aquatic life community for warm water species" (IDAPA §58.01.02.100.01.d).

Agricultural Tailwater Discharges Belie True Nature of Jacks Creek

The Jacks Creek water source is primarily from artesian geothermal wells. These water sources are used for irrigation and thus become the principal component of the Jacks Creek drainage once it discharges as tailwater into Jacks Creek. This practice has been on-going since the late 1930s for irrigated agriculture.

Because of this tailwater discharge into Jacks Creek, it is possible to conclude that Jacks Creek is "intermittent."

However, Jacks Creek is ephemeral and not intermittent for a number of hydrologic and geologic reasons:

- A streambed with cobble does not necessarily exist in the creek due to the embeddedness from the sediment deposits throughout the conveyance.
- The nature of the water itself is predominantly agricultural tailwater and not comparable to other similar streams in the subbasin that have baseflow, except under adverse drought conditions.
- Natural stream flow occurs only during those periods when high flow storm water exists and essentially "shoots through" Jacks Creek from Big Jacks Creek and Little Jacks Creek.
- The stream does not have characteristics of riffles and pools within the stream channel as would be seen in perennial and intermittent examples.

Additionally, because the tailwater is being conveyed through Jacks Creek, the stream has evolved into a ditch or irrigation water conveyance. There is some evidence to indicate that Jacks

Creek, as it exists today, is not necessarily the exact stream channel as it existed prior to the late 1930s. In fact, channelization and channel straightening of the stream has occurred in certain sections, done, in all likelihood, as short-term solutions to flooding of agricultural fields or historical cultural requirements. Because of this, the water quality in Jacks Creek is predominantly representative of tailwater (or ditch water) and thus has murkiness for its clarity (high turbidity) and excess nutrients, sediment, and bacteria, as described in Table 37, page 66.

Lack of Historic Flow Data

Relative to flow, representation of average or median flow conditions in Jacks Creek cannot be associated like unto Big Jacks Creek (which possesses natural flow characteristics) because, unlike Big Jacks Creek, Jacks Creek is highly dependent and associated with the water delivery from the artesian geothermal wells (as agricultural tailwater); thus making it difficult (if not impossible) to predict adequately what an average or median flow value might be as representative of the stream.

During the data collection phase of the TMDL modification, DEQ was unable to find historical flow data specific for Jacks Creek other than IDWR water right information. Consequently, the 70th percentile of the flows taken in the 2004 monitoring season was used to represent the "normal" condition for Jacks Creek. The 70th percentile is a mathematical compromise between 30% of the flows that exist greater than the 70th percentile (which represent "higher" flows that "push" quickly through) and 70% of the flows that exist less than the 70th percentile (which represent "lower" flows that move "normally" and minimally through).

The 70th percentile flow is 17.49 cfs of the flows that eventually pass the monitoring sites 7-Main and 7-Wetland prior to discharge into the C. J. Strike Reservoir. By statistical definition, the 70th percentile flow indicates that 70% of the annual daily mean streamflows are below 17.49 cfs (Stogner 2000 [p 2, Table 1]). The 70th percentile flow shown in Table 5, page 18, (or 9.81 cfs) is the flow for all monitoring sites in 2004 and not specific for flows that would be found at 7-Main and 7-Wetland. (See footnote H in Table 5.)

One condition of this TMDL modification that must be researched further by DEQ with actual field monitoring is to obtain more flow information at the 7-Main site and utilize this flow information to more accurately describe the flow condition of Jacks Creek prior to discharge into the C. J. Strike Reservoir.

Warm Water Fish Obligates

The significance of cold water obligates implies that the stream temperature is essentially cold; and, thus, such obligates require cold water for existence (Ricklefs 1979 [pp 225, 229]). In the case of thermally stratified lakes that separate the epilimnion from the hypolimnion by a thermocline, "and if there is adequate oxygen in solution below the thermocline, they may be expected to support trout [a cold water obligate] and other coldwater fishes" (Lagler 1975 [p 265]).

In the case of Jacks Creek, we have essentially an ephemeral stream that is influenced by artesian geothermal well warm water for 60.6% of the time (primarily in the spring, summer, and early fall months). And this influence has been on-going since the late 1930s. Thus, Jacks Creek has been predominantly influenced by warm water and its existing fishery are warm water obligates (e.g., carp, tilapia).

In effect, the "local input from ground water [the artesian geothermal well water] can have significant effects on temperature in stream or lake systems," such as Jacks Creek (Stevenson et al. 1996 [p 150]). As a consequence of these artesian geothermal well sources, the viability of cold water obligates is minimal at best in Jacks Creek. At the present time, cold water fish obligates have not been found in Jacks Creek. However, in the upstream Big Jacks Creek drainage, cold water fish obligates have been found. As an example, brown trout (a cold water fish obligate) are known to exist near the headwaters reach (in the Big Jacks Creek drainage). However, the Little Jacks Creek system is ephemeral and has no established fishery. Therefore, the warm water artesian geothermal wells which discharge into Jacks Creek as irrigation tailwater have only warm water obligates in Jacks Creek. Thus, it is no surprise to find carp (*Cyprinus carpio*) in the WMA where they "root up the bottom" of the waterbody (the WMA marshland and wetland substrate) as they feed "and thereby greatly increases the turbidity of the lake" (Moyle and Cech 1988 [p 358]).

As shown in Table 22, page 35, the warm water obligates include carp and tilapia. The tilapia is probably due to escapees from the aquaculture fish hatcheries, whereas carp are primarily from the Wildlife Management Area, where they are known to spawn and breed.

In conclusion, the weight of evidence indicates that no known cold water obligates exist in Jacks Creek.

6.4.2 Water Quality Target Modifications

The water quality instream targets defined for TSS and *E. coli* will not be changed in this TMDL modification. Those include an instream target of 50.0 mg/L for TSS and an instream target of 100 cfu/100 mL for *E. coli*.

TP, TSS, and E. coli

The TP instream target, however, will be modified from 0.050 mg/L to 0.100 mg/L, since this is more characteristic of agricultural conveyances that carry tailwater and have been targeted by TMDLs (such as the Upper Snake Rock TMDL and the Lake Walcott TMDL) to reduce TP below 0.100 mg/L.

The flow that will be used is the 70th percentile flow (17.49 cfs) as previously discussed. Additionally, the 70th percentile flow also represents low flow conditions because of drought in Jacks Creek since the period of TMDL monitoring (1999-2000) through the present (2001-2004). Therefore, the flow conditions, although average, represent the worst case scenario, which is the low flow condition (Figure 10).

TP: 0.100 mg/L x 17.49 cfs x 5.4 = 9.44 lb/day TP
TSS: 50.0 mg/L x 17.49 cfs x 5.4 = 4,722.3 lb/day TSS
E. coli: **100 cfu/100 mL x 17.49 cfs x 0.02445 = 42.8 cfu9/day** *E. coli*

Figure 10. Proposed water quality modifications.

Margin of Safety

The margin of safety (MOS) established by the Bruneau TMDL at 10% for all pollutant waterbody combinations (Lay 2000 [p 101]) will be maintained in this TMDL modification. Woven into this explicit MOS is an implicit component with the assumption "that conservative

approaches taken throughout the document (Bruneau TMDL) will have been sufficiently identified in appropriate sections" (Lay 2000 [p 101]).

Beneficial Use Attainment

Beneficial use attainment for TSS and TP is summarized in Table 24, which includes the analysis compiled in section 5.6 (*Fish Hatchery Influent/Effluent Results and Proposed Reductions*, page 30) for Ace Development and Arraina. Two percent (2%) of the total nonpoint source load is temporarily provided to those construction activities that may tend to have a TSS, TP, or *E. coli* discharge with storm water. (The 2% limitation is only for the period of construction and reverts back to the overall nonpoint source component after the construction period.)

Table 24. TSS, TP and *E. coli* load capacity and existing load for Jacks Creek.

LOAD CAPACITY (based on Q = 17.49 cfs)			
CONSTITUENTS	**TSS lb/day**	**TP lb/day**	***E. coli* cfu[9]/day**
NONPOINT SOURCES			
NPS (Ag, Graze, Private, Corridor)	3,601.5	0.88	37.7
Federal Energy Regulatory Commission (FERC), Land Application Facilities (LAFs), Confined Feeding Operations (CFOs)	0.0	0.00	0.0
Stormwater – Construction Activities	73.5	0.02	0.8
POINT SOURCES			
Ace Development	218.7	2.90	0.0
Arraina Inc.	356.4	4.70	0.0
OTHER SOURCES & LOAD CAPACITY			
Future Growth	0.0	0.0	0.0
Margin of Safety, 10% (includes Background)	472.2	0.94	4.3
Total Load (Load Capacity)	4,722.3	9.44	42.8
EXISTING LOAD (BASED ON Q = 17.49 cfs)			
Existing Load (based on Mean Concentration Values)	3,919.5 (41.5 mg/L)	22.01 (0.233 mg/L)	1,024.2 (2,395 cfu/100 mL)
Max Load (based on Max Concentration Values)	7,687.9 (81.4 mg/L)	28.33 (0.300 mg/L)	4,586.3 (10,725 cfu/100 mL)
TSS = Total Suspended Sediment. TP = Total Phosphorus. E. COLI = Escherichia coli. NPS = Nonpoint Source Industries. Ag = Agriculture – both irrigated and dryland. Graze = Grazing. Private = Private Landownership. Corridor = Specific to the displacement of pollutants that are confined within the streambanks and streambed of Jacks Creek. Q = flow in cfs. Note: EXISTING LOAD based on Table 3 Mean and Max values for TSS, TP and E. coli and a flow of 17.49 cfs.			

Based on the Load Capacity values provided for TSS, TP, and *E. coli*; the instream targets of 0.100 mg/L TP, 50.0 mg/L TSS, and 100 cfu/100 mL *E. coli*; the best management practices that will be in place for the point source fish hatcheries (see Table 23, page 41); and the best management practices that must and will be developed for the agricultural farmlands along the Jacks Creek corridor; there is a reasonable assurance that the beneficial uses of Jacks Creek will be met and the water quality standards will not be violated as defined in Table 7.

As a general condition, and based on a flow of 17.49 cfs, TSS has an average load of 3,919.5 lb/day (Table 3: 17.49 cfs x 41.5 mg/L TSS x 5.4 = 3,919.5 lb/day), which is well below the Load Capacity described (i.e. 3,919.5 lb/day TSS < 4,722.3 lb/day TSS). However, during

certain times of the year the Load Capacity is exceeded and may climb to as high as 7,687.9 lb/day (Maximum: 17.49 cfs x 81.4 mg/L TSS x 5.4 = 7,687.9 lb/day). Under these maximum conditions, the reduction in sediment would need to be as much as 38.6% (100-[(4,722.3 lb/day / 7,687.9) x 100%)] lb/day) because of the influx of sediment from the various farms and ranchlands, which are the predominant source of sediment to Jacks Creek.

As a general condition, and based on a flow of 17.49 cfs, TP has an average load of 22.01 lb/day (Table 5: 17.49 cfs x 0.233 mg/L TP x 5.4 = 22.01 lb/day), which is well above the Load Capacity as described in Table 7. Under these average conditions a 57.1% (100-[(9.44 lb/day / 22.01 lb/day) x 100%] lb/day) reduction in TP would be needed to meet the Load Capacity for TP. Yet, during certain times of the year the Load Capacity is exceeded and has climbed to as high as 28.33 lb/day (Maximum: 17.49 cfs x 0.300 mg/L TP x 5.4 = 28.33 lb/day). Under these conditions the reduction in TP would need to be as much as 66.7% (100-[(9.44 lb/day / 28.33 lb/day) x 100%] lb/day) because of the influx of TP from the point source fish hatcheries and the various farms and ranchlands.

