Kalispell Resident Fish Project

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Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

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KALISPEL RESIDENT FISH PROJECT

ANNUAL REPORT 1995

Prepared by:

Kulispel Natural Resource Department

and

Washington Department of Fish and Wildlife

Prepared for:

U. S. Department of Energy
Bonneville Power Administration
Environment. Fish and Wildlife
P.O. Box 3621
Portland. OR 9720X-362 l

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Executive Summary

In 1995 the Kalispel Natural Resource Department (KNRD) in conjunction with the Washington Department of Fish and Wildlife (WDFW) initiated the implementation of a habitat and population enhancement project for bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and largemouth bass (*Micropterus salmoides*). Habitat and population assessments were conducted in seven tributaries of the Box Canyon reach of the Pend Oreille River. Assessments were used to determine the types and quality of habitat that were limiting to native bull trout and cutthroat trout populations. Assessments were also used to determine the effects of interspecific competition within these streams. A bull trout and brook trout (*Salvelinus fontinalis*) hybridization assessment was conducted to determine the degree of hybridization between these two species. Analysis of the habitat data indicated high rates of sediment and lack of wintering habitat. The factors that contribute to these conditions have the greatest impact on habitat quality for the tributaries of concern. Population data suggested that brook trout have less stringent habitat requirements; therefore, they have the potential to outcompete the native salmonids in areas of lower quality habitat. No hybrids were found among the samples, which is most likely attributable to the limited number of bull trout. Data collected from these assessments were compiled to develop recommendations for enhancement measures. Recommendations for restoration include riparian planting and fencing, instream structures, as well as, removal of non-native brook trout to reduce interspecific competition with native salmonids in an isolated reach of Cee Cee Ah Creek.

The KNRD and contractors completed the planning and design for the construction of a largemouth bass hatchery and rearing facility to stock largemouth bass into the Box Canyon reach of the Pend Oreille River. A bass habitat utilization study was also designed and will be conducted within the rearing sloughs of the hatchery prior to 1997 operation, to determine optimum overwinter habitat structures for juvenile largemouth bass.

Acknowledgments

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Introduction

Aboriginally and historically the Kalispel relied heavily upon anadromous salmonid fish of the upper Columbia River and its major tributaries. Per capita consumption estimates of anadromous fish for the Kalispel range from 100 lbs to 658 lbs annually (Hewes 1973. Scholz *et al.* 1985). With the construction of the Grand Coulee Dam. all migration of anadromous stocks were precluded from the upper Columbia River system, removing this resource from Kalispel exploitation. The Kalispel incurred additional losses in a cultural sense. as these fish also served ceremonial and religious functions.

Resident fisheries were at least as. if not more. important to the Kalispel than their anadromous fishery (Bonga 1978. Smith 1983. 1985). Ethnographic data indicates that the Kalispel had an elaborate technology used for the exploitation of resident fishery resources. Gilbert and Evermann (1895) reported that in 1894 bull trout (*Salvelinus confluentus*) were abundant in the Pend Oreille River and specimens as large as twenty-six inches long and weighing five pounds or more were in the possession of individual Kalispel. The subsequent construction of Box Canyon and Albeni Falls Dams in the 1950's furthered the decline in the resident fishery by causing a shift in fish populations from predominantly trout. char and whitefish to predominantly squawfish and suckers (Glen Nenema, Chairman. Kalispel Tribe. Stan Bluff. Kalispel Tribal Council Member pers. comm.). The dams forever changed the habitat in this reach from that of a cold water fast-moving river. to a warm and shallow reservoir, with velocities ranging from 0.1 feet-per-second (fps) during summer low flows to upwards of 2.0 fps during high flows (Falter *et al.* 1991). The slow moving reservoir created by these dams. with its artificially fluctuating depths. creates habitat unsuitable for the native salmonids once contained in this reach.

The fluvial-geomorphology of the tributaries of the lower Pend Oreille River were formerly dictated by the geology of the area. The granitic based geology contributes heavy amounts of bedload into streams. Gruss (deteriorated granite). one of the principal substrates of the tributaries. is a result of weathering processes on exposed granitic intrusions. Historic hydrologic patterns transported naturally occurring sediment during high flow periods maintaining relatively low embeddedness. As land use practices increased. the sediment input into the streams has increased over historic conditions. thus the equilibrium of sediment transport was altered. The direct effect of this is marked increases in accretion of sediment within the stream channels. The fluvial processes of suspension and transport of bedload were reduced by the increased sedimentation rate. With this additional amount of sediment in the tributaries. the hydrocurve is incapable of removing the additional sediment attributed to land use practices.

Land-use practices within this system have further degraded both the habitat and community dynamics of native fish. While these changes have been detrimental to the native fish in this system, they have created an environment conducive to introduced non-native fish populations (Behnke 1979). Introduction. whether through entrainment or stocking. of non-native fish to the Pend Oreille River exacerbated the already declining native fishery. These exotic species stress the native fish by both competing for their habitat and by possible hybridization. lessening the genetic integrity of the native populations (Leary et *al*. 1993). These combinations of effects have led to an overall depletion in the native fish resources in this system.

Bull trout populations are on the decline in most bodies of water they inhabit (Ratliff *et* al. 1992. Pratt 1992. Mongillo 1993. Brown 1994). In many aquatic systems, bull trout have been limited to small areas of suitable habitat (Brown 1994). Effects such as habitat degradation. hybridization. competition between native and non-native salmonids and overharvest have limited bull trout populations throughout their range (Ratline *et al*. 1992). The requirements of bull trout for very cold water and high quality habitat makes them a valuable barometer of ecosystem integrity and health (Ratliff et al. 1992). Historically. abundant populations of bull trout have decreased in numbers sufficiently to give cause to recognize bull trout. in most parts of its range, as a Category 1 or 2 candidate species under the Endangered Species Act. Within the Pend Oreille River system. bull trout are delineated as a Category l candidate species.

Westslope cutthroat (*Oncorhynchus clarki lewisi*) is another of the native species affected by the altered conditions in this region and throughout their historic distribution. It has been estimated that 99% of the original population of westslope cutthroat have already been lost (Behnke 1972). Overexploitation. introgression, competition with introduced salmonids and degradation or loss of habitat have all led to the decline of their population (Liknes and Graham 1988). The life history of these fish require specific habitat quality. that. in many cases. is no longer available (Liknes and Graham 1988). It is the concern over this loss that has lead to the current listing of westslope cutthroat as a Category. 2 candidate species under the federal Endangered Species Act within the Pend Oreille River system.

In an attempt to partially. mitigate for the resident and anadromous fish losses caused by hydropower development and operation. the Northwest Power Planning Council (NWPPC) called for recommendations to develop a program that would provide measures to protect. mitigate and enhance fish and wildlife affected by the construction and operation of hydroelectric facilities located on the Columbia River and its tributaries. The Kalispel Tribe. in conjunction with the Upper Columbia United Tribes (UCUT) Fisheries Center. undertook a three year assessment of the fishery opportunities in the Pend Oreille River (Ashe *et al*. 1991) to provide the NWPPC with their recommendations. The recommendations were adopted and incorporated into the 1994 resident fish and wildlife section of the NWPPC's Columbia River Basin Fish and Wildlife Program (NWPPC 199-l) and further revised in the NWPPC 1995 program.

In 1995 the Kalispel Natural Resource Department (KNRD) and the Washington Department of Fish and Wildlife (WDFW) began the development of the Kalispel Resident Fish Project. The biological objectives developed by the KNRD and WDFW for this project were then adopted into the NWPPC's program during the 1995 amendment cycle. Data collected through the 1995 field season by the KNRD and the WDFW were evaluated to identify specific limiting factors of habitat to resident fish populations in the Bos Canyon reach and its tributaries. These limiting factors were used to develop specific enhancement objectives for each tributary in order to address the biological objectives adopted by the NWPPC's program (NWPPC 1995).

Enhancement measures will focus on habitat and population restoration for native bull trout and westslope cutthroat trout within the priority tributaries of the Pend Oreille River. Cee Cee Ah Creek. Mill Creek. Indian Creek and the LeClerc Creek systems were selected as priority tributaries for enhancement. based on their higher potential for restoration. Habitat and population enhancement for bull trout and cutthroat trout will focus on restoring riparian areas. instream restoration and exotic brook trout (*Salvelinus fontinalis*) removal. Subsequent monitoring and evaluation of these measures will determine the effectiveness of actions taken toward meeting each tributary's individual objectives. as well as the overall biological objectives for the Box Canyon reach. Monitoring and evaluation of the prescribed measures will judge their scientific merits and aid in the institution of this project's adaptive management approach.

Bull trout and cutthroat trout habitat assessment

Physical habitat information allows for a detailed description of the functional units that each stream is composed of and is integral to evaluation of the stream's overall ecological integrity (Simonson *et al.* 1993). The data collected through habitat assessment can be used to determine the relative quality and quantity of habitat available for fish within the stream (Armantrout 1982). Intrastream and interstream comparisons of assessment data combined with fish population data can aid in the prediction of fish species presence or abundance within particular stream reaches (Gorman and Karr 1978: Binns and Eiserman 1979: Schlosser 1982: Fausch *et al.* 1988; Lyons 1991). These comparisons also help to highlight the areas with the poorest habitat as sites for potential enhancement. Enhancement of habitat type and quality provides one means for population enhancement of target species (Hunter 1991). The baseline data collected in the habitat and population assessments become reference points for the long-term monitoring of the proposed enhancement measures. The goals of this project are to assess present conditions. identify trouble areas. propose enhancement measures and implement recommendations to improve the quality and quantity of the available habitat. This information can be further used to recommend continued restoration on these individual tributaries. as well as provide recommendations for proposing habitat enhancements in other tributaries.

Population Density

Knowledge about fish populations is essential for developing management plans and evaluating the success of the implemented plans. These population assessments are important for plotting fluctuations in abundance possibly due to habitat degradation and 'or habitat enhancement. Baseline data collected in the population assessment become reference points for long term monitoring. This monitoring will provide information on the fluctuation of populations due to habitat enhancement. It is expected that habitat enhancement will improve the populations of the already existing native salmonids.

Riparian area restoration

Riparian areas are those areas of. on. or relating to the banks of a natural course of water. Riparian areas contain characteristic plants and animals that have evolved to utilize the diverse habitat provided by the riparian area (Kelly *et al.* 1975). The vegetation associated with a stream bank can have direct and indirect influence on instream characteristics making it an integral part in habitat management (Thomas *et al.* 1979). Establishment of healthy riparian areas can increase bank stability in locations where there is increased erosion of stream banks. Grazing. along with other land use practices. have degraded bank stability. Fencing of riparian areas provides relatively short-term benefits towards the revegetation of these areas by reducing traffic and foraging. Fencing will increase the survivability of seral or early successional species (e.g.. grasses and sedges). Long-term vegetative enhancement of riparian areas is achieved through planting of coniferous and deciduous shrubs and trees. The maturation of these shrubs and trees can produce instream improvements such as: reduced stream width, increased stream depth. lower water temperature and increase overwintering habitat (Platts ct *al.* 1987). The most significant contribution is the recruitment of large woody debris (Bryant 1983). The goals for riparian restoration are to reduce the impacts of land-use practices and enhance the natural recovery process in disturbed reaches of the streams.

Instream restoration

Instream restoration is the direct modification of streams with artificial structures to increase their complexity. The installation of instream structures perform specific improvements for fish habitat. including spawning habitat. rearing cover. feeding areas and overwintering habitat (Hall and Baker 1982). These structures provide desirable salmonid habitat characteristics in areas where the stream conditions have been degraded (House and Boehne 1985). Land-use practices in this region have exacerbated already degraded stream conditions. Structures will aid in the scouring of the stream's substrate and help transport the increased sediment load associated with poor land-use practices. Reduction of sediment and an increase in habitat quantity and quality can improve fish habitat by increasing: salmonid reproduction. salmonid rearing. invertebrate production. species diversity. bedload transport. water quality and stream depth. (MacDonald *et al.* 1991. Beschta and Platts 1986. Hynes 1970). The goals of instream restoration are to improve the habitat quality and quantity in degraded areas and increase cutthroat trout and bull trout populations by providing an increase in habitat quantity and quality.

Exotic brook trout removal

Exotic trout removal is the physical removal of non-native trout from a stream. Of all the factors threatening bull trout and westslope cutthroat trout. hybridization and interspecific competition with introduced salmonids represent the most detrimental problem to these species (Liknes and Graham 1988. Leary *et al.* 1991. Markle 1992)). Exotic removal eliminates interspecific competition and the potential for hybridization with these introduced species. The removal of brook trout in upper Cee Cee Ah Creek will allow higher availability of habitat to native trout and is one measure toward increasing their populations. The goal of exotic removal is to increase native salmonid populations by minimizing or eliminating interspecific competition.

Hybridization of brook trout and bull trout

Hybridization. the act or process of interbreeding between two closely related species. can be potentially damaging to the species of concern. The potential for heterosis does not exist between these two species as bull/brook trout hybrids are sterile (Leary *et al.* 1993). Bull trout eshibit already depressed population levels. Consequently. the potential for hybridization is of serious concern. The physical act of hybridization eliminates the potential for bull trout mating therefore wasting that years reproductive effort. A direct result of this phenomenon is limited recruitment. Hybridization is determined through genetic testing of the species of concern.

Genetic tests will clearly detail the estent of spawning interaction and incidence of hybridization between native and non-native char species. One esplanation for low numbers of bull trout may be hybridization between bull trout and non-native brook trout. In the case of the Bos Canyon Reservoir tributaries. brook trout are the most numerous species and have an advantage because less reproductive effort is wasted on hybridization. The goals of this genetic analysis study will be to determine the magnitude of hybridization that is occurring between brook trout and bull trout in tributary streams of the Bos Canyon Reservoir and determine the effects. if any. that brook trout are having on bull trout populations.

The goals for the Resident Fish Project are to identify the existing population and habitat conditions for resident fish in the Bos Canyon Reach of the Pend Oreille River and its tributaries. Data collected on these conditions will be used in the recommendation of enhancement measures to increase native bull trout and westslope cutthroat trout populations.

Description of Study Area

Bull trout and cutthroat trout study area

The Pend Oreille River system begins as the Clark Fork River in west central Montana. The Clark Fork River empties into Pend Oreille Lake. The Pend Oreille River begins at the outflow of Pend Oreille Lake. The river flows westward into Washington then turns northward until it reaches Canada where it joins the Columbia River. The study area is in the northeast corner of Washington State. The approximate drainage area of the Pend Oreille River between the border of Washington and Idaho and the international border is 65.300 km’.

The Bos Canyon Reservoir is formed by the impoundment of the Pend Oreille River by Bos Canyon Dam. The reservoir has 47 tributaries and covers 90 river kilometers of the Pend Oreille River, from Albeni Falls Dam to Bos Canyon Dam. The priority tributaries for the study are located within the Bos Canyon reservoir (Figure 1).

Mill creek has a drainage basin area of 80.2 km’. with 9.7 km of stream that empties into the Pend Oreille River at river kilometer 95. The system is fed by water sources from North Baldy and the surrounding lower ridges. The stream in the upper r-caches has a gentle gradient with beaver habitat and a slow meandering channel. Due to erosion resistant geology, the lower portion of the stream changes to a high gradient system with cascading riffles and plunge pools until it reaches the confluence with the Pend Oreille River. Mill creek enters the Pend Oreille River at approsimately river kilometer 108.

Cee Cee Ah Creek has a drainage basin area of 63.5 km^2, with 14.6 km of stream. Cee Cee Ah has a diverse morphology with varied gradient. Cee Cee Ah has an intermediate gradient on top. a flat gradient in the middle. a steep gradient in the lower section with a 25 m waterfall. and a low gradient for the last 2 km of stream. This creek has an extensive slough sy stem for the last lkm before it’s confluence with the Pend Oreille River. Cee Cee Ah Creek empties into the Pend Oreille River at river kilometer 130.

LeClerc Creek is the largest drainage of the three priority tributaries. LeClerc Creek’s drainage basin is 161 km’. The LeClerc system is split into three separate branches (East. West. and Middle). There is approximately 93 km of stream in the LeClerc system. This is one of the largest tributary systems in the Bos Canyon Reservoir. Tributaries to the LeClerc system are. hlineral and Whiteman Creeks (tributaries to the West Branch of LeClerc). and Fourth of July Creek (tributary to East Branch of LeClerc Creek). The East and Middle branch flow together 5 km above the confluence with the Pend Oreille River. The main branch is formed by the merging of the East and West branches 2.5 km above the Pend Oreille River. LeClerc Creek flows into the Pend Oreille River at approximately river kilometer 90.

Indian Creek has the smallest drainage basin of all the tributaries surveyed at 20 km^2 and is one of the shortest tributaries with 3.84 km of stream. This stream has no secondary tributaries and is spring fed. This stream flows through relatively low gradients and is generally wide and shallow. A series of beaver dams are constructed at the mouth of this stream creating potential migration barriers. The stream flows into the Pend Oreille River on the East side at river kilometer 140.

Cedar Creek has a drainage basin area of 85 km’ and is approximately 19 km long. Cedar Creek is fed by the water from surrounding ridges and a single secondary tributary. This stream is dammed at the lower portion of the stream as a resen’e water supply for the town of lone. The stream enters the Pend Oreille River on the west side at approsimately river kilometer 59.

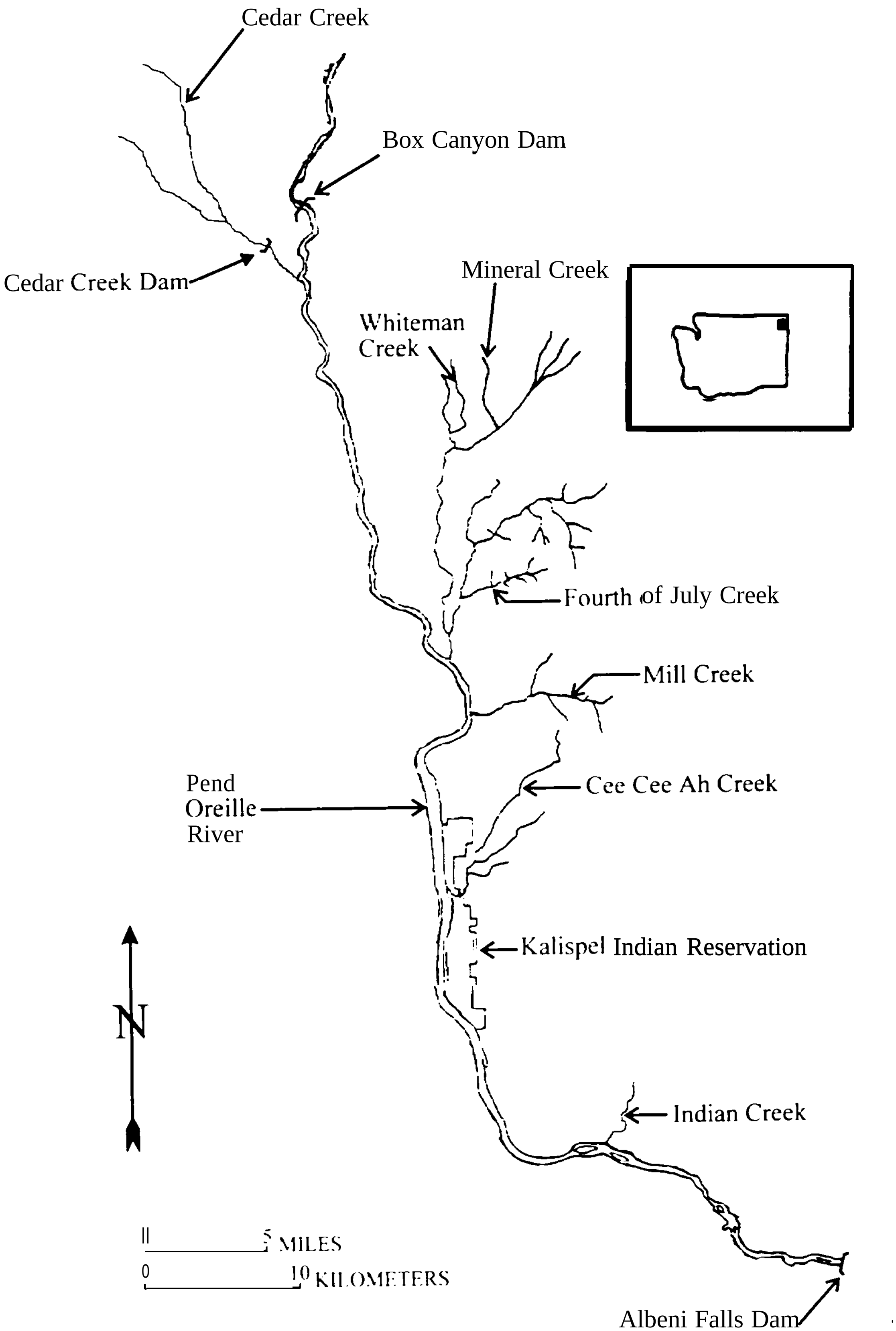


Figure 1. Box Canyon Reservoir and priority tributaries.

Methods

Bull trout and cutthroat trout habitat assessment

The stream habitat survey methodology contained three facets: transect surveys, reach overviews and interreach comparisons. This stream survey methodology used within the Box Canyon Reach is similar to that developed by Espinosa (1988) and further revised by Huntington and Murphy (1995) (KNRD internal doc. l-95).

Habitat surveys were broken into two components 1) transect surveys and 2) reach overview surveys. Transect suneys are the division of the stream into 30m segments. Primary pools. spawning habitat and acting woody debris counts were collected for the entire length of each 30m segment. The remainder of the habitat quality parameters in Table 1 were collected at the end of each 30m segment (the actual transect site). This method allows for a number value to be assigned to each habitat quality parameter. Reaches were defined by stretches of stream with common gradient, substrate and vegetation. Breaks between two homogeneous areas defined a new reach. Reach overview surveys are the visual obsenation and description of variables occurring within each reach (Table 2). Each reach was permanently marked and flagged using aluminum tags and flagging as a reference point for long-term monitoring.

Following the compilation of transect data. an inter-reach comparison was conducted using the mean values for each reach. This was the fundamental unit of comparison to determine specific reaches for enhancement projects. Threshold values were established for embeddedness. bank stability. bank cover. instream cover. pool-riffle ratio. spawning gravel and primary pools (Table 3). All threshold values were obtained from Hunter (199 1) and/or MacDonald *et al.* (199 1). The mean data for each reach was analyzed by using these threshold criteria. Each habitat value that did not fall within the threshold was counted as habitat that was unsatisfactory for quality or quantity.

Population Density

Fish densities were collected using standard snorkel survey techniques (Espinosa 1988) for all streams except Cee Cee Ah Creek. Cee Cee Ah Creek fish data was taken from Ashe's (1990) assessment data. Sampling was conducted during the period from July 15 through September 15. Population density was addressed by number, size (age class) and species of fish per 1 $00m^2$ (Table 3). The standard size/age classes for salmonid species were determined according to Espinosa (1988). Lengths of stations were 30 meters and selected so that beginning and ending points for stations never bisected pool habitat. Fish stations were permanently marked and flagged using aluminum tags and flagging.

