RECLAMATION

Managing Water in the West

APPRAISAL STUDY, FISH PASSAGE IMPROVEMENTS, BOHANNON CREEK DIVERSIONS 3, 4, AND 6, LEMHI RIVER BASIN, IDAHO

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

PACIFIC NORTHWEST REGION

SNAKE RIVER AREA OFFICE SALMON FIELD STATION AND

PACIFIC NORTHWEST REGION DESIGN GROUP

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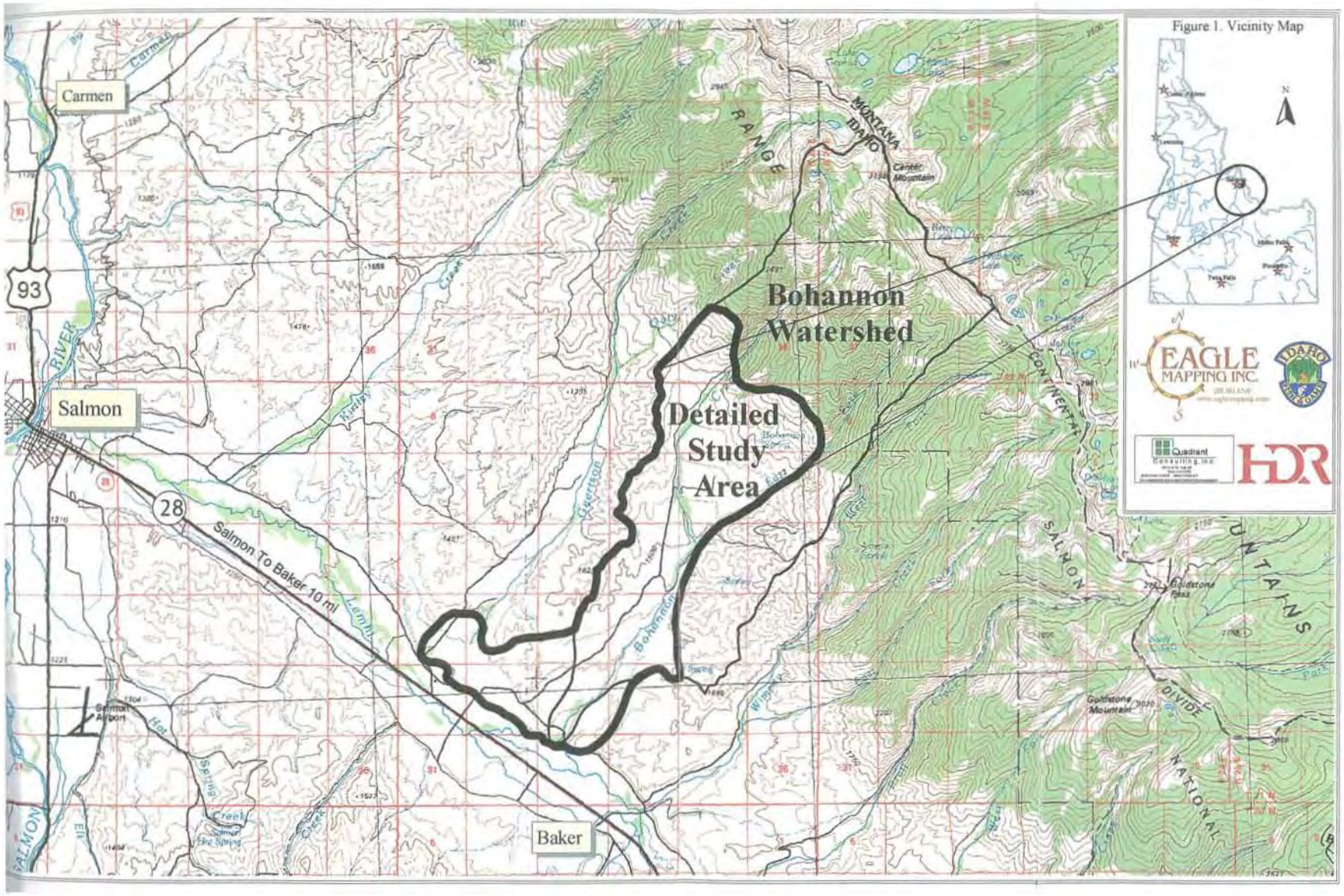

Location map, Bohannon Creek Watershed, Lemhi River Subbasin, Idaho.
["Detailed Study Area" was used in *Bohannon Creek Irrigation System Analysis, September 2002* (prepared for Idaho Department of Fish and Game by Quadrant Consulting, Inc. and HDR Engineering)]

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1. INTRODUCTION

1.1 BACKGROUND

The Upper Salmon Basin Watershed Project (USBWP) and the Idaho Department of Water Resources (IDWR) requested the Bureau of Reclamation (Reclamation) to develop options for irrigation diversion in the lower reach of Bohannon Creek. The mutual goal was to eliminate fish-migration barriers and stream-channel dewatering. This report provides conceptual-level alternatives to improve fish passage in Bohannon Creek. Further development of any one of these alternatives would require detailed analysis beyond the scope of this appraisal.

In Sec. 7(a)(2) of the Endangered Species Act (ESA), all Federal agencies, including Reclamation, are required to avoid the likelihood of jeopardizing listed species or adversely affecting their critical habitat as a consequence of actions the agency proposes to undertake or fund. NOAA Fisheries oversees the implementation of the ESA for certain listed species including anadromous salmon and steelhead. NOAA Fisheries' judgment concerning the effects of a proposed Federal action on these species is presented in a biological opinion (BiOp) issued to the Federal agency.

The Federal Columbia River Power System (FCRPS) consists of 14 dams and related facilities operated by the Army Corps of Engineers (Corps) and the Bureau of Reclamation; the Bonneville Power Administration (BPA) transmits and markets the electrical energy generated by the Corps and Reclamation Projects. Jointly, these three Action Agencies make operational decisions about this integrated system. All decisions must conform to the requirements defined in the projects purposes established by the Congress for each project.

There are 12 listed anadromous ESUs (evolutionarily significant units) and one ESU proposed for listing in the Columbia River which are affected by the operation of the FCRPS. The Action Agencies have consulted with NOAA Fisheries on these ESUs, with the most recent BiOp issued on November 30, 2004. That consultation included an "Updated Proposed Action" (UPA) by the Action Agencies which included a tributary habitat program.

Reclamation is implementing the Tributary Habitat Program for the Lemhi Subbasin as set forth in the Updated Proposed Action as a conservation measure to provide for early actions to assist with recovery of the Snake River steelhead and Snake River spring/summer Chinook ESUs.

The limiting factors that Reclamation will address in the conservation measure subbasins may include instream flows, channel morphology, and entrainment. For these programs, Reclamation will work with willing partners on non-Federal lands to provide technical assistance and logistical help with the correction of tributary and spawning and rearing deficiencies associated with these three limiting factors.

The goal of the USBWP is to improve anadromous fish habitat in specific local river reaches and also to improve overall aquatic health. The UPBWP also seeks to increase the number, density and composition of fish species in the rivers and increase the use of habitat by multiple fish species.

Restoration activities in the Upper Salmon basin are coordinated through the USBWP which ensures that projects are directed toward important habitats. This is accomplished through an objective

ranking process with established prioritization procedures. Planning and implementation of projects are directed through the USBWP with assistance from local, State, Tribal, and Federal agencies and other entities, including private consultants.[1/] It is the goal of the USBWP to work in a collaborative fashion with local landowners and irrigators, and local, State, Tribal, and Federal agencies.

The USBWP is the largest collaborative effort to restore salmon habitat on non-federal lands in Idaho. The project covers four hydrologic units that include the Lemhi, Upper Salmon, Pahsimeroi, and Middle Salmon-Panther Creek watersheds. The USBWP is coordinated through the Idaho Soil Conservation Commission, with assistance from the Lemhi [County] and Custer [County] Soil and Water Conservation Districts. The program has resulted in habitat restoration projects in areas where such activities previously had been quite limited (NPCC 2004).

IDWR is responsible for administering the Columbia Basin Water Transactions Program (CBWTP) in Idaho. The CBWTP was launched by BPA as a pilot project in 2002. The concept of the CBWTP involves using voluntary, market-based approaches to acquire water for instream flows. IDWR, WSBWP, and Reclamation are hopeful that alternatives presented in this appraisal could lead to solutions for fish passage problems in lower Bohannon Creek.

1.2 EXISTING CONDITIONS

Located in Lemhi County, Idaho, Bohannon Creek is 14 miles long and has one tributary, East Fork Bohannon Creek. The watershed's drainage area is about 14 square miles. Bohannon Creek enters the Lemhi River at river mile (RM) 10.7. The creek rises in the Bitterroot Range, which also establishes the Continental Divide. Elevations in the watershed range from about 5,300 feet at the Lemhi River to over 10,000 feet at Castle Mountain; the "mean" (average) basin elevation is about 7,365 feet, and the basin is steeply sloped, almost 45 percent.