As a general condition and based on a flow of 17.49 cfs, *E. coli* has an average load of 1,024.2 cfu^9/day (Table 5: 17.49 cfs x 2,395 cfu/100 mL *E. coli* x 0.02445 = 1,024.2 cfu^9/day), which is well above the Load Capacity as described in Table 7. Under these average conditions a 95.8% (100-[(42.8 cfu^9/day / 1,024.2 cfu^9/day) x 100%] cfu^9/day) reduction in *E. coli* would be needed to meet the Load Capacity for *E. coli*. Yet, during certain times of the year the Load Capacity is exceeded and has climbed to as high as 4,586.3 cfu^9/day (Maximum: 17.49 cfs x 10,725/100 mL *E. coli* x 0.02445 = 4,586.3 cfu^9/day). Under these conditions the reduction in *E. coli* would need to be as much as 99.1% (100-[(42.8 cfu^9/day / 4,586.3 cfu^9/day) x 100] cfu^9/day) because of the influx of *E. coli* from the various farms and ranchlands. Aquaculture fish hatcheries are not known to generate *E. coli* since fish are considered cold-blooded and not warm-blooded.

7. Site Summary and Conclusions

This section summarizes the conclusions for pollutant sources and instream targets for the TMDL modification on Jacks Creek.

7.1 Major Pollutant Sources to Jacks Creek

Based on the Bruneau River TMDL (Lay 2000) and this Jacks Creek TMDL Modification, the sources for the major pollutants-of-concern are defined in Table 25. These sources are assumed to have contributions to Jacks Creek because their activity is near Jacks Creek. This does not mean or imply that these activities are presently contributing these pollutants; but rather, that the activity from these pollutant sources has the potential to contribute these pollutants.

Table 25. Major pollutant sources to Jacks Creek.

Pollutant Sources	Source Type	TSS	TP	*E. coli*
Irrigated Agriculture	Nonpoint	X	X	X
Grazing	Nonpoint	X	X	X
Stream Corridor Erosion	Nonpoint	X	X	X
FERC Facilities	Nonpoint			
Land Application Facilities	Nonpoint	X	X	X
Confined Feeding Operations	Nonpoint	X	X	X
Construction Activities	Nonpoint	X	X	X
Septic Systems	Nonpoint	X	X	X
Aquaculture Fish Hatcheries	Point	X	X	
Riparian and Wetland Areas	Nonpoint	X	X	X

Major pollutant sources to Jacks Creek as defined in the Bruneau River TMDL (Lay 2000) and in the Jacks Creek TMDL Modification.

The Jacks Creek TMDL Modification takes into account these major pollutant sources and defines the load capacity for Jacks Creek according to the standard TMDL algorithm (Equation 1):

$$\text{TMDL} = \text{Margin of Safety} + \text{Background} + \text{Point Source} + \text{Nonpoint Source} + \text{Future Growth}$$

Equation 1. Standard TMDL Calculation.

The point source component is identified with the fish hatchery facilities (e.g. Ace Development and Arraina).

The nonpoint source component is identified with irrigated agriculture, grazing, stream corridor erosion, Federal Energy Regulatory Commission (FERC) facilities, land application facilities, confined feeding operations (CFOs), construction facilities and septic systems.

The background and margin of safety components are jointly identified with riparian and wetland areas as well as with the unknown variability inherent with most pollutants.

Future Growth was not considered since the stakeholders during the Bruneau River TMDL development chose not to apply a portion of the load capacity for this.

7.2 Water Quality Instream Targets to Meet Beneficial Uses

The instream targets for TSS (50.0 mg/L), TP (0.100 mg/L) and *E. coli* (100 cfu/100 mL) are set primarily to meet the existing beneficial uses of Jacks Creek.

Reasonable Assurance for Point Sources

There is a reasonable assurance that the point sources in Jacks Creek (i.e., the aquaculture facilities) are only discharging 15% of their effluent (as described under *Potential Targets*, page 12) into Jacks Creek. This means that on an annual basis (and based on the load capacity of each pollutant) only 708.3 lb/day TSS, 1.42 lb/day TP and 4.3 cfu9/day *E. coli* is delivered to Jacks Creek directly.

In addition, these facilities have established best management practices (Table 23) that deal with an overall BMP Plan, the waste management of the raceways, the strategy for feeding the fish, employee education, the handling of hatchery water, the disposal of fish mortalities, the lack of therapeutants use, sludge disposal, and the use of geothermal water that is pumped into cooling ponds for fish culturing and irrigation.

There is reasonable assurance that these facilities will be complying with the overall intent of the Jacks Creek TMDL Modification because they are already implementing many of these BMPs.

Reasonable Assurance for Nonpoint Sources

There is a reasonable assurance from the nonpoint source private landowners that projects formulated to control erosion and tailwater pollutants from impairing Jacks Creek and its beneficial uses will be applied. These water cleanup projects will be formulated through Clean Water Act Section 319 Grants, and other water quality funding sources, that protect the stream corridor from impairments due to agricultural and grazing erosion. Already, water quality projects are being reviewed and considered in the Jacks Creek corridor and will come on-line on an individual farm site basis. The ISCC in conjunction with the IASCDs and the NRCS will be providing the necessary expertise as agricultural land managers to participate in these efforts.

7.3 Conclusions

Based on the load capacity targets of Table 24 and the various potential projects being considered to restore the existing beneficial uses of Jacks Creek, the Jacks Creek TMDL Modification provides the necessary strategy and direction (in conjunction with the overall TMDL for the Bruneau subbasin) that will allow Jacks Creek to achieve its beneficial uses over a 20-year period.

Assessments will be conducted by DEQ of Jacks Creek every 5 years to ascertain beneficial use attainment with public comment/input from the stakeholders.

References

Bonneville Power Administration (BPA). 1986. Status Review of Wildlife Mitigation at 14 of 27 Major Hydroelectric Projects in Idaho. Portland (OR): BPA.

Boyd C. E. 1990. Water Quality in Ponds for Aquaculture. Copyright by Alabama Agricultural Experiment Station, Auburn University, Alabama. Birmingham (Alabama): Birmingham Publishing Co.

Buhidar B. B. 2005. The Upper Snake Rock TMDL Modification. Twin Falls (ID): IDEQ-TFRO.

Bureau of Land Management (BLM). 1996. A Report on the Owyhee Uplands Region – Oregon, Idaho, Nevada. Portland (OR): The Nature Conservancy & BLM-Vale District.

Campbell K. 2002. Lower Jack Creek water quality monitoring report April 1999 through March 2001, ISDA Technical Results Summary No. W-4. Boise (ID): ISDA.

Idaho Department of Fish and Game (IDFG). 2005. Desert Facts. From: Internet IDFG Web Site: http://www.idahoptv.org/dialogue4kids/season3/desert/facts.html .

Indiana Department of Natural Resources (IDNR). 2005. Riparian management zones and ephemeral streams. From: Internet IDNR Web Site: http://www.in.gov/dnr/forestry/index.html? http://www.state.in.us/dnr/forestry/bmp/logrip.htm&2

U.S. Environmental Protection Agency [EPA]. 1986. Quality Criteria for Water 1986 ("Gold Book"). EPA 440/5-86-001. Washington (D.C.): EPA Office of Water.

EPA. 1992. U. S. EPA Environmental Response Team Standard Operating Procedures. Surface Water Sampling – SOP#2013. Washington (D.C.): U. S. Department of Housing and Urban Development, Real Estate Assessment Center (REAC).

EPA. 1994. U. S. EPA Environmental Response Team Standard Operating Procedures. Sediment Sampling – SOP#2016. Washington (D.C.): U. S. Department of Housing and Urban Development, Real Estate Assessment Center (REAC).

EPA. 1995. U. S. EPA Environmental Response Team Standard Operating Procedures. Groundwater Well Sampling – SOP#2007. Washington (D.C.): U. S. Department of Housing and Urban Development, Real Estate Assessment Center (REAC).

EPA. 2000. U. S. EPA Environmental Response Team Standard Operating Procedures. Soil Sampling – SOP #2012. Washington (D.C.): U. S. Department of Housing and Urban Development, Real Estate Assessment Center (REAC).

EPA. 2000. EPA Quality Manual for Environmental Programs 5360A1. Washington (D.C.): EPA Office of Environmental Information.

EPA. 2000C. Ambient Water Quality Criteria Recommendations – Rivers and Streams in Ecoregion III. EPA 822-B-00-016. Washington (D.C.): EPA Office of Water.

EPA. 2001. U. S. EPA Environmental Response Team Standard Operating Procedures. General Field Sampling Guidelines – SOP#2001. Washington (D.C.): U. S. Department of Housing and Urban Development, Real Estate Assessment Center (REAC).

EPA. 2001. EPA Requirements for Quality Assurance Project Plans EPA QA/R-5. Washington (D.C.): EPA Office of Environmental Information.

EPA. 2002. EPA Guidance for Quality Assurance Project Plans EPA QA/G-5. Washington (D.C.): EPA Office of Environmental Information.

EPA. 2002. U. S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA 540-R-01-008. Washington (D.C.): Office of Emergency and Remedial Response.

EPA. 2004. Wadeable streams assessment quality assurance project plan. EPA 841-B-04-005. Washington (D.C.): EPA, Office of Water, Office of Environmental Information.

EPA. 2005A. Surf Your Watershed. Internet Website: Bruneau Watershed Profile – USGS Cataloging Unit No. 17050102: http://cfpub.epa.gov/surf/huc.cfm?huc_code=17050102

EPA. 2005B. Total Maximum Daily Loads – Listed Water Information Cycle 1998. Waterbody Name: Jacks Creek. Internet Website: http://oaspub.epa.gov/pls/tmdl/enviro.control?p_list_id=ID2551&p_cycle=1998

EPA. 2005C. 305(b) Lists/Assessment Unit Information Year 2002. National Assessment Database: Internet Website: Jacks Creek – 1st and 2nd Order – Water Quality Attainments: http://oaspub.epa.gov/pls/tmdl/enviro_v2.wcontrol?p_id305b=ID17050102SW002_02; Jacks Creek – 3rd Order – Water Quality Attainments: http://oaspub.epa.gov/pls/tmdl/enviro_v2.wcontrol?p_id305b=ID17050102SW002_03; Jacks Creek – 4th Order – Water Quality Attainments: http://oaspub.epa.gov/pls/tmdl/enviro_v2.wcontrol?p_id305b=ID17050102SW002_04; Jacks Creek – 5th Order – Water Quality Attainments: http://oaspub.epa.gov/pls/tmdl/enviro_v2.wcontrol?p_id305b=ID17050102SW002_05

EPA. 2005D. National Assessment Database. Assessment Data for Idaho, Bruneau Watershed, Year 2002. Internet Website: http://oaspub.epa.gov/pls/tmdl/w305b_report_v2.huc?p_huc=17050102&p_state=ID

Idaho Department of Fish and Game (IDFG). 2004. Idaho Bird Inventory and Survey (IBIS). Boise (ID): IDFG.

ISCC (Idaho Soil Conservation Commission). 2002. Jacks Creek Watershed Agricultural TMDL Implementation Plan. Boise (ID): ISCC.

Johnson F. G. and Stickney R. R. 1989. Fisheries – Harvesting Life from Water. ISBN No. 0-8403-5532-7.Dubuque (Iowa): Kendall/Hunt Publishing Company.

Lagler K. F. 1975. Freshwater Fishery Biology. 2nd Edition. ISBN No. 0-697-04675-3. Dubuque (Iowa): Wm. C. Brown Company Publishers.

Lay C. 2000. Bruneau Subbasin Assessment and Total Maximum Daily Loads of the §303(d) Water Bodies. Twin Falls (ID): DEQ.

Mast M A and Clow D W. 2000. Environmental characteristics and water-quality of hydrologic benchmark network stations in the Western United States, USGS Circular 1173-D, p 115. Boise (ID): USGS.

Moss B. 1988. Ecology of Fresh Waters – Man and Medium. 2nd Edition. ISBN No. 0-632-01642-6. Oxford (England): Blackwell Scientific Publications.

Moyle P. B. and Cech J. J. 1988. Fishes – An Introduction to Ichthyology. 2nd Edition. ISBN No. 0-13-319211-3. Englewood Cliffs (N. J.): Prentice-Hall, Inc.

Ricklefs R. E. 1979. Ecology. 2nd Edition. ISBN No. 0-913462-07-1. New York (N. Y.): Chiron Press.