Table 1. Transect variables and method of collection.

C'ariable	Method of collection
Habitat Ty pe	Visually determine habitat types (i.e., pool, riffle, glide, pocketwater, run. alcove)
Dominant Substrate Size	Visually determine largest percentage of substrate for that habitat type (i.e.. silt. sand, gravel, cobble, boulder, bedrock)
Habitat Function	Visually determine habitat functions (i.e., winter, summer, spawning or unusable)
Spawning Gravel Amount and Quality	Measure potential square meters of spawning gravels within each transect and quality (i.e. gravel size, location and current velocity)(Kalispel internal doc. I-95) Good = All criteria met. Fair = 2 criteria met. Poor = 1 criteria met.
Stream Depths	Measure depth at 1/4, 1/2, 3/4 across channel to the nearest cm
Habitat Widths	Measure each specific habitat type in a transect to the nearest 0.1 m
Primary Pools	Sumber of pools with length or width greater than the avg. width of stream channel within each transect
Pool Quality	Rating based upon collection of length. width. depth, and cover
Pool Creator	Identify item creating the pool (e.g., large woody debris, boulders. beaver. enhancement. other)
Cobble Embeddedness	Visual estimate of the percentage fine or coarse sediment surrounding substrate Actual measurement was recorded with an embed meter approximately every 20 transects, Regression of the estimated numbers with the actual measurements calculated a correction factor for all estimated values.
Bank Stability	Visual estimate of the percentage of unstable bank per transect for possible sediment source
Instream Cover Rating	Percent of the stream surface covered by large woody debris. aquatic vegetation. bank vegetation in or near the surface of the water ' Amount of cover provided by undercuts. root wads. boulders or turbulence.
Dominant/Subdominant Riparian Vegetation	Visual estimate of dominant vegetation and of subdominant vegetation species
Stream Channel Gradient	Using a clinometer measure percent slope
Acting Woody Debris	Sumber of woody debris with a diameter > I Ocm and a length > I m in the stream
Potential Debris Recruitment	Number of trees within the transect that could potentially fall into the stream > 10 cm and a length > Im
Residual Pool Depth	The average pool depth by averaging the deepest portion of the pool and the pool tailout. Measure to the nearest 0.01cm

Table 2. Reach variables and method of collection

Variables	Method of Collection
Air and Water Temperature	Thermometer reading in centigrade
Channel Type	A general classification of channel type based on channel morphology (see Rosgen 1994)
Average Embeddedness	Estimate of the average embeddedness for the entire reach Actual measurement was recorded with an embed meter approximately every 20 transects. Regression of the estimated numbers with the actual measurements calculated a correction factor for all estimated values.
Dominant Habitat Type	Dominant habitat type for the reach (i.e., pool. riffle. glide. pocketwater, run, alcove)
Disturbance	Estimation of the effects of land use practices (i.e. logging, roads. cattle. mining)
Aquatic Vegetation	Estimation of the occurrence of aquatic vegetation for the reach (i.e., abundant. fairly common, scarce, none)
Shading	Visual estimation of the amount of stream shaded by canopy along the stream reach
Habitat Quality	Estimation of the habitat quality for the entire reach (i.e., good, fair, poor)
Other	Any notable attribute not required for recording that can be recorded for reference to impact. or interest to habitat quality.

Table 3. Interreach comparison threshold values (after Hunter 1991; MacDonald 1991).

Limiting Factors	Threshold Value
Embeddedness	Any value ≥ .30 or ≤ .70
Bank Stability	Any value ≤ 2.5
Bank Cover	Any value ≤ 2.5
Instream Cover	Any value ≤ 2..0
Pool - Riffle Ratio	Any value ≤ .5:1 or ≥ 1.5:1
Spawning Gravel	Three lowest cumulative values
Primary Pools	Three lowest values

Table 4. Fish species designation by length group as developed by Espinosa 1988.

Species	Age	Length
Cutthroat Trout	0+	< 65 mm FL
Rainbow Trout	1+	65-110 mm FL
	2+	111-150 mm FL
	3+	151-200 mm FL
	4+	201-305 mm FL
	BIG	> 305 mm FL
Bull Trout	0+	< 65 mm FL
Brook Trout	1+	65-115 mm FL
Brown Trout	2+	116-165 mm FL
	3+	166-210 mm FL
	4+	211-305 mm FL
	BIG	>305 mm FL
Mountain Whitefish	N/A	< 100 mm
	N/A	100 - 305 mm
	N/A	> 305 mm
Sculpin	N/A	N/A
Sucker	N/A	N/A

Hybridization assessment of brook trout and bull trout

A genetic assessment was conducted to determine the degree of hybridization occurring in the tributaries of the Box Canyon Reach. The hybridization assessment was contracted to Dr. Gary Thorgaard. Department of Zoology,, Washington State University (WSU). All methodology. results and portions of the discussion for the hybridization study were written by the contractor (Thorgaard and Weaver 1995). Bull Trout, brook trout and potential hybrids were collected in 11 tributaries of the Box Canyon reach. Laboratory work extracted the DNA and utilized Microsatellite Primers and RAPD's (Random Amplified Polymorphic DNA) to test for bull trout x brook trout hybrids. Fish used in the sampling were collected through electroshocking. One cm^2 fin clips were taken to provide the DNA samples and stored in a 1.5 ml vial of 95% ethanol. Each vial number was recorded along with suspected species. fish length, stream name, and site location. A total of 295 samples were collected and sent to Dr. Gary Thorgaard and Derek Weaver at WSU for genetic analysis.

DNA was extracted from individual samples using standard phenol-chloroform extraction procedures. Individual tin clips were digested with cell digestion buffer and proteinase K. then subjected to one phenol-chloroform extraction. DNA was precipitated in 100% ethanol with ammonium acetate. Samples were then centrifuged into pellets and rinsed in 70% ethanol. Pellets were dried and rediluted in approximately 250ul of .1X TE buffer. Samples were allowed to dissolve for several days at 4 C then quantified using a flourometer and 375ng standard.

Samples were screened using two sets of microsatellite primers and three different RAPD (Random Amplified Polymorphic DN.4) primers. This was done to assure more accurate identification. The use of RAPD primers requires no known knowledge of the DNA being amplified whereas microsatellite primers require knowledge of DNA regions unique to the species of interest. The microsatellites chosen were derived from Brown Trout (Estoup *et* al.. 1993: Sakamoto *et* al.. 1994). The microsatellite primers are used in pairs. one as a forward primer and the other as a reverse primer. Amplified product was run and visualized in Agarose gel.

Complete volume of each individual reaction was loaded into a 2% ethidium bromide stained agarose gel and run in 1X TEA buffer for 2.5 hours at 50 volts. Two 20 toothed well combs were used per gel (175ml mid-sized gel). 1 kb molecular weight standard was loaded at the ends and in the middle of each comb. PCR products were visualized by photographing the gels under UV light conditions. Photographs were compared to those of known brook. hybrid, and bull samples.

Results

Bull trout and cutthroat trout habitat assessment

All streams surveyed exhibited high rates of embeddedness ($\bar{x}$ = 72.4% ± 12.8), with the exception of Cedar Creek ($\bar{x}$ = 31.8% ± 2 1.9). Mill Creek had the highest rate of embedded substrate ($\bar{x}$ = 86.2% ± 18.3). followed by Fourth of July ($\bar{x}$ = 77.7% ± 27.2). Cee Cee Ah ($\bar{x}$ = 73.8% ± 26.8). and Mineral Creek ($\bar{x}$ = 70.1% ± 25.7). Whiteman Creek and Indian Creek exhibited moderately high rates of embeddedness ($\bar{x}$ = 52.4% ± 37.6 and $\bar{x}$ = 5 1.8% ± 28.3. respectively). High rates of embeddedness were common for individual reaches in each stream as well. Figures 2 through 6 specie reach location and fish stations for each stream. Each stream contained reaches with greater than 70% embeddedness with exception of Cedar Creek. Mill Creek (Table 5) and Fourth of July Creek (Table 6) each contained only one reach with rates less than 70%. Cee Cee Ah Creek (Table 7) and Mineral Creek (Table 8) exhibited rates of greater than 70% in half of their reaches. Whiteman Creek (Table 9) contained two reaches and Indian Creek (Table 10) contained one reach with rates greater then 70%. Cedar Creek (Table 11) differed. in that. no reaches were greater than 70% and more than half were less than 40%.

The high rates of embeddedness limited the area of higher quality spawning gravels for both spring and fall spawners. Cee Cee Ah Creek contained the least amount of spawning habitat with 5.9m^2/km of spawning gravel all of poor quality. Whiteman Creek contained only 14.3m^2/km of spawning gravel without any gravels of good quality. Mineral Creek contained 34.8m^2/km of spawning gravels; however. only 1 .5m^2/km were of good quality. Mill Creek and Fourth of July Creek both contained relatively large amounts of spawning gravels. 77m^2/km and 93.4m^2/km respectively. but having the two highest rates of embeddedness has reduced the amount of quality gravels to less than 7m^2/km for each stream. Indian Creek and Cedar Creek had the two lowest rates of embedded substrates and consequently they contained the most spawning gravels of higher quality. 2 1 .5m^2/km and 18.8m^2/km respectively.

Most streams eshibited low habitat diversity with primarily summer habitat and low primary pool counts. Fourth of July Creek and Indian creek exhibited 100% summer habitat in half of their reaches and had the lowest number of primary pools per kilometer (3.5 km). Cee Cee Ah Creek exhibited six of ten reaches that were 100% summer habitat and only a slightly higher number of primary pools per kilometer (3.6/km). Three out of eight reaches on Whiteman Creek exhibited 100% summer habitat and 6.3 primary pools per kilometer. Two of the ten reaches of Mill Creek were comprised of 100% summer habitat and the number of primary pools per kilometer was 6.8 for the stream. One of the four reaches on Mineral Creek exhibited 100% summer habitat and 7. I primary pools per kilometer. Cedar Creek exhibited only one reach of fourteen that was 100% summer habitat and the largest number of primary pools per kilometer at 7.9.

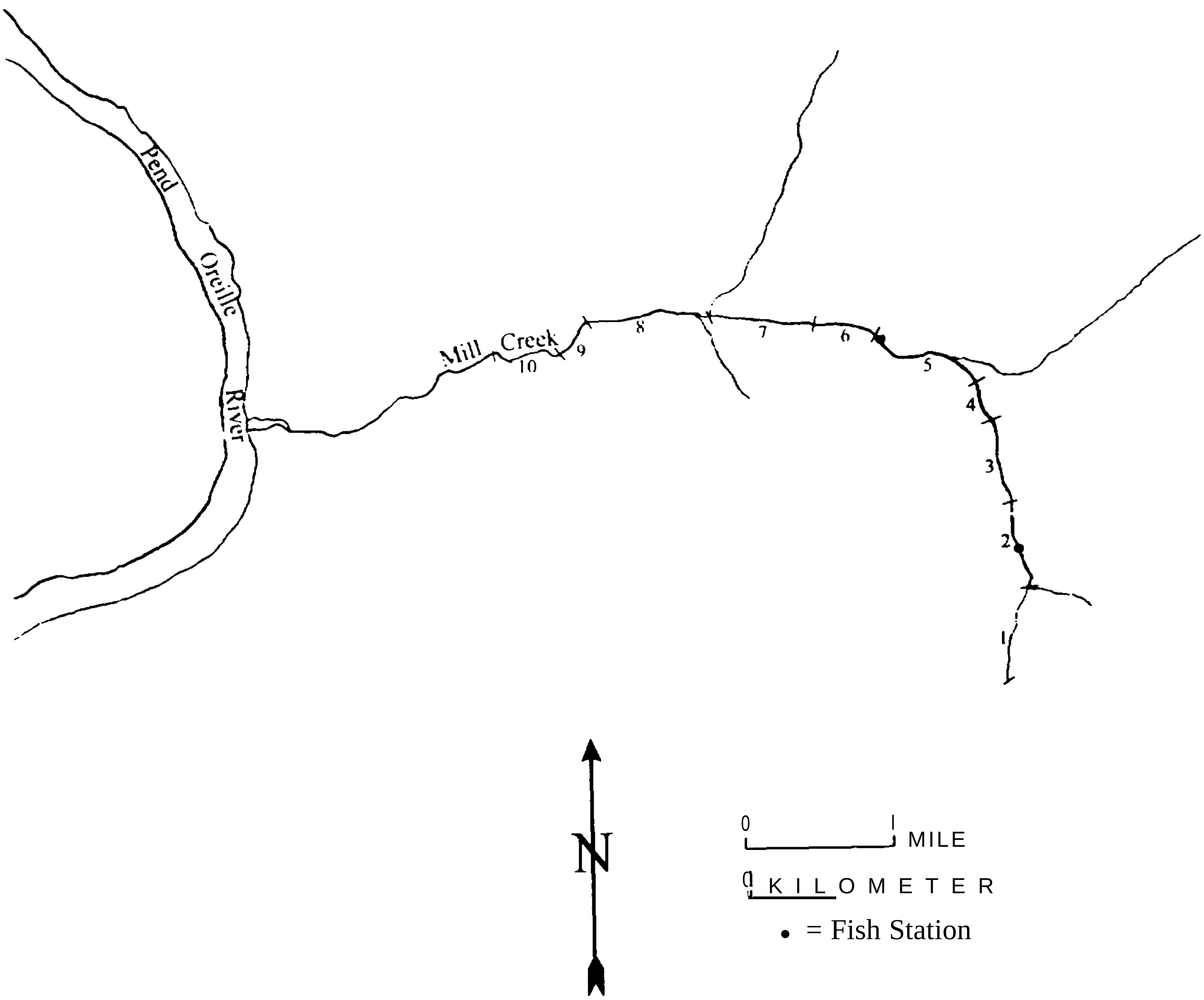


Figure 2. Mill Creek fish station and reach locations.

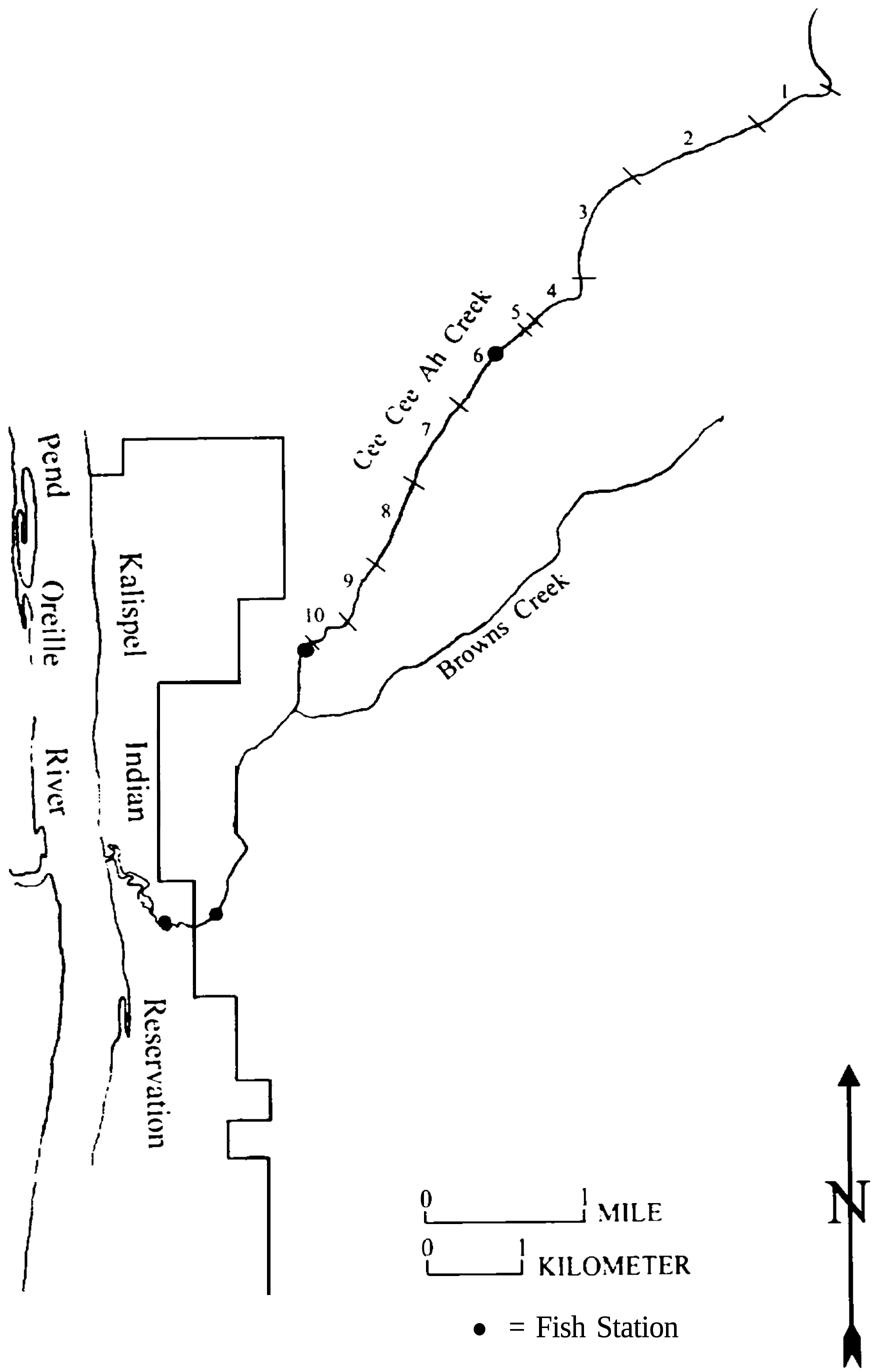


Figure 3. Cee Cee Ah Creek reach and fish station locations.

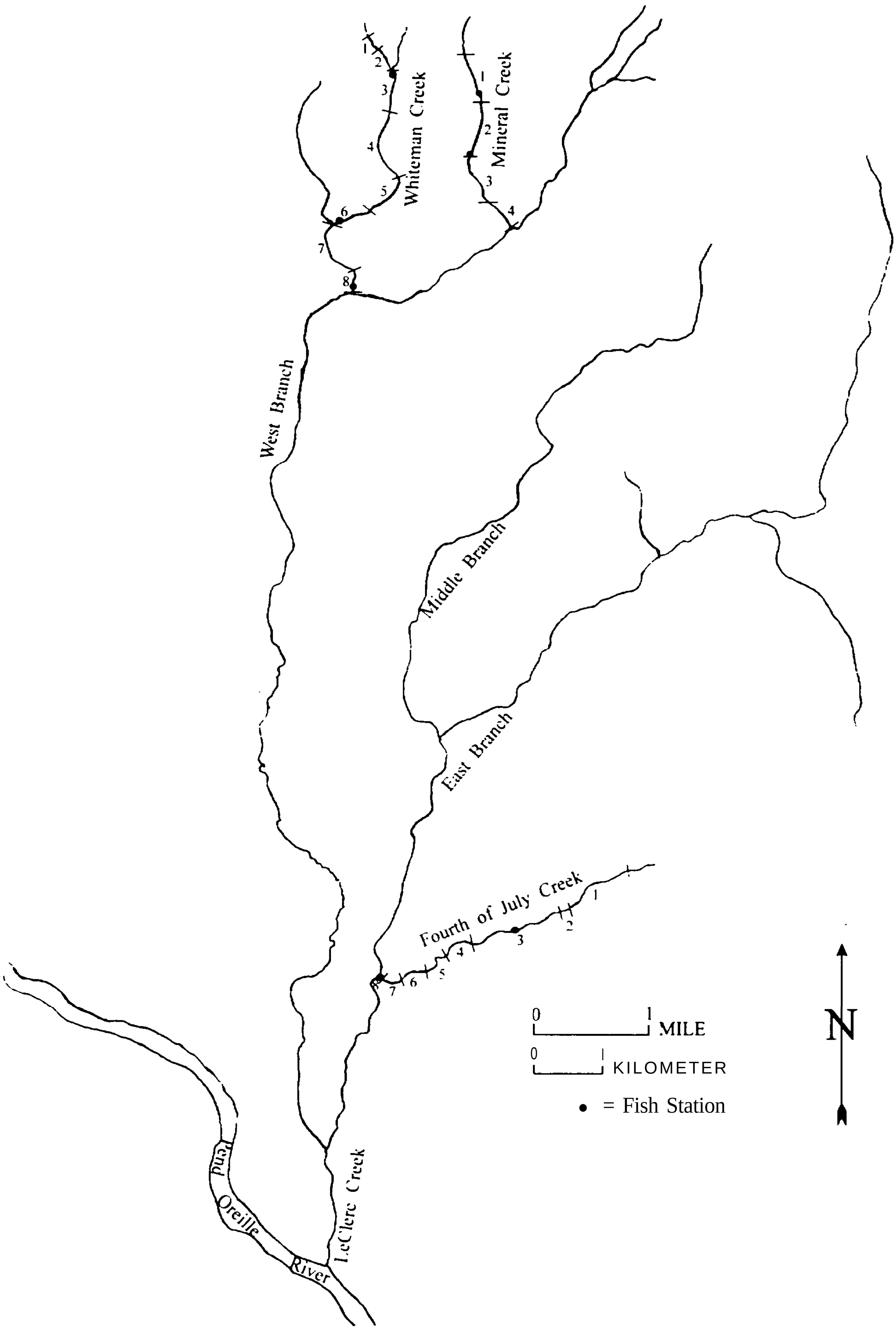


Figure 4. Fish station and reach locations for Fourth of July Creek, Mineral Creek and Whiteman Creek.