There are fourteen irrigation diversions on the creek; they are numbered consecutively from the mouth to upstream. Only three of the first six diversions are addressed in this appraisal, Bohannon Creek (BC) BC-3, BC-4, and BC-6. Of the others, BC-1 supplies an ornamental pond and is considered non-consumptive, is not a barrier to fish, and does not significantly diminish flow in the lower reach of the stream. The BC-2 diversion has not been used for several years, but does have a water right to supply 37 acres. BC-5 was slated for improvements by the USDA Natural Resource Conservation Service (NRCS), but after this appraisal was in progress, the owner withdrew his participation. Concurrent with efforts to maintain continuous flow in the lower reach of Bohannon Creek, the Idaho Department of Fish and Game (IDFG) is proceeding with plans to construct fish screens and replace headgates on diversions BC-3, BC-4, BC-5, and BC-6.

BC-3, BC-4, and BC-6 were chosen for this appraisal because they are the three lowest active diversions in the drainage and were are not part of an NRCS-funded project. The three diversions

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[1] These agencies include the Shoshone-Bannock Tribes, private consultants, Idaho Department of Fish and Game (IDFG), Idaho Department of Water Resources (IDWR), Bonneville Power Administration (BPA), U.S. Bureau of Land Management (BLM), USDA Natural Resources Conservation Service (NRCS), National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries), Reclamation, U.S. Fish and Wildlife Service (FWS), and U.S. Forest Service (USFS).

are unscreened and the diversion structures consist of earth and rock berms. Each facility has a wooden gate or wasteway structures either at the head of the ditch or a short distance downstream on its ditch. The three diversions and their conveyance facilities supply lands that use both flood and sprinkler irrigation systems. Combined, they irrigate about 745 acres.

As noted, the focus of this appraisal report is to present alternatives that could reconnect the creek for fish passage from the BC-3 diversion downstream to the confluence with the Lemhi River. Typically, this reach is dewatered twice during irrigation season: from the start of irrigation (around April 1) to about June 1 and again from about August 1 to the end of irrigation (around October 15). The amount of water desired for adequate fish passage has not yet been determined but is expected to be several cubic feet per second (cfs) or more.

Additionally, any future diversions that might be constructed should provide fish passage and fish screens that meet current criteria. During the irrigation season, all three diversions are barriers to migration and none are screened. IDFG is planning to install fish screens and replace headgates on diversions BC-3, BC-4, and BC-5 in the spring of 2005; similar work on BC-6 will be in 2006.

The report *Bohannon Creek Irrigation System Analysis* (IDFG 2002) provided a preliminary assessment of irrigation practices within the entire Bohannon Creek drainage. It also developed alternatives for improving irrigation efficiency and correcting fish passage on the entire drainage. It analyzed water rights, irrigation practices, stream hydrology, and opportunities for diversion consolidation and screening. The IDFG report provided an excellent analysis of the Bohannon Creek drainage and was a foundation for the development of this appraisal. However, the IDFG water rights analysis upon which this appraisal is based is very likely outdated and should be re-evaluated in light of recent adjudication activities in the basin. During the 2004 irrigation season, Reclamation conducted a “PHABSN” flow study of mainstem Bohannon Creek. The study’s purpose was to determine minimum flows required for fish passage. Results will not be available until mid 2005.

2. WATER RIGHTS

As noted, a detailed analysis of water rights was not completed for this appraisal. Bohannon Creek irrigators rely heavily upon flows during spring runofrf. High flow claims in the Lemhi Subbasin are currently being adjudicated by IDWR. According to *Bohannon Creek Irrigation System Analysis* (IDFG 2002), the combined water rights for the three diversion is 23 cfs (BC-3, 12 cfs; BC-4, 4 cfs; and BC-6, 7 cfs); this supplies 745 irrigated acres. The total for the water rights for all 14 diversions on the Bohannon Creek drainage is 55.2 cfs; this supplies 1,850 irrigated acres.

Sufficient flows to fulfill the total appropriation of water rights are not available throughout the entire irrigation season, according to the Bohannon Creek watermaster. Diversion flows are regulated by the watermaster during the typically low-water months of August, September, and October; they are considerably less than the total appropriation. In the late season, priority dates for these water rights are treated equally by the watermaster, and when there is insufficient water to meet the total appropriation, all irrigators are reduced proportionally.

According to the watermaster, from early June through July there is typically only sufficient water in Bohannon Creek to provide flow in the stream channel below the BC-3 diversion. The formal irrigation season is from about March 1 to November 15.

The points-of-diversion and the conveyance ditches around the fields are shown in the drawings of each of the six alternatives in Attachment C.

Table 2-1. Bohannon Creek Exceedance Flow Probabilities by Month

Month	**Percent Exceedance**	**Flowrate "Q"** (cfs)	**Undiverted flow rate 80% exceedance** (cfs)
October	80	2.50	2.5
	50	4.35	
	20	5.51	
November	80	2.97	3.0
	50	3.59	
	20	4.69	
December	80	2.58	2.6
	50	3.13	
	20	3.96	
January	80	2.41	2.4
	50	2.84	
	20	3.68	
February	80	2.30	2.3
	50	2.84	
	20	3.68	
March	80	2.35	2.3
	50	3.10	
	20	4.20	
April	80	3.40	3.4
	50	4.89	
	20	8.80	
May	80	3.42	3.4
	50	9.31	
	20	20.61	
June	80	4.38	4.4
	50	12.95	
	20	28.95	
July	80	3.59	3.6
	50	5.47	
	20	10.22	
August	80	2.25	2.2
	50	3.14	
	20	4.52	
September	80	1.99	2.0
	50	2.59	
	20	3.51	

Source: adapted from *Bohannon Creek Irrigation System Analysis* (Appendix 3), September 2002, Quadrant Consulting Inc. and HDR; "Calculations completed using USGS Water Resource Investigation Report 01-4093 by Jon E. Hortness & Charles Berenbrock (July 22, 2002)".

3. HYDROLOGY

Watershed yield flow estimates for Bohannon Creek were prepared using the USGS "Berenbrock" methodology (IDFG 2002). The methodology provides estimates of "mean" (average) monthly "exceedance flows;" this is the probability, measured as a percentage, that a certain rate of flow could be exceeded. For example, the March

"20 percent exceedance" is 4.20 cfs; flows higher than this would occur only 20 percent of the time. Table 1 shows estimates of the probability of occurrence that a monthly flow would occur at 80 percent (low), 50 percent (average), and 20 percent (high) exceedance.

In the Bohannon Creek drainage, the highest estimated mean monthly flows are in June; 4.4 cfs (at 80 percent exceedance); 12.9 cfs (at 50 percent exceedance); and 29.0 cfs (at 20 percent exceedance). The lowest estimated monthly flows are in September: 2.0 cfs, 2.6 cfs, and 3.5 cfs, (80, 50, and 20 percent, respectively). Comparison of these monthly flow estimates to the total water right for all diversions (55.2 cfs) indicates the stream has insufficient flows to provide sum total of all the water rights.

Even in the month of highest flows (June), the estimated average flow (50 percent exceedance) would supply less than one-quarter of the total water rights In the month of the lowest flows (October) at 50 percent exceedance, the creek would supply less than 10 percent of the irrigation water rights.

Diversion flow records for the years 1996 through 2001 also provide an estimate of available water in the creek (IDFG 2002). In most months during the irrigation season, all of the creek is diverted for irrigation. These records indicate that for all of the diversions on the creek, average flows diverted for this period of record are 27 cfs in May, 37 cfs in June, and 25 cfs in July. Thus, diversion-flow records indicate significantly higher flows than the flow estimates using the Berenbrock methodology. The reason for the difference between the two is unclear. Flow estimates could be in error, but it is considered more likely that return flow from upstream flood irrigation recharges the creek; such recharge provides multiple re-use of water at subsequent diversions downstream (Bohannon Creek watermaster, pers. comm.)

4. ALTERNATIVE METHODS FOR IRRIGATION DIVERSION AND CONVEYANCE

Six possible alternatives are presented in this section. For ease of comparison, their respective advantages and disadvantages are presented in the next section. It should be noted that pursuit of alternatives that entail a change in the geographic point-of-diversion would require a legal transfer from IDWR.

4.1 ALTERNATIVE 1, COMBINED PUMPED DIVERSION OUT OF THE LEMHI RIVER AND DISTRIBUTION PIPE

This alternative would provide a single pumping plant and screened intake structure on the Lemhi River to replace the three diversion (BC-6, BC-4, and BC-3) and serve the same lands. Two potential locations are described below. A buried pipe to carry the water would route along the east edges of the fields now irrigated from B-6 and BC-4.

Turnout structures would be constructed where the new pipeline crossed each of the existing ditches. The existing distribution ditches would continue to be used from present turn-out structures at BC-3, BC-4, and BC-6. The present diversion structures and headgates for each of the ditches would be abandoned or removed. In each of the ditches, the portions above the new turnout structures would be plugged at their upstream ends and abandoned. Drawing 1 in Attachment C is a site plan for this alternative.