Stevenson R. J., Bothwell M. L. and Lowe R. L. 1996. Algal Ecology – Freshwater Benthic Ecosystems. ISBN No. 0-12-668450-2. San Diego (CA): Academic Press.

Stickney R. R. 1979. Principles of Warmwater Aquaculture. ISBN No. 0-471-03388-X. New York (N. Y.): John Wiley & Sons.

Stogner R. W. 2000. USGS – Trends in precipitation and streamflow in the Fountain Creek watershed, Southeastern Colorado, 1977-99. USGS Fact Sheet 136-00. Pueblo (CO): USGS. Internet Web Site: http://pubs.usgs.gov/fs/fs-136-00/ .

U. S. Geological Survey (USGS). 1970. Artesian Well Logs for the USGS. Boise (ID): USGS.

USGS. 2004. Surface Water for Idaho: Daily Streamflow for USGS Gage 13169500 – Big Jacks Creek near Bruneau, Idaho. Internet Website: http://waterdata.usgs.gov/id/nwis/discharge .

Waters T. F. 1995. Sediment in Streams – Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. Bethesda (MD): American Fisheries Society.

Wetzel R. G. 1983. Limnology. 2nd Edition. ISBN No. 0-03-057913-9. Fort Worth (TX): Saunders College Publishing, Harcourt Brace College Publishers.

Wicklow-Howard M. C. 1994. Vesicular-arbuscular mycorrhizae from sagebrush steppe habitat in western Idaho and parts of eastern and central Oregon. Boise (ID): Boise State University.

Young H W and Whitehead R L. 1975. An Evaluation of Thermal Water in the Bruneau-Grand View Area, Southwest Idaho. In USGS Water Information Bulletin No. 30. Boise (ID): USGS.

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Appendix A: QAPP, Data Validation, and Laboratory Data

The following sections provide a statistical summary in the determination of precision, sample holding times, field instrument calibration, and blank sample calibration as part of the overall quality assurance project plan (QAPP) for the Jacks Creek TMDL modification. Data quality objectives (DQOs) are specified for each parameter within each particular section. Precision, accuracy, and completeness are associated with quantitative measurements. Comparability and representativeness are assessed using indirect methods that provide weight of evidence via comparison with generally accepted standards.

A.1 Field Activities and Analytical Protocols

The Jacks Creek post-TMDL monitoring plan was developed by DEQ prior to field sampling. A review of the data previously collected during the development of the Bruneau River TMDL was conducted by DEQ. Interviews were conducted with the previous DEQ TMDL writer; personnel of the Idaho Association of Soil Conservation Districts; personnel of the Bruneau River Soil Conservation District; and Robert C. Williams, owner, of Ace Development USA, Inc. and Arraina, Inc.

Based on existing field knowledge of both fish hatcheries and of Jacks Creek, the Jacks Creek Monitoring Plan was developed by DEQ. This monitoring plan is detailed in the following.

Site inspection field activities were conducted in accordance with the SQAP. No deviations occurred or were required from the SQAP and overall sampling strategy.

Sampling Methodology

The sampling methodology used was divided into surface soil samples, substrate stream sediment samples, ground water artesian well samples, surface water samples, and NPDES fish hatchery influent/effluent samples. These are further described in the subsections that follow.

Surface Soil Samples

Surface soil samples followed the procedure outlined by the U. S. EPA Environmental Response Team Standard Operating Procedures for general field sampling guidelines (EPA 2001), for soil sampling (EPA 2000), and for sediment sampling (EPA 1994). The sample taken was the white alkali crust sample that is well represented in the Jacks Creek floodplain drainage and is indicative of a high water table. The only modification to the procedure was that the sample was collected in a double-plastic zip lock bag and this was transferred to the lab in a 4°C cooler filled with sufficient crushed ice. A clean rust-free shovel was used to collect the samples.

Substrate Stream Sediment Samples

Substrate stream sediment samples followed the procedure as outlined in Appendix A-9 (Surface Soil Samples).

Groundwater Artesian Well Samples

With the exception of one sample, all of the artesian well samples were collected while the operation was utilizing the wells for irrigation purposes. Thus, purging the water lines for a minimum of 10 minutes was not necessary to obtain the samples. The one sample exception required a 10-minute purge of the well prior to sampling.

Groundwater artesian well samples followed the procedure outlined by the U. S. EPA Environmental Response Team Standard Operating Procedures for ground water well sampling (EPA 1995). The Bureau of Laboratories, Idaho Department of Health and Welfare in Boise, is an EPA Certified Laboratory and provided the sampling materials. The samples were transferred to the lab in a 4°C cooler filled with sufficient crushed ice.

Surface Water Samples and Flow Measurements

Ten (10) surface water sites on the Jacks Creek drainage were selected to summarize the water quality above and below the input from the two aquaculture facilities. The sampling sites were selected with the input from the fish hatcheries' owner; the ISCC; various private cropland owners; and the previous sites selected in the Bruneau River TMDL on Jacks Cree. Samples were collected from downstream to upstream locations to avoid potential cross-contamination of downstream samples. See Sections 5.2 and A.0.3 for identification of surface water sampling sites along with their latitude-longitude coordinates. Collection of surface water samples followed the procedure as previously outlined in Section 5.2.

Flow information was also collected from each of the sites when surface water was present as an open channel flow measurement (OCFM). The OCFM process used in this sampling strategy is based on the Beneficial Use Reconnaissance Program (BURP) Water Body Assessment Guidance II (WBAG II) document. The WBAG II process is identified in IDAPA §58.01.02.053.

NPDES Fish Hatchery Influent/Effluent Samples

The Arraina and Ace Development fish hatcheries collected samples from their influent and effluent discharges. The period of record is March 2000 through March 2004 and contains the following reported sampling events:

Sampling Year	Arraina	Ace Development
2000	May – Dec = 8	May – Dec = 8
2001	Feb – Oct = 6	Jan – Oct = 6
2002	Jan – Oct = 3	Jan – Oct = 4
2003	Feb – Sep = 5	Jan – Sep = 3
2004	Feb = 1	Feb = 1 .
Total Samples Taken	23	22

The samples taken were tested for temperature, total phosphorus, total suspended sediment, total ammonia nitrogen (NH_3), total nitrate + nitrite (NOx), total Kjeldahl nitrogen (TKN), and dissolved oxygen (DO). The NH_3, NOx, TKN and DO were taken during the effluent characterization period in the General Aquaculture permit. Net values were calculated from the raw effluent minus the raw influent concentration or load values. Flow was also taken in the influent and effluent discharges. This information was collected from the NPDES permits for Arraina (IDG-130122) and Ace Development (IDG-130123), which are submitted to EPA and DEQ as part of their compliance monitoring for their NPDES permit.

Analytical Protocols and Procedures

All of the ground water and surface water samples had certain field measurements analyzed by a Hydrolab Quanta probe. The analytical protocols for the Quanta were based on the manufacturer's specifications.

When chlorophyll-a was determined in the field, a Hydrolab SCUFA probe was used. The analytical protocols for the SCUFA were based on the manufacturer's specifications. Both the Quanta and the SCUFA use a Hydrolab Surveyor® 4 data display for readout of information.

Table 26 summarizes the range, accuracy and resolution for the field parameters. Note that the SCUFA reads total dissolved solids and the Quanta reads salinity. The SCUFA SC is in µS/cm whereas the Quanta conductivity is in mS/cm.

Table 26. Field parameter range, accuracy and resolution.

ANALYTE	RANGE	ACCURACY	RESOLUTION
Temperature (°C)	-5°C to 50°C	±0.20°C	0.01°C
Dissolved Oxygen (DO)	0 to 50 mg/L	±0.2 mg/L to 20 mg/L	0.01 mg/L
Specific Conductance (SC)	0 to 100 mS/cm	±1% of reading ±1 count	4 digits
pH (SU)	2 to 12 units	±0.2 units	0.01 units
Salinity (PSS)	0 to 70 PSS	±1% of reading ±1 count	0.01 PSS
Turbidity (NTU)	0 to 100 NTU	±2.6% of range	0.1 NTU
% DO Saturation (%DO)	0 to 100%	±0.1% to 10%	0.01%
PSS = Practical Salinity Scale. SU = Standard Units. NTU = Nephelometric Turbidimetric Units. The % DO Saturation value may be calculated from the function of temperature per *Standard Methods* (20th Edition) 2810 Dissolved Gas Supersaturation.			

All of the ground water and surface water samples were analyzed by the Bureau of Laboratories, Idaho Department of Health and Welfare in Boise, Idaho. Since this lab is an EPA Certified Laboratory, their analytical protocols are based on EPA methodology procedures. Table 10 summarizes the ground water and surface water procedures used.

Table 27. Analytical protocols and procedures for ground water and surface water samples.

ANALYTE	STORET NUMBER	METHODOLOGY	REPORTING LIMIT
Total suspended sediment (TSS)	00530	EPA 160.2	1.0 mg/L
Total phosphorus (TP)	00665	EPA 365.2	0.005 mg/L
Escherichia coli (*E. coli*)	50468	SM 9222G	1 cfu/100 mL
EPA = U. S. Environmental Protection Agency method number. SM = *Standard Methods*. If sample is too turbid to filter, then SM9222G will be replaced by SM9221E.			

All of the surface soils and substrate sediment samples were transported by DEQ to Stukenholtz Laboratory, Inc. in Twin Falls, Idaho. This laboratory is recognized by the University of Idaho as a soils laboratory that is qualified for soil analytical protocols that are similar and consistent with the University of Idaho Soils Analytical Laboratory in Moscow, Idaho. In addition, the lab is well acquainted with the USDA-NRCS soil analytical procedures. Qualification of this laboratory is based on a soil-sample exchange process conducted by the University of Idaho known as the North American Proficiency Testing Program.

Table 28 summarizes the analytical protocols and soil procedures used.

Table 28. Analytical protocols and procedures for surface soils and substrate sediment samples.

ANALYTE	UNITS		SSLM METHODOLOGY	REPORTING LIMIT	
Soil Moisture	%		U of I Pw Test	0.1%	
Organic Matter	%		U of I Loss on Ignition	0.1%	
pH	SU		U of I Saturated Paste	0.01 units	
Excess Lime	%		U of I Titrimetric	0.1%	
Total Soluble Salts	mmhos/cm		USDA Method 8A1	0.1 mmhos/cm	
Soil Texture	Type		Field Book 2-30	Textural Triangle	
Sand	%		USDA Method 3A1e	0.5%	
Silt	%		USDA Method 3A1e	0.5%	
Clay	%		USDA Method 3A1e	0.5%	
Total P	ppm		U of I Total P Test	1.0 ppm	
Bicarbonate P	ppm		U of I Olsen Method	0.1 ppm	
Water-soluble P	ppm		USDA Method 6S7	0.1 ppm	
CEC	mEq/100 g		U of I Calculation	0.1 mEq/100 g	
Sodium	mEq/100 g	ppm	U of I NH4-Acetate	0.1 mEq/100 g	1.0 ppm
Potassium	mEq/100 g	ppm	U of I NH4-Acetate	0.1 mEq/100 g	1.0 ppm
Calcium	mEq/100 g	ppm	U of I NH4-Acetate	0.1 mEq/100 g	1.0 ppm
Magnesium	mEq/100 g	ppm	U of I NH4-Acetate	0.1 mEq/100 g	1.0 ppm
SSLM = Soil Survey Laboratory Methods from the USDA NRCS = USDA Method = USDS-NRCS, Soil Survey Laboratory Methods Manual, 1996. Field Book = USDA Field Book = USDA-NRCS, Field Book for Describing and Sampling Soils, 2002. U of I = University of Idaho followed by name of procedure used. Pw = Test for percent water or moisture of soil.					

Global Positioning System

A Garmin eTrex Vista™ personal navigator® Global Positioning System (GPS) survey unit (serial No. 89817994) was used by DEQ personnel to record coordinates of all sample locations. Location sites are summarized in Table 29.

Table 29. GPS survey data for monitoring locations on Jacks Creek.