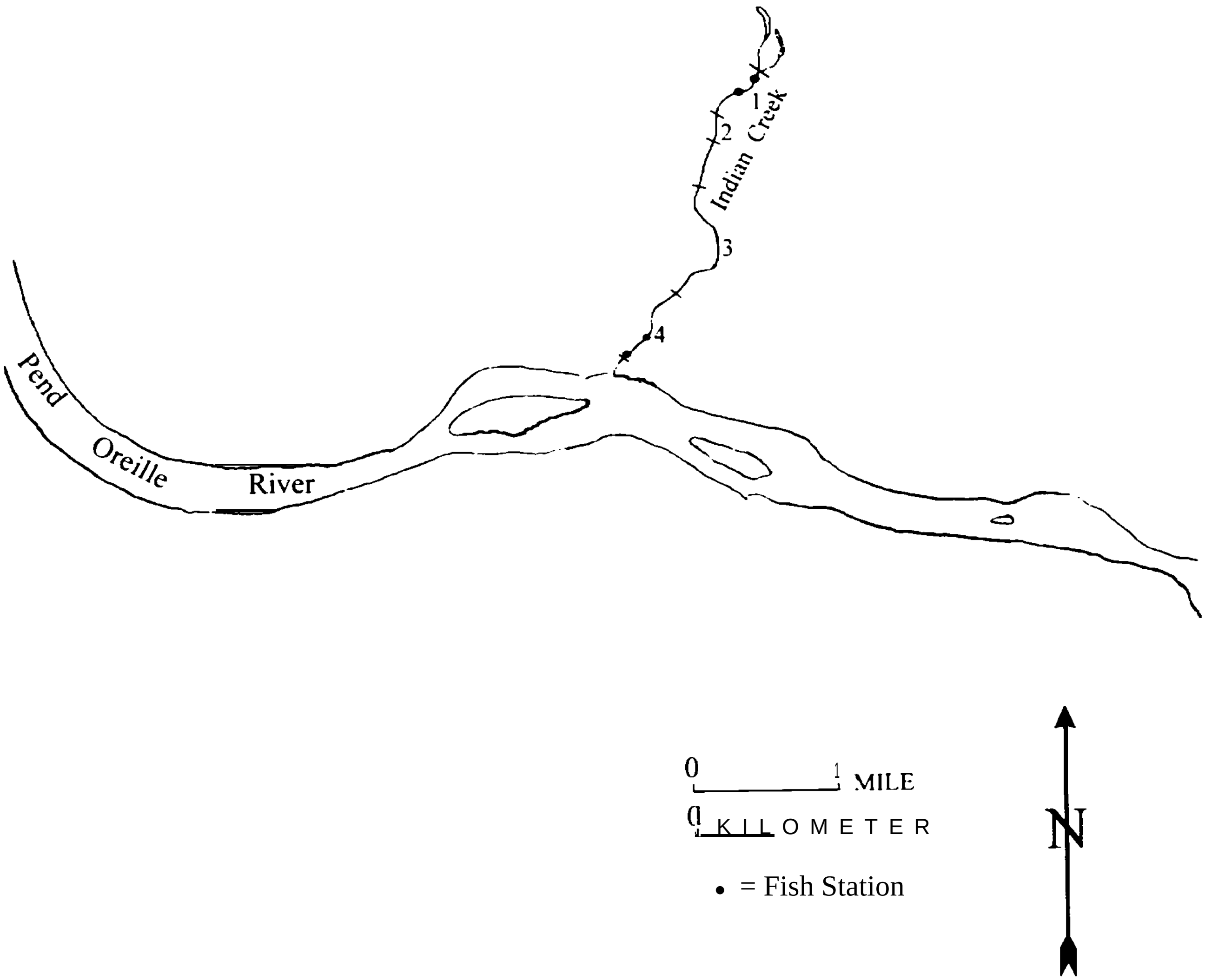


Figure 5. Indian Creek fish station and reach locations.

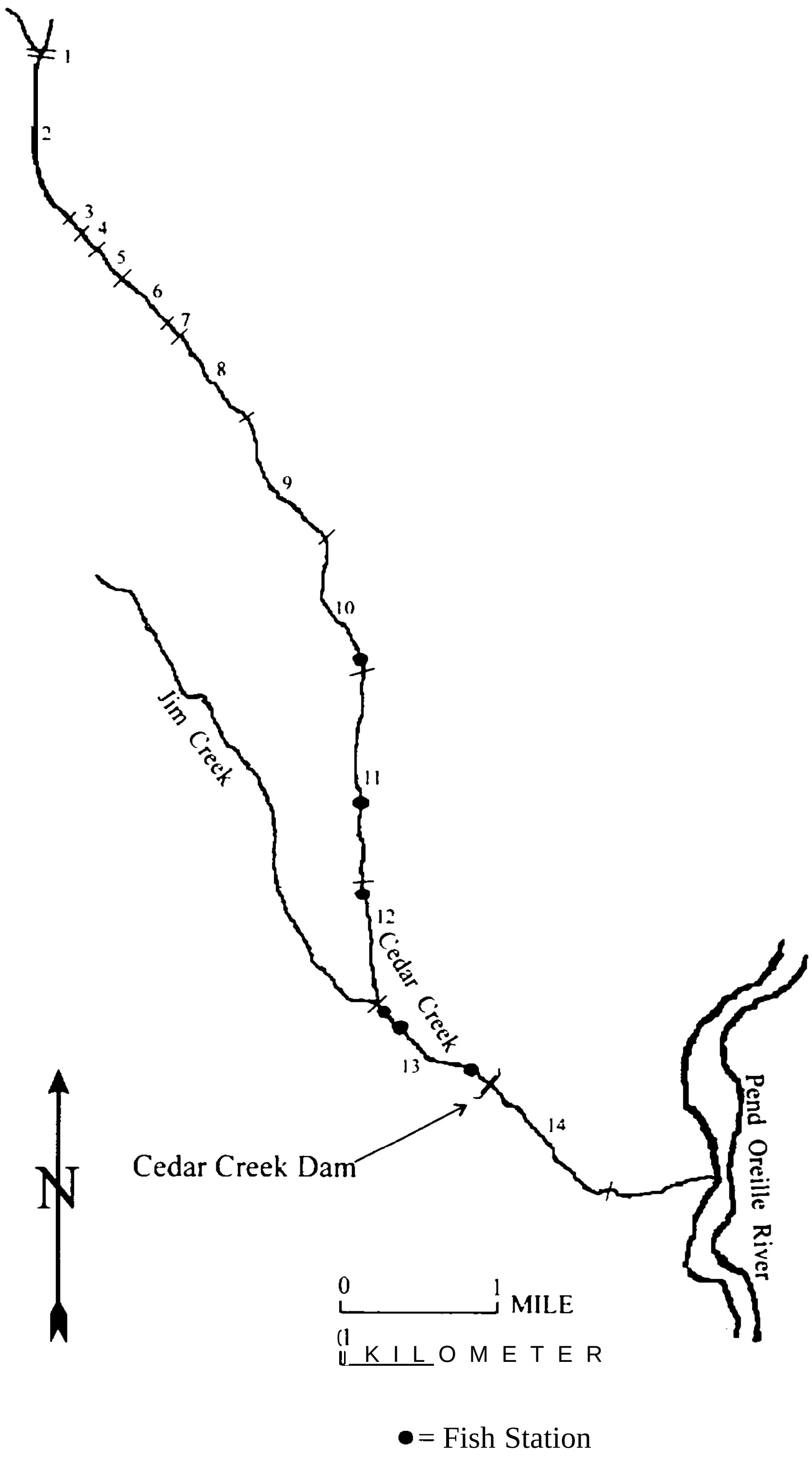


Figure 6. Cedar Creek fish station and reach locations.

Table 5. Mill Creek reach data

Habitat Variables	Reach 1 Mean	Reach 1 S D	Reach 2 Mean	Reach 2 S D	Reach 3 Mean	Reach 3 S D	Reach 4 Mean	Reach 4 S D	Reach 5 Mean	Reach 5 S D
Embeddness (%)	805	157	932	12	94 7	159	68 5	199	961	135
Bank Stability	3	0 26	29	0 35	28	0 07	3	15	20	077
Bank Cover	22	075	21	0 63	26	11	2	0 a2	27	079
Instream Cover	21	0 65	2	0 99	29	0 99	2	0 66	2	0 84
Pool-Riffle Ratio	011		031		061		0 2.1		081	
Acting Debris (#/100m)	26 3		195		36 7		25 6		24 2	
Primary Pools (#/Km)	67		138		57		44		29	
Gradient (%)	77	31	41	13	2 8	0 82	74	33	34	096
Avg Depth (cm)	139	112	106	88	17 9	24 5	14 7	72	155	149
Avg Stream Width (m)	25		23		62		27		104	

Habitat Variables	Reach 6 Mean	Reach 6 SD	Reach 7 Mean	Reach 7 SD.	Reach 6 Mean	Reach 6 SD.	Reach 9 Mean	Reach 9 S D.	Reach 10 Mean	Reach 10 SD
Embeddness (%)	07 9	126	899	12	85 2	15.9	75 8	2 5	72 5	27.5
Bank Stability	22	0 39	2	07	18	0 55	34	0 8	4	0.69
Bank Cover	29	0 76	29	1	13	0 67	22	0.9	2	081
Instream Cover	27	07	2.9	09	14	0 69	29	0 6	33	089
Pool-Riffle Ratio	051		051		0.6:1		0 5.1		041	
Acting Debris (#/100m)	36 5		31 5		25 3		33 6		27 5	
Primary Pools (#/Km)	38		79		12.6		0		27	
Gradient (%)	4	0 97	39	08	2.6	0 52	4.3	11	62	12
Avg Depth (cm)	22	108	25	11	37.3	24.7	26	12	23 1	112
Avg Stream Width (m)	37		32		45		47		49	

Spawning Gravel (sq m)	Reach 1 Spring	Reach 1 Fall	Reach 2 Spnng	Reach 2 Fall	Reach 3 Spring	Reach 3 Fall	Reach 4 Spnng	Reach 4 Fall	Reach 5 Spnng	Reach 5 Fall
Poor	155	30	34		10	14	1	1	24	31
Fair	21	21 5	40	44 5	135	11	37.5	12	20	16.5
Good			2	35 5	25	25			20	20

Spawning Gravel (sq m)	Reach 6 Spring	Reach 6 Fall	Reach 7 Spring	Reach 7 Fall	Reach 6 Spnng	Reach 6 Fall	Reach 9 Spnng	Reach 9 Fall	Reach 10 Spring	Reach 10 Fall
Poor	40 7	36.5	49.9	59	17.5	24	59	5.5	35	2.5
Fair			168	8			4	4		
Good										

Habitat Function	Reach 1 Occurance	Reach 2 Occurance	Reach 3 Occurance	Reach 4 Occurance	Reach 5 Occurance	Reach 6 Occurance	Reach 7 Occurance	Reach 6 Occurance	Reach 9 Occurance	Reach 10 Occurance
Unusable:								0 6%		
Summer:	63 7%	91 6%	46 2%	93 2%	22.7%	100%	100%	70.2%	92 0%	84.4%
Winter:	36.3%	8 4%	53.8%	68%	77 3%			21.2%	8.0%	156%
Spawning'										

Table 6. Fourth of July Creek reach data.

Habitat Variables	Reach 1 Mean	Reach 1 SD	Reach 2 Mean	Reach 2 SD	Reach 3 Mean	Reach 3 SD.	Reach 4 Mean	Reach 4 SD.	Reach 5 Mean	Reach 5 SD	Reach 6 Mean	Reach 6 SD	Reach 7 Mean	Reach 7 SD	Reach 6 Mean	Reach 6 SD.
Embeddness (%)	79.5	29 9	68 7	23 1	811	29	82 6	25.6	74 ä	25 8	72 8	25 5	76.4	24.6	70	27.1
Bank Stability	18	09	2.2	1.1	21	0 88	3 3	1 14	3 9	1 1	3 2	0.63	3 4	0 52	3	0.71
Bank Cover	31	1.12	3.4	0 89	2 9	1.28	34	1	3 4	1 3	3 7	0 95	39	11	4.4	0 55
Instream Cover	2 3	0 99	3 6	0 55	2 4	0.84	3 6	0 65	4.1	0 66	41	0 57	4	0 67	3.6	0 55
Pool-Riffle Ratio	0 4 1		1 5 1		0 6 1		1 6 1		0 4 1		0 2 1		0 1:1		0	
Acting Debris (#/100m)	13		20 7		159		31 4		40 7		23 3		20		7 3	
Primary Pools (#/Km)	5 6		0		5 6		2 4		0		3 3		0		0	
Gradient (%)	3.8	1 15	7 9	3.19	2 9	091	6 7	2 75	104	4 5	98	65	14.3	4 2	5.1	27
Avg Depth (cm)	9 6	8.59	105	3.82	108	86	91	6	112	9.3	19	92	91	5.8	5	3.1
Avg Stream Width (m)	1 5		1 3		1 8		2 2		1.6		1 5		1.9		2.7	

Spawning Gravel (sq m)	Spring	Fall	Spnng	Fall	Spring	Fall	Spnng	Fall	Spnng	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Poor	37	5	2 9		18.5	7.5	2.5	1.5	5 5	4.5	4	4	1 5		3	
Fair:	42.5	1			114 5	64.5	115	1	1	1						
Good.	1				7	7	1									

Habitat Function	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance
Unusable:	4.4%							
Summer:	75.5%	100%	68.9%	90.0%	100%	100%	100%	90.3%
Winter:	20.1%		18.9%	10.0%				
Spawning:			12.2%					9.7%

Table 7. Cee Ccc Ah Creek reach data.

	Reach 1		Reach 2		Reach 3		Reach 4		Reach 5		Reach 6		Reach 7		Reach 6		Reach 9		Reach 10	
Habitat Variables	**Mean**	**SD.**	**Mean**	**SD.**	*Mean*	**SD.**	**Mean**	**S D**	Mean	SD	*Mean*	*S.D*	**Mean**	**SD.**	**Mean**	*S.D.*	*Mean*	*SD*	*Mean*	*S.D*
Embeddness (%)	442	32 3	8 5 6	1 7 5	76.1	32 1	4 8 6	1 4 5	51.4	18.9	66 7	16.8	90.4	23 6	7 6 1	2 1 9	9 5 . 7	1 0 9	63 1	338
Bank Stability	2 4	098	19	0 47	2.3	071	3 7	0 4 8	2 7	0 9 5	2 5	0 5 7	2	0	2.3	0 45	2 4	0 64	2.9	1.1
Bank Cover	13	059	12	0 37	1 6	091	1	0	1	0	1	0 1 8	1	0.18	1 1	0.29	1	0.19	1 3	0.67
Instream Cover	14	07	1 3	0.54	1 6	1	1 1	0 36	1 1	0 37	12	0.4	1 4	068	15	0 62	1 8	0.64	2	1.2
Pool-Riffle Ratio	0 4 1		0 4 1		0 7 1		0 1 1		0 1 1		0 1 1		0 5 1		0 2 1		0 8 1		0 3 1	
Acting Debris (#/100m)	108		114		10		102		18 1		174		30 5		16 1		185		193	
Primary Pools (#/Km)	3 9		7 5		2 8		0		0		0		6 3		1		4 9		0	
Gradient (%)	3 4	099	36	055	23	1 08	5 6	0 6 3	4 6	0.38	4.4	0 72	4 9	0 34	5.7	0.67	2 7	0 67	4 7	0.95
Avg. Depth (cm)	154	114	22	157	47.5	36 1	1 8 2	1 6 7	103	34	14 8	12.8	21 a	41 7	1 6 4	9 . 4 5	26.9	11 4	21	7.5
Avg Stream Width (m)	1.7		2.2		5 7		2.5		2.2		2 2		2 6		2 7		2.8		3 3	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Poor:	6	4	8 5	4.5			1	0 5					19	6	0 5	0.5				0 5
Fair:																				
Good																				

Habitat Function	Occurance	**Occurance**	Occurance	Occurance	Occurance	Occurance	**Occurance**	Occurance	Occurance	Occurance
Unusable.										
Summer:	100%	**85.8%**	20.5%	100%	100%	100%	80.3%	100%	89.2%	100%
Winter:		14.2%	79.5%				19.7%		10.8%	
Spawning										

Table 8. Mineral Creek reach data.

	Reach 1		Reach 2		Reach 3		Reach 4	
Habitat Variables	*Mean*	*S D.*	*Mean*	*S D*	*Mean*	*S.D.*	*Mean*	*S.D.*
Embeddness (%)	57	26.1	78 7	22	81.7	20 6	61.2	29.5
Bank Stability	2.6	11	1.8	056	17	0.54	1.9	0.76
Bank Cover	3 5	1 1	3	1 3	2.8	1.21	2.9	1.1
Instream Cover	4	0 79	3 4	1.5	2 6	1 3	3 6	0.71
Pool-Riffle Ratio	0.2: 1		0 4:1		0 2.1		0.3:1	
Acting Debris (#/100m)	18.6		46.3		40		40.3	
Primary Pools (#/Km)	7.6		8.3		71		5.3	
Gradient (%)	7	1 2	a l	1 7	4 6	1 6	8.3	2.47
Avg Depth (cm)	17.2	91	198	11	20.7	10.5	20.1	20.7
Avg. Stream Width (m)	2 5		2 7		2 9		2.3	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Poor	143	6 9	27 2	104	166	9 2	9.3	3
Fair	3			3				
Good	45							

Habitat Function	Occurance	Occurance	Occurance	Occurance
Unusable.				
Summer.	97.3%	94 1%	78 8%	100.0%
Winter:	2.7%	5 9%	21.2%	
Spawning:				

Table 9. Whitcman Crcck reach data.

Habitat Variables	Reach 1 Mean	S D	Reach 2 Mean	S D	Reach 3 Mean	S D	Reach 4 Mean	SD	Reach 5 Mean	SD	Reach 6 Mean	SD	Reach 7 Mean	SD	Reach 6 Mean	SD
Embeddness (%)	31 6	40 3	31 4	27 2	96	109	82	28 5	38	32 1	53 9	31.2	46 8	31.9	28.3	37.5
Bank Stability	43	12	28	12	11	03	24	1	4 2	1	3 8	0 6 6	4.3	0.6	4 6	051
Bank Cover	26	08	27	06	23	09	1 7	1	17	08	2	0 62	1 8	0 64	1.7	08
Instream Cover	43	08	34	12	28	08	19	12	3 3	1	2 8	0 97	2 8	1	3 6	0 83
Pool-Riffle Ratio	0 2 1		0 2 1		1 5 1		0 2.1		0 2 1		0 3 1		0 4 1		0 3.1	
Acting Debris (#/100m)	30		37 3		196		30 5		29 4		24 1		18		26.9	
Primary Pools (#/Km)	4 8		3		167		9		2 6		1 5		5.7		6 7	
Gradient (%)	33	136	153	71	1 9	08	54	37	a	2 3	65	12	76	25	14.1	7 3
Avg Depth (cm)	144		17.7				10 6	114	143	51	141	46	15.6	6	15.7	4 7
Avg. Stream Width (m)	2 2		2 7		8 6		3		2 7		2 7		2.3		2	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Poor	0 4			0 5	6	20	12	9	1	0 5	3.9	3	7	4 5	1	1
Fair																
Good																

Habitat Function	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance
Unusable:	18.5%						5.1%	
Summer.	al .5%	100%	5.8%	91.4%	100%	100%	88.9%	92.5%
Winter:			94.2%	8.6%			6.1%	7.5%
Spawning:								

Table 10. Indian Creek reach data.

	Reach 1		Reach 2		Reach 3		Reach 4	
Habitat Variables	*Mean*	*SD*	**Mean**	*SD*	**Mean**	*S.D.*	**Mean**	*S.D.*
Embeddness (%)	a4	23 2	57 4	24.9	37 9	19.41	42 4	la.7
Bank Stability	2 6	0 a9	3.1	0 88	3.4	0.82	3.2	0.62
Bank Cover	2.1	1	21	0 88	2 4	0 a5	2.4	0.77
Instream Cover	2 3	1 3	2 9	0 99	3	0 71	2.7	0.59
Pool-Riffle Ratio	1.2 : 1		02 1		0.1 1		0.1 1	
Acting Debris (#/100m)	20 a		22 3		16		5.7	
Primary Pools (#/Km)	117		0		1.8		1.9	
Gradient (%)	1 5	1 7	1 4	0 97	6 5	3 23	3.8	0 a3
Avg Depth (cm)	30 3	134	168	4 5	14.8	7 9	12.4	5.3
Avg Stream Width (m)	7.7		5 4		3 6		2.6	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spnng	Fall	Spring	Fall
Poor-	23.3	13 1	6.8	6 8	6	15	115	5.5
Fair:					1795	131 5	20	10
Good-					20 5	16 5		

Habitat Function	Occurance	Occurance	Occurance	Occurance
Unusable:			04%	
Summer-	a6 4%	100%	98.1%	100%
Winter	13 6%			
Spawning:			1 5%	

Table 1 1. Cedar Creek reach data.

Habitat Variables	Reach 1 Mean	Reach 1 SD.	Reach 2 Mean	Reach 2 SD	Reach 3 Mean	Reach 3 S.D	Reach 4 Mean	Reach 4 SD	Reach 5 Mean	Reach 5 SD.	Reach 6 Mean	Reach 6 SD	Reach 7 Mean	Reach 7 S.D	Reach 6 Mean	Reach 6 S.D
Embeddness (%)	57.1	30 3	37 6	16 1	42 7	126	26.1	133	38 3	119	27.1	14.9	*29.9*	14.4	36.5	17.4
Bank Stability	36	0.55	37	0.67	4	0 5	4 9	0.29	4	0 38	4	0.62	4 6	0.52	4.3	0 45
Bank Cover	4	1.22	31	1 06	3 2	0 67	4 2	0 67	37	0 62	33	0.77	2 8	0.63	3.3	0.75
Instream Cover	36	1 14	36	1 04	31	1.05	3 6	1 36	3 9	0 a3	3.8	1 05	3 9	0 88	3.8	0.94
Pool-Riffle Ratio	0 8:1		041		0 5:1		0 7.1		0 7:1		1 2.1		1 1		06.1	
Acting Debris (#/100m)	173		114		7.4		16 1		11 1		5.4		2		6	
Primary Pools (#/Km)	133		a 5		14 a		61		2 2		a 3		3.3		2 6	
Gradient (%)	7	0 35	7 8	1 69	7 4	1 75	1 5 9	3 9 9	10 7	2 02	127	3	153	41	10 7	2 24
Avg Depth (cm)	174		20 a		22 2		20.2		24 3		28 2		26.6		30 6	
Avg Stream Width (m)	33		3.8		4 2		51		4 5		41		3.2		4 3	

Spawning Gravel (sq m)	Spnng	Fall	Spnng	Fall	Spnng	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spnng	Fall	Spring	Fall
Poor	4 2	4 1	11.7	7 2	1 3	1.3	3	0.8	1.5	0 5	7	3	0.5		1	1.5
Fair	l a	5	31 a	l o	5 5	3.5			3.5	1.5	10	4			7	2
Good			20	115	0 8	0 4					3.5	3.5				

Habitat Function	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance
Unusable:							7.2%	1.6%
Summer,	100%	83.3%	70.3%	84.3%	92.0%	81.1%	83.2%	87.5%
Winter:		16.7%	19.3%	11.3%	8.0%	18.9%	9.7%	10.9%
Spawning:			10.4%	45%				

Table 11 . Cedar Creek reach data.

Habitat Variables	Reach 9 Mean	Reach 9 SD	Reach 10 Mean	Reach 10 SD	Reach 11 Mean	Reach 11 SD	Reach 12 Mean	Reach 12 S.D	Reach 13 Mean	Reach 13 SD	Reach 14 Mean	Reach 14 SD
Embeddness (%)	33 7	125	36.1	l a 4	40 2	20.7	49 5	24.2	6 3 7	2 9 3	68 1	21 4
Bank Stability	4	1.25	3 6	0 64	31	0 94	3 2	0 88	3	1.07	3 3	0.71
Bank Cover	3 2	0.81	3 4	0 77	3	0 9	3 3	0 95	2 7	1 18	2 7	0 93
Instream Cover	3.8	0 74	3 4	1 27	2 9	1 28	3 3	1 26	3	1 44	2.8	1 05
Pool-Riffle Ratio	0 4 1		0 1 1		0 2 1		0 1 1		0 4 1		0 2 1	
Acting Debris (#/100m)	1 3		4 7		9 4		157		193		9 7	
Primary Pools (#/Km)	5 6		7 2		5 6		a 3		17 1		9 3	
Gradient (%)	a 7	2 26	6	1 55	3 9	0 98	3 8	1 01	2 2	0 91	2 7	0 94
Avg Depth (cm)	27 3		18		179		16 a		24 7		22 1	
Avg Stream Width (m)	4 3		4 2		3 9		4 1		5		4.8	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Poor	1 6	0 3	2	0 5	7	7	3	3	27	27	13	13
Fair	135	6	9 5	10.5	5	16	31	32 5	1675	1475	175	14
Good	5	5	14	14	20	10	9	a	42 5	38 5		

Habitat Function	Occurance	Occurance	Occurance	Occurance	Occurance	Occurance
Unusable:						
Summer:	90 5%	98.1%	94 2%	96.1%	67.5%	85.7%
Winter:	9.5%	1.9%	58%	3.9%	28.1%	14.3%
Spawning:					4.4%	

Population Density

Mill Creek (Figure 7 & 8). Cee Cee Ah Creek (Figure 9 & IO), Whiteman Creek (Figure 11 & 12). Indian Creek (Figure 13 & 14) and Cedar Creek (Figure 15 & 16) exhibited non-native salmonid populations that heavily outnumbered the native salmonid populations (98.3 non-native salmonids/100m^2 - 10.5 native salmonids/100m^2).