The pumping plant, fish screen, and first section of buried pipe would be designed for the combined water rights of 23 cfs, the total needed for flood irrigation. The pumping intake would likely require a minimum depth of 3 to 4 feet of water. Two options for location of these facilities are presented. One would entail construction of a new diversion dam on the Lemhi River; this would be located downstream from the mouth of Bohannon Creek and upstream of the L-9 diversion. Another option could be locate the intake to the pump in the forebay of the existing L-9 diversion structure.

To accommodate the maximum design flow (MDF) of 23 cfs (10,350 gpm), the pumping plant is estimated to require an 880 horsepower (hp) pump. A variable frequency drive pump could be used. The estimate assumes a 450-foot maximum design head and a pump efficiency of 75 percent.

Based on the historic diversion of water from Bohannon Creek, the pumping plant would probably run “24/7” at three different production levels during the irrigation season. In June and July, this would be at 100 percent of the MDF; in May, August, and September, at 50 percent; and in April and October, at 25 percent. Multiple pumps are recommended so that during periods of low demand or limited water availability some pumps could be idled.

The screened intake would require approximately 60 square feet of submerged screen area during periods of low river flows. An estimated 10,500 feet of buried pipe, from 18 inches to 30 inches in diameter, would be required. A point-of-diversion transfer from Bohannon Creek to Lemhi Creek would be required.

4.2 ALTERNATIVE 2, COMBINED GRAVITY DIVERSION NEAR THE EXISTING BC-6 DIVERSION SITE AND DISTRIBUTION PIPE

In this alternative, a combined diversion structure, headworks, and fish screen would replace the three diversions (BC-6, BC-4, and BC-3). It would be located at or near the existing BC-6 diversion structure. A buried pipeline would convey the water from the POD to existing distribution ditches. The present irrigation methods for each parcel would continue. Drawing 2 in Attachment C shows the site plan for this alternative.

The new combined diversion structure, headgate, fish screen, and the upper section of buried pipe would be designed for the combined water rights of 23 cfs.

A buried gravity pipe would route generally along the east edges of the areas presently irrigated by BC-6 and BC-4. New turnout structures (concrete or metal) would be constructed where the pipeline crossed each of the existing BC-6, BC-4, and BC-3 ditches. The existing diversion structures and headgates for the BC-6 ditch would be removed. Diversions BC-3 and BC-4 would be abandoned and removed, and the portions of each of the two ditches upstream of the new turnout structures would be plugged at their upstream ends and abandoned.

The fish screen could be located in an open-channel section of ditch located downstream of the headgates and upstream of the inlet for the main pipeline. A standard IDFG paddle-wheel drive, drum-type fish screen should work well at this location. An estimated 13,500 feet of buried pipe, from 15 inches to 24 inches in diameter, would be installed.

4.3 ALTERNATIVE 3, COMBINED PUMP DIVERSION OUT OF THE LEMHI RIVER AND TOTAL CONVERSION TO PIPE AND SPRINKLERS

Alternative 3 would consist of a buried pipe from a combined pumping plant and fish screen structure on the Lemhi River, the same general system and layout as Alternative 1. However, as much as possible, in this alternative, center pivot sprinklers would replace the existing flood irrigated areas. The somewhat smaller pumping plant and fish screen structure would be at the same location as Alternative 1 (on the Lemhi River, just downstream from the mouth of Bohannon Creek). Drawing 3 in Attachment C shows a site plan of this alternative. The MDF for Alternative 3 would be about one-third of that in Alternative 1.

Metal turnout structures from the buried pipeline would be installed at locations that best suit the sprinkler layout, instead of where the pipeline crossed the existing ditches as in Alternative 1. The layout and maximum design flow (MDF) for the proposed sprinklers would be the same for the BC-3, BC-4, and BC-6 diversions as used in the IDFG 2002 report. Because of the reduced irrigation flow needed for sprinkler irrigation as compared to flood irrigation, the MDF would be about 7.3 cfs (3,300 gpm) compared to 23 cfs (10,350 gpm) needed for Alternative 1 (IDFG 2002).

The pumping plant, fish screen, and first section of buried pipe would be designed for the MDF of 7.3 cfs. The pumps would require an estimated total of 250 hp (compared to the 880 hp in Alternative 1). The significant decrease in the water usage with sprinkler-type irrigation would allow the pumping plant to run 24/7 at the 100 percent MDF during from May through September

and at 50 percent MDF during April and October. Multiple pumps are recommended so that some could be idled at periods of low flow or low demand.

The fish screen would require about 20 square feet of submerged screen area during low river flows. The main distribution pipeline would require an estimated 7,500 feet of buried pipe, from 12 inches to 15 inches in diameter. About 29,000 feet of sprinkler distribution pipe, from 6 inches to 12 inches in diameter, would be required.

4.4 Alternative 4, Combined gravity diversion near the existing BC-6 diversion site and total conversion to pipe and sprinklers

This alternative would use a buried gravity pipeline to convey the water, the same general layout and plan as Alternative 2. The diversion structure, headworks, and fish screen would be somewhat smaller than called for in Alternative 2 and would be located about 1,500 feet upstream from the existing BC-6 diversion. Drawing 4 in Attachment C shows a site plan for this alternative. The MDF for Alternative 4 would about one-third of that required for Alternative 2.

This alternative would provide additional head for the proposed center-pivot sprinklers compared to Alternative 2. However, sprinklers would not irrigate as much land as currently irrigated by flood. Metal pipe turnout structures from the buried main pipe would be installed at locations that best suit the sprinkler layout, instead of where the pipe crosses the existing ditches as in Alternative 2.

The layout and MDF for the sprinklers used for this report would be the same as for Alternative 3. Because of the reduced irrigation flow needed for sprinkler irrigation as compared to flood irrigation, the MDF for Alternative 3 would be about 7.3 cfs (3,300 gpm) compared to 23 cfs (10,350 gpm) in Alternative 2. Some booster pumps would be required, mostly on the BC-6 sprinkler distribution pipes to raise pressure to the minimum required for sprinkler irrigation.

The diversion structure, fish screen, and first section of pipe would be designed for the MDF of 7.3 cfs. The diversion structure would remain the same size as Alternative 2, but the area of the fish screen could be reduced. An estimated 15,500 feet of buried pipe, 12 inches to 16 inches in diameter, would be installed for the main distribution pipe. About 31,000 feet of sprinkler irrigation pipe, from 6 inches to 12 inches in, would also be required.

4.5 Alternative 5, Use existing pump and pipe and install new pump in L-8A ditch to provide all of the BC-3 diversion

This alternative would use the existing pump plant in the L-8A ditch and pipe and install a new pump on the L-8A ditch to provide the entire diversion amount (12 cfs) for the BC-3 diversion. The existing pump is located about 2,500 feet downstream from the existing fish screen for the L-8A ditch; therefore, no additional fish screening would be required. Drawing 5 in Attachment C shows a site plan for this alternative.

The existing L-8A pump is 100 hp and provides partial and part-time irrigation water for only the Jolley portion of the BC-3 irrigated area. Of the 12 cfs water right for the BC-3 diversion, the Jolley portion is about 8 cfs and the Stokes portion about 4 cfs.

A second pump (of 100 hp) would be installed to provide the entire 12 cfs flow. The existing pump station and controls would be upgraded and modified to accommodate the two pumps. The existing 15-inch-diameter steel pipe has the capacity to provide the full 12 cfs. The L-8A headgate and the canal and screen are designed for 31 cfs, which includes 5 cfs of Jolley supplemental water. The headgate would be removed and replaced. The ditch and fish screen structure would be upgraded to handle the additional 7 cfs of flow. The pumps would be assumed to operate on the same timeframe as in Alternative 3.

4.6 ALTERNATIVE 6, USE EXISTING AND UPGRADED L-8A AND L-9 PUMPS AND PIPES TO PROVIDE ALL OF THE BC-3 DIVERSION

This alternative would use the existing pumping plant and pipe on the L-8A ditch for the 8 cfs Jolley portion of the BC-3 diversion; for the 4 cfs Stokes portion, an existing buried pipe on the L-9 ditch would be used. A 110 hp pump would replace the existing 100 hp L8A pump. Drawing 6 shows a site plan of this alternative.

The existing L-9 pump and pipe have not been used for many years; the pump would be replaced with an estimated 50 hp pump. A pump-intake type screen would be required on the pump intake because the new pump would be located in the ditch upstream from the existing L-9 fish screen. The recently replaced L-9 headgates have a design capacity of 36 cfs; the ditch has a 28 cfs design flow; the ditch was assumed to be able to handle the additional 4 cfs of Stokes BC-3 flow. The existing L-9 pump and pipe are located about 250 feet downstream from the headgates. Both pumps would operate on the same timeframe as Alternative 2.