LOCATION SITE	LATITUDE	LONGITUDE
7-Wetland Area	N 42° 53.938′	W 115° 52.129′
7-Main Jacks Creek above Wetland	N 42° 53.934′	W 115° 52.302′
6-Jacks Creek by Highway 78	N 42° 53.698′	W 115° 52.337′
5-Jacks Creek by Davis Road	N 42° 51.495′	W 115° 52.540′
4-Jacks Creek by Cattle Drive Road	N 42° 50.626′	W 115° 53.481′
3-Jacks Creek by Selman Farm	N 42° 49.346′	W 115° 54.048′
2-Jacks Creek by Shoo Fly Road	N 42° 54.955′	W 115° 54.955′
1-Jacks Creek off Vaught Road	N 42° 47.747′	W 115° 56.321′
0-Weir of Big Jacks & Little Jacks	N 42° 47.130′	W 115° 58.380′
Ace Artesian Well	N 42° 49.412′	W 115° 53.722′
Arraina Artesian Well	N 42° 49.818′	W 115° 53.643′

Relative to artesian wells listed in Table 30, there were several additional private landowners that allowed DEQ to sample their wells with the stipulation that their name and location not be included in the final TMDL modification document. To account for these sampling sites, these are identified with an alphabetical letter but without latitude-longitude values in Table 13 and with their relative location above or below the aquaculture fish facilities along Jacks Creek. Without this stipulation from the private landowners, it would be difficult to define the water quality characteristics of the artesian well complex along Jacks Creek.

Table 30. Artesian well monitoring sites contributing to Jacks Creek.

LOCATION SITE	LATITUDE	LONGITUDE
Ace Artesian Well	N 42° 49.412′	W 115° 53.722′
Arraina Artesian Well	N 42° 49.818′	W 115° 53.643′
A – Artesian Well	Below the aquaculture fish facilities- discharges to Jacks Creek.	
B – Artesian Well	Below the aquaculture fish facilities- discharges to Jacks Creek.	
C – Artesian Well	Below the aquaculture fish facilities- discharges to Jacks Creek.	
D – Artesian Well	Above the aquaculture fish facilities- discharges to Jacks Creek.	
E – Artesian Well	Above the aquaculture fish facilities- discharges to Jacks Creek.	
F – Artesian Well	Above the aquaculture fish facilities- discharges to Jacks Creek.	

Investigation-Derived Waste

No investigation-derived waste (IDW) was generated during the sampling efforts at any of the sampling sites inclusive of the two aquaculture facilities. All sample containers with sample

material were placed in 4°C coolers with sufficient crushed ice. The coolers were transported by DEQ to a transport courier (who took the materials to the IDHW-Lab in Boise) or taken by DEQ to the Stukenholtz Lab in Twin Falls, Idaho for laboratory analysis.

A.2 Precision on Jacks Creek Surface Water Quality Samples

As previously stated in Section A.10.3 (of Appendix A-1), precision is represented by the standard deviation (*s*), the relative standard deviation (RSD) or coefficient of variation (CV), and the relative percent difference (RPD). Each of these components has its own set of proficiency requirements (DQOs) to qualify the data both in the field and in the laboratory. The proficiency requirements were established by DEQ based on field and laboratory data collected from 1995 through 1999. This determination was in consultation with the IDHW-Lab in Boise, Idaho.

Table 31 summarizes the precision components used in this study of the field parameters based on two samples with nine replicates each over eight monitoring stations. This was done to ascertain the degree of variability and comparability for each of the field parameters to describe the general water-quality characteristics of Jacks Creek. The Rule of Acceptance is based on EPA's protocol for duplicates and replicates; and stipulates that to accept the duplicate data at the 95% CL, the data is acceptable when the RPD % value is ≤ two times the sigma of the *s* plus 20%. This acceptance of the data is a conservative approach that takes into account the field variability based on the RPD % value.

Table 31. Precision components of field parameters.

Rate	FIELD PARAMETERS						
	TEM °C	DO mg/L	SC µmhos/cm	pH SU	TDS g/L	TURB NTU	CHLOR mg/L
GENERAL DESCRIPTIVE STATISTICS							
N	18	18	18	18	18	18	18
M1±S	18.01 ± 10.18	8.81 ± 2.64	887.9 ± 618.1	7.84 ± 0.38	0.5690 ± 0.3947	15.8 ± 17.1	0.63 ± 0.59
M2±S	17.90 ± 10.30	7.70 ± 1.94	889.5 ± 646.8	7.84 ± 0.32	0.5664 ± 0.4124	18.5 ± 19.1	0.59 ± 0.59
Mean	17.96	8.26	888.7	7.84	0.5677	17.2	0.61
SD	10.24	2.29	632.4	0.35	0.4035	18.1	0.59
RSD	57.0	27.7	71.2	4.5	71.1	105.6	97.1
RPD	0.6	13.4	0.2	0.0	0.5	15.2	6.7
s: OVERALL %V = 96.6%							
SD	10.24	2.29	632.4	0.35	0.4035	18.1	0.59
C/S	25.0	5.0	750.0	0.50	0.5000	20.0	1.0
DQO	M	M	M	M	M	M	M
%V	98.0	97.7	95.6	96.5	96.0	95.5	97.1
RPD % = CV %: OVERALL %V = 96.1%							
RSD	57.0	27.7	71.2	4.5	71.1	105.6	97.1
C/S	75.0	50.0	75.0	19,9	75.0	125.0	100.0

DQO	M	M	M	M	M	M	M
%V	96.2	97.2	95.3	97.8	95.3	95.8	95.1
RPD %: OVERALL %V = 98.0%							
RPD	0.6	13.4	0.2	0.0	0.5	15.2	6.7
C/S	2.0	20.0	2.0	2.0	2.0	20.0	10.0
DQO	M	M	M	M	M	M	M
%V	98.5	96.7	99.5	100.0	98.8	96.2	96.7
OVERALL MEAN – *s*, RSD%, and RPD%: Overall %V of All Parameters = 96.3%							
Mean	97.5	97.2	96.9	98.0	96.7	95.8	96.3
RULE OF ACCEPTANCE							
RPD	0.6	13.4	0.2	0.0	0.5	15.2	6.7
$2S_M$	7.2	1.6	447.3	0.3	0.3	12.8	0.4
$2S_M$%	40.3	19.8	50.3	3.2	50.3	74.8	68.7
20%	60.3	39.8	70.3	23.2	70.3	94.8	88.7
Bool	0.6 ≤ 60.3	13.4 ≤ 39.8	0.2 ≤ 70.3	0.0 ≤ 23.2	0.5 ≤ 70.3	15.2 ≤ 94.8	6.7 ≤ 88.7
Acc	Accept	Accept	Accept	Accept	Accept	Accept	Accept

N = 14 = Number of samples used to determine the overall C/S for the DQO. RATE = The category defined as Value, C/S, DQO, or %V. Value = The actual reading or value as compared to the C/S. TEM = Temperature. DO = Dissolved oxygen. SC = Specific conductance. pH = Standard units. TDS = Total dissolved solids. Turb = NTU = Turbidity = Nephelometric turbidimetric units. CHLOR = Chlorophyll-a. C/S = Comparison standard or proficiency requirement. DQO = Data quality objective, which is summarized as M for Meets DQO Requirements or E for Estimates DQO Requirements. M is expressed as 95.0% CL such that the range from 95% to 100% is a 5.0 difference. Therefore, %V = 100-((Value / C/S) x 5.0). %V = The actual % value of the DQO requirement based on the individual value regressed against the C/S value. *s* = standard deviation. M1±S = Mean of sample 1 ± standard deviation. M2±S = Mean of sample 2 ± standard deviation. Mean = the mean value of samples M1 and M2. SD = the mean standard deviation of samples M1 and M2. RPD = Relative Percent Difference. $2S_M = 2S_{Mean}$ as found in Table 15. $2S_M\% = 2S_{Mean}\%$ as found in Table 15. 20% = $2S_{Mean}\%$ + 20% as found in Table A-2. Bool = Boolean as found in Table 15. Acc = Accept as found in Table 15.

Relative to the laboratory parameters (TP, TSS, Total Coliform, and *E. coli*), Table 15 summarizes the duplicate field samples. The water sample was collected in a churn splitter and thoroughly mixed prior to sampling for the sample and three replicates. A control limit or DQO for each laboratory parameter was selected by DEQ with consultation with the IDHW-Lab based on analysis of similar parameters for the period 1995-1999. The DQOs were based on the *s*, RSD %, and the RPD % values. In addition, Table 32 summarizes the Rule of Acceptance, which is based on EPA's protocol for duplicates and replicates. It stipulates that to accept the duplicate data at the 95% CL, the data is acceptable when the RPD % value is ≤ two times the sigma of the *s* plus 20%. This acceptance of the data is a conservative approach that takes into account the field variability based on the RPD % value.

Table 32. Precision analysis of laboratory parameters.

PARAMETER		LABORATORY PARAMETERS			
		TOTAL PHOSPHORUS mg/L	TOTAL SUSPENDED SEDIMENT mg/L	TOTAL COLIFORM cfu/100 mL	*ESCHERICHIA COLI* cfu/100 ml
Sample 1	Rep 1-A	0.172	2.8	14,000	70
	Rep 1-B	0.170	1.2	20,000	100
Sample 2	Rep 2-A	0.170	1.6	8,700	48
	Rep 2-B	0.170	2.0	24,000	120
GENERAL DESCRIPTIVE STATISTICS					
N		4	4	4	4
Mean1 ± SD1		0.171 ± 0.001	2.0 ± 1.1	17,000 ± 4,243	85 ± 21
Mean2 ± SD2		0.170 ± 0.000	1.8 ± 0.3	16,350 ± 10,819	84 ± 51
Overall Mean		0.171	1.9	16,675	85
Overall RSD %		0.4%	37.2%	45.2%	42.7%
Overall RPD %		0.6%	10.5%	3.9%	1.2%
***s*: OVERALL %V = 98.6%**					
SD		0.001	0.7	7,531	36
C/S		0.050	2.0	20,000	100
DQO		Meets	Meets	Meets	Meets
%V		99.9%	98.2%	98.1%	98.2%
RPD % = CV %: OVERALL %V = 95.9%					
SD		0.4	37.2	45.2	42.7
C/S		0.5	50.0	50.0	50.0
DQO		Meets	Meets	Meets	Meets
%V		96.0%	96.3%	98.1%	95.7%
RPD %: OVERALL %V = 97.1%					
SD		0.6	10.5	3.9	1.2
C/S		1.0	15.0	5.0	5.0
DQO		Meets	Meets	Meets	Meets
%V		97.0%	96.5%	96.1%	98.8%
OVERALL MEAN – *s*, RSD%, and RPD%: Overall %V of All Parameters = 97.2%					
Mean		97.6%	97.0%	96.6%	97.6%
RULE OF ACCEPTANCE					
RPD%		0.6%	10.5%	3.9%	1.2%

$2S_{Mean}$	0.000707	0.583095	5,810.443	27.57716
$2S_{Mean}$%	0.4%	30.7%	34.8%	32.6%
$2S_{Mean}$% + 20%	20.4%	50.7%	54.8%	52.6%
Boolean	0.6% ≤ 20.4%	10.5% ≤ 50.7%	3.9% ≤ 54.8%	1.2% ≤ 52.6%
Acceptance	Accept	Accept	Accept	Accept

cfu = coliform form units. N = Number of samples taken. RSD = Relative standard deviation = Coefficient of variation (CV). RPD = Relative percent difference. SD = Standard Deviation = *s*. DQO = Data quality objective, which is summarized as M for Meets DQO Requirements or E for Estimates DQO Requirements. M is expressed as 95.0% CL such that the range from 95% to 100% is a 5.0 difference. Therefore, %V = 100-((Value / C/S) x 5.0). $2S_{Mean} = (\sqrt{((SD1)^2 + (SD2)^2)})/2$. $2S_{Mean}$% = ((100)($2S_{Mean}$))/Mean. $2S_{Mean}$% + 20% = Add 20% to the value obtained from $2S_{Mean}$%. Boolean = The RPD% value is either ≤ or else it is > $2S_{Mean}$% + 20%. Acceptance = If Boolean is ≤ $2S_{Mean}$% + 20%, then Accept the value; else, if Boolean is > $2S_{Mean}$% + 20%, then Reject the value.