Brook trout were the most abundant species found in these streams and throughout the study area (115.9/100m^2). These streams were also similar, in that, the brook trout populations contained representatives for nearly all age classes.

Cutthroat were generally obsened in isolated areas of higher quality habitat. Fourth of July Creek (Figure 17 & 18) was the only stream that had a higher density of native salmonids (40.1 cutthroat/100m^2 - 1.1 brook trout/100m^2). Three fourths of the cutthroat population in Fourth of July were juvenile fish and brook trout were only recorded immediately above the confluence with East Branch LeClerc Creek. Mineral Creek (Figure 19 & 20) was the only stream that had relatively similar densities of native and non-native species (16.5 brook trout/100m2 - 13.2 cutthroat/100m2). Cee Cee Ah Creek and Indian Creek data indicate multiple non-native species. Brown trout (*Salmo trutta*) were recorded in both streams and rainbow trout (*Oncorhynchus mykiss*) were recorded in Indian Creek as well. Cedar Creek was the only stream surveyed where a bull trout was found in an official snorkel station. Brook trout were more abundant (30.6/100m^2) than either cutthroat (5.9/100m^2) or bull trout (0.1/100m^2) for this stream. Although brook trout were more abundant in the stream as a whole, they were associated with the lower portion of the stream and especially in close proximity with the dam. Cutthroat were mostly associated with the higher quality habitat of the upper reaches (1-9). Cutthroat were found in every snorkel station above the dam and contained representatives for each age class (Figure 16). Three bull trout were identified during snorkel training sessions. one in Mill Creek. one in East Branch LeClerc and an additional one in Cedar Creek.

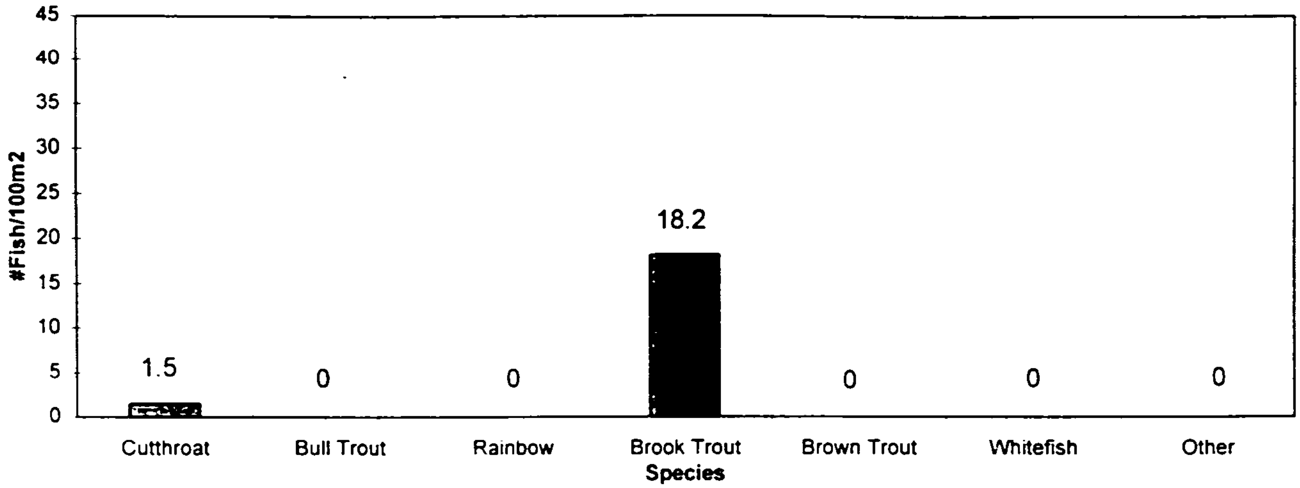
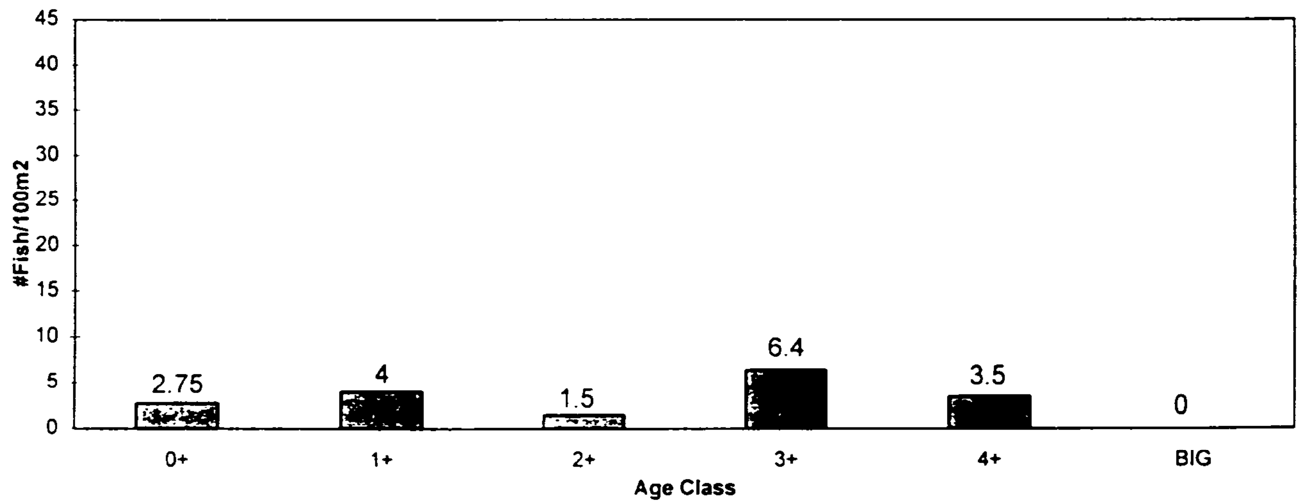


Figure 7. Species density for two fish stations on Mill Creek.



(A)

(B)

Figure 8. Density of brook (A) and cutthroat trout (B) stratified by length frequency for two fish stations on Mill Creek.

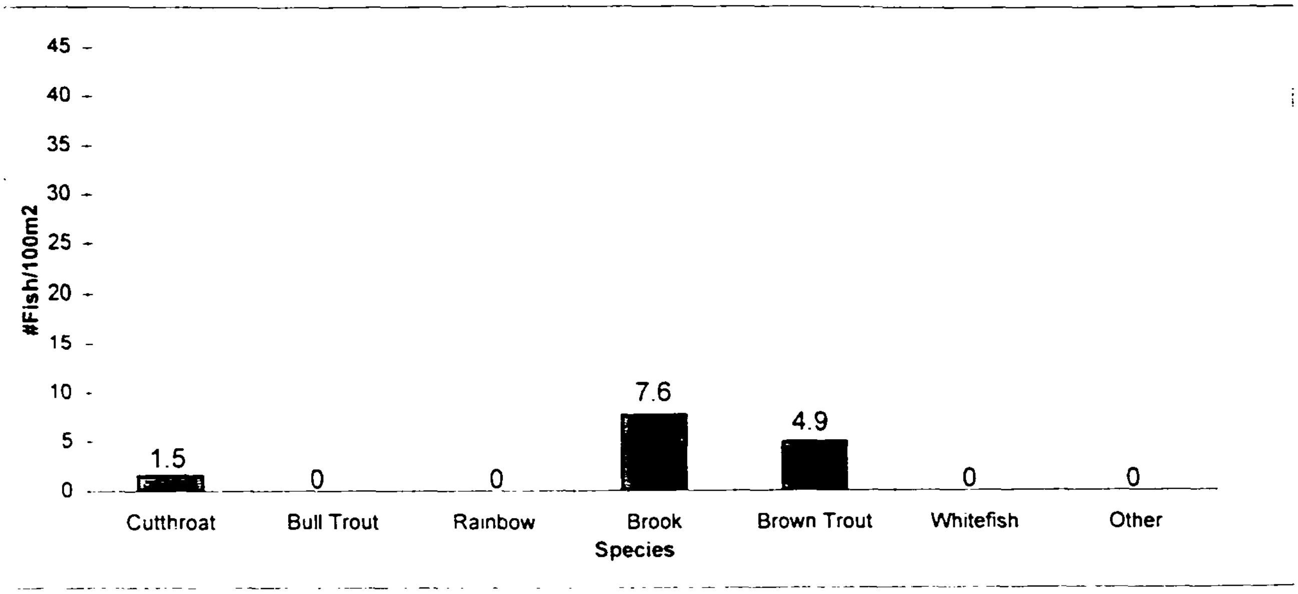


Figure 9. Species density for four fish stations on Cee Cee Ah Creek.

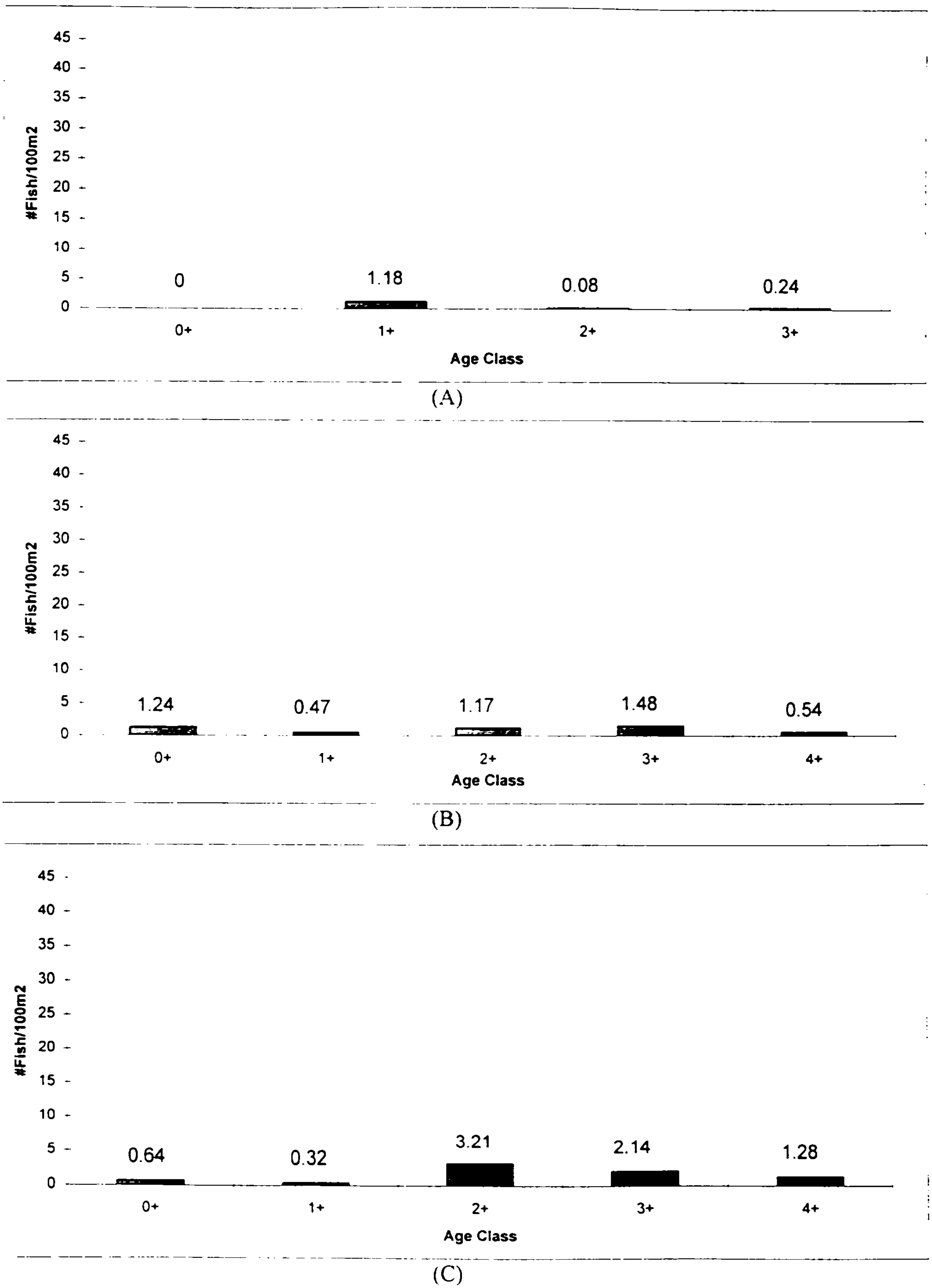


Figure 10. Density of cutthroat (A), brown (B) and brook trout (C) stratified by length frequency for four fish stations on Cee Cee Ah Creek.

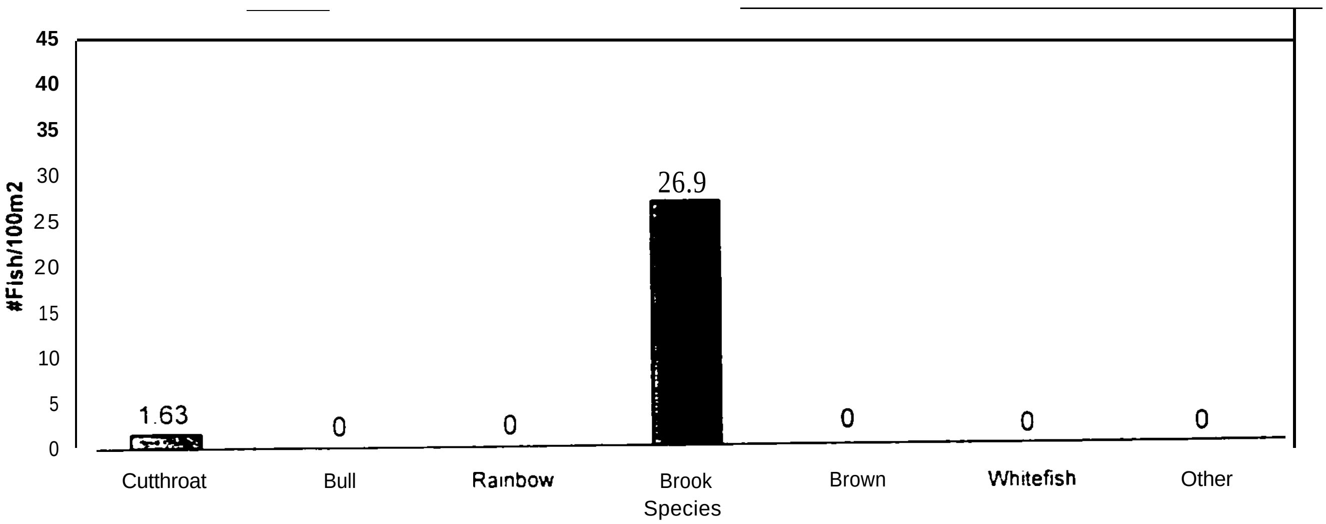
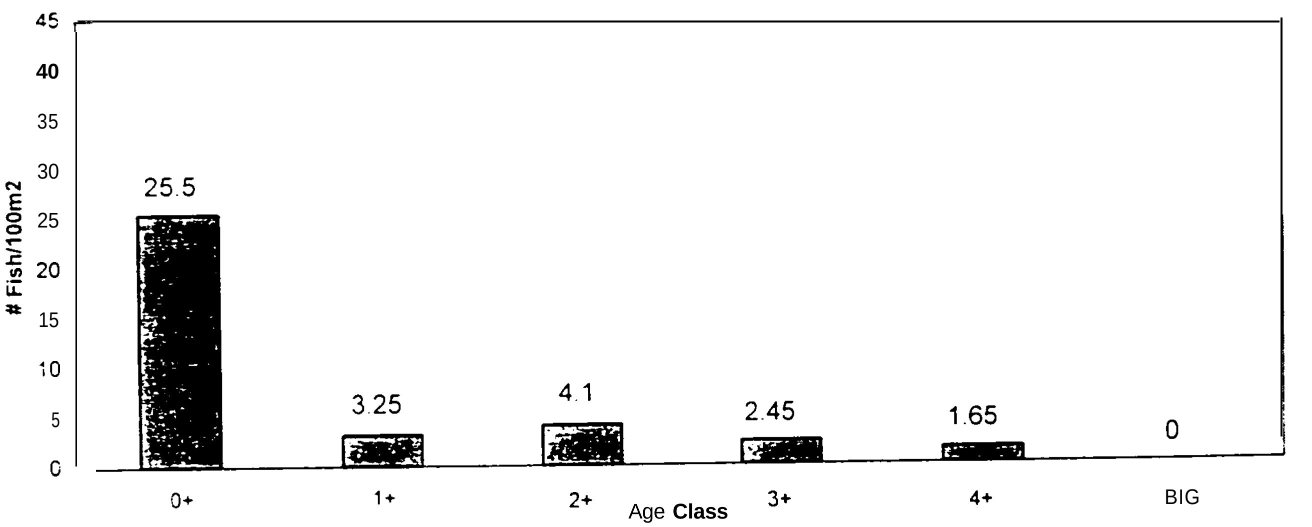
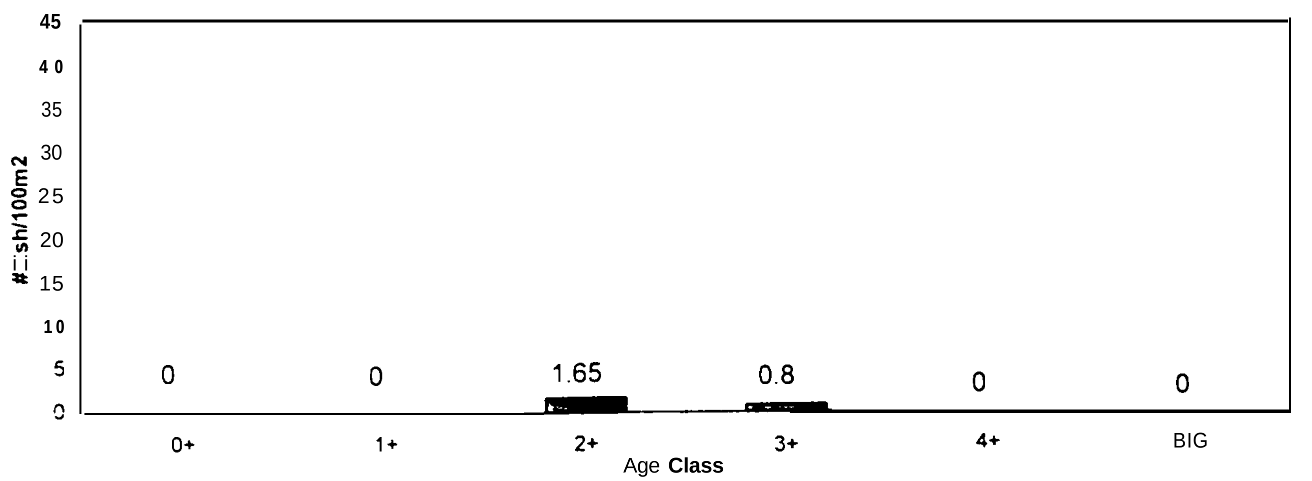


Figure 11. Species density for three fish stations on Whiteman Creek.



(A)



(B)

Figure 12. Density of brook (A) and cutthroat trout (B) stratified by length frequency for three fish stations on Whiteman Creek.