No additional fish screening would be required because the existing L-8A pump is located downstream of the L-8A screen. The existing L-8A headworks, canal, and screen are designed for 31 cfs (which includes 5 cfs of Jolley water for a supplemental right). Therefore, for the purposes of this appraisal, it is assumed that these structures would handle the additional 3 cfs of Jolley flow without need for upgrades or improvements.

4.7 OTHER ALTERNATIVES IDENTIFIED AND INITIALLY CONSIDERED

Initially, other possible alternatives were identified. They were not appraised because the agency representatives judged that the potential costs would be relatively high for the benefits or would not be as effective as the ones presented here. These are summarized below.

- Use the existing L-8A pump and pipe for only the 8 cfs of BC-3 Jolley water. This might require changing only the point-of-diversion. Retain the 4 cfs of the BC-3 Stokes water, only diverting from the existing BC-3 diversion. Construct a new fish-friendly diversion structure in Bohannon Creek. Possibly add a new measurement structure in the ditch. A new headgate and fish screen would be required for the now-reduced flow (4 cfs) at the existing BC-3 diversion.

- Pump the BC-3 Jolley flow from the L-8A ditch whenever the Jolley BC-3 legal water right drops to 3 cfs or less. This alternative was described to the major water users on the L8A and L-9 ditches by IDWR contractor Bob Loucks (in an October 23, 2003 letter).

- Allow the first 3 cfs of BC-3 Jolley water to run as fish flows down Bohannon Creek to the Lemhi River, and that water then be pumped by the existing L-8A pump and pipe. This would require only a change to the water rights, a new diversion structure, and reduced-size headgate and fish screen at the existing BC-3 diversion. This was also described by Loucks.
- Pump the 8 cfs of BC-3 Jolley water at the existing L-9 pump and pipe. The advantage of this would be that the pumping head and pipe length for the L-9 location are both less than at L-8A. This would reduce the long-term pumping costs and the size of the pump size as compared with doing the same thing at L-8A. A change in water rights would also be necessary. The 4 cfs of BC-3 Stokes water would be diverted at the existing BC-3 diversion and a new diversion structure and headgate and screen would be constructed. This was also described by Loucks.

5. ADVANTAGES AND DISADVANTAGES OF ALTERNATIVES

5.1 ALTERNATIVE 1, COMBINED PUMPED DIVERSION OUT OF THE LEMHI RIVER AND DISTRIBUTION PIPE

5.1.1 Advantages

- The entire diverted flow would remain in the creek for fish passage until is diverted after entering the Lemhi River
- The upper ends of each ditch would be in pipe instead of open ditch which will reduce ditch seepage losses

5.1.2 Disadvantages

- Construction, operation, maintenance costs are high
- Pumping costs would be highest

5.2 ALTERNATIVE 2, COMBINED GRAVITY DIVERSION NEAR THE EXISTING BC-6 DIVERSION SITE AND DISTRIBUTION PIPE

5.2.1 Advantages

- The upper ends of each ditch would be in pipe instead of open ditch which would reduce ditch seepage losses
- A single consolidated headworks and screen would serve all three diversions
- No pump maintenance or pumping costs

5.2.2 Disadvantages

- High cost
- The diverted flow for all three diversions would be taken out of the stream at the most-upstream of the three diversions thereby dewatering a longer reach of the creek than presently occurs

5.3 ALTERNATIVE 3, COMBINED PUMP DIVERSION OUT OF THE LEMHI RIVER AND TOTAL CONVERSION TO PIPE AND SPRINKLERS

5.3.1 Advantages

- Elimination of all ditch seepage losses
- Significant reduction in water requirement if all of the three irrigated areas were under sprinkler irrigation compared to the current method of (primarily) flood irrigation
- A single consolidated headworks and screen would serve all three diversions
- Significant reduction in size and cost of pumps and in pumping costs compared to Alternative 1

5.3.2 Disadvantages

- High construction cost

- Relatively high operation, maintenance, and pumping costs
- Could affect groundwater recharge and return flows

5.4 ALTERNATIVE 4, COMBINED GRAVITY DIVERSION NEAR THE EXISTING BC-6 DIVERSION SITE AND TOTAL CONVERSION TO PIPE AND SPRINKLERS

5.4.1 Advantages

- Elimination of all losses from ditch seepage
- Significant reduction in distribution losses and increased efficiency in irrigation application by sprinkler irrigation compared with the current methods of (primarily) flood irrigation
- A single consolidated headworks and screen would serve all three diversions.

5.4.2 Disadvantages

- Highest construction cost
- The diverted flow for all three diversions would be taken out of the stream at the most-upstream of the three diversions thereby dewatering a longer reach of the creek than presently occurs
- Could affect groundwater recharge and return flows

5.5 ALTERNATIVE 5, USE EXISTING PUMP AND PIPE IN L-8A DITCH TO PROVIDE ALL OF THE BC-3 DIVERSION

5.5.1 Advantages

- The entire BC-3 diversion flow, an amount which may be adequate for fish passage, would remain in the creek until diverted after entering the Lemhi River
- Much lower construction and operation costs compared to pumping (as in Alternative 1 and Alternative 3)

5.5.2 Disadvantages

- Would require upgrading of the existing L-8A headworks, fish screens, and a portion of the canal, and installation of a larger (or additional) pump
- Would require additional operation, maintenance, and pumping costs when compared with the current operation of the L-8A pump for the BC-3 diversion
- Would require approval of L-8A water users for increased diversion

5.6 ALTERNATIVE 6, USE EXISTING AND UPGRADED L-8A AND L-9 PUMPS AND PIPES TO PROVIDE ALL OF THE BC-3 DIVERSION

5.6.1 Advantages

- The entire BC-3 diversion flow, an amount which may be adequate for fish passage, would remain in the creek until diverted after entering the Lemhi River
- Much lower construction and operation costs compared to pumping (as in Alternatives 1 and 3)

5.6.2 Disadvantages

- Would require upgrading of the existing L-8A headworks, fish screens, and a portion of the canal, and a installation of a larger (or additional) pump
- Would require a new pump and fish screen at the existing L-9 pump
- Would require approval of L-8A and L-9 water users

5.7 COST ESTIMATES

Tables A-1 through A-6 provide appraisal-level cost estimates for Alternatives 1 through 6.

5.8 ESTIMATED PUMPING COSTS

Table A-7 shows the estimated pumping costs for Alternatives 1, 3, 5, and 6.

6. REFERENCES

Citation in narrative	Full Citation
IDFG 2002	*Bohannon Creek Irrigation System Analysis.* 2002. Prepared for Idaho Department of Fish and Game by Quadrant Consulting, Inc. and HDR Engineering, Inc., Boise, Idaho. September 2002.
NPCC 2004	Northwest Power and Conservation Council website. October 7, 2004. http://www.nwcouncil.org/fw/stories/uppersalmon.htm

ATTACHMENT A.

CONSTRUCTION COST ESTIMATES AND PUMPING COST ESTIMATES

Table A-0. Comparative Summary of Electricity and Construction Costs for Alternatives 1-6

Table A-1. Cost Estimates, Alternative 1, Combined pumped diversion out of the Lemhi River and distribution pipe

Table A-2. Cost Estimates, Alternative 2, Combined gravity diversion near the existing BC-6 diversion site and distribution pipe

Table A-3. Cost Estimates, Alternative 3, Combined pump diversion out of the Lemhi River and total conversion to pipe and sprinklers

Table A-4. Cost Estimates, Alternative 4, Combined gravity diversion near the existing BC-6 diversion site and total conversion to pipe and sprinklers

Table A-5. Cost Estimates, Alternative 5, Use existing pump and pipe, new pump in L-8A ditch to provide all of BC-3

Table A-6. Cost Estimates, Alternative 6, Use existing and upgraded L-8A and L-9 pumps and pipes to provide all of the BC-3 diversion

Table A-7. Cost Estimates Electricity Use for Alternatives 1, 3, 5, and 6 , Bohannon Creek Appraisal Report

Table A-0. Comparative Summary of Electricity and Construction Costs for Alternatives 1-6,		
Alternative	**Estimated Cost** (in $1,000s)	
	Electrical	**Construction**
1. Combined pumped diversion out of the Lemhi River and distribution pipe	$93.2	$2,183
2. Combined gravity diversion near the existing BC-6 diversion site and distribution pipe	—	$2,049
3. Combined pump diversion out of the Lemhi River and total conversion to pipe and sprinklers	$39.7	$2,884
4. Combined gravity diversion near the existing BC-6 diversion site and total conversion to pipe and sprinklers	—	$3,644
5. Use existing pump and pipe in L-8A ditch to provide all of the BC-3 diversion	$31.8	$186
6. Use existing and upgraded L-8A and L-9 pumps and pipes to provide all of the BC-3 diversion	$25.4	$116