A.3 Sample Holding Times on Jacks Creek Surface Water Quality Samples and Associated Substrate and Soil Samples

The Sampling Holding Times (SHT) is based upon two DQOs previously defined as a consequence of historical performance of other projects related to water quality monitoring. First, SHT-1 has a DQO of 24 hours for a period between the date of sample collection and the date of sample submission to the air courier. Second, SHT-2 has a DQO of 48 hours for a period between the date of sample collection and the date the laboratory received the samples. Relative to soils, the DQO is 72 hours for SHT-1 and SHT-2. Table 33 summarizes the sample holding times and the DQO requirements for the IDHW-Lab and the soil lab.

Table 33. Sample holding times.

Date of sample collection	Date of sample submission	Date of lab receiving samples	DQO Qualification: IDHW-Lab -------TP-------		-------TSS------		-----E. coli---	
			SHT-1	SHT-2	SHT-1	SHT-2	SHT-1	SHT-2
09 Feb 2004	09 Feb 2004	11 Feb 2004	M	M	M	M	M	M
30 Mar 2004	30 Mar 2004	31 Mar 2004	M	M	M	M	M	M
20 Apr 2004	20 Apr 2004	21 Apr 2004	M	M	M	M	M	M
18 May 2004	18 May 2004	19 May 2004	M	M	M	M	M	M
22 Jun 2004	22 Jun 2004	23 Jun 2004	M	M	M	M	M	M
14 Jul 2004	14 Jul 2004	15 Jul 2004	M	M	M	M	M	M
31 Aug 2004	31 Aug 2004	01 Sep 2004	M	M	M	M	M	M
22 Sep 2004	22 Sep 2004	23 Sep 2004	M	M	M	M	M	M
Number of Times Meets DQO Requirements			8 M	8 M	8 M	8 M	8 M	8 M
Completeness Ratio			8/8	8/8	8/8	8/8	8/8	8/8
% Completeness			100%	100%	100%	100%	100%	100%
Date of sample collection	**date of sample submission**	**date of lab receiving samples**	**DQO qualification: SOIL LAB --Standard--**		**-SATURATED-**		**---TEXTURE---**	
			SHT-1	**SHT-2**	**SHT-1**	**SHT-2**	**SHT-1**	**SHT-2**

09 Feb 2004	12 May 2004	12 May 2004	M	M	M	M	M	M
18 May 2004	19 May 2004	19 May 2004	M	M	M	M	M	M
22 Jun 2004	25 Jun 2004	25 Jun 2004	M	M	M	M	M	M
Number of Times Meets DQO Requirements			3 M	3 M	3 M	3 M	3 M	3 M
Completeness Ratio			3/3	3/3	3/3	3/3	3/3	3/3
% Completeness			100%	100%	100%	100%	100%	100%
DQO = Data Quality Objective, which is summarized as M for Meets DQO Requirements or D for Does Not Meet DQO Requirements for sampling holding times. IDHW = Idaho Department of Health and Welfare. TP = Total Phosphorus. TSS = Total Suspended Sediment. *E. coli* = *Escherichia coli*. STANDARD = Standard soil test for fertility requirements. SATURATED = Saturated soil past for water-soluble requirements. TEXTURE = Sand, silt, and clay tests for particle size analysis as texture determination. Completeness Ratio: 8/8 = 8 actual sampling events/8 planned sampling events; 3/3 = 3 actual sampling events/3 planned sampling events. % Completeness: 8/8 = (8/8) x 100 = 100%; 3/3 = (3/3) x 100 = 100%.								

A. 4 Field Instrument Calibration (FIC) on Jacks Creek Surface Water Quality Samples

Field equipment involved in field data generation was calibrated by DEQ prior to use in the field according to manufacturer's specifications. As part of this process, the field equipment was standardized using reference standards. Stability of calibration of the HydroLab Quanta and the HydroLab Scufa are one month based on manufacturer's specifications. However, DEQ calibrates both instruments no more than 7 days prior to use in the field. Relative to the individual parameters the DQO by DEQ stipulates that calibration must be performed unless the parameter is based on manufacturer's settings. Table 34 summarizes the field instrument calibration for nine field parameters with their DQO value.

Table 34. Field instrument calibration.

FIC	DOSC	DQO	DQO FOR CALIBRATION OF FIELD INSTRUMENT PARAMETERS TEM	DO	SC	pH	TDS	NTU	%DO	CHLO
06 Feb 2004	09 Feb 2004	M	IIS	M	M	M	IIS	M	IIS	M
29 Mar 2004	30 Mar 2004	M	IIS	M	M	M	IIS	M	IIS	M
14 Apr 2004	20 Apr 2004	M	IIS	M	M	M	IIS	M	IIS	M
14 May 2004	18 May 2004	M	IIS	M	M	M	IIS	M	IIS	M
21 Jun 2004	22 Jun 2004	M	IIS	M	M	M	IIS	M	IIS	M
13 Jul 2004	14 Jul 2004	M	IIS	M	M	M	IIS	M	IIS	M
29 Aug 2004	31 Aug 2004	M	IIS	M	M	M	IIS	M	IIS	M
20 Sep 2004	22 Sep 2004	M	IIS	M	M	M	IIS	M	IIS	M
Number of Times Meets DQOs		8 M	8 IIS	8 M	8 M	8 M	8 IIS	8 M	8 IIS	8 M

Completeness Ratio	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8
% Completeness	100%	100%	100%	100%	100%	100%	100%	100%	100%

FIC = Field Instrument Calibration. DOSC = Date of Sample Collection. DQO = Data Quality Objective for meeting the period in calibration of the field instrument prior to sampling in the field. TEM = Temperature. DO = Dissolved Oxygen. SC = Specific Conductance. TDS = Total Dissolved Solids. NTU = Turbidity. %DO = % Dissolved Oxygen Saturation. CHLO = Chlorophyll-a. M = Meets the DQO for calibration within the time frame allowed. IIS = Internal Instrument Setting and does not require calibration because of manufacturer's settings and specifications. Completeness Ratio: 8/8 = 8 actual calibration events/8 planned calibration events. % Completeness: 8/8 = (8/8) x 100 = 100%.

A.5 Blank Calibration on Jacks Creek Surface Water Quality Samples

Field blanks consist of deionized water that is provided by the IDHW-Lab in one-liter plastic cubitainers ready for use in the field. They are used for two purposes:

- To calibrate field instruments by zeroing out the reading.
- To assess the contamination from field sources such as airborne materials, containers, and preservatives.

Therefore and in addition to field instrument calibration, a field blank is used to check for cross-contamination during sample collection, sample shipment, and in the laboratory. Table 35 summarizes the calibration of the HydroLab Scufa and the HydroLab Quanta and demonstrates that regardless of the reading (Before) for SC, NTU, and Depth, the instrument is calibrated (or "zeroed out") to zero (After) prior to use in the field.

Table 35. Blank calibration for select field parameters.

FIC	SC CALIBRATION		NTU CALIBRATION		DEPTH CALIBRATION	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
06 Feb 2004	0.0	0.0	0.0	0.0	0.0	0.0
29 Mar 2004	0.0	0.0	0.0	0.0	0.0	0.0
14 Apr 2004	0.0	0.0	0.0	0.0	0.1	0.0
14 May 2004	0.0	0.0	3.0	0.0	0.3	0.0
21 Jun 2004	0.0	0.0	0.0	0.0	0.0	0.0
13 Jul 2004	0.0	0.0	0.0	0.0	0.0	0.0
29 Aug 2004	0.0	0.0	0.0	0.0	0.0	0.0
20 Sep 2004	0.0	0.0	0.0	0.0	0.0	0.0
Number of Times Meets DQOs	8 M	8 M	8 M	8 M	8 M	8 M
Completeness Ratio	8/8	8/8	8/8	8/8	8/8	8/8
% Completeness	100%	100%	100%	100%	100%	100%

FIC = Field Instrument Calibration. SC = Specific Conductance. NTU = Turbidity. Before = Reading prior to calibration. After = Reading after calibration to zero. M = Meets DQO Requirements. Completeness Ratio: 8/8 = 8 actual calibration events/8 planned calibration events. % Completeness: 8/8 x 100 = 100%.

Table 36 summarizes the field contamination levels for the parameters indicated. Fourteen percent of the samples were taken as blanks at a rate of 1.4 samples per 10 samples taken. The DQO for TP is < 0.005 mg/L. The DQO for TSS is < 1 mg/L. And, the DQO for *E. coli* is < 10 cfu/100 mL. All DQO requirements were met as determined by the percent completeness (%C).

Table 36. Summary of field contamination based on blank water analysis.

REPLICATE BLANKS	TP mg/L	TSS mg/L	*E. coli* cfu/100 mL
Replicate 1-A	< 0.005	< 1.0	< 10
Replicate 2-A	< 0.005	< 1.0	< 10
Replicate 3-A	< 0.005	< 1.0	< 10
DQO%	%C = 100%	%C = 100%	%C = 100%
Replicate 1-B	< 0.005	< 1	< 10
Replicate 2-B	< 0.005	< 1	< 10
Replicate 3-B	< 0.005	< 1	< 10
DQO%	%C = 100%	%C = 100%	%C = 100%
Replicate 1-C	< 0.005	< 1	< 10
Replicate 2-C	< 0.005	< 1	< 10
Replicate 3-C	< 0.005	< 1	< 10
DQO%	%C = 100%	%C = 100%	%C = 100%

TP = Total Phosphorus. TSS = Total Suspended Sediment. *E. coli* = *Escherichia coli*. cfu = coliform forming units. DQO = Data Quality Objective. % C = Percent Completeness.

A.6 Jacks Creek Surface Water Quality Samples

Table 37 provides an annual summary of the Jacks Creek surface water quality samples taken from 2001 through 2004. Sampling was conducted by two agencies: (1) 2001-2004, ISCC for selected sites, and (2) 2004, DEQ for all monitoring sites and the fish hatcheries.

Table 37. Jacks Creek surface water quality samples (2001-2004).

YEARLY SUMMARY	TSS mg/L	TP mg/L	Total coliform cfu/100 mL	*E. coli* cfu/100 mL
2001	214.0	0.332	-	-
2002	79.4	0.338	87,755	10,140
2003	61.3	0.250	38,840	2,694
2004	31.4	0.218	17,261	1,675
Mean (2001-2004)	96.5	0.285	47,952	4,836

Other analyses are available and can be segregated into monthly sampling. Table 37 is an annual summary of four selected parameters.

A.7 NPDES Influent/Effluent Fish Hatchery Samples

Table 38 summarizes the NPDES influent/effluent fish hatchery samples as collected by the Arraina (IDG-130122) and Ace Development (IDG-130123) facilities for the period of record from March 2000 through March 2004. The data is based on the raceways only.

Table 38. Summary of NPDES influent/effluent fish hatchery samples – mean values.

NPDES PARAMETERS	ARRAINA Fish Hatchery			ACE Development Fish Hatchery		
	Raw Inf	Raw Eff	Net	Raw Inf	Raw Eff	Net
Flow, cfs	5.5	4.4	NA	3.7	2.7	NA
Temperature, °C	36.00	28.00	NA	37.47	25.55	NA
TP, mg/L	0.012	0.235	0.223	0.020	0.351	0.331
TSS, mg/L	1.1	17.7	16.6	1.0	26.6	25.6
SS, ml/L	NA	0.1	NA	NA	0.1	NA
TAN, mg/L	0.025	0.350	0.325	0.031	0.617	0.586
NOX, mg/L	0.240	0.280	0.040	0.253	0.296	0.043
TKN, mg/L	0.039	1.044	1.005	0.049	1.350	1.301
DO, mg/L	NA	7.09 Min	NA	NA	8.24 Min	NA

Inf = Influent. Eff = Effluent. Net = Eff – Inf. TP = Total Phosphorus. TSS = Total Suspended Sediment. SS = Settleable Solids. TAN = Total Ammonia Nitrogen. NOX = Total Nitrate + Nitrite. TKN = Total Kjeldahl Nitrogen. DO = Dissolved Oxygen. NA = Not Applicable. Min = Minimum value. Net Effluent values were corrected so that they mathematically corresponded to the difference between the Raw Effluent and the Raw Influent.