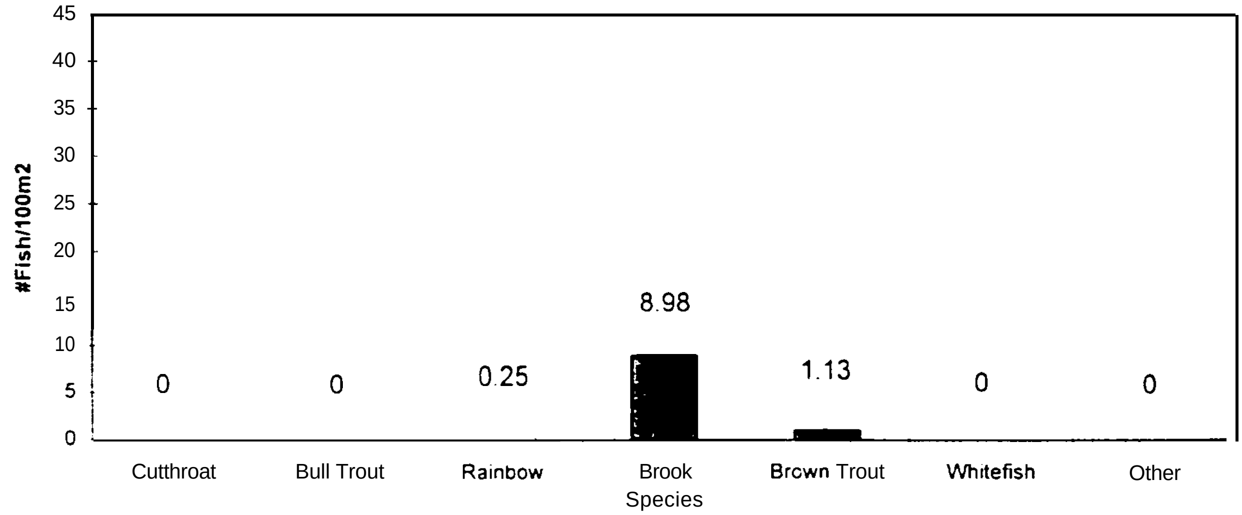
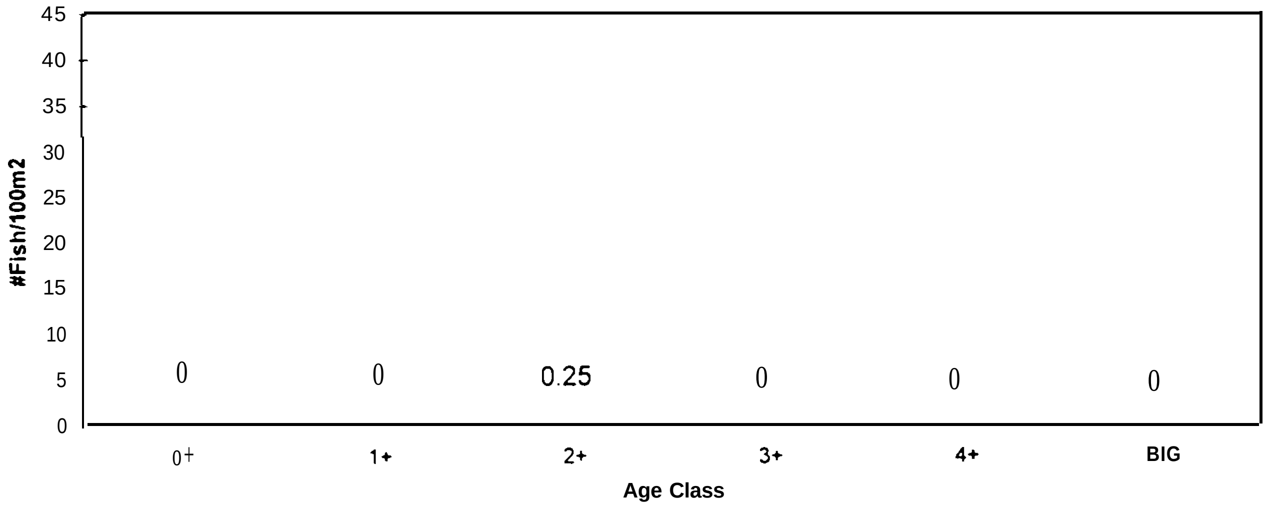
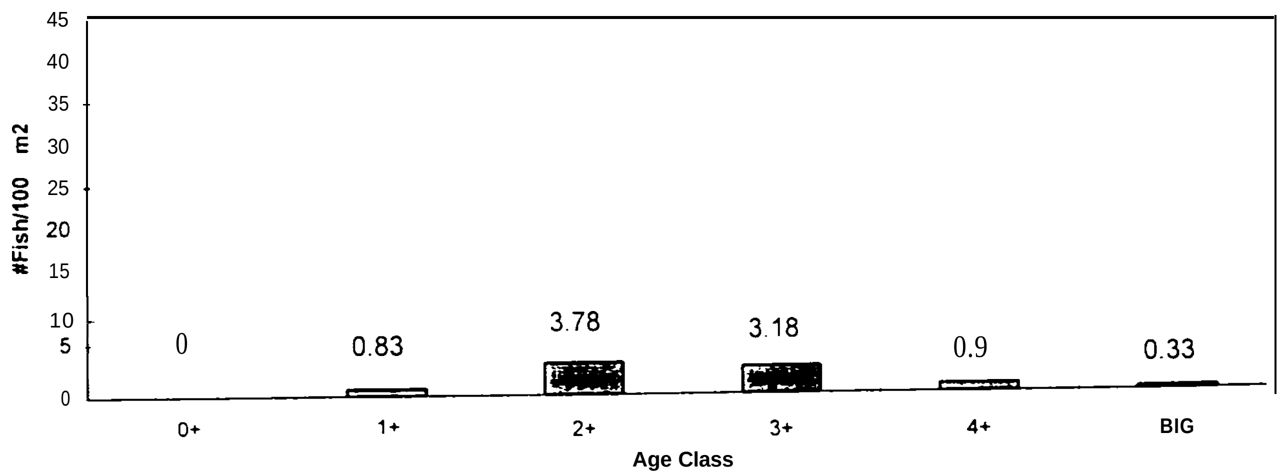


Figure 13. Species density for four fish stations on Indian Creek.



(A)



(B)

(C)

Figure 14. Density of rainbow (A), brook (B) and brown trout (C) stratified by length frequency for four fish stations on Indian Creek.

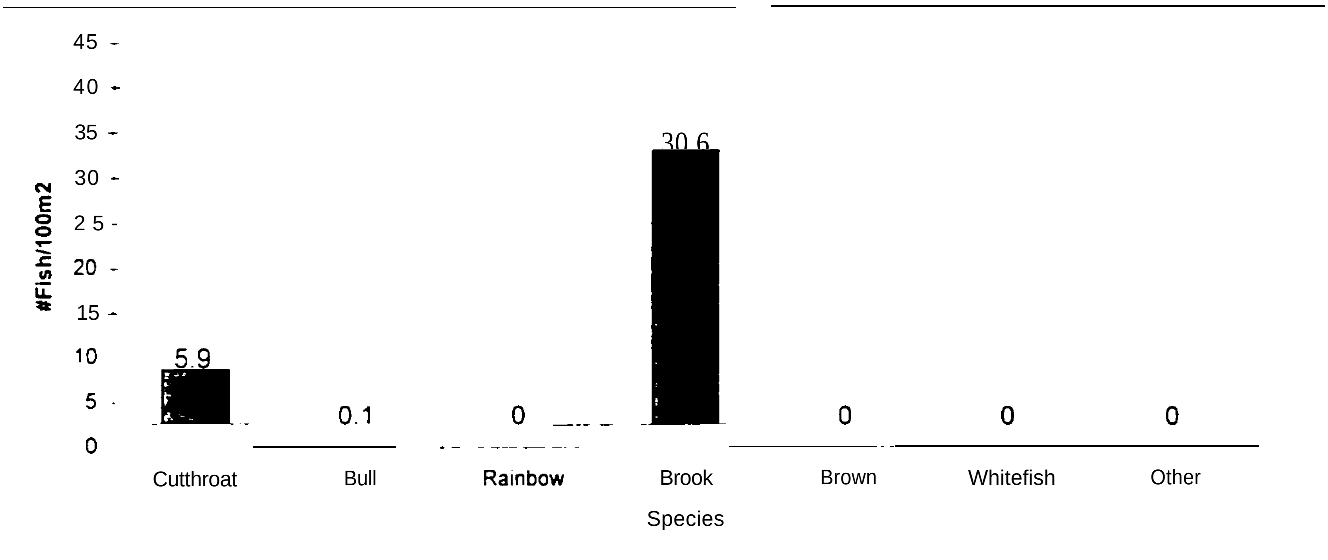


Figure 15. Species density for six fish stations on Cedar Creek.

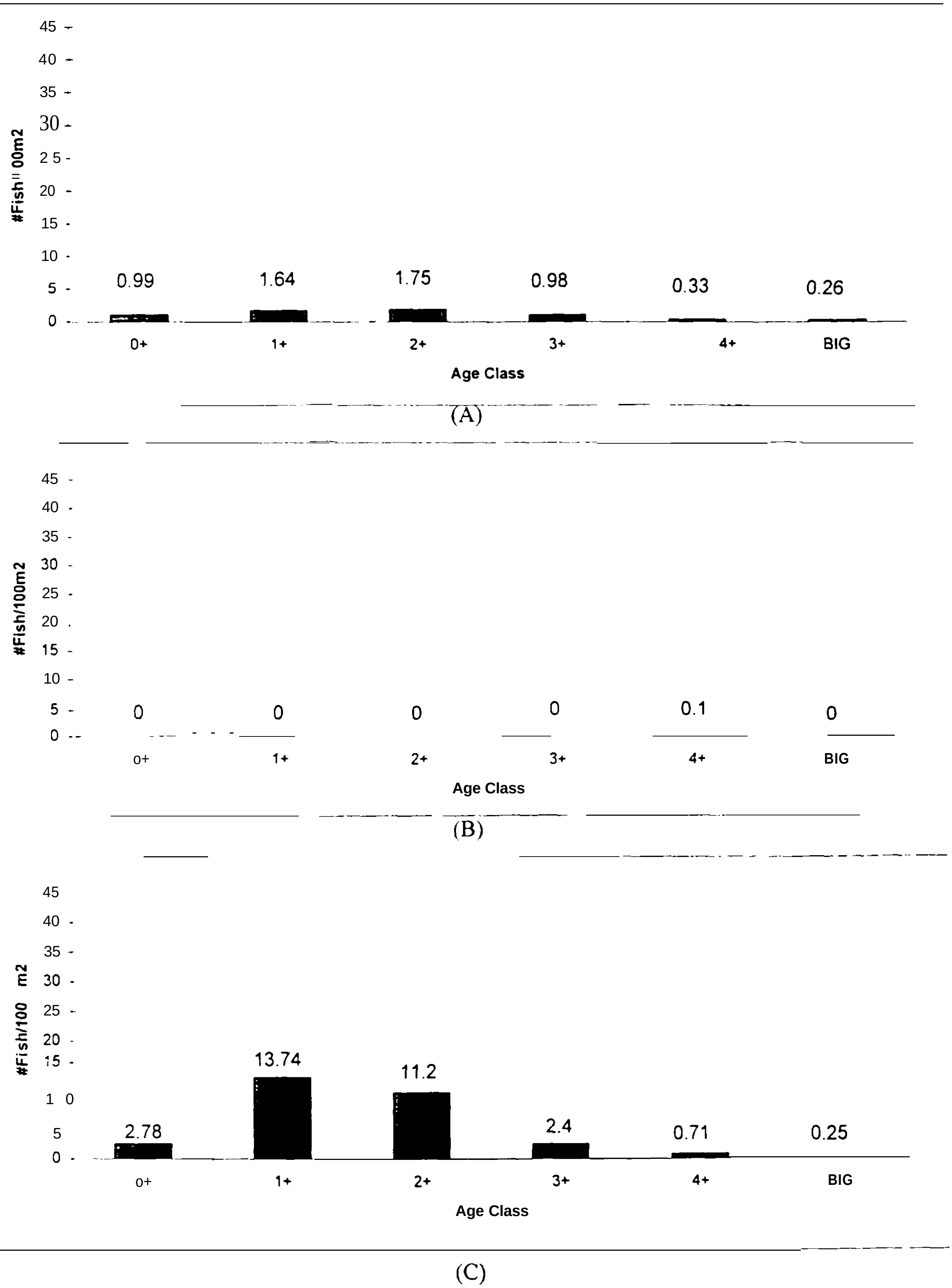


Figure 16. Density of cutthroat (A). bull trout (B) and brook trout (C) stratified by length frequency for six fish stations on Cedar Creek.

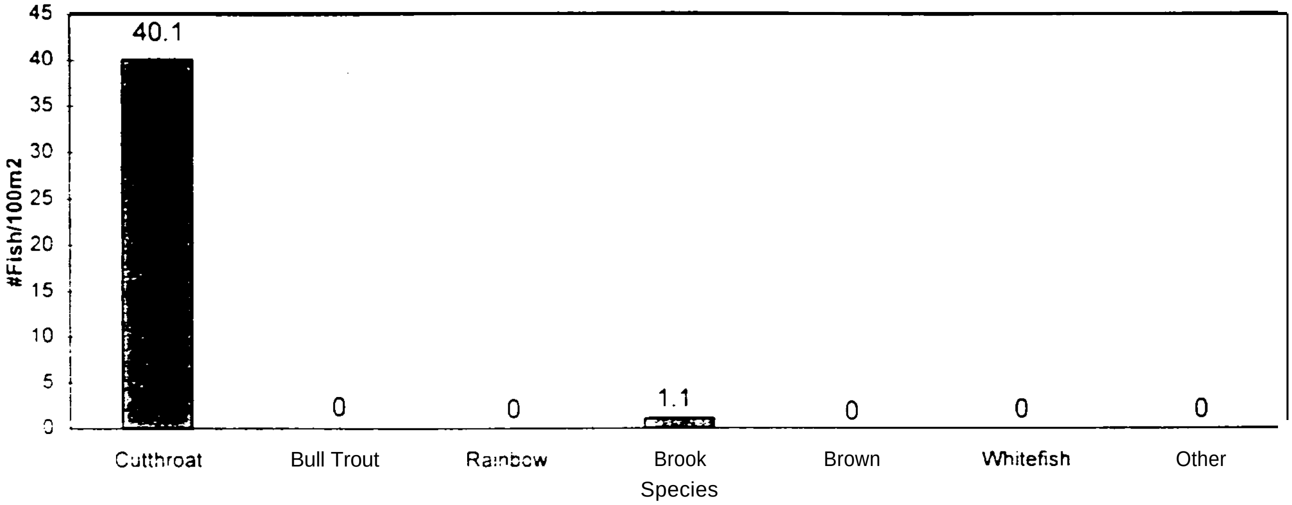
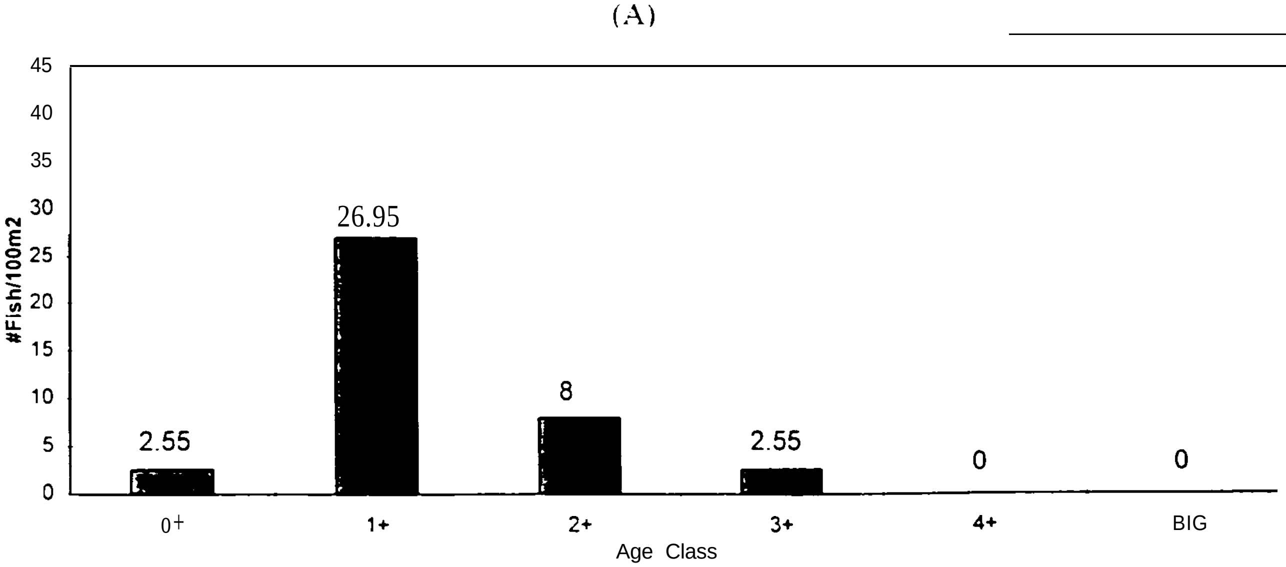


Figure 17. Species density for two fish stations on Fourth of July Creek.

(A)



(B)

Figure 18. Density of brook (A) and cutthroat trout (B) stratified by length frequency for two fish stations on Fourth of July Creek.

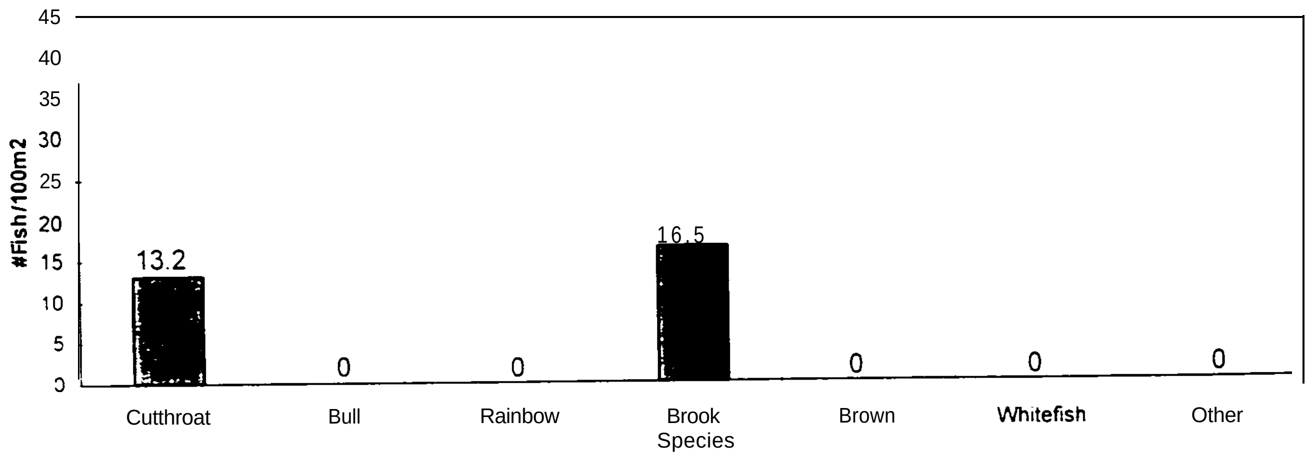
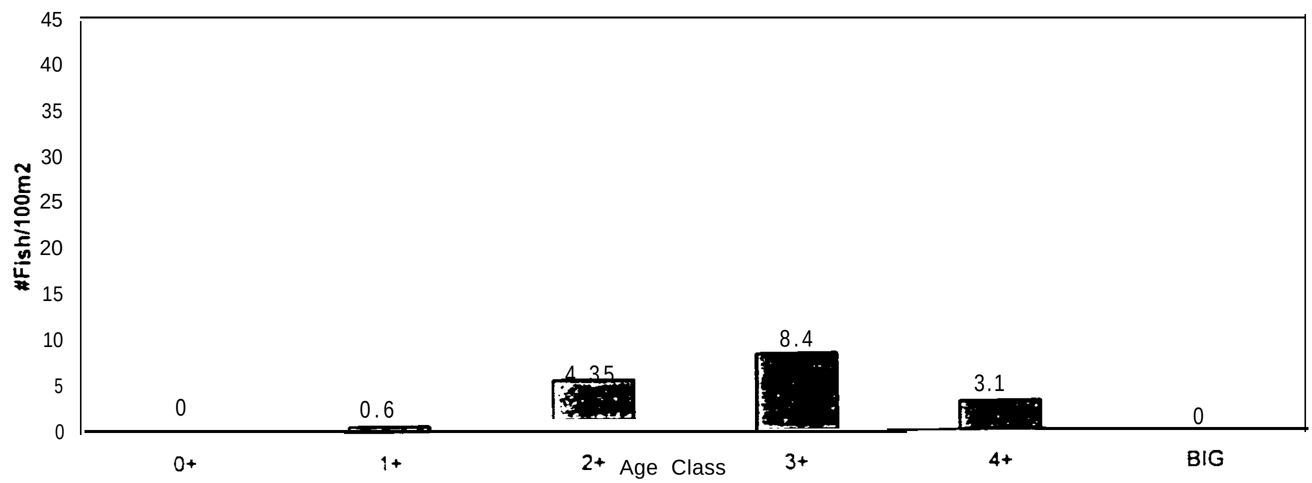
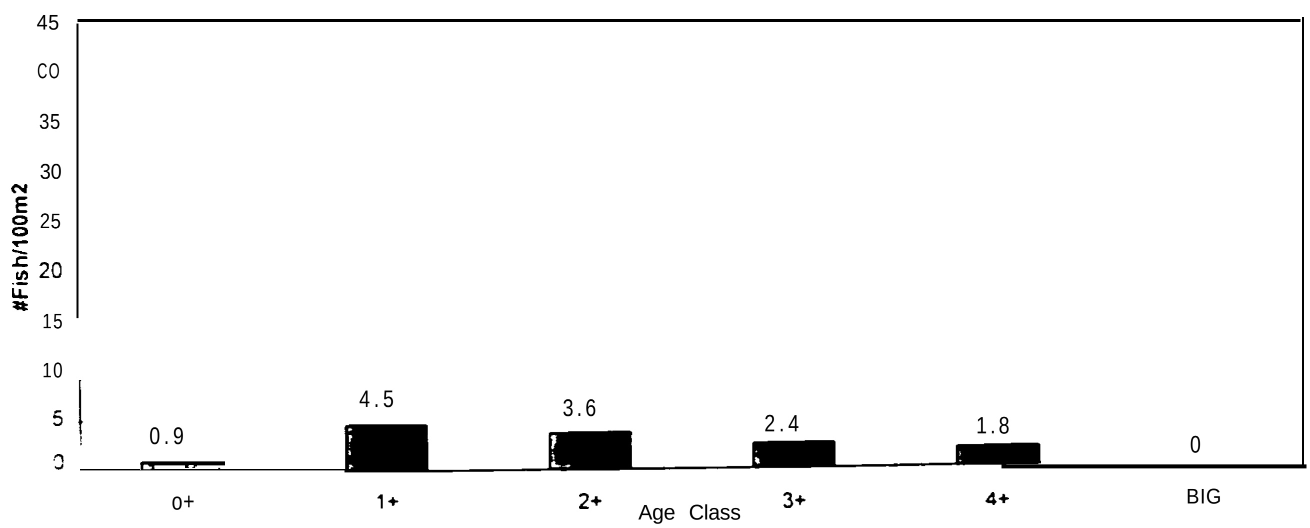


Figure 19. Species density for two fish stations on Mineral Creek.



(A)



(B)

Figure 20. Density of brook (A) and cutthroat trout (B) stratified by length frequency for two fish stations on Mineral Creek.

Hybridization assessment of brook trout and bull trout

There was no indication of bull trout or hybrids among the 300 samples collected. In order to determine DNA markers or a bull trout. a specimen from Lake Pend Oreille was used. The sperm from this bull trout was crossed with eggs from a female brook trout to establish a hybrid and determine the DNA markers for the hybrid. Some banding patterns were consistent within the brook trout. however some samples contained extra bands that weren't present in any of the known samples. This can be attributed to differences within species. The varied size of some amplified product can also be attributed to genetic variation among the species. i.e. the size range between 230bp and 240bp seen in the brook trout when using microsatellite EP 5-6 (see Table 12).

In some instances there were bands present in the hybrid that weren't present in either of' the parent bull or brook trout. Banding patterns present for brook trout. bull trout and hybrids art' listed in Table 12.

Table 12. Three random amplified polymorphic DNA markers (RAPDs) and two microsatellite primers used for identifying all brook trout. bull trout and hybrid samples.

RAPD CS 31:
Brook trout - 20 1 bp. 344bp. 415bp. 580bp. 600bp. and 800bp.
Hybrid trout - 201 bp. 350bp. 410bp. 585bp. 630bp. 800bp. and 1018bp.
Bull trout - 201 hp. 360bp. 4 1 Obp. 590bp. 650bp. 800bp. 900bp. and 1018bp.

RAPD CS32:
Brook trout - 195bp. 380bp. 506bp. 530bp. 600bp. 640bp. 850bp, 900bp. and 1200bp.
Hybrid trout - 195bp. 380bp. 506bp. 530bp. 640bp. 850bp. 900bp, and 1150bp.
Bull trout - 195bp. 506bp. 530bp. 640bp. 750bp. 850bp. and 1300bp.

RAPD UBC 502:
Brook trout - 370bp. 850bp. 980bp. 1018bp. and 1300bp.
Hybrid trout - 370bp. 450bp. 600bp. 850bp. 1 1 00bp. and 1300bp.
Bull trout - 370bp. 450bp. 600bp. 650bp. 1200bp. and 1300bp.

Microsatellite EP 1-2:
Brook trout - 100bp. and 330bp.
Hybrid trout - 1 00bp. and 300bp.
Bull trout - 1 00bp. and 270bp.

Microsatellite EP 5-6:
Brook trout - 1 00bp and between the regions of 230-240bp.
Hybrid trout - 1 00bp. and 220bp.
Bull trout - 1 00bp. and 201 bp.