Table A-1. Cost Estimates, Alternative 1,

Combined pumped diversion out of the Lemhi River and distribution pipe,

Item	Description	Est. Qty	Unit	Unit Price	Amount
1	Mobilization and demobilization	1	LS	$105,805	$105,805
2	Demolition/removal of existing dam and headworks	1	LS	$5,000	$5,000
3	Seeding	1	acre	$2,000	$2,000
4	Diversion and care of stream	1	LS	$10,000	$10,000
5	Removal of water	1	LS	$10,000	$10,000
6	Construct diversion structure	1	LS	$50,000	$50,000
7	Construct pump station and controllers	1	LS	$40,000	$40,000
8	Furnish and install 300 hp pump	1	EA	$40,000	$40,000
9	Furnish and install 200 hp pump	3	EA	$15,000	$45,000
10	Construct fish screen structure	12	CFS	$8,000	$96,000
11	Construct turnout structures	3	EA	$2,000	$6,000
12	Furnish and install 30-inch PCV pipe w/earthwork	1,000	LF	$175	$175,000
13	Furnish and install 24-inch PVC pipe w/earthwork	5,000	LF	$130	$650,000
14	Furnish and install 18-inch PVC pipe w/ earthwork	4,500	LF	$85	$382,500
15	*Subtotal Construction Cost (Items1-14)*				*$1,617,305*
16	10% Unlisted items (of Item 15)				$161,731
17	25% Contingencies (of Item 15)				$404,326
18	**Total Construction Cost** (Items 15, 16, and 17)				**$2,183,362**

Table A-2. Cost Estimates, Alternative 2, Combined gravity diversion near the existing BC-6 diversion site and distribution pipe					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Amount**
1	Mobilization and demobilization	1	LS	$99,295	$99,295
2	Demolition/removal of existing dam and headworks	1	LS	$5,000	$5,000
3	Seeding	1	acre	$2,000	$2,000
4	Diversion and care of stream	1	LS	$5,000	$5,000
5	Removal of water	1	LS	$5,000	$5,000
6	Construct diversion structure	1	LS	$30,000	$30,000
7	Construct headgate structure	1	LS	$15,000	$15,000
8	Construct fish screen structure	12	CFS	$4,000	$48,000
9	Construct turnout structures	3	EA	$2,000	$6,000
10	Furnish and install 24-inch PVC pipe w/earthwork	4,000	LF	$130	$520,000
11	Furnish and install 18-inch PVC pipe w/earthwork	4,500	LF	$85	$382,500
12	Furnish and install 16-inch PVC pipe w/earthwork	5,000	LF	$80	$400,000
13	*Subtotal Construction Cost* (Items 1-12)				*$1,517,795*
14	Unlisted items (10% of Item 13)				$151,780
15	Contingencies (25% of Item 13)				$379,449
16	**Total Construction Cost** (Items 13, 14, and 15)				**$2,049,023**

Table A-3. Cost Estimates, Alternative 3, Combined pump diversion out of the Lemhi River and total conversion to pipe and sprinklers					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Amount**
1	Mobilization and demobilization	1	LS	$43,610	$43,610
2	Demolition/removal of existing dam and headworks	1	LS	$5,000	$5,000
3	Seeding	1	acre	$2,000	$2,000
4	Diversion and care of stream	1	LS	$10,000	$10,000
5	Removal of water	1	LS	$10,000	$10,000
6	Construct diversion structure	1	LS	$50,000	$50,000
7	Construct pump station and controllers	1	LS	$35,000	$35,000
8	Furnish and install 100 hp pump	3	EA	$12,000	$36,000
9	Construct fish screen structure	8	CFS	$8,000	$64,000
10	Construct turnout structures	3	EA	$2,000	$6,000
11	Furnish and install 16-inch PVC pipe w/earthwork	1,000	LF	$80	$80,000
12	Furnish and install 12-inch PVC pipe w/earthwork	6,500	LF	$50	$325,000
13	Furnish and install sprinkler pipe (6"-12")	29,000	LF	$30	$870,000
14	Furnish and install center pivot sprinklers	20	EA	$30,000	$600,000
15	*Subtotal Construction Cost* (Items 1-14)				*$2,136,610*
16	Unlisted items (10% of Item 15)				$213,661
17	Contingencies (25% of Item 15)				$534,153
18	**Total Construction Cost** (Items 15, 16. and 17)				**$2,884,424**

Table A-4. Cost Estimates, Alternative 4, Combined gravity diversion near the existing BC-6 diversion site and total conversion to pipe and sprinklers					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Amount**
1	Mobilization and demobilization	1	LS	$137,900	$137,900
2	Demolition/removal of existing dam and headworks	1	LS	$5,000	$5,000
3	Seeding	1	acre	$2,000	$2,000
4	Diversion and care of stream	1	LS	$5,000	$5,000
5	Removal of water	1	LS	$5,000	$5,000
6	Construct diversion structure	1	LS	$30,000	$30,000
7	Construct headgate structure	1	LS	$15,000	$15,000
8	Construct fish screen structure	8	CFS	$4,000	$32,000
9	Construct turnout structures	3	EA	$2,000	$6,000
10	Furnish and install 16-inch PVC pipe w/earthwork	5,500	LF	$80	$440,000
11	Furnish and install 12-inch PVC pipe w/earthwork	10,000	LF	$50	$500,000
12	Furnish and install sprinkler pipe (6"-12")	31,000	LF	$30	$930,000
13	Furnish and install center pivot sprinklers	20	EA	$30,000	$600,000
14	*Subtotal Construction Cost* (Items 1-13)				*$2,707,900*
15	Unlisted items (10% of Item 14)				$270,790
16	Contingencies (25% of Item 14)				$676,975
17	**Total Construction Cost** (Items 14, 15, and 16)				**$3,655,665**

Table A-5. Cost Estimates, Alternative 5, Use existing pump and pipe, new pump in L-8A ditch to provide all of BC-3					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Amount**
1	Mobilization and demobilization	1	LS	$9,030	$9,030
2	Demolition/removal of existing dam and headworks	1	LS	$2,000	$2,000
3	Seeding	1	acre	$2,000	$2,000
4	Diversion and care of stream	1	LS	$2,000	$2,000
5	Removal of water	1	LS	$2,000	$2,000
6	Remove and replace L-8A headgate	1	LS	$15,000	$15,000
7	Upgrade L-8A ditch	5,000	LF	$5	$25,000
8	Upgrade L-8A fish screen structure	7	CFS	$8,000	$56,000
9	Upgrade pump station and controls	1	LS	$10,000	$10,000
10	Furnish and install 100 hp pump	1	EA	$15,000	$15,000
11	*Subtotal Construction Cost* (Items 1-10)				*$138,030*
12	Unlisted items (10% of Item 11)				$13,803
13	Contingencies (25% of Item 11)				$34,508
14	**Total Construction Cost** (Items 11, 12, and 13)				**$186,341**

Table A-6. Cost Estimates, Alternative 6, Use existing and upgraded L-8A and L-9 pumps and pipes to provide all of the BC-3 diversion					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Amount**
1	Mobilization and demobilization	1	LS	$1,610	$1,610
2	Demolition/removal of existing dam and headworks	1	LS	$2,000	$2,000
3	Seeding	1	acre	$2,000	$2,000
4	Diversion and care of stream	1	LS	$2,000	$2,000
5	Removal of water	1	LS	$2,000	$2,000
6	Furnish and install 110 hp L-8A pump	1	EA	$15,000	$15,000
7	Construct L-9 pump station and controllers	1	LS	$20,000	$20,000
8	Furnish and install 50 hp L-9 pump	1	EA	$10,000	$10,000
9	Furnish and install L-9 pump fish screen	4	CFS	$8,000	$32,000
10	*Subtotal Construction Cost* (Items 1-9)				*$86,610*
11	Unlisted items (10% of Item 10)				$8,661
12	Contingencies (25% of Item 10)				$21,653
13	**Total Construction Cost** (Items 10, 11, and 12)				**$116,924**

Table A-7. Cost Estimates Electricity Use for Alternatives 1, 3, 5, and 6 , Bohannon Creek Appraisal Report								
	Alternative 1		**Alternative 3**		**Alternative 5**		**Alternative 6**	
	430' static head		**430' static head**		**140' static head**		**140' static head**	
pump hp	*880 hp*		*250 hp*		*200 hp*		*160 hp*	
	Costs		Costs		Costs		Costs	
Month	Electricity	Demand	Electricity	Demand	Electricity	Demand	Electricity	Demand
Apr	$5,829	$2,534	$3,312	$720	$2,650	$576	$2,120	$461
May	$11,658	$2,534	$6,624	$720	$5,299	$576	$4,239	$461
Jun	$23,316	$2,534	$6,624	$720	$5,299	$576	$4,239	$461
Jul	$23,316	$2,534	$6,624	$720	$5,299	$576	$4,239	$461
Aug	$11,658	$2,534	$6,624	$720	$5,299	$576	$4,239	$461
Sep	$11,658	$2,534	$6,624	$720	$5,299	$576	$4,239	$461
Oct	$5,829	$2,534	$3,312	$720	$2,650	$576	$2,120	$461
Subtotals	*$93,266*	*$12,672*	*$39,744*	*$5,040*	*$31,795*	*$4,032*	*$25,436*	*$3,226*
Total (annual)	**$105,938**		**$44,784**		**$35,827**		**$28,662**	

Notes:

Costs for this estimate were obtained from Idaho Power Company (in January of 2002) and are for irrigation users in Idaho Power's service area. The basic power rate used is 4.6 cents per kilowatt hour (kWh). In addition, there is a monthly demand charge for any pumps over 5 hp. This charge is $3.60 per kW capacity of the pump per month for each monthly billing cycle that the pump was used at all. To convert from hp to kW, a multiplier of 0.8 was used (as suggested by Idaho Power).