A.8 Substrate Streambed Samples

Table 39 summarizes the substrate streambed samples for Jacks Creek and Big Jacks Creek. Background or substrate streambed samples were also collected just below the irrigation weir as the "headwaters" of Jacks Creek and in Big Jacks Creek. Both these additional samples serve as background samples to the location sites on Jacks Creek. The location sites on Jacks Creek include 7-Wetland, 7-Main, 6-Highway 78, 5-Davis Road, 4-Cattle Drive Road, 3-Selman Farm, 2-Shoo Fly Cut Off Road, and 1-Vaught Road.

Table 39. Substrate streambed samples for Jacks Creek and Big Jacks Creek.

ANALYTE	7-W	7-M	6	5	4	3	2	1	WEIR	BIG
pH, SU	7.1	7.4	7.2	7.0	7.2	7.3	7.3	7.6	8.0	7.6
OM %	2.68	1.93	1.78	1.68	0.81	0.91	2.71	1.19	0.70	0.50
Lime %	3.8	1.5	1.1	0.7	1.4	0.8	0.7	0.7	0.7	0.5
Texture	Si Lo	Lo Sa	Sa	Lo Sa	Sa	Sa	Lo	Lo Sa	Si Lo	Si Lo
Sand %	62.5	72.4	97.1	80.1	94.3	93.8	47.3	83.2	38.0	39.0
Silt %	31.8	26.6	2.2	15.8	4.2	4.1	41.3	9.0	51.9	47.3
Clay %	5.7	1.0	0.7	4.1	1.5	2.1	11.4	7.8	10.1	13.7

Total P ppm	801.0	654.5	797.0	691.5	1288.0	941.0	862.0	912.5	639.0	486.9
Olsen P ppm	33.0	15.0	5.0	9.0	3.0	6.0	7.0	4.0	7.0	11.0
Water P ppm	29.0	9.0	2.5	3.7	1.7	5.8	2.4	1.3	3.0	5.0

7-W = 7-Wetland. 7-M = 7-Main channel. 6 = 6-Highway 78. 5 = 5-Davis Road. 4 = 4-Cattle Drive Road. 3 = 3-Selman Farm. 2 = 2-Shoo Fly Cut Off Road. 1 = 1-Vaught Road. Weir = On Jacks Creek just below the irrigation weir below the USGS Gage. BIG = Big Jacks Creek. SU = Standard units. OM = Organic matter. Sa = Sand. Lo = Loam. Si Lo = Silt Loam. Lo Sa = Loamy Sand. Total P ≠ TP in water, but rather is a chemical extraction process that extracts from the soil the mineral and organic phosphorus, both soluble and insoluble fractions. Olsen P = Bicarbonate P test in soils. Water P = Water-soluble P based on a saturated paste extraction from the soil.

A.9 Artesian Well Samples

Table 40 summarizes a comparison study of the artesian wells that exist above and below the fish hatcheries.

Table 40. Artesian well information for temperature and total phosphorus on Jacks Creek.

BELOW FISH FACILITIES			ABOVE FISH FACILITIES		
Facility No.	Tem, °C	TP, mg/L	Facility No.	Tem, °C	TP, mg/L
A	36.04	0.014	G	29.91	0.013
B	33.34	0.024	H	37.72	0.016
C	35.67	0.021	I	36.78	0.014
D	34.22	0.015	J	30.29	0.020
E	33.75	0.014	K	36.04	0.021
F	35.05	0.014	L	35.84	0.018
N	6	6	N	6	6
Mean	34.68	0.017	Mean	34.43	0.017
StDev	1.08	0.004	StDev	3.42	0.003
Variance	1.17	0.000	Variance	11.70	0.000

TP = Total phosphorus. The facilities requested to be anonymous and therefore are labeled with alphabetical letters. No. = Facility Number. Tem = Temperature. N = Number of samples. StDev = Standard Deviation.

A.10 Surface Soil Samples

Table 41 summarizes the 0-3" surface soil sample taken from the Jacks Creek drainage. This surface soil sample represents the visible saline-alkali conditions that exist along the uplands portion within 100 feet of the stream.

Table 41. Salty high-mineral soil of Jacks Creek drainage.

ANALYTE, UNIT OF MEASURE	VALUE	RELATIVE INTERPRETATION of condition indicated
pH, SU	10.7	Strongly alkaline
Organic Matter, %	2.03	Marshland
Lime, %	3.9	Marshland
Carbonate, ppm	85.0 estimate	Strongly alkaline
Bicarbonate, ppm	1,200.0 estimate	Strongly alkaline
Soluble Salts, mmhos/cm	122.8	Saline
Texture	Loamy sand	Mud flat; Marshland
Sand, %	85.0	Mud flat
Silt, %	11.5	Mud flat
Clay, %	3.5	Mud flat; Marshland
Ammonium-N, ppm	1.0	Strongly alkaline
Nitrate-N, ppm	11.0	Marshland
Olsen-P, ppm	39.0	Marshland
Potassium, ppm	1630.0	Saline-sodic
Sulfate-S, ppm	2,500.0 estimate	Saline
Chloride, ppm	3,221.0	Saline-sodic
Na, mEq/100 g	49.0	Sodic
Ca, mEq/100 g	2.5	Sodic
Mg, mEq/100 g	0.1	Sodic
CEC, mEq/100 g	57.0	Saline-sodic
Water-soluble Na, ppm	12,516.0	Saline
Water-soluble Ca, ppm	611.0	Saline
Water-soluble Mg, ppm	16.3	Saline
Water-soluble K, ppm	2,321.0	Saline
Zinc, ppm	0.5	Strongly alkaline
Iron, ppm	4.2	Strongly alkaline
Manganese, ppm	4.5	Strongly alkaline
Copper, ppm	0.2	Strongly alkaline
Boron, ppm	20.75	Saline-sodic
Molybdenum	2.23	Strongly alkaline
SU = Standard Units. Na = Sodium. Ca = Calcium. Mg = Magnesium. K = Potassium. CEC = Cation Exchange Capacity.		

A.11 Summary of Quality Control/Quality Assurance

All data performed by the various laboratories were reviewed and validated by the DEQ Chemist in TFRO. This included field data collected by DEQ during sampling runs. Data qualifiers were applied by the DEQ Chemist as necessary according to statements of work and following the guidance of *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (2002). The following section provides a description of the quality assurance/quality control (QA/QC) relative to data quality objections, QA/QC control samples, precision, accuracy, completeness, representativeness, and comparability.

Satisfaction of Data Quality Objectives

Data quality objectives for this post-TMDL sampling effort were based on EPA Requirements for Quality Assurance Project Plans (2001), EPA Quality Manual for Environmental Programs (2000), and EPA Guidance for Quality Assurance Project Plans (2002). In general, the development of a QA Project Plan (QAPP) for the Jacks Creek post-TMDL monitoring efforts includes the following:

- The QAPP describes the activities of the post-TMDL monitoring effort on Jacks Creek and the two aquaculture fish hatchery facilities with the acquisition of environmental sampling information generated from direct measurements activities and collected from EPA discharge monitoring reports (DMRs) of the fish facilities.
- The QAPP documents the results of the post-TMDL monitoring effort's technical planning process, thus providing a clear, concise, and complete plan for the environmental data operation and its quality objectives and identifying essential project personnel.
- The QAPP describes the necessary QA procedures, quality control (QC) activities, and other technical activities that will be implemented for the specific post-TMDL monitoring effort on Jacks Creek.
- The QAPP is included in this document as part of the post-TMDL modification to the Bruneau River TMDL relative to Jacks Creek. By including the QAPP in this document, it can easily be communicated to all stakeholders that the post-TMDL monitoring effort on Jacks Creek had an implementable project design, thus ensuring that data quality objectives were achieved for the project.
- The QAPP was designed by DEQ and implemented by DEQ in the post-TMDL monitoring effort on Jacks Creek. Since this effort was not funded by EPA, approval of the QAPP was by DEQ as part of the overall TMDL effort in Idaho. The Twin Falls Regional Office of DEQ utilizes EPA's QAPP process in all its TMDL efforts.

Quality Assurance/Quality Control Samples

Since samples were shipped to the IDHW-Lab in Boise, Idaho, the lab provided DEQ with materials necessary to collect and process the samples in the field to assist analysis of QA/QC measures. The field QA/QC process included blanks, spikes, and duplicates as 10% of the total samples sent to the lab.

In addition, DEQ personnel performed duplicate monitoring at all sites to ascertain precision of the Hydrolab Quanta and SCUFA instruments in replication of instrument results over a 10-

minute period. This was also done to determine if any events were occurring that might be localized to the stream.

Relative to the field instruments, DEQ performed maintenance and QA/QC calibration on all field instruments prior to use in the field. A maintenance log is held by DEQ and it summarizes all of the calibrations. This log was reviewed by the DEQ Chemist to verify the calibrations.

Project-Specific Data Quality Objectives

There are five project-specific data quality objectives that were utilized in the post-TMDL monitoring effort of Jacks Creek. These data quality objectives (DQOs) are a part of the QAPP process utilized in this monitoring effort. They are summarized in the following sub sections:

- *Precision*. The reproducibility of the sampling and analytical methodology. If the samples do not meet the precision DQOs based on the measure of relative percent difference (RPD) between lab and duplicate samples or matrix spike duplicate samples, the results are qualified as "Estimated, Bias Unknown." Precision is represented by the standard deviation (s), the relative standard deviation (RSD) or coefficient of variation (CV), and the relative percent difference (RPD).
- *Accuracy*. The measure of bias from a set of measurements relative to a known or true value. Data accuracy is measured using various quality control samples and procedures that include maximum sample holding times; instrument calibration and performance checks; preparation, calibration, and temperature blank analyses; interference check sample, serial dilution, and lab control sample analyses; and, matrix spike analyses.
- *Completeness*. The percentage of usable data such that usable data are divided by the total possible data where estimated values are considered usable. It is also the comparison between the amounts of valid, or usable, data that was originally planned for collection, versus how much was actually collected.
- *Representativeness*. The degree to which the sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or environmental condition, at the time that a sample was collected.
- *Comparability*. The ability to evaluate one set of data with another. In this TMDL modification, it is the extent to which data can be compared between sample locations or periods of time (sampling events), within the project.

Precision

The objective of duplicate sample analysis is to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analyses are also performed to generate data that determines the long-term precision of the analytical method on various matrices as well as to ascertain if any field contamination has occurred from sampling or sample transporting to the lab. Non-homogenous samples can impact the apparent method precision. However, aqueous samples are generally homogenous and most soil samples are homogenous within a factor of two or three. (EPA 2002 [Contract Laboratory Program, p 25]) Thirteen duplicate samples were analyzed along with 64 samples, or 20.3% of the samples represented duplicates at a rate of 2 duplicates in 10 samples. This exceeded the DQO of 10% for duplicates.

The precision components for the field and laboratory parameters are summarized in Table 42. Three DQO levels were considered: *s*, RSD% (or CV%), and RPD%. Table 25 summarizes Table 14 and Table 15 for the three DQO levels. The combining of these three levels into one general mean represents the overall performance level for precision for both the field and laboratory parameters. This DQO Result was qualified by the DEQ Chemist as Meets the DQO Requirement for each individual parameter.

This is explained in *Completeness*, following.

Table 42. Precision components of field and laboratory parameters.