Discussion

Bull trout and cutthroat trout habitat assessment

The highest rates of embeddedness within Mill Creek generally occurred with the lowest gradient areas. A general characteristic of Mill Creek is a poor width-depth ratio. this could be due to removal of riparian vegetation. Furthermore. the potential for woody debris recruitment has been removed. The amount of large and small woody debris currently in portions of the stream is greater than what would have been deposited naturally. This is a function of large woody debris deposition from land use activities around the stream. The overabundance of woody debris encourages increased sediment deposition in areas where pools and spawning gravel are present.

The low pool-riffle ratio indicates riffle habitat is dominant in all reaches of CCA Creek but two reaches. Primary pools were limited in numbers throughout the entire stream surveyed. Reaches 4. 5. and 6 were identical in the respect that they all contained the lowest instream cover. primary pool counts. and pool-riffle ratios. The low width to depth ratio of these reaches highlight this area as predominately riffle habitat with a lack of' holding water.

Fourth of July Creek is highly embedded while having a generally high gradient. The presence of cattle leads to poor bank stability and sediment deposition in reach 3. Reduced riparian vegetation has increased lateral channel incision further adding to bank instability and sediment problems. The adverse impacts of land-use practices have contributed to sufficient amounts of sediment to alter the morphology of this reach. The upper reaches are noteworthy in other respects. in that. they have large amounts of spawning gravels. winter habitat and fair pool-riffle ratios. The lower reaches of Fourth of July Creek. specifically reach 8. have uniformly poor pool-riffle ratios and display a lack of pool habitat which could potentially limit the holding water for migration of adult spawning fish. In addition there is a lack of wintering habitat for juvenile and adult fish residing in the lower reaches.

Cattle are present along most of Whiteman Creek which contributes to poor bank stability and sediment deposition. primarily in reach 4. This reach contains a large beaver pond which acts as a sediment trap for the upper reaches possibly eliminating large amounts of sediment deposition in lower reaches. All reaches had poor pool-riffle ratios and a lack of winter habitat. Reaches 5 and 6 have low bank and instream cover. The close proximity of these reaches to the confluence of West Branch LeClerc Creek make them good staging and spawning grounds to fluvial populations. However. the lack of pool habitat inhibits both adult holding and juvenile rearing.

Mineral Creek exhibited high embeddedness rates. poor bank stability. and poor pool-riffle ratios. The presence of cattle and reduced riparian vegetation has increased lateral channel incision further adding to bank instability and sediment problems. The adverse impacts of land-use practices have contributed to sufficient amounts of sediment to alter the morphology of this stream. Riffle habitat is dominant throughout the stream. indicating a lack of winter habitat and primary pools.

The main limitation in habitat for Indian Creek is the lack of pools. Reaches 2. 3 and 4 art' composed of essentially all riffle habitat providing virtually no wintering or holding waters. These reaches are also similar in that they exhibit low bank cover.

Cedar Creek has the least degraded habitat of all the tributaries assessed. All facets of the habitat arc' relatively intact. Embeddedness is the best indicator of habitat quality for Cedar Creek. Ten of the fourteen reaches fall below 45 percent embeddedness. Those reaches that exceed this amount arc related to old clearcut areas or arc associated with a dam that has backed the sediment up into reach 13 and aided in deposition of sediment below the dam. Bank stability. bank cover and instream cover are excellent for the entire creek. This stream certainly exhibits the least degraded habitat of the streams assessed. especially in the upper reaches.

Population Density

Within two snorkeling stations in Mill Creek. isolated areas of higher quality habitat had a higher density of cutthroat. however the abundance of brook trout heavily outnumbers cutthroat trout. Throughout most of the stream. habitat assessment results indicated high embeddedness. low number of spawning gravels and poor bank stability.

Cee Cee Ah Creek differs from most of the other streams assessed. in that two species of non-native salmonids were recorded. Brown trout and brook trout were not only more abundant than the native cutthroat but also contained representatives of all age classes. unlike cutthroat. The combination of degraded habitat and the addition of another non-native species appears to further the decline for cutthroat populations.

Fourth of July held the largest density of cutthroat trout and the lowest density of brook trout for all streams surveyed. The majority of cutthroat found in this stream were juvenile fish. Brook trout were only recorded immediately above the confluence with East Branch of LeClerc Creek. High gradient. beginning directly above the confluence. may limit upward movement of brook trout. This may explain the increase density of cutthroat trout by decreased interspccitic competition. The abundance of young cutthroat may indicate the value of this tributary as a natal stream for fluvial and/or adfluvial cutthroat trout.

Whiteman Creek had one of the greatest densities of brook trout for all streams surveyed. The number of juvenile brook trout compared to adults details a more stable population of brook trout. Cutthroat age distributions detail a less stable population. This stream has a similar steep gradient just above the confluence as fourth of July Creek: however. there are considerably less spawning gravels in upper Whiteman. This may suggest that the quality and quantity of spawning habitat have greater impact on the numbers of juvenile cutthroat than accessibility or that brook trout had not been introduced to the upper reaches of Fourth of July Creek.

Mineral Creek fish stations indicated that densities of cutthroat trout and brook trout are similar. Age distributions for both species include all age classes except “BIG”. indicating relatively stable populations.

Indian Creek fish stations differed from all streams surveyed in that three non-native species were recorded and no native fish were recorded. This data would seem to suggest this stream has little value in terms of enhancing for native salmonids: however.

bull trout have reportedly been caught in the Pend Oreille at the mouth of Indian Creek and cutthroat were observed during electroshocking for genetic sampling.

Cedar Creek is the only stream surveyed where a bull trout was found in an official snorkel station. Although brook trout were more abundant in the stream as a whole, they were more closely associated with the lower portion of the stream and especially in close proximity with the Cedar Creek dam. Cutthroat were mostly associated with the higher quality habitat of the upper reaches (reaches l-9). Cutthroat were found in every snorkel station above the dam and contained representatives for each age class.

Brook trout were the principle species in all but one snorkel station during the field season 1995. Behnke (1979) described how clearcutting along two streams in the Smith River drainage of Montana increased erosion, sediment loads, and water temperatures; the westslope cutthroat trout population was eliminated in the disturbed area, and brook trout was the principle species. The habitat assessments during field season 1995 would solidify that the habitat is disturbed, primarily due to land use practices.

Hybridization assessment of brook trout and bull trout

Bull trout and brook trout have been shown to hybridize in streams where interaction is not precluded (Leary *et al.* 1993) The lack of hybrids found in this sample is probably due to the limited number of bull trout in the streams sampled and in the Box Canyon reach as a whole.

In some instances there were bands present in the hybrid that weren't present in either of the parent bull or brook trout. The most likely explanation is the competition between sites for amplification. The band that is present in the hybrid might actually be present in one or both of the parents but because of stronger amplification sites near this weak region it doesn't get amplified. These more strongly amplified regions might not be present in the hybrid allowing amplification of the waker region.

Also, in some instances the presence of a strongly amplified region close to that of a weaker region can create a drag effect in the weaker region. This effect interferes with the true mobility of the weaker region.

General discussion

Mill Creek, Cee Cee Ah Creek, Indian Creek and the LeClerc Creek tributaries all exhibit reaches with highly degraded stream conditions. These degraded conditions include limited winter habitat, limited spawning habitat and high embeddedness, with sediment as the most prevalent problem. Sediment, in the amounts found in the priority tributaries, has adverse impacts on salmonid reproduction, salmonid rearing, invertebrate production, species diversity, bedload transport, water quality, and stream depth (MacDonald *et al.* 1991, Beschta and Platts 1986, Hynes 1970). Embeddedness rates for all of the surveyed stream reaches were greater than 25 percent. The lowest embeddedness rate for a reach surveyed was 26.1 percent; however, the lowest mean embed rate for an entire stream was 41.8 percent and was as high as 86.2 percent.

Stream degradation, in terms of increased sediment, has direct impact on salmonid populations. It has been recorded that embeddedness of greater than 20 percent limits salmonid alevin emergence from interstitial spaces by 30 to 40 percent (Hynes 1970). Studies have described bull trout survival rates to emergence at nearly 50 percent in substrates containing 10 percent or less fine materials and zero percent survival in substrates containing 50 percent or greater fine materials (Weaver et *al.* 1985). Bull trout's long overwinter incubation and development make them particularly vulnerable to increases in fine sediments and degradation of water quality (Fraley and Shepard 1989).

Although stream degradation is detrimental to native salmonids, it generally favors introduced salmonid species. Behnke (1979) described how clearcutting along two streams in the Smith River drainage of Montana increased erosion, sediment loads and water temperatures. The westslope cutthroat population was eliminated in the disturbed area and brook trout became the principle species. However, a small area in the headwaters of one stream was not logged and an indigenous cutthroat population still dominated in that reach. Platts (1974) also reported that cutthroat were common only in undisturbed reaches of streams in the Salmo River drainage of Idaho. This supports the argument that protection of high quality habitat is essential for the continued existence of westslope cutthroat populations (Liknes and Graham 1988).

The overall reduction of the median bed material particle size is one of the most common and probably the most damaging effects of land-use practices in forested streams. Reduction in particle size in bed material directly affects the flow resistance in the channel, and the stability of the bed (Beschta and Platts 1986). If the bed is composed solely of fine materials, the spaces between particles are too small for many organisms. Coarser materials provide a variety of small niches important for all small fish (e.g. juvenile salmonids) and benthic invertebrates (MacDonald et *al.* 1991).

There is some evidence that increased deposition of fine materials may be partially self perpetuating. In some cases the occurrence of bedload transport is delayed when interstitial spaces are filled with sediment, resulting in a decreased frequency of bedload transport (MacDonald *et al.* 1991). This would provide more opportunity for sediment deposition, and limit the frequency at which sediment is washed out during high flow events. This can explain the lack of pools and the poor pool-riffle ratios throughout the streams surveyed. The threshold of sediment which can be transported may have been exceeded, and therefore, sediment is not being transported through the system.

The removal of riparian vegetation alters bull trout and cutthroat trout habitat by reducing recruitment of woody debris and opening the canopy (Oliver 1979, Shepard *et al.* 1984, Elliot 1986, Goetz 1989, Buckman *et al.* 1992). Instream woody debris serves an important habitat function. Bull trout juveniles have been found to heavily utilize woody debris in low flow areas and side channels (Goetz 1991). Adult bull trout were found to use woody debris as cover and territory to occupy when in competition with other species (Shepard *et al.* 1984, Oliver 1979).

The removal of riparian vegetation also increases the mean stream temperature. Increased temperatures may increase competition with more temperature tolerant species, such as brook trout, brown trout and rainbow trout (Ratliff *et* al. 1992). Higher stream temperatures are limiting to bull trout egg survival, embryo growth rates and juvenile growth rates (McPhail *et al.* 1979, Shepard *et al.* 1984). The highest embryo survival was documented to be in 2-4° C water (McPhail *et al.* 1979. Brown 1985, Carl 198 5). Bull trout prefer to live in temperatures ranging from j-l 2.5” C and fall spawning does not start until the water temperature is 9” C with optimum temperatures at around 5° C (McPhail *et al.* 1979. Wydoski *et al.* 1979. Weaver *et al.* 198 5, Fraley *et al.* 1989). Cutthroat trout are spring spawners that also prefer colder stream temperatures near 10° C (Roscoe 197-l). This is why many of the interior cutthroat trout are found in small, high-elevation streams above the upstream limit of brook trout (MacPhee 1966, Griffith 1988). Stream temperatures are generally cooler at upstream sites dominated by cutthroat trout than at downstream sites dominated by brook trout (De Staso and Rahel 1994). Cold water temperatures may provide a competitive advantage to cutthroat trout that allows them to resist brook trout invasions (Fausch 1989).

These types of stream and riparian degradation were relatively common and can help to esplain the two general patterns eshibited in the streams surveyed; 1) non-native salmonids were more abundant with generally more stable populations and 2) native salmonids were consistently found in higher quality habitat. Habitat degradation and non-native introduction in this region has led to the proliferation of those species, predominantly brook trout. It appears that brook trout have less restrictive habitat requirements and are more tolerant to habitat degradation . as they were found even in the poorest of habitats. This suggests that maintenance of high quality habitat and enhancement of degraded habitat is necessary in order to increase native populations and strengthen their community dynamics.

The addition of more than one non-native salmonid appears to further the decline of native populations. Cee Cee Ah Creek contained both brook trout and brown trout as well as cutthroat. The combination of habitat degradation and additional interspecific competition have left this stream with one of the lowest cutthroat densities surveyed. Indian Creek had three non-native salmonids and no native salmonids were recorded. This data would seem to suggest this stream has little value in terms of enhancement for native salmonids. However. bull trout have been recorded in the Pend Oreille at the mouth of Indian Creek (Ashe *et al.* 1990). The limited number of bull trout found throughout the tributaries of the Pend Oreille lends the value to enhancement of this stream for potential adfluvial bull trout runs.

Cedar Creek may represent the best habitat conditions of all the streams in the Box Canyon Reach. This stream eshibits the least degraded habitat of the streams assessed. especially in the upper reaches. The amount of consecutive reaches exhibiting quality habitat is unequaled. The cutthroat abundance and the presence of bull trout in the upper reaches support the argument that. given higher quality habitat the native salmonids can compete at least as well as the non-natives. The upper reaches of Cedar Creek provide data that describe a relatively healthy stream that will be used as a guideline for habitat goals for the remainder of the streams where enhancement is prescribed.

Exotic brook trout removal

Competition with introduced salmonids is often listed as a major reason for the decline of cutthroat populations (Linkes and Graham 1988). Although introduced salmonids may have actively displaced westslope cutthroat trout from some waters, brook trout and perhaps other introduced salmonid competitors may have simply replaced westslope cutthroat trout populations that had been depressed by other factors such as high fishing pressure or habitat degradation (Griffith 1988). Brook trout tend to outcompete cutthroat trout in streams containing more sediment and warmer temperatures (Weaver and Fraley 199 1).

Removal or suppression of these exotic species. primarily brook trout. may play a role in the recovery of cutthroat trout in some locations. Typical removal projects have focused on small. headwater populations with an upstream barrier and the introduced species is removed upstream of the barrier. A good location for this is Cee Cee Ah Creek. There is a waterfall approximately four miles from the mouth which acts an upstream migration barrier. Above this waterfall. brook trout would be removed in order to reduce the interspecific competition and aid in the recovery of cutthroat trout.

Habitat enhancement

Habitat enhancement has been shown to be an effective means of increasing targeted fish populations (Hunt 1976). De Staso and Rahel (1994) reported that, abiotic conditions may determine which species of trout will dominate and species replacements should be expected as conditions change. This approach has its difficulties, in that. “ideal” conditions are difficult to define. which impairs ranking streams classified as acceptable. However. the assessment of habitat can define the problematic areas to the reaches that have been clearly impacted by land management activities (MacDonald et al. 1991). Thus. defined areas for restoration can be located and designs for enhancement can be applied. Since problematic areas have been identified, recommendations for restoration activities will occur on Indian Creek. Mill Creek, Cee Cee Ah Creek, Mineral Creek. Whiteman Creek and Fourth of July Creek.

The compilation of transect surveys and reach overviews were used to define the most degraded reaches through interreach comparisons. The interreach comparison within each individual tributary filtered out the specific reaches where these factors were the most numerous for each particular stream (Table 13). The reaches with the most numerous unsatisfactory habitat values were identified as enhancement sites for that particular stream. The habitat quality values that did not fall within the threshold values were addressed with specific structure or enhancement measure selection. Sixteen reaches were selected as the sites for enhancement projects.

Table 13. Reaches of enhancement and their data compared to threshold values.

	Embeddedness ≥ .30 or ≤ .70	Bank Stability ≤ 2.5	Bank Cover ≤ 2.5	Instream Cover ≤ 2.0	Pool - Riffle Ratio ≤ .5:1 or ≥ 1.5:1	Spawning Gravel 3 lowest values/stream	Primary Pools/Km 3 lowest values/stream
MILL							
Reach 4	68.5	3	2	2	0.2:1	49.5	4.4
Reach 8	85.2	1.8	1.3	1.4	0.6:1	41.5	12.6
CEE CEE AH							
Reach 4	48.6	3.7	1	1.1	0.1:1	1.5	0
Reach 5	51.4	2.7	1	1.1	0.1:1	0	0
Reach 6	66.7	2.5	1	1.2	0.1:1	0	0
FOURTH OF JULY							
Reach 3	82.6	2.1	2.9	2.4	0.6:1	219	5.6
Reach 8	70	3	4.4	3.6	0	3	0
WHITEMAN							
Reach 4	82	2.4	1.7	1.9	0.2:1	21	9
Reach 5	38	4.2	1.7	3.3	0.2:1	1.5	2.6
Reach 6	53.9	3.8	2	2.8	0.3:1	6.9	1.5
MINERAL							
Reach 1	57	2.6	3.5	4	0.2:1	26.2	7.6
Reach 3	81.7	1.7	2.8	2.6	0.2:1	25.8	7.1
Reach 4	61.2	1.9	2.9	3.6	0.3:1	9.6	5.3
INDIAN							
Reach 2	57.4	3.1	2.1	2.9	0.2:1	17.6	0
Reach 3	37.9	3.4	2.4	3	0.1:1	369	1.8
Reach 4	42.4	3.2	2.4	2.7	0.1:1	46	1.9

Recommendations

Riparian area and instream restoration

Riparian fencing will be done in areas where cattle have affected bank stability and disrupted the vegetation cover of the riparian zone. Fencing these areas will help to restore the riparian cover and lessen the introduction of sediment into these streams. The use of native local varieties of plants will help ensure the establishment of riparian vegetation. Deciduous planting will involve the planting of trees such as willows (*Salix spp.*), red-osier dogwood (*Cornus stolonifera*) and black cottonwood (*Populus trichocarpa*). Coniferous planting will involve the planting of trees such as western redcedar (*Thuja plicata*) and Englemann spruce (*Picea englemanii*).

The data from the specific reaches identified in the interreach comparison were evaluated in a flowchart to provide a list of possible options for the types of structures or measures to be used in enhancement (Figure 21). Each structure is designed to perform specific functions and requires specific habitat placement (Table 14). Specific structure selection was made by reviewing the list of options for enhancement and choosing the structure that addresses the limiting factors for each particular reach of enhancement. Reach accessibility was also considered when choosing between structures with similar function but varying levels of effort in their construction. Specific placement of the structures was determined by the transects within each reach that were in the habitat type each structure was designed for.

Mill Creek (Figure 22)

Reach 4.

In order to increase the flow velocity in this reach, small woody debris will be removed. Increasing the velocity will decrease embeddedness for this reach.

Reach 8.

One log and bank structure will be constructed in three separate pool transects (284, 285 and 286). These structures will provide overhead cover and some stream bank protection.

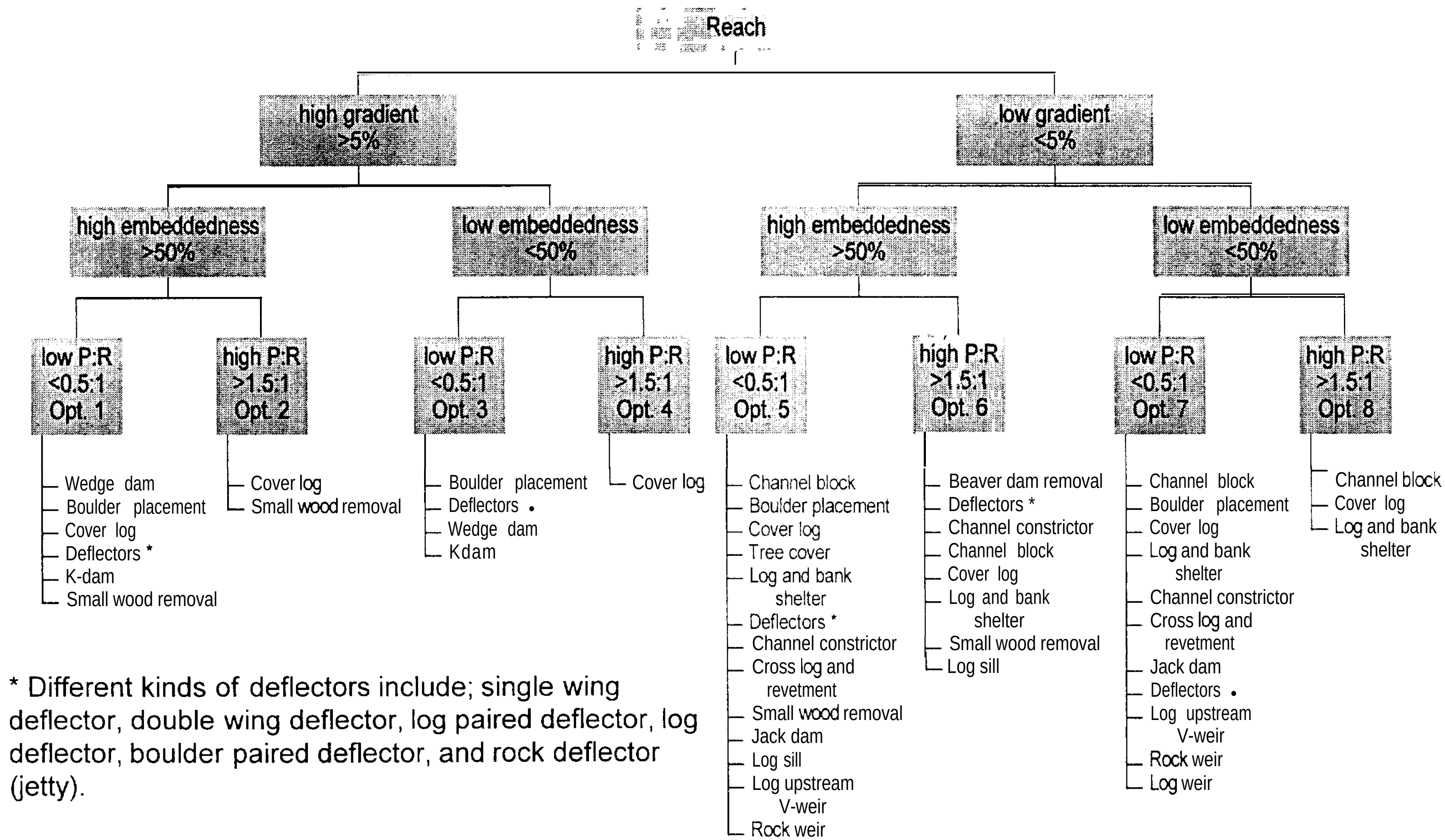


Figure 2 1: Flowchart for indentified reaches of enhancement and the possible structures available for enhancement. Values derived after Harrelson et *al*. 1994, Macdonald 1991 and Hunter 1991.