For Alternative 1, the pumps were assumed to be running at 100% of maximum design flow (MDF) 24 hours a day and 7 days a week in June and July; at 50% of MDF in May, August, and September; and at 25% of MDF in April and October.

For Alternatives 3, 4, and 6, the pumps were assumed to be running at 100% MDF in May through September and at 50% MDF in April and October.

ATTACHMENT B.

PHOTOGRAPHS

Adapted from *Bohannon Creek Irrigation System Analysis* (September 2002)

produced for Idaho Department of Fish and Game

by Quadrant Consulting, Inc. and HDR Engineering

Photo B-1. Dewatering of Bonhannon Creek below LBC-03 diversion

Photo B-2. LBC-03 headgate and diversion.

Photo B-3. LBC-03, water-measuring weir in ditch.

Photo B-4. LBC-04 headgate and diversion.

Photo B-5. LBC-06 diversion and ditch.

Photo B-6. LBC-06 headgate/blowoff structure in diversion ditch.

Photo B-7. Jolley Pump Station, located in the L-8A Diversion Canal.

Photo B-8. Stokes pump station, located in L-9 diversion canal.

ATTACHMENT C. DRAWINGS

Drawing 1. Alternative 1, Site Plan (1678-100T-430)

Drawing 2. Alternative 2, Site Plan (1678-100T-431)

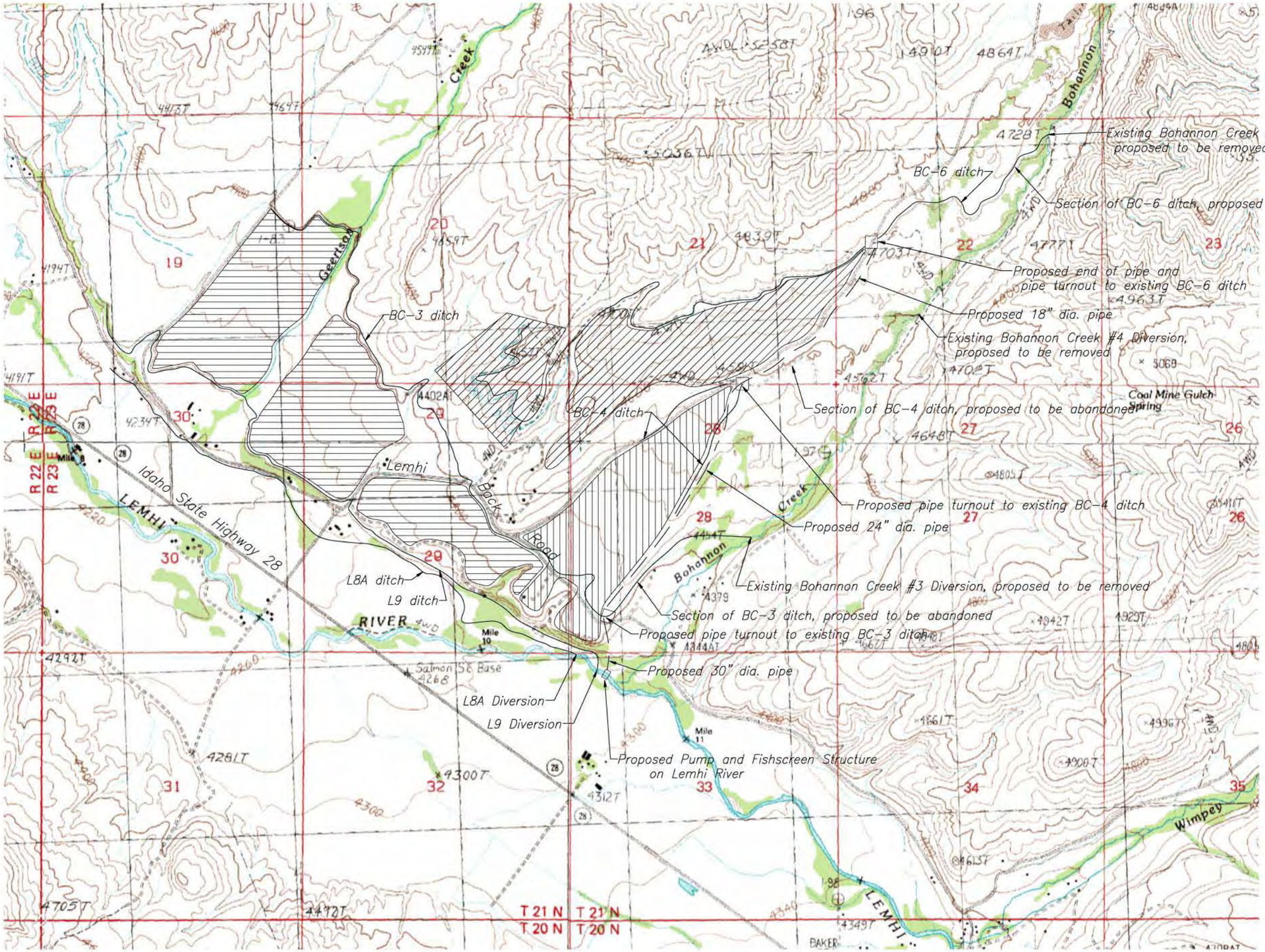
Drawing 3. Alternative 3, Site Plan (1678-100T-432)

Drawing 4. Alternative 4, Site Plan (1678-100T-433)

Drawing 5. Alternative 5, Site Plan (1678-100T-439)

Drawing 6. Alternative 6, Site Plan (1678-100T-440)

1678-100T-430



APPROXIMATE IRRIGATED AREAS

BC 3

BC 4

BC 6

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SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
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BUREAU OF RECLAMATION
COLUMBIA/SNAKE RIVER SALMON RECOVERY PROJECT
LEMHI RIVER SUBBASIN - IDAHO

BOHANNON CREEK APPRAISAL REPORT

ALTERNATIVE 1

SITE PLAN

DESIGNED _____ CHECKED _____

DRAWN Ed Mordhorst _____ TECH. APPR. _____

APPROVED _____ PROGRAM MANAGER

BOISE, IDAHO 2004-08-16 SHEET 1 OF 1

1678-100T-430

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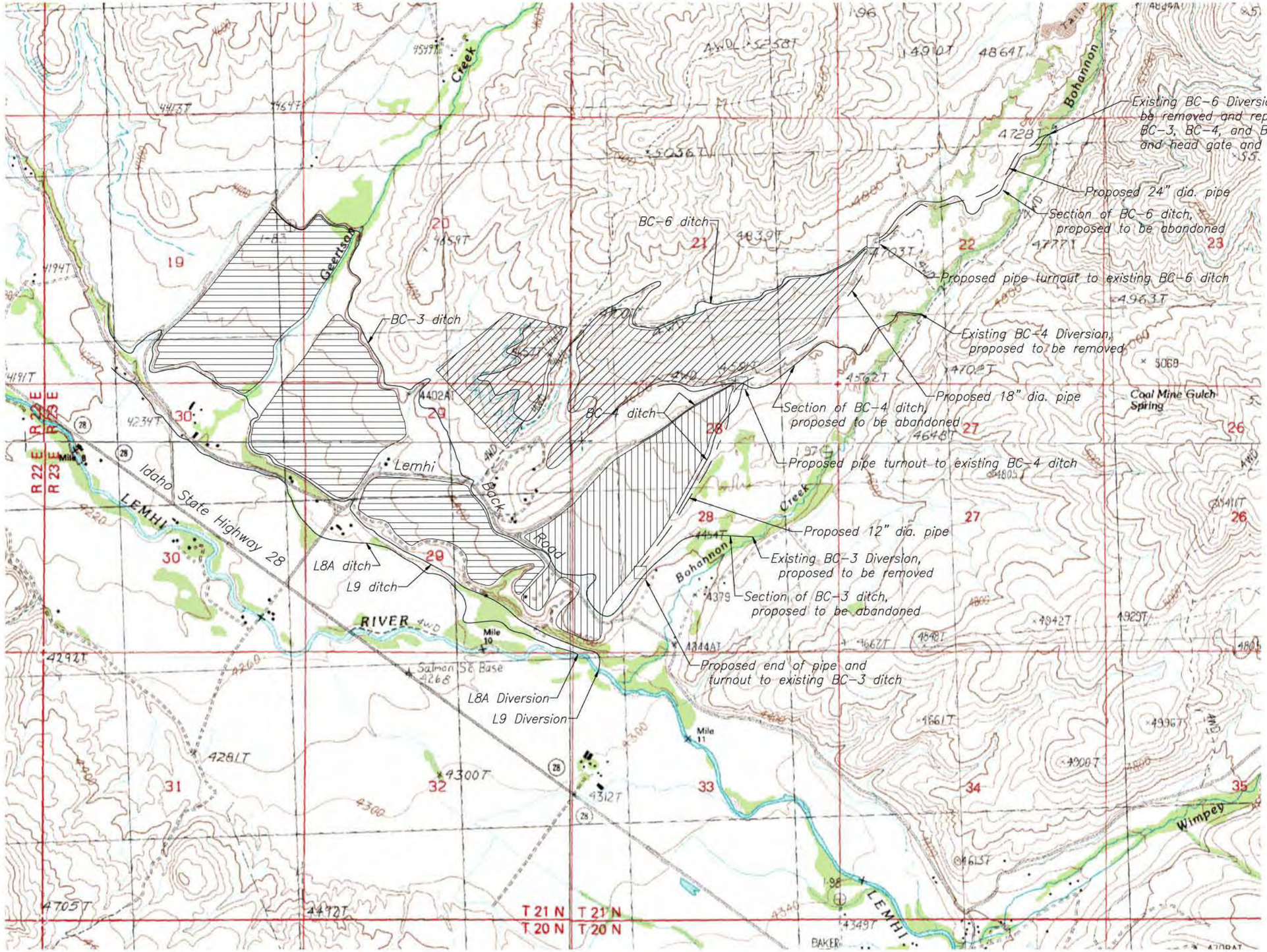