PARAMETER	s	RSD% (CV%)	RPD%	MEAN
FIELD PARAMETERS				
Temperature	98.0%	96.2%	98.4%	97.5%
Dissolved Oxygen	97.7%	97.2%	96.7%	97.2%
Specific Conductance	95.8%	95.3%	99.6%	96.9%
pH	96.5%	97.8%	99.9%	98.0%
Total Dissolved Solids	96.0%	95.3%	98.9%	96.7%
Turbidity	95.5%	95.8%	96.2%	95.8%
Chlorophyll-a	97.1%	95.1%	96.6%	96.3%
LABORATORY PARAMETERS				
Total Suspended Sediment	98.2%	96.3%	96.5%	97.0%
Total Phosphorus	99.9%	96.0%	97.0%	97.6%
Total coliform	98.1%	95.5%	98.8%	97.6%
Escherichia coli	98.2%	95.7%	98.8%	97.6%
Overall Mean DQO %	98.6%	95.9%	97.1%	97.2%
DQO Requirement	≥ 95.0%	≥ 95.0%	≥ 95.0%	≥ 95.0%
DQO Result	Meets	Meets	Meets	Meets

s = Standard Deviation. RSD% = Relative Standard Deviation as a %. CV% = Coefficient of Variation as a %. RSD% = CV%. RPD% = Relative Percent Difference. DQO = Data Quality Objective. The Quanta instrument also recorded salinity, which is not reported in this table.

Accuracy

Accuracy represents the measure of bias from a set of measurements relative to a known or true value. Data accuracy was measured using various quality control samples and procedures that included:

- *Maximum Sample Holding Times*. All samples collected in the field were submitted to the IDHW-Lab on the same day by air courier. Soil samples were submitted within 72 hours to the soil lab. All analyses were conducted within the technical water holding times; therefore no qualification was made by the DEQ Chemist based on holding time. See Appendix A-2.
- *Instrument Calibration and Performance Checks*. Field equipment or instruments involved in field data generation were calibrated by DEQ prior to use in the field according to

manufacturer's specifications. As part of this process, the field equipment was standardized using reference standards. The results of this standardization are maintained by DEQ in a calibration and maintenance log. No qualification was required by the DEQ Chemist based on field instrument calibration. See Appendix A-3.
Relative to laboratory data generation, the IDHW-Lab followed the calibration process for EPA certified laboratories. In addition to various blanks, the laboratory uses Laboratory Duplicate Samples at a rate of one duplicate for every 10 samples or less with an acceptable limit of 15% RPD of 0.050 ppm or a higher sample. No qualification was made by the DEQ Chemist based on lab instrument calibration or performance checks.
Relative to the soils laboratory, Stukenholtz Lab routinely analyzes QA/QC samples, standards, and performance checks on batches of 50-60 samples as part of their calibration process. No qualification was made by the DEQ Chemist based on the calibration process.

- *Preparation, Calibration, and Temperature Blank Samples*. All blank samples are prepared and provided to DEQ by the IDHW-Lab as distilled water. These samples come packaged in one-liter plastic cubitainers ready for use in the field. DEQ's standard protocol for blank samples is that the IDHW-Lab provides the blank samples for use in the field. Field blanks are used for two purposes:
    1. To calibrate field instruments by zeroing out the reading.
    2. To assess the contamination from field sources such as airborne materials, containers, and preservatives.

For field instrument calibration based on blank samples, the formula used for percent completeness (%C) is applied. Therefore, the generic formula (v/T x 100) was used, where v represents the number of planned sampling events that require field instrument calibration to zero. T represents the total number of actual measurements. The formula is applied to demonstrate that field instruments for blank samples are made to read zero for certain parameters. The parameters are specific conductance, turbidity, and depth. The DQO for these parameters is 100%. As demonstrated in Table 18 (Appendix A-4) all three parameters met the DQO value for blank samples in nine sampling events.

For assessment of field contamination, the same field blank samples were used in the field. Blank samples were transferred to one-liter cubitainers, labeled appropriately, and submitted to the IDHW-Lab for analysis. Table 19 (Appendix A-4) summarizes the results of the laboratory analysis. The DQOs for TP, TSS, and *E. coli* were met based on the low field contamination found from the blank water analysis.

- Interference Check Samples, Serial Dilution, and Laboratory Control Samples Analyses**:**

  The IDHW-Lab conducts a number of blank calibrations internally to guarantee the QC of the sample results of total phosphorus and total suspended sediment. These blank calibrations include the following:

    1. *Laboratory Reagent Blank***.** This blank is analyzed as one in a batch of 20 samples or less.
    2. *Laboratory Fortified Blank***.** This blank is analyzed as one in a batch of 20 samples or less. The acceptable recovery limit is a spiked value ± 10%.
    3. *Calibration Blank*. This blank is analyzed in conjunction with an Instrument Performance Check (IPC). Immediately after the analysis of the Calibration Blank, the acceptable limit for the IPC is the true value ± 10%. After every ten analyses and at the end of the sample run, the acceptable limit is the true value ± 15%.

Relative to bacteria analysis, the IDHW-Lab runs blanks daily as provided by the submitter of the samples. In addition, the IDHW-Lab in terms of each lot of media and testing vessels; on a daily basis; on a monthly basis; and, on a yearly basis provides the following:

1. *Each Lot of Media*. Three control organisms are run at concentrations of less than 100 cfu/mL. A sterility check is conducted. The autofluorescence is checked.
2. *Each Lot of Testing Vessels*. Check for sterility. There is also a volume check.
3. *Daily*. Temperatures are taken twice daily with a minimum of four hours of separation. A control standard is used with each reading. Blanks are run as provided by the submitter.
4. *Monthly*. Known control organisms are run at concentrations of less than 100 cfu/mL. Quanti tray sealer checked for integrity of seal.
5. *Yearly*. Thermometers are calibrated against a certified thermometer. Control species are identified to species.

- Sample Handling and Chain of Custody:
- Prior to sample collection, a plastic cooler was prepared with pre-cooled gel packs (or Blue Ice). A minimum of three gel packs was contained inside the cooler during the sampling period. Prior to return to the DEQ office, the cooler was filled with crushed ice covering all of the samples. The gel packs were removed prior to shipping of the cooler to the IDHW-Lab. Sample information was maintained on check-in sheets and placed in a zip lock plastic bag inside the cooler but on top of the crushed ice. Sample check-in sheets were prepared the day before the sampling event.
- Upon arrival at the DEQ office, the chain of custody sheet was filled out by DEQ personnel and submitted to the air courier who signed the sheet along with their invoice for transport. The IDHW-Lab was notified by email that samples were coming, along with a list of the samples to expect. This is standard operating procedure for field samples collected by DEQ.
- Matrix Spike Analyses:
- The IDHW-Lab for its internal QC uses a Laboratory Fortified Matrix sample for total phosphorus and total suspended sediment in 10 samples or less with an acceptable recovery limit of the spiked value ± 20%.

Completeness

Percent completeness (%C) is determined by the generic formula (v/T) x 100, where v represents the number of planned measurements judged valid and T is the total number of measurements. This formula can be applied under a number of varying regimes as indicated as follows. The project DQOs for completeness is 90% for soil/sediment samples and 95% for water samples.

Precision Completeness

For precision and referring to Table 25, v is represented by the number of planned measurements that meet (M) the DQO requirements. Therefore, the %C for s is defined as 10 M values out of 10 samples, or 100%C. The overall actual %C is not 100%, but 97.8% as defined statistically by linear regression as the overall %V (or % Value). Both the 100% and the 97.8% meet the DQO requirement (95%) for s. Each parameter met the DQO since no value fell into the estimate category (E) with unknown bias. The lowest DQO C/S value was turbidity (95.7%). Therefore,

- The %C for RSD% is defined as 9 M values out of 10 samples, or 90%C. The overall actual %C is not 90% but 95.5% as defined statistically by linear regression as the overall %V (or % Value). The overall actual value (95.5%) meets the DQO requirement (95%) for RSD%. With the exception of turbidity, each parameter met the DQO since these values did not fall into the estimate category (E) with unknown bias. The lowest DQO C/S value was turbidity (81.9%). Excluding the turbidity value, the overall actual %C is 97.0%, and thus meets the DQO requirement (95%) for RSD%.
- The %C for RPD% is defined as 9 M values out of 10 samples, or 90%C. The overall actual %C is not 90% but 93.9% as defined statistically by linear regression as the overall %V (or % Value). The overall actual value (93.9%) does not meet the DQO requirement (95%) for RSD% because of the turbidity parameter. With the exception of turbidity, each parameter met the DQO since these values did not fall into the estimate category (E) with unknown bias. The lowest DQO C/S value was turbidity (74.3%). Excluding the turbidity value, the overall actual %C is 96.1%, and thus meets the DQO requirement (95%) for RSD%.
- As a whole, the %C is defined as 28 M values out of 30 samples, or 93.3%C. The overall actual %C is not 93.3% but 95.7% as defined statistically by linear regression as the overall %V (or % Value) for the entire dataset of N=30 samples. The overall actual value (95.7%) meets the DQO requirement (95%) for all three components (s, RSD%, and RPD%) of precision. With the exception of turbidity, each parameter met the DQO since these values did not fall into the estimate category (E) with unknown bias. Again, the lowest DQO C/S value was turbidity (81.9% and 74.3%). Excluding the two turbidity values, the overall actual %C is 97.0%, and thus meets the DQO requirement (95%) for all three components.

Based on the precision completeness, the turbidity is one parameter in the Jacks Creek drainage that falls in the estimate category with unknown bias. On further investigation at each individual site along Jacks Creek, it became obvious that the majority of the surface water in Jacks Creek represented tailwater from the various farms, and included higher levels of total suspended sediment and turbidity; thus accounting for the higher RSD (or CV) in the turbidity parameter.

Accuracy Completeness

For accuracy of sample holding times and referring to Table 16 (Appendix A-2), *v* is represented by the number of planned events that meet (M) the DQO requirements for sample holding times. The following summarizes the accuracy completeness of sample holding times:

- The %C for s for the IDHW-Lab is defined as 9 M values out of 9 sampling events, or 100%C. The period of sample submission to the IDHW-Lab meet the DQO requirements as 100%C. The period of the IDHW-Lab receiving the samples meet the DQO requirements as 100% C. See Appendix A.
- The %C for s for the soil lab is defined as 3 M values out of 3 sampling events, or 100%C. The period of sample submission for the soil lab meet the DQO requirements as 100%C and the period of the soil lab receiving the samples meet the DQO requirements as 100% C. See Appendix A.

Based upon the accuracy completeness of the sample holding times to the IDHW-Lab and the soil lab, the DQO requirements were met for the period of sample submission and for the period the lab actually received the samples.

Field Instrument Calibration Completeness

For accuracy of field instrument calibration and referring to Table 17 (Appendix A-3), *v* is represented by the number of planned events that meet (M) the DQO requirements under two DQOs. First, the calibration period cannot exceed 7 days prior to the sampling event although calibration can last a period of one month. Second, the field parameters must be calibrated prior to data collection in the field. As part of this field instrument calibration, certain parameters do not require calibration because they have already pre-set values based on manufacturer's specifications. The following summarizes the accuracy completeness of the field instrument calibration:

- The %C for s for the IDHW-Lab is defined as 9 M values out of 9 sampling events, or 100%C. The time frame for field instrument calibration meets the DQO requirements as 100%C. See Appendix A.
- The %C for s for those parameters that must be calibrated during the field instrument calibration is defined as 9 M values out of 9 sampling events, or 100%C. These parameters include dissolved oxygen, specific conductance, pH, turbidity, and chlorophyll-a. These parameters met the DQO requirements as 100%C. See Appendix A.
- Parameters that do not require field instrument calibration include temperature, total dissolved solids, and % dissolved oxygen saturation. These are pre-set according to manufacturer's specifications.

Based upon the accuracy completeness for field instrument calibration, the DQO requirements were met for the time frame for field instrument calibration. They DQO was also met for those individual parameters that require calibration during the field instrument calibration.

Blank Calibration Completeness

Referring to Tables 18 and 19 (Appendix A-4) and Blank Calibration Completeness, field blanks as distilled water are used to calibrate field instruments by zeroing out the reading (Table 18) and to assess the contamination from field sources such as airborne materials, containers, and preservatives (Table 19).

Relative to Blank Calibration Completeness, the DQOs were met for the three parameters, thus meeting the DQO requirements of 100%. Relative to field contamination completeness, the DQOs were met for the three laboratory parameters, thus meeting the DQO requirements of 100%.