Table 14. Instream structures and the descriptions for placement requirements, function and impacts

Structure	**Habitat**	**Stream Requirements**	**Purpose**	**Impacts**
Channel Constrictor	Riffles Runs Glides	Provides best results when **placed** in long, straight, low-gradient stretches of stream.	Provides overhead cover Narrows channel Scour and deepen streambed	+ Scours the streambed + Increases velocity + Helps transport sediment **-** May concentrate sediment below structure **+/-** Incises the channel
Log Deflector	Riffles Glides Runs	When possible, divert water into a relatively stable section of stream bank Suitable for a variety of sites Most suitable in **wide** shallow riffles	Constricts and diverts water flow so that pools are formed by scouring Creates spawning gravel	**+** Constricts and diverts water flow **+/-** May cause deposition of sediment just below structure towards bank + Directs meander
Log Paired Deflector	Riffles Runs Glides	Especially suitable for shallow sections of stream where the gradient is too steep for effective deflector and cover log.	Creates mid-channel pools through scouring Creates spawning gravel at tail-out of pool	+ Narrows channel + Scours a pool below structure **+/-** May cause deposition of sediment just below structure towards bank
Rock Deflector	Riffles Runs Glides	When possible, divert water into a relatively stable section of stream bank Suitable for a variety of sites Most suitable in wide shallow riffles	Directs flow from **cut bank** Directs meander Scours pool	+ Constricts **and diverts water flow** **+/-** May cause deposition of sediment just below structure towards bank + Directs meander .
Boulder Paired Deflector	Riffle Runs Glides	Especially suitable for shallow sections of stream where the gradient is too steep for effective deflector and cover log.	Creates mid-channel pools through **scouring** Creates spawning gravel at tail-out of **pool**	+ Narrows channel + Scours a pool below structure **+/- May cause deposition of sediment just below** structure towards bank

Note: **"+"** Indicates Positive Impacts and **"-"** Indicates Negative Impacts.

Table 14. Instream structures and the descriptions for placement requirements, function and impacts

Structure	Habitat	Stream Requirements	Purpose	Impacts
K-Dam	Riffles Runs	Well defined stream banks Stream < 15 ft. wide Gradient >5% Substrate consisting of: rubble, cobble and gravel Ideal locations are at a break in gradient with a steeper section immediately upstream	Creates a fair to excellent scour pool Creates spawning gravel at tail-out of pool	+/- Creates calmer water above the structure + Creates a scour pool below the structure +/- May act as a trap for sediment - Prone to undercutting of structure
Small Wood Removal	Riffles Glides Runs	Small wood must be acting as a silt trap or inhibiting fish migration in order to be removed Typically used to increase velocity and transport sediment	Typically used to increase velocity and transport sediment Helps expose substrate	+ Increases velocity + Transports sediment + Exposes substrate + Narrows channel
Channel Block	Braided Channel	Braided channel that is virtually unusable	Consolidates flow into a single, deeper channel	+ Concentrates flow into a single deeper channel + May increase velocity - May concentrate sediment deposition downstream
Tree Cover	Riffles Runs Glides	Suitable for a variety of sites Greatest benefits probably occur in wide shallow streams with sand or gravel substrate	Provides excellent overhead cover Increases stream velocity Transports sediment	+ Constricts wide shallow channels + Increases stream velocity + Transports sediment
Log & Bank Shelter	Open Pools	Suitable for use in low gradient stream bends or meanders Can be used with a deflector	Provides overhead cover Provides some streambank protection	+ Creates overhead cover + Directs current away from meander
Cross Log & Revetment	Riffles Runs	Structure works best in low gradient sections of the stream Works even better at the beginning of wide, shallow bends with marginal pools or cover	Creates scour pool Creates overhead cover Protects the bank	+ Creates a scour pool + Protects bank

Note: "+" Indicates Positive Impacts and "-" Indicates Negative Impacts.

Table 14. Instream structures and the descriptions for placement requirements, function and impacts

Structure	Habitat	Stream Requirements	Purpose	Impacts
Wedge dam	Riffles Runs	Well defined stream banks Stream < 30 ft. wide Gradient >5% Substrate consisting of: rubble, cobble and gravel Ideal locations are at a break in gradient with a steeper section immediately upstream	Creates a fair to excellent scour pool Creates spawning gravel at tail-out of pool	+/- Creates calmer water above the structure + Creates a scour pool below the structure +/- May act as a trap for sediment
Boulder placement	Riffles Runs Glides Open Pools	Greatest benefits in currents exceeding 2 feet per second Suitable for any size stream	Provides overhead cover and resting areas Creates natural appearance	+ Creates pocketwater behind boulder + Added depth is also created by the scouring resultin from reduced channel capacity and increased current velocity
Cover log	Open Pools Runs	Works best in meanders or in conjunction with deflectors Requires adequate water depth (at least 8" deep) Suitable for any size stream	Provides optimum cover	+ Creates overhead cover + Directs current away from meander - May cause unwanted bank cutting
Single-Wing Deflector	Riffles Glides Runs	When possible, divert water into a relatively stable section of stream bank Suitable for a variety of sites Most suitable in wide shallow riffles	Constricts and diverts water flow so that pools are formed by scouring Creates spawning gravel	+ Constricts and diverts water flow +/- May cause deposition of sediment just below structure towards bank + Directs meander - May cause unwanted bank cutting
Double-Wing Deflector	Riffles Runs Glides	Especially suitable forshallow sections of stream where the gradient is too steep for effective deflector and cover log.	Creates mid-channel pools through scouring Creates spawning gravel at tail-out of pool	+ Narrows channel + Scours a pool below structure +/- May cause deposition of sediment just below structure towards bank - May cause unwanted bank cutting

Note: "+" Indicates Positive Impacts and "-" Indicates Negative Impacts.

Table 14. Instream structures and the descriptions for placement requirements, function and impacts

Structure	**Habitat**	**Stream Requirements**	**Purpose**	**Impacts**
Jack Dam	Riffles Runs	High banks Moderate to steep gradient	Produces deep scour pools	**+/-** Creates calmer water above the structure + Creates scour pool
Log Sill	Riffles Runs	Well defined stream banks Stream **<** 15 ft. wide Gradient **<5%**	Creates scour pool May create spawning gravel	**+/-** Creates calmer water above the structure + Creates a scour pool below the structure **+/-** May act as a trap for sediment
Log Upstream V-Weir	Riffles Runs	Well defined stream banks Stream **<** 15 ft. wide Gradient **<5%** Works well in sand and gravel substrate	Creates deep plunge pool Creates spawning gravel at tail-out of pool	**+/-** Creates calmer water above the structure + Creates a scour pool below the structure **+/-** May act as a trap for sediment
Rock Weir	**Riffles** Runs	Well defined stream banks Stream **<** 15 ft. wide Gradient **<5%**	Creates scour pool	**+/-** Creates calmer water above the structure + Creates a scour pool below the structure **+/-** May act as a trap for sediment
Log Weir	Riffles Runs	Well defined stream banks Stream **<** 15 ft. wide Gradient **<5%**	Creates scour pool	**+/-** Creates calmer water above the structure + Creates a scour pool below the structure **+/-** May act as a trap for sediment
Beaver dam removal	Long Pools	A beaver dam in the in the lower **2/3** of the stream A beaver dam that **may** inhibit fish passage	Narrows channel Exposes substrate	**-** Releases a large volume of sediment downstream **+/-** Incises the channel + Decreases sediment upstream + May expose substrate such as cobble, gravel and boulders

Note: **"+"** Indicates Positive Impacts and **"-"** Indicates Negative Impacts.

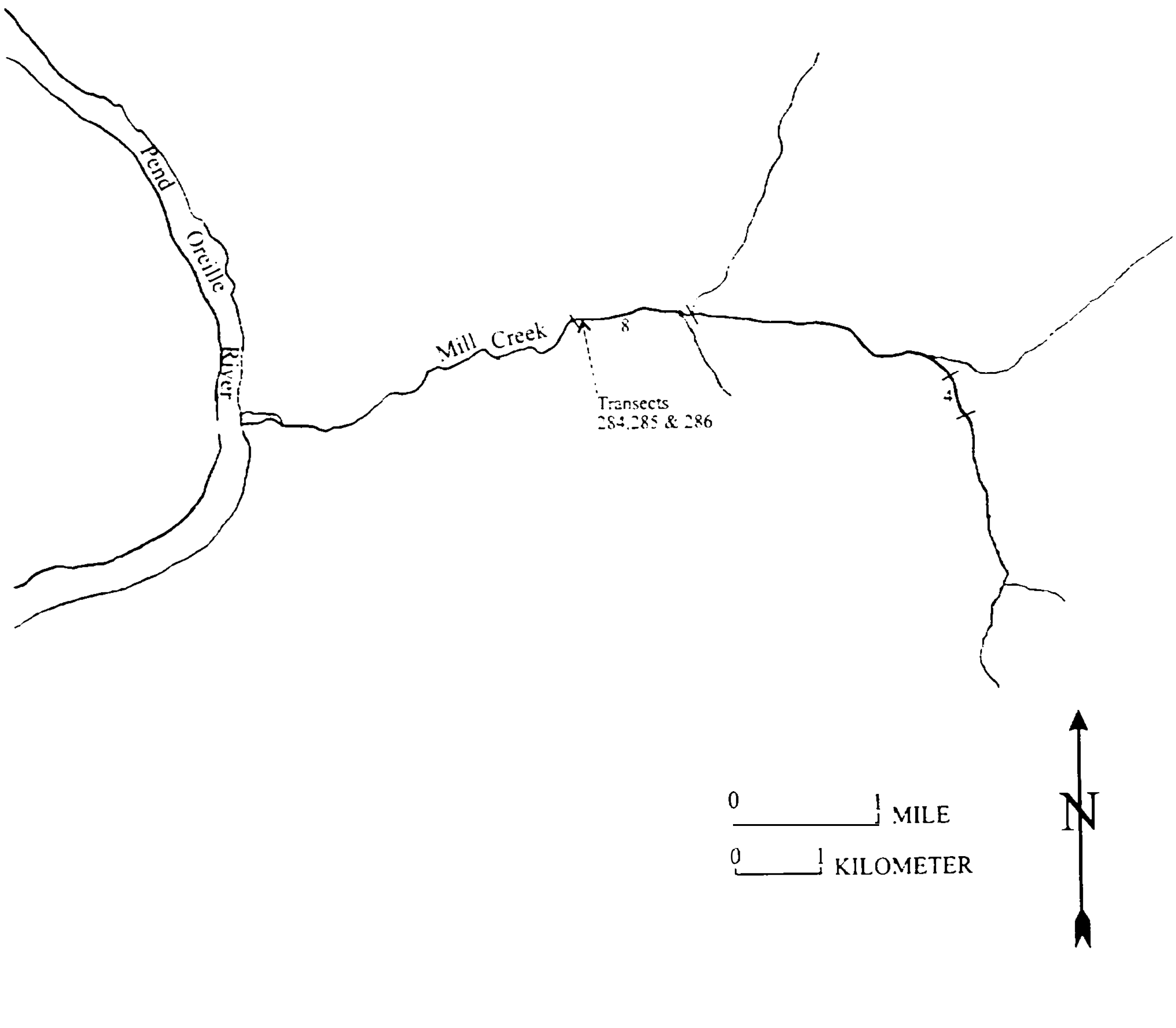


Figure 22. Mill Creek reach and transect locations for enhancement.

Cee Ccc **Ah Creek** (Figure 23)

Reach 4.

One K-dam will be constructed in three separate riffle transects (139, 140 and 141) to increase pool-riffle ratio and primary pools by scouring action in shallow sections of stream. Increasing pools in the stream will increase winter habitat and instream cover. Spawning gravel will increase at the tailout areas of the pools.

Reach 5.

One cross log revetment structure will be constructed in three separate riffle transects (153. 154 and 155) to create scour pools. The revetment logs will provide overhead cover. as well as. protect the banks. These structures will provide instream cover. bank cover. increase pool-riffle ratio and increase winter habitat. They may also provide pockets of spawning gravel in the tailout areas of pools. These structures present a more natural appearance. which was important in this reach as it is bordered by a campground.

Reach 6.

One log upstream v-weirs will be constructed in three separate riffle transects (174. 175 and 176) with a transect separation between each structure. These structures will create deep plunge pools and spawning gravels in the pool tailout.

Fourth of July Creek (Figure 24)

Reach 3.

Riparian fencing and planting will be done in this reach. Fencing will be constructed at the start of the reach. One km of creek will be fenced 15 m from the stream on both sides. Riparian planting will accompany the fencing project. The deciduous trees and shrubs to be planted will be 3000 dogwoods planted on 3m centers within the fenced area (Zierke 1993). Coniferous trees (Englemann spruce and western redcedar) will be planted outside the fenced area on 4m centers (Heron 1996 pers. comm.). 1000 Englemann spruce and 1000 western redcedar seedlings will be planted in random order of differing species. Fencing the riparian zone will allow the area to recover. increasing bank stability. decrease the width to depth ratio, reduce embeddedness. and increase instream cover.

Reach 8.

In order to increase flow velocity. small woody debris will be removed. Increased velocity will decrease the embeddedness for this reach. One wedge dam will be constructed in three separate riffle transects (121. 122 and 123) after the small woody debris removal. These measures will provide an increased pool-riffle ratio and increased spawning gravel.

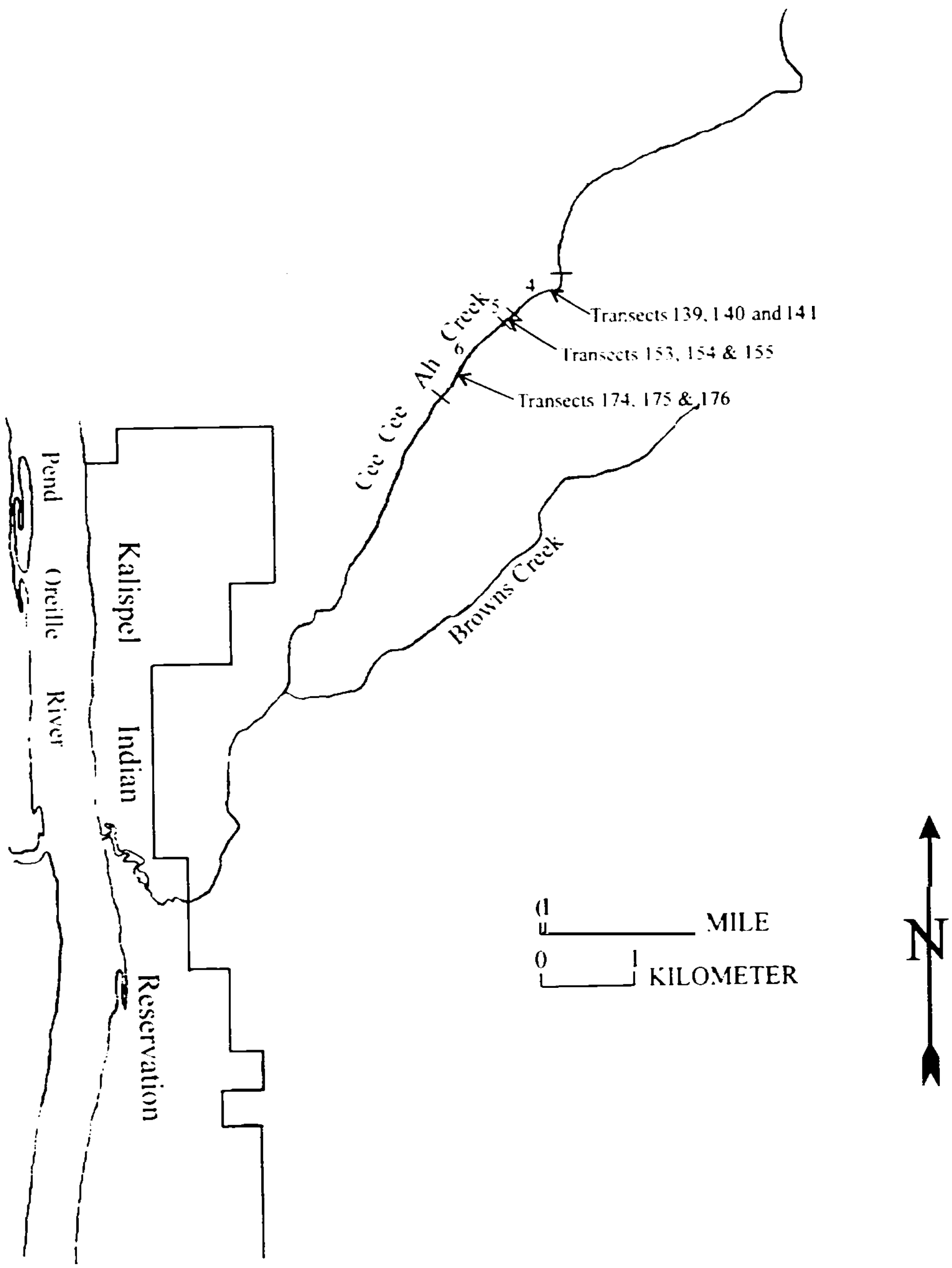


Figure 23. Cee Cee Ah Creek reach and transect locations for enhancement.

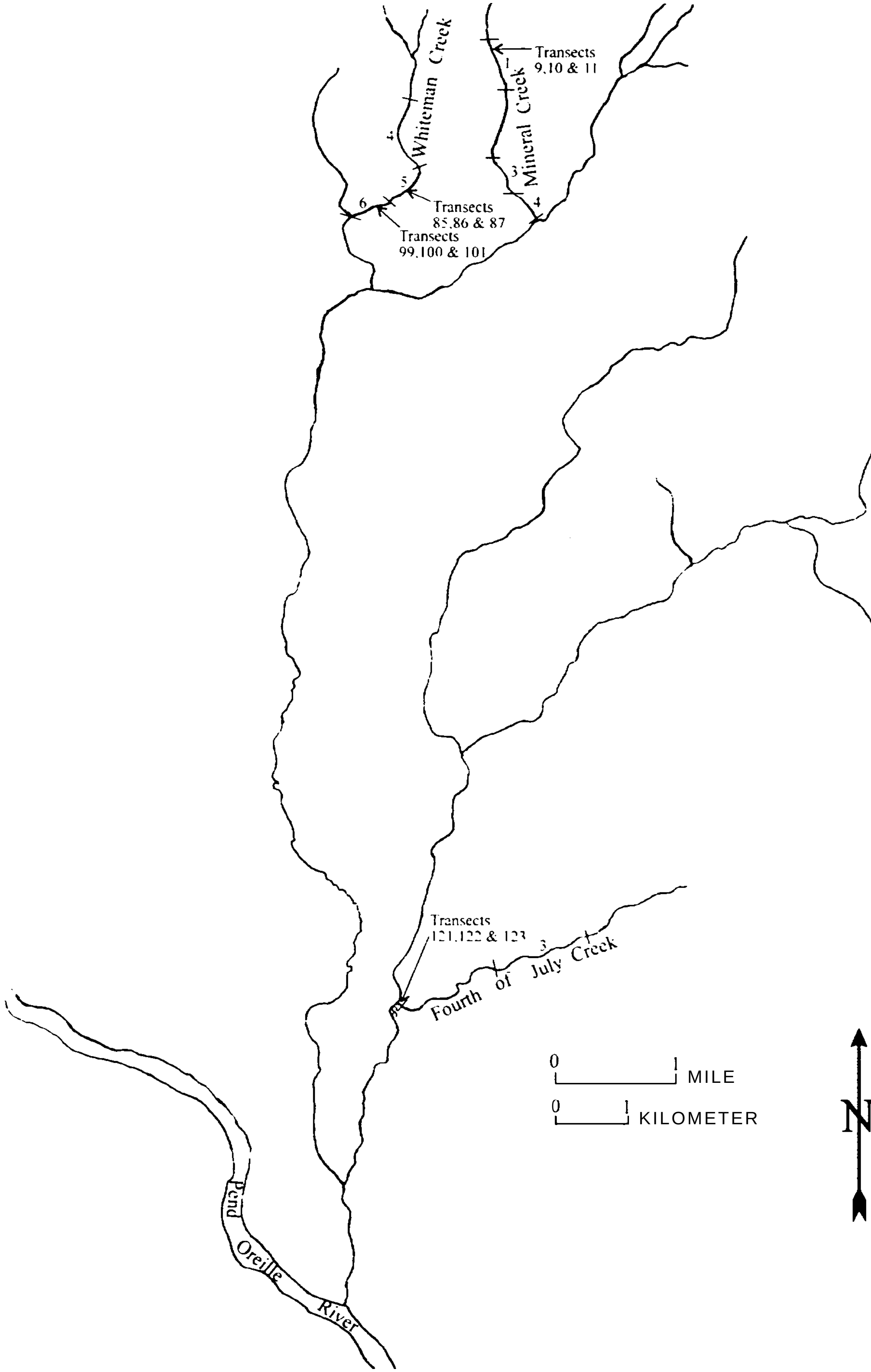


Figure 24. Fourth of July Creek, Whiteman Creek and Mineral Creek reach and transect location for enhancement.

Whiteman Creek (Figure 24)

Reach 4

Riparian fencing and planting will be done in this reach. Fencing will be constructed at the start of the reach. One km of creek will be fenced 15 m from the stream on both sides. Riparian planting will accompany the fencing project. The deciduous trees and shrubs to be planted will be 3000 dogwoods planted on 3m centers within the fenced area (Zierke 1993). Coniferous trees (Englemann spruce and western redcedar) will be planted outside the fenced area on 4m centers (Heron 1996 pers. comm.). 1000 Englemann spruce and 1000 western redcedar seedlings will be planted in random order of differing species. Fencing the riparian zone will allow the area to recover. increasing bank stability. decrease the width to depth ratio. reduce embeddedness. and increase instream cover.

Reach 5.

One wedge dam will be constructed in three separate riffle transects (85, 86 and 87) to increase primary pools. This will also increase winter habitat. pool-riffle ratio and increase spawning habitat in the tailouts.

Reach 6.

One double wing deflector will be constructed in three separate riffle transects (99. 100 and 101). By constricting the channel and creating mid-channel pools. these structures will increase pool-riffle ratio. increase winter habitat. provide cover and increase spawning habitat.

Mineral Creek (Figure 24)

Reach 1.

One double wing deflector will be constructed in three separate riffle transects (9. 10 and 11). By constricting the channel and creating mid-channel pools, these structures will increase pool-riffle ratio. increase winter habitat. provide cover and increase spawning habitat.

Reach 3.

Riparian fencing and planting will be done in this reach. Fencing will be constructed at the start of the reach. One km of creek will be fenced 15 m from the stream on both sides. Riparian planting will accompany the fencing project. The deciduous trees and shrubs to be planted will be 3000 dogwoods planted on 3m centers within the fenced area (Zierke 1993). Coniferous trees (Englemann spruce and western redcedar) will be planted outside the fenced area on 4m centers (Heron 1996 pers. comm.). 1000 Englemann spruce and 1000 western redcedar seedlings will be planted in random order of differing species. Fencing the riparian zone will allow the area to recover. increasing bank stability. decrease the width to depth ratio. reduce embeddedness. and increase instream cover.

Reach 4.

Removal of acting debris will be done in this reach. This will allow increased flow velocity to scour pools. decrease embeddedness and increase spawning habitat.

Indian Creek (Figure 25)

Reach 2.

One channel constrictor will be constructed in two separate riffle transects (21 and 22). These structures will narrow the channel and deepen the midstream section of the stream. They also help to scour substrate and increase sediment transport.

Reach 3.