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ALTERNATIVE 2

SITE PLAN

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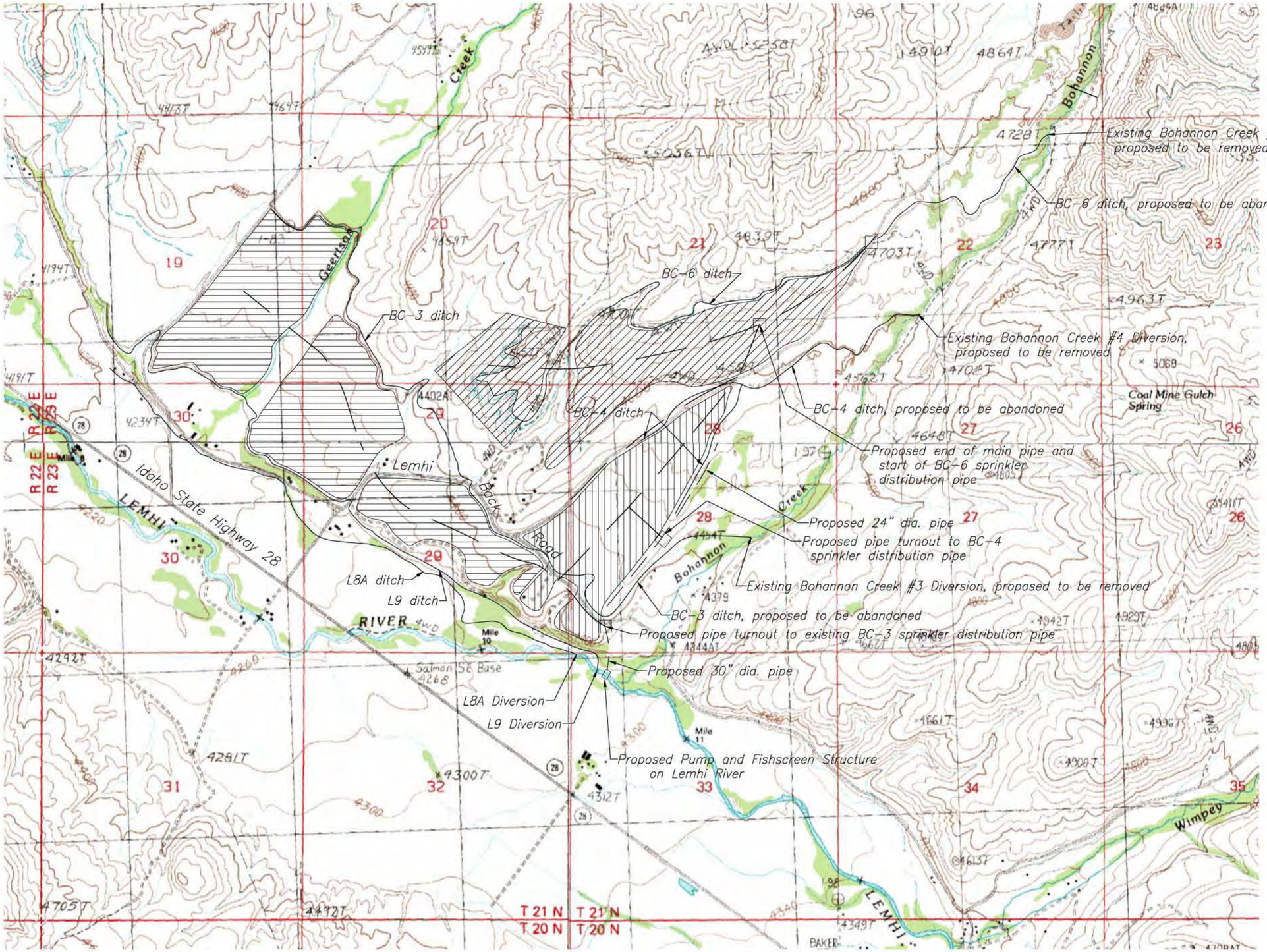

APPROXIMATE IRRIGATED AREAS

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BC 4

BC 6

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SCALE OF FEET

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ALTERNATIVE 3

SITE PLAN

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1678-100T-432

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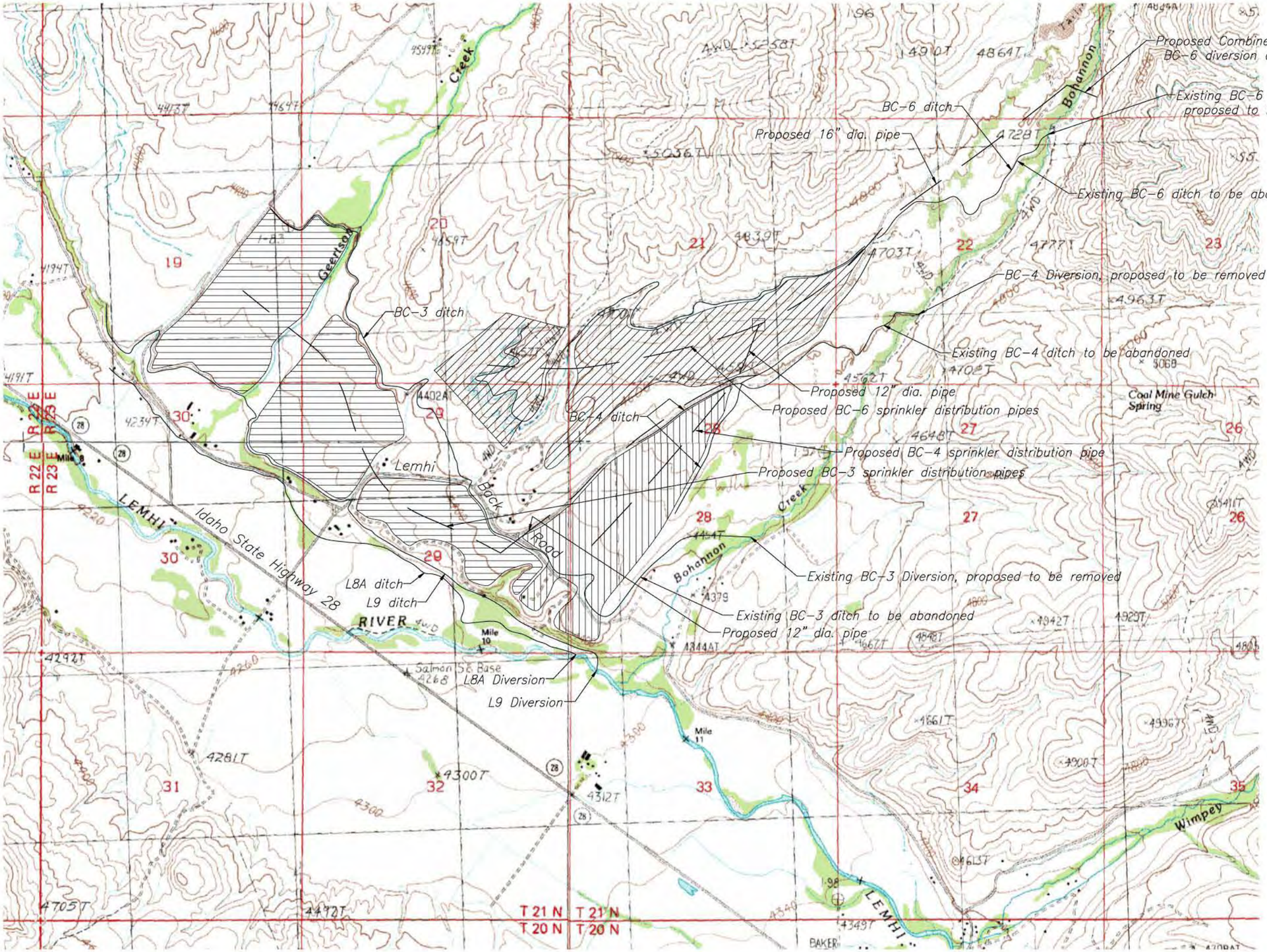