Representativeness

This section covers the degree to which the monitoring was representative of the Jacks Creek drainage and the pollutant sources. Representativeness expresses the degree to which sample data accurately and precisely represent (1) the characteristics of a population of samples, (2) parameter variations at a sampling point, or (3) environmental conditions. Representativeness is also an expression of the monitoring design and thus provides the basis for which the sampling will accurately describe the environmental conditions of Jacks Creek. Representativeness is established based on the following assessments conducted by the DEQ Chemist:

- *Assessment of the Monitoring Design*. Prior to monitoring a sampling design was developed by DEQ whose primary purpose was to collect monitoring samples that were representative

of environmental conditions on Jacks Creek. Based on the previous TMDL work (Lay 2000) and additional monitoring by IDA (Campbell 2002), sampling sites were expressly selected that were above and below the discharge of the fish hatcheries. Three sites were selected upstream of the hatcheries and this included 1-Vaught, 2-Shoo Fly, and 3-Selman. Three sites were also selected downstream of the hatcheries and this included 4-Cattle Drive, 5-Davis, and 6-Highway 78. Two additional sites were selected as the receiving components prior to discharge into C. J. Strike Reservoir. This included 7-Main Stem on Jacks Creek about 1 mile north of 6-Highway 78. The other site was 7-Wetland Complex. Each site was visited prior to monitoring and was investigated relative to access and safety issues. Because of the privacy issue, permission was obtained from the numerous land owners along Jacks Creek with assistance from the ISCC.

- *Assessment of Characteristics of a Population of Samples*. Field duplicates of the various monitoring sites were conducted on a regular basis with the Hydrolab and SCUFA instrumentation to verify data results that appeared extreme, particularly those that were statistically higher/lower than the associated monitoring sites. This established "correctness" to the sampling value which might draw a question as to its reliability. Through the monitoring season of 2004, each monitoring site established itself as unique in comparison to other monitoring sites because of the drought conditions and the higher levels of turbidity and sedimentation that were present in the instream water. Consequently, the DEQ Chemist determined that there was a sufficient guarantee that the field parameters were substantially accurate based on sufficient duplicates for those extreme values. In addition, pollutant sources were investigated and confirmed during each sampling event to develop a "probability sample." A key property of a probability sample is that every element in the population has some chance of being included in the sample. If this were not the case, then some parts of the population might as well not exist, since no matter what, their condition could have no influence on estimates of population characteristics. This property has a side benefit in that it forces an explicit and complete definition of the population being described. This may seem trivial; however, in practice, it is almost never easy to tightly delimit a real, physical population (EPA 2004 [p 20]).
- *Assessment of Parameter Variations at Sampling Points*. An assessment of variability (as the coefficient of variation) was conducted on all sampling parameters for each monitoring site. Variations that were high were immediately explored in the field as to their source of pollutants and location. This provided evidence that the higher variations were characteristic of the existing conditions on Jacks Creek. It also showed to be an extension of the "probability sample" previously discussed as the Characteristic of a Population of Samples.
- *Assessment of Representativeness of Environmental Conditions*. Based on the assessment of the monitoring design, the assessment of characteristics of a population of samples, and the assessment of parameter variations at sampling points, it may be concluded that the representativeness of Jacks Creek is well documented. Therefore, the representativeness of environmental conditions on Jacks Creek is properly documented for the 2004 monitoring season.

Comparability

Comparability is established via the same methods used for ensuring representativeness plus the use of conventional and standard units for reporting. It is also the confidence with which one

data set can be compared to another. Comparability between monitoring sites and for the various matrices studied on Jacks Creek (stream water, streambed substrates, and riparian/floodplain soil) was verified by the DEQ Chemist based on the following assessments:

- *Assessment of Standardized Sampling Procedures*. Standardized sampling procedures were followed as previously established by DEQ through other monitoring experiences and as established since 1995. Set field protocols for monitoring and collecting the data were followed strictly and conformed to all established monitoring protocols.
- *Assessment of Sampling Equipment and Field Instrumentation*. All sampling equipment and field instrumentation was prepared and standardized according to manufacturer's specifications and in conjunction with DEQ policy and protocols previously established since 1995.
- *Assessment of Habitat Process*. All habitat field assessment was conducted in conjunction with the standard assessment protocols defined by the BURP process and as established since 1995. The BURP Coordinator and trained BURP crew for the DEQ-TFRO conducted all habitat assessments affiliated with the Jacks Creek monitoring. A fuller BURP assessment was conducted in 2005, but these results are not reported in this TMDL modification document because the laboratories involved could not process the samples prior to completion of this document. The results will be included as an addendum to this document.
- *Assessment of Analytical Methodologies*. All analytical methodologies from the standard protocols of EPA's laboratory procedures and methods, Standard Methods for surface waters, or University of Idaho soils procedures were utilized by the various laboratories used to analyze the samples.
- *Assessment of QA/QC Procedures*. Comparability of data within and among indicators can be guaranteed based on the implementation of standardized QA and QC techniques and standardized performance and acceptance criteria. For all measurements, reporting units and format were specified and followed and incorporated into standardized data recording forms. Documentation of the information was conducted by the DEQ Chemist into an Excel spreadsheet.
- *Assessment of QA Sample Data*. Blanks, duplicates, and spikes were subjected to statistical analysis of precision and accuracy to determine a performance evaluation in reference to completeness, representativeness, and comparability. No incompatibility was established during the monitoring of Jacks Creek.

NPDES Influent/Effluent Data DQOs

The certification for all NPDES influent and effluent samples for the fish hatcheries is dependent on the facility operator, owner, and/or legal representative. This individual certifies upon submission of the discharge monitoring reports (DMRs) that the information and data is "true, accurate and complete." In addition, a QA/QC plan is submitted as part of the NDPES permitting process that stipulates the methodology and process for certifying that the lab results are "true, accurate and complete." All DMRs were certified by the owner of the facilities for each month that a submission was made. Therefore, the DQOs for the NPDES influent/effluent data were met in all cases.

The laboratory that is used by the owner is the Rangen Aquaculture Hatchery & Research Center (RARC). The laboratory QA requirements under the 1999 NPDES general aquaculture permit include the following:

1. The laboratory-specific quality assurance requirements are based on the following:
   a. 1999 Idaho NPDES General Aquaculture Permit.
   b. *You and Quality Assurance in Region* 10, EPA Region 10, Quality and Data Management Program, March 1988.
2. RARC personnel are qualified and trained to perform the water quality tests. Curriculum vitae and training records are on file at RARC.
3. A complete and current set of standard operating procedures (SOPs) is maintained at RARC. These SOPs are followed during each respective test, which addresses the following:
   a. Proper sample collection, preservation, and storage.
   b. Testing methods for each required parameter.
   c. Calibration, operation, maintenance, and repairs of necessary equipment.
   d. Accurate data entry, correction, storage, and transfer to customer forms.
   e. Quality assurance for each of these to ensure high data quality.
4. RARC incorporates internal quality control samples into every "batch" of samples tested, as prescribed in *Standard Methods*, 1998 Edition. External standards are obtained from EPA-approved suppliers and analyzed annually.
5. Methodology conforms to 40 CFR Part 136.3 relative to water samples. Table 43 summarizes the methodology for the indicated laboratory parameters with their indicated method detection limit (MDL):

Table 43. RARC's laboratory parameter methodology

Parameter	Methodology	Method Detection Limit
Total Suspended Sediment	EPA Method No. 160.2	2.00 mg/L
Total Phosphorus	EPA Method No. 365.2	0.005 mg/L
Total Ammonia Nitrogen	EPA Method No. 350.2/350.3	0.050 mg/L
Total Kjeldahl Nitrogen	EPA Method No. 351.3/350.3	0.050 mg/L
Total Nitrate + Nitrite	EPA Method No. 353.3	0.010 mg/L

Conclusions about DQOs

DEQ sets a stringent set of DQOs for its QA/QC program. The necessity for this stringency is based in part because of historical experience in dealing with sampling events that produced estimate results with low, high, or unknown bias. Since 1995, DEQ has taken a more aggressive role in minimizing the bias through redundancy of duplicates, blanks, and spikes. Consequently, the following conclusions may be derived with the Jacks Creek monitoring samples:

- 10% of the total field samples sent to the lab met the maximum QA/QC conditions for blanks, spikes, and duplicates. All QA/QC conditions were reviewed by the DEQ Chemist and no qualifications were required.
- Duplicate monitoring was conducted at all sites to ascertain precision of the Hydrolab Quanta and SCUFA instruments. All duplicate monitoring was reviewed by the DEQ Chemist and no qualifications were required.

- Maintenance and QA/QC calibration of field instruments was performed and a maintenance log of these calibrations was maintained by DEQ. All QA/QC calibrations were reviewed by the DEQ Chemist and no qualifications were required.
- Based on the summary in Tables 14 and 15, DQO requirements for precision and precision completeness were met for all field and laboratory parameters. Duplicate sampling amounted to 20.3% of the samples or 2 duplicates in 10 samples, which exceeded the DQO requirement of 10%. The duplicate samples were reviewed by the DEQ Chemist. See Appendix A-1.
- All maximum holding times for field sample delivery to the lab were never exceeded inclusive of soil samples. See Table 16 in Appendix A-2. The DEQ Chemist reviewed the information and made no qualifications because of holding times. Sample handling and chain-of-custody DQOs were met and therefore no qualifications were required by the DEQ Chemist. Thus, accuracy completeness was met for all samples.
- All field instrumentation was calibrated by DEQ according to manufacturer's specifications prior to deployment in the field. The field instruments were standardized using reference standard. No qualifications were required by the DEQ Chemist. See Appendix A-3, Table 17.
- Field blanks were used to calibrate the field instruments and to assess contamination from field sources. All field instruments were calibrated against their field blank to zero prior to deployment in the field. See Appendix A-4. Table 18 summarizes the blank calibration for selected field parameters. And, Table 19 summarizes the field blanks relative to the laboratory parameters. Again, no qualifications were required by the DEQ Chemist since blank calibration completeness was achieved for all samples.
- Representativeness DQOs were met by all samples since the DEQ Chemist concluded from the precision and accuracy completeness of the samples that the characteristics of the population of samples per site were well represented for the conditions of Jacks Creek; that parameter variations at each sampling site demonstrated the conditions that exist in Jacks Creek; and, that the environmental conditions of Jacks Creek as presently constituted are represented by the samples from each of the monitoring sites.
- Relative to the Jacks Creek surface water samples taken at various monitoring sites, all DQOs relative to precision, accuracy, and completeness were met. Therefore, no qualifications of the data were required by the DEQ Chemist. See Appendix A-5, Table 20. Therefore, the data collected and analyzed for TSS, TP, total coliform and E. coli was precise, accurate, complete and representative of the field conditions.
- NPDES influent/effluent data from the DMRs of the fish hatcheries were assumed to be "true, accurate and complete" based on the QA/QC plan that was submitted by the client and his personal monthly certification of the DMRs. Consequently, no reason could be established to disqualify any of the DMR data. See Appendix A-6, Table 21.
- Relative to the substrate streambed samples, all DQOs relative to precision, accuracy, and completeness were met. Therefore, no qualifications of the data were required by the DEQ Chemist. See Appendix A-7, Table 22. Therefore, the data collected and analyzed for pH, OM, lime, texture, sand, silt clay, Total P, Olsen P and water P was precise, accurate, complete and representative of the field conditions.

- Relative to the artesian geothermal well samples, all DQOs relative to precision, accuracy, and completeness were met. Therefore, no qualifications of the data were required by the DEQ Chemist. See Appendix A-8, Table 23. Statistical analysis of the wells above and below the fish hatcheries demonstrated that no statistical difference could be ascertained. Consequently, the data represents the water source as being similar or from the same aquifer source.
- Relative to the surface soil sample, all DQOs relative to precision, accuracy, and completeness were met. Therefore, no qualifications of the data were required by the DEQ Chemist. See Appendix A-9, Table 24. Therefore, the data collected and analyzed for the various surface analytes were precise, accurate, complete and representative of the field conditions.

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