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ALTERNATIVE 4

SITE PLAN

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BOISE, IDAHO SHEET 1 OF 1 2004-08-16 1678-100T-433

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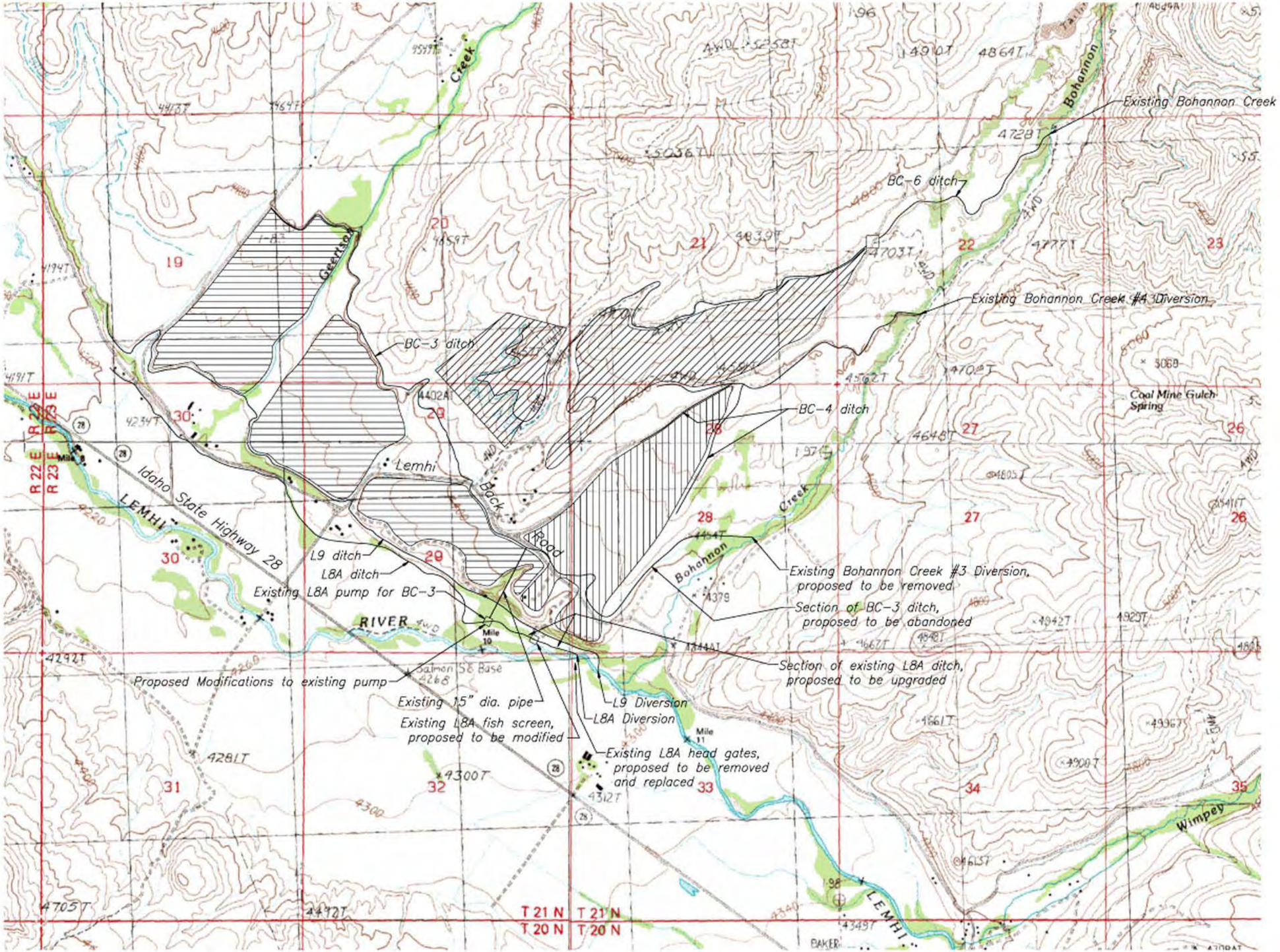

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BOHANNON CREEK APPRAISAL REPORT

ALTERNATIVE 5

SITE PLAN

DESIGNED _____ CHECKED _____

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BOISE, IDAHO SHEET 1 OF 1 2004-08-16

1678-100T-439

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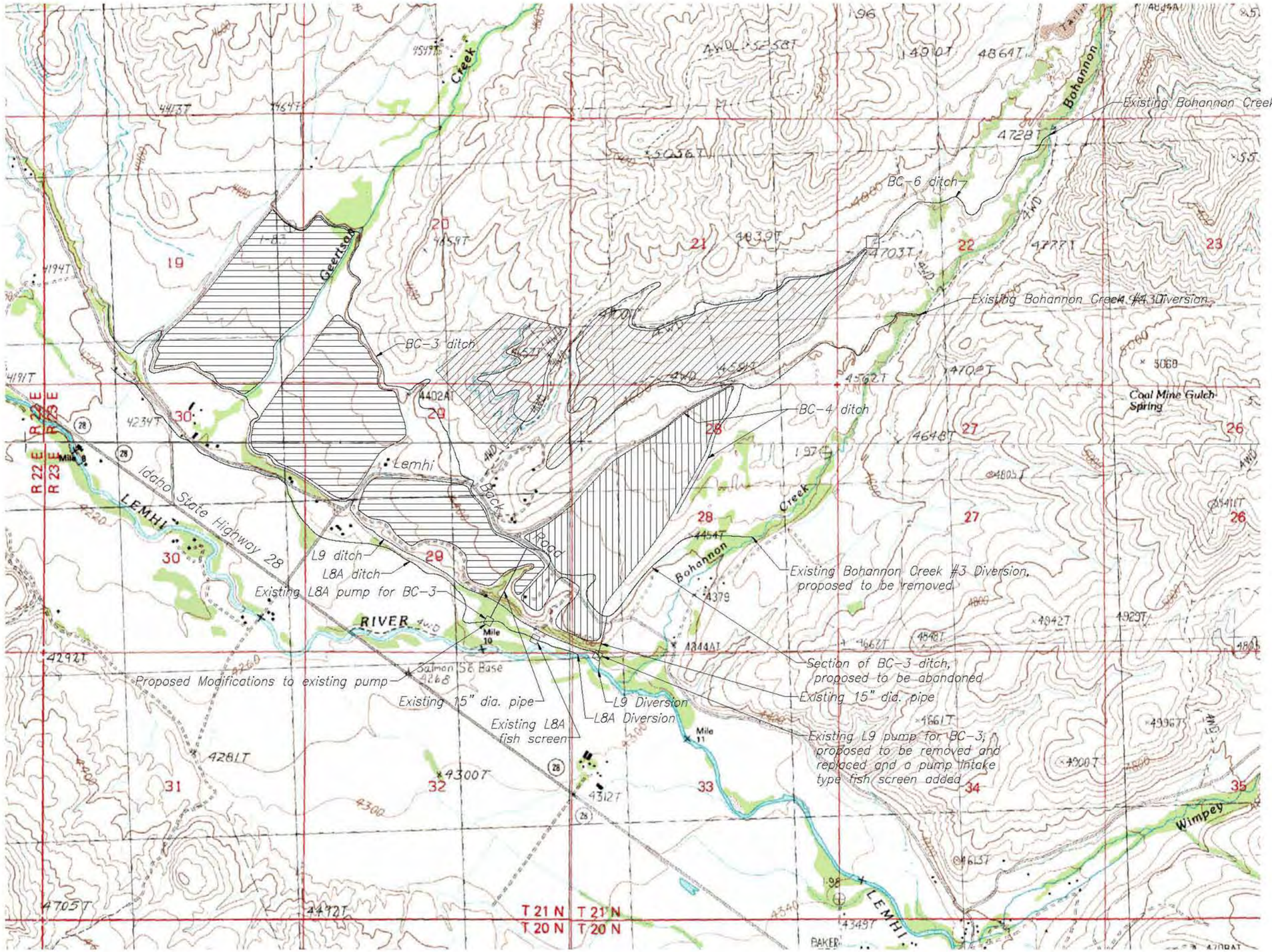

APPROXIMATE IRRIGATED AREAS

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- BC 4
- BC 6

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SCALE OF FEET

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ALTERNATIVE 6

SITE PLAN

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