One double-wing deflector will be constructed in three separate riffle transects (57,58 and 59). These structures create midchannel pools through scouring and create spawning habitat at the tail-out of the pools.

Reach 4.

One log weir will be constructed in three separate riffle transects (117,118 and 119). These structures create scour pools and may expose spawning habitat. Beaver dams at the end of this reach and at the mouth of the stream will be removed to reduce migratory obstruction and aid in the transport of sediment.

Exotic brook trout removal

Brook trout will be removed from the upper portion of Cee Cee Ah Creek. Removal of introduced species is difficult because of their mobility in most systems. However, Cee Cee Ah Creek is clearly divided into two separate sections of stream by a large waterfall that acts as a migration barrier to fish. This isolating component gave this portion of the tributary optimal conditions to attempt a partial to complete removal of non-native brook trout. By minimizing or eliminating the non-native competition from the stream. the native fish populations and community dynamics should improve as more habitat types become available.

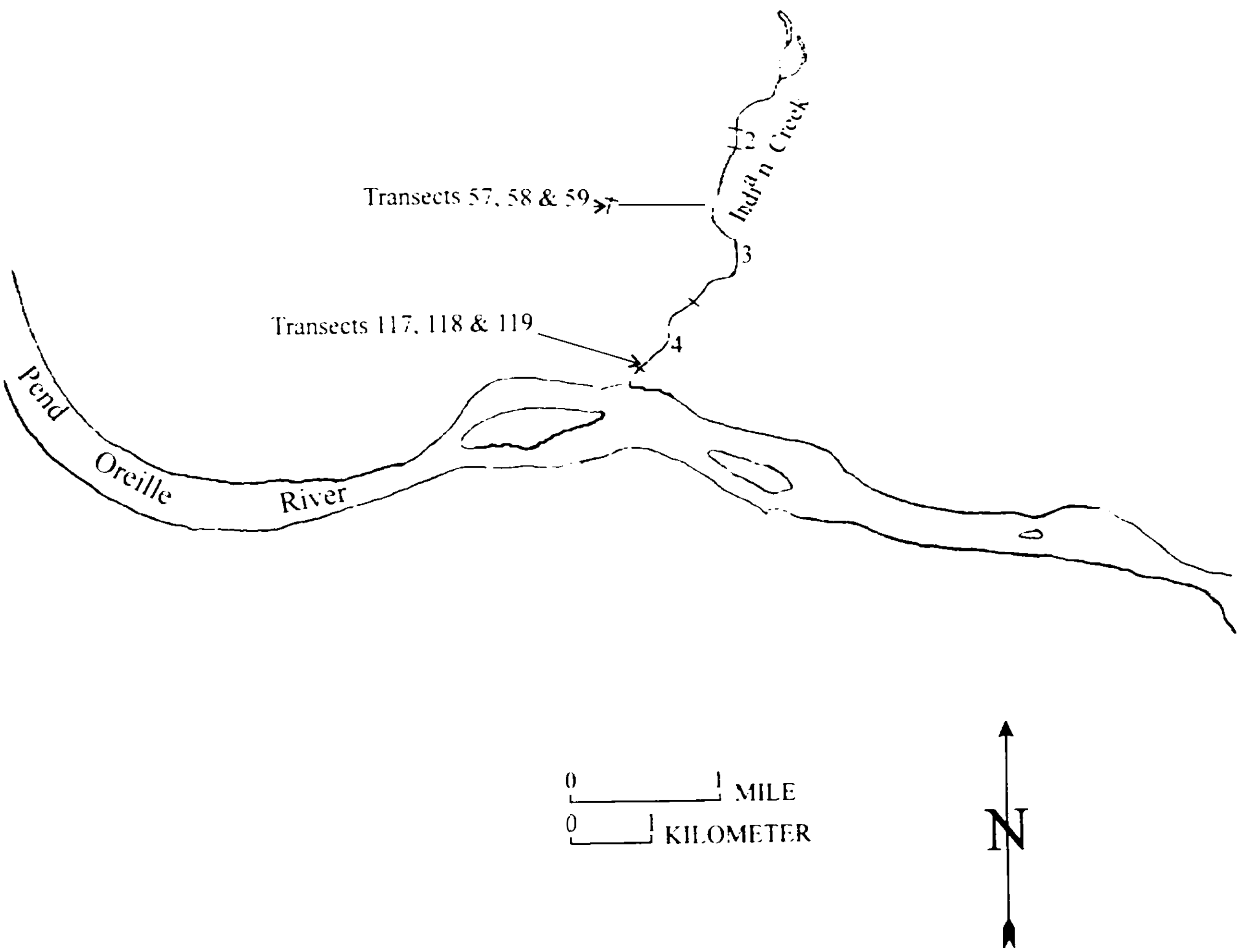


Figure 26. Indian Creek reach and transect locations for enhancement.

Monitoring and Evaluation

Riparian area and instream restoration

Monitoring and evaluation of riparian restoration will be conducted in two phases: a pre-assessment and post implementation assessment. The post implementation assessment will be a repeat of the procedure used in the pre-assessment. Both assessment phases will consist of a broad assessment of the reach. an intensive assessment of the restoration area and a fish snorkel survey for the instream effects of restoration. Riparian planting will also be monitored for plant survivability as to species and planting distance.

The broad assessment will consist of the transect data collected in field season 1995 and cross sections of the stream that will be constructed every 20 transects at the bankfull height of the stream. Snorkeling stations will be done to determine the abundance of all fish species present at a rate of one 30m station per 1.6 km.

The intense assessment will be conducted using standard transect methodology within the actual project implementation area. The only modification to the transect methodology is a shortening of the length between transects. Riparian project areas will be assessed with 10m transects for each kilometer where fencing and planting occurred. lnstream structures will be assessed using 5m transects from 30m above the structure site to 30m below. Cross sections of the stream will be done at a rate of one per every 30m (riparian restoration) and 10m (instream restoration) once every season and following peak flow events. Cross section sites will be benchmarked using aluminum tags. labeled with cross section number. and attached to rebar stakes.

Fish sample stations for riparian restoration were calculated to be one 30 meter snorkel station per every 250 meters of stream (Figure 26.). A minimum sample size of three snorkel stations for each restoration area will be done. unless the area is less than or equal to 90 meters long. in which case the entire area will be snorkeled. Assuming the lowest known bull trout population density (0.075 bull trout30 meters) in the state of Washington (Hillman and Platts 1993). we are 95% confident that if bull trout are in the stretch of the stream we will observe them at this rate of sampling. Bull trout were used to determine the sample size because they are the least abundant native salmonid species in the area.

$$n = \frac{-\ln(1-a)}{b}$$

Where: *n* = the number of sample 30 meter snorkel stations

-ln = negative natural log

a = level of confidence

b = lowest density (fish/30m of stream) of bull trout in the state of Washington

Figure 26. Calculation for number of sample stations.

Each station will be benchmarked at the upper and lower boundary with labeled aluminum tags attached to rebar stakes. The same stations will be sampled in the spring, summer. and fall. Data from snorkel stations will be used to determine densities of all fish species present. Fish sampling for instream structures will be done with a 60m station. 30m above and 30m below, to determine the fish numbers and species associated with the structure. To avoid confusion of benchmarks. fish stations will be located by the actual structure.

Exotic brook trout removal

All salmonids will be removed from upper Cee Cee Ah Creek by block netting and electroshocking. Block nets will be set up isolating 100m sections of the stream. The downstream block net will be removed after shocking and replaced 100m upstream of the upstream net. The number of electroshocking passes done per section will be determined by the number of salmonids captured per pass. When no salmonids are captured on a pass the process proceeds upstream to the next section. All native fish captured during the electroshocking process will be retained in a 5 gallon bucket and released downstream of the electroshocking process only the brook trout will be permanently removed. The process will be repeated for the entire 8.6 kilometers of the project area. The shocking process will be done two times, once in July and again in October.

A fish count survey using standard snorkeling methodology (Espinosa 1988) will be done in October 1996 to assess the effectiveness of the shocking project. Native salmonids will be monitored for population growth and community dynamics. Monitoring will continue for five years. Each year two snorkeling surveys will be conducted in July and September. The surveys will record fish number, age class , and habitat preference.

Biological Objectives

The overall biological objectives were established to provide production goals for all of the Box Canyon Reach tributaries, as adopted by the NWPPC. Monitoring and evaluation of each individual project tributary will determine the need for modification of these objectives. Through these adaptive management strategies biological objectives that are more suitable for these tributaries may be established at a later date.

Biological objective 1

Attain densities (all age classes) of 9.8 bull trout/100m^2 (or 390 fish /linear mile) age class in the upper one third of each major tributary system. This equates to 97,410 bull trout (all age classes) in approximately 250 miles of suitable tributary habitat in the system. Total numbers of adult bull trout recruited to the fishery will be 4,410 fish. composed of an escapement of 2.205 and harvest of 2.205 fish. by the year 2016.

Biological objective 2

Interim bull trout targets are established at 48.855 total fish (all age classes), including a total of 2.205 fish recruited to the fishery. composed of an escapement of 1.102 fish and a harvest of 1.103 fish. by the year 2006.

Biological objective 3

Attain population o242.2 12 adult cutthroat in 500 miles of suitable cutthroat habitat in the system. including an escapement of 156.800 fish and harvest of 85.4 12 fish by the year 20 16.

Biological objective 4

Interim cutthroat targets are established at 121.106 total adults recruited to the fishery. composed of an escapement of 78.400 fish and harvest of 42.706 fish by the year 2006.

Monitoring and evaluation of riparian area restoration. instream restoration and exotic brook trout removal will determine the effectiveness of these measures toward meeting the biological objectives established for each tributary. These objectives all contain interim and final targets that are subject to modification based on the data collected during the monitoring and evaluation process. The biological objectives for the individual tributaries will establish goals for production that will increase bull trout and cutthroat trout populations. Decisions pertaining to target numbers for biological objectives were extracted from 1995 fish abundance data. These increases will forward this project toward meeting the biological objectives established for the Box Canyon Reach.

Mill Creek

Biological Objective 1

To increase bull trout density from a remnant population to an interim target of 0.5 fish per kilometer in 1998. to 1 fish per kilometer by 2003, to 4 fish per kilometer by 2008.

Biological Objective 2

To increase cutthroat trout density from a remnant population to an interim target of 20 fish per kilometer by 1998. to 40 fish by 2003, to 60 fish per kilometer by 2008.

Cee Cee Ah Creek

Biological Objective 1

To increase bull trout density from a remnant population to an interim target of 0.5 fish per kilometer in 1998. to 1 fish per kilometer by 2003, to 4 fish per kilometer by 2008.

Biological objective 2

To increase cutthroat trout density from a remnant population to an interim target of 20 fish per kilometer by 1998. to 40 fish by 2003. to 60 fish per kilometer by 2008.

Biological Objective 3

Eliminate brook trout or other exotic species from upper Cee Ah Creek by 1997.

Fourth of July Creek

Biological objective 1

To increase bull trout density from a remnant population to an interim target of 0.5 fish per kilometer in 1998, to 1 fish per kilometer by 2003, to 4 fish per kilometer by 2008.

Biological Objective 2

To increase cutthroat trout density from a remnant population to an interim target of 300 fish per kilometer by 1998. to 400 fish per kilometer by 2003, to 500 fish per kilometer by 2008.

Whiteman Creek

Biological Objective 1

To increase bull trout density. from a remnant population to an interim target of 0.5 fish per kilometer in 1998. to 1 fish per kilometer by 2003. to 4 fish per kilometer by 2008

Biological Objective 2

To increase cutthroat trout density from a remnant population to an interim target of 20 fish per kilometer by 1998. to 40 fish by 2003. to 60 fish per kilometer by 2008.

Mineral Creek

Biological Objective 1

To increase bull trout density from a remnant population to an interim target of 0.5 fish per kilometer in 1998. to 1 fish per kilometer by 2003. to 4 fish per kilometer by 2008.

Biological Objective 2

To increase cutthroat trout density. from a remnant population to an interim target of 20 fish per kilometer by 1998. to 40 fish by 2003. to 60 fish per kilometer by 2008.

Indian Creek

Biological Objective 1

To increase bull trout density from a remnant population to an interim target of 0.5 fish per kilometer in 1998. to 1 fish per kilometer by 2003. to 4 fish per kilometer by 2008.

Biological Objective 2

To increase cutthroat trout density from a remnant population to an interim target of 20 fish per kilometer by 1998. to 40 fish by 2003, to 60 fish per kilometer by 2008.

Largemouth Bass Supplementation and Habitat Implementation

Introduction

Bass habitat study

Juvenile overwintering survival has been determined to be the limiting factor for largemouth bass (*Micropterus salmoides*) in the Box Canyon Reservoir (Ashe *et al.* 1991. Bennett 1991). Lack of cover is believed to be related to obsened declines in standing crops of largemouth bass. and may result in reduced food availability and higher predation on young-of-year (Brouha and von Gcldem 1979). Adding artificial structures has been shown to improve fish habitat and increase local productivity and growth (Prince and Maughan 1979: Wege and Anderson 1979). These structures may increase productivity and growth. in that. they provide essential wintering habitat for bass (Carlson 1992). The goal for this project is to determine habitat structures that will maximize overwintering success of juvenile largemouth bass.

Bass rearing and population supplementation

Ashe (1991) indicated that growth rates of largemouth bass during the first four years in the Box Canyon Reservoir were lower than bass from other locations of the northern United States. and conversely growth rates after the fourth year were comparable or even higher than other locations. The slower growth combined with a high rate of juvenile mortality associated with overwintering have reduced the potential for the bass population within the reservoir. Largemouth bass density estimates are approximately 6 pounds per surface acre in the Box Canyon Reservoir.

Ashe (1991) and Bennett (1991) suggested the possibility of an off-site rearing facility to supplement the number of juvenile largemouth bass within the Box Canyon Reservoir. Supplemental stocking of yearling largemouth bass has been proven successful in other reservoirs. In Chatfield Reservoir. Colorado. largemouth bass were hatchery reared to one year of age using intensive and extensive culture from 1978 to 198 1. Subsequent samples of age 2 bass in the reservoir composed 12%. 59%, and 59% of the population. during sample years 1980. 198 1 and 1982 respectively (Kreiger and Puttman 1986). Increases in the age 2 class fish were directly attributed to hatchery supplementation. The goals of this project are to facilitate the production and rearing of juvenile largemouth bass for supplementation and thereby increase the production of harvestable bass.

Description of Study Area

Hatchery, rearing sloughs and bass habitat study area

The Pend Oreille River begins at the outlet of Pend Oreille Lake. Idaho, and flows in a westerly direction to approximately Dalkena. Washington. From Dalkena the river turns and flows north into British Columbia. where it flows into the Columbia River. The approximate drainage area at the international border is 65.300 km' (Barber et al. 1990). The normal high flow month is June with a mean discharge of 61.858 cfs. the normal low flow month is August with a mean discharge of 1 1.897 cfs (Barber et al. 1990). The Box Canyon Reservoir has 47 tributaries and covers 90 river kilometers of the Pend Oreille River. This reservoir begins from Albeni Falls Dam at the southern border and then flows north to Box Canyon Dam.

The warm water fish hatchery and bass habitat study will be located at the 436 acre Pend Oreille Wetlands Wildlife Mitigation Project site. The project is located on the east side of the Pend Oreille River. approximately nine miles north of the Usk bridge on LeClerc Road adjacent to the north boundary of the Kalispel Indian Reservation (Figure 27).

The bass habitat study will utilize the two sloughs located on the mitigation site. that are part of' the juvenile bass rearing facility. The north slough is one acre with an average depth of 1.9 feet. and the south slough is .5 acre and has an average depth of 2.4 feet.

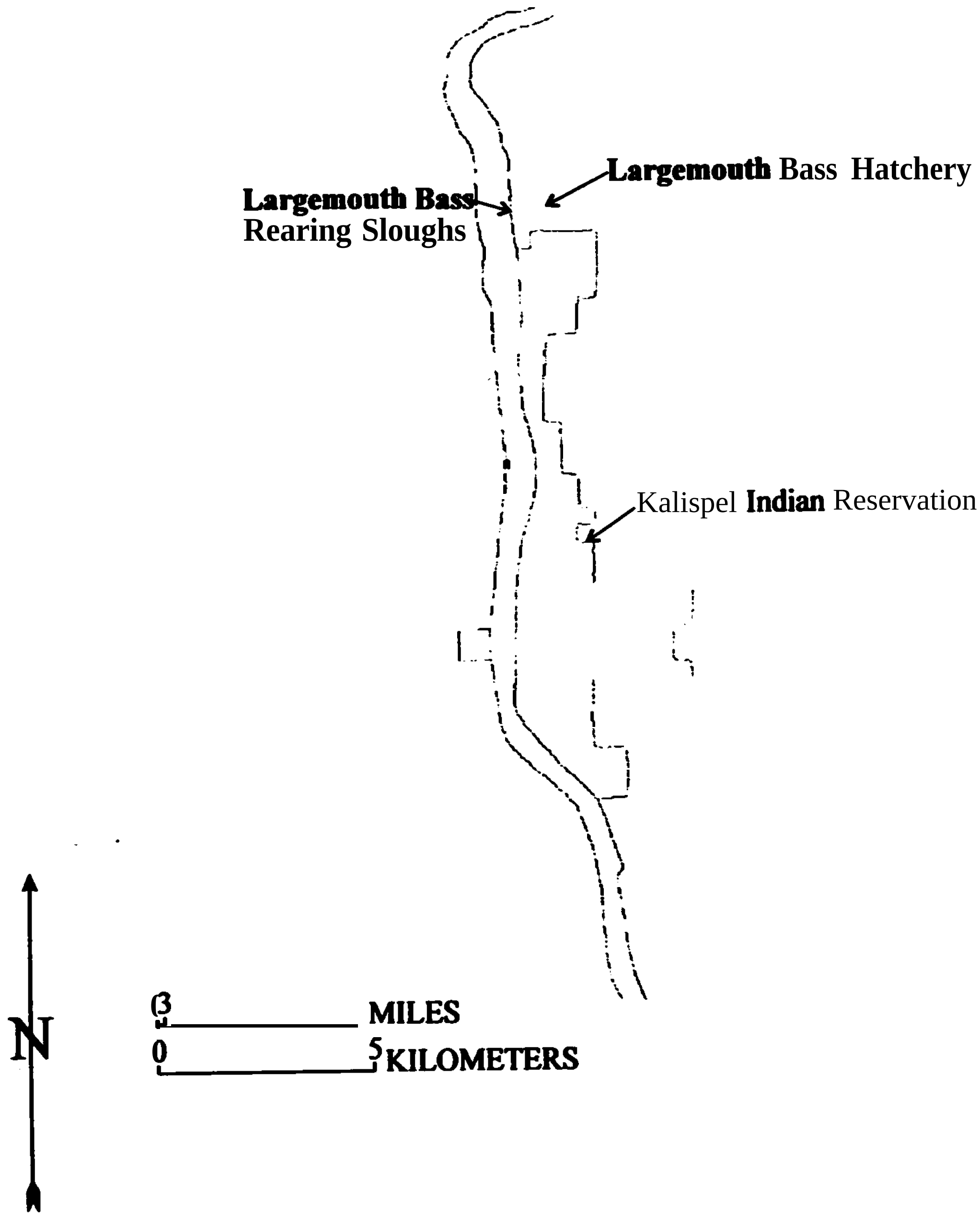


Figure 27. Largemouth bass hatchery and rearing sloughs.

Recommendations

Hatchery and rearing sloughs

To supplement largemouth bass in Box Canyon reservoir. Ashe (1991) and Bennett (1991) suggested the possibility of an off-site rearing facility. To ensure overwintering survival. the facility would raise 0- largemouth bass to a size of 32-140mm. Based on this recommendation. the KNRD requested proposals for design of a hatcher>- and water control structures. JUB Engineers and JC Aquaculture Consultants were awarded the contract. Their product is a design for the Kalispel Largemouth Bass Hatchery (Appendix A). Their report details the geotechnical research. field evaluations and engineering analysis for the hatchery site. Construction requirements for the hatchery include: hatchery building. river intake and pumpstation. raceway. effluent ponds and water control structures. The largemouth bass production program has been designed to utilize both intensive and extensive culture practices. thus taking advantage of both the site area and the available water. The goal of the largemouth bass hatchery and rearing sloughs is to increase the resident largemouth bass population in the Box Canyon Reach of the Pend Oreille River through annual plantings of up to 100.000 32mm fry and or up to 50.000 140mm fingerlings.

Physical aspects of the hatchery

The efficient operation of a fish hatchery depends on a number of factors including: adequate water source and supply structure. facility design. hatching and rearing facilities. and hatchery effluent treatment. The water supply for the hatchery is the Pend Oreille River. A 500 ft. long. 8-inch diameter pipeline will extend along the river bottom to a minimum elevation of 2.022 feet ("normal" river level is 2.031 ft.). The pipeline will be weighed down by concrete blocks to prevent movement. and a small stainless steel screen will prevent the entry of larger debris and fish. The intake pipeline is sized for future flow requirements (400 gpm). and will be designed to be easily extended to deeper water. if need be. Two pumps. each capable of supplying a minimum of 100 gpm at a total dynamic head (TDH) of 78 feet. plus an air blower (80 scfm at 3.5 psi) will be installed in the sound proofed. heated and insulated pumpstation shed. A 6-inch diameter supply pipeline will carry water to the raceway and hatchery building. An emergency generator will not be installed at the pump station as a cost-reduction measure. During the initial phase ofopcration. the hatchery building and raceway unit will rely on water reuse and oxygen supplementation/aeration during power outages.

The 2.529 ft^2 hatchery building will consist of a "dry" and "wet lab" area. The "dry" area contains ceilings and studwalls partitioned into offices, restrooms, lunch room and visitor facilities. The large (1 .400 ft^2) "wet lab" area will house 4 FRP troughs-each 2.5ft. by 24 ft long: overhead distribution lines for air and water; a floor-mounted and LPG powered boiler with plate heat exchanger and (2) circulation pumps; a 46 inch diameter by 9 ft tall biofilter with backwash motor (for raceway and trough water reuse during power outages and/or early start on spawning and incubation); a wall-mounted 10 lamp ultraviolet (U.V.) disinfection unit: and two loft-mounted water treatment units consisting of a 30 micron rotating drum screen (for screening river water prior to its use at the hatchery and the raceway). and a 12-inch diameter degassing column for re-aerating reuse water and for degassing of any heated water. A 200 ft^2 feed preparation room will be enclosed within the "wet lab" area. Lighting in the wet lab area will consist of 14 fluorescent light fistures (4 bulbs each) with sealed cleared lens covers. The fixtures will be suspended from the ceiling/roof trusses. and will be wired to control the lighting in four individual areas (4 switches). Space heaters (also suspended from the roof trusses) and three large exhaust fans will provide heating and ventilation for the wet lab spaces.

A reinforced concrete raceway. measuring 8 ft wide by 60 ft long and 4 ft deep, will be used for largemouth bass spawning as well as intensive rearing. The raceway will be supplied with water both directly from the river (untreated). as well as screened and disinfected hatchery water. The raceway unit will be fully enclosed with an insulated fabric and steel frame enclosure roughly 22 ft wide by 70 ft long.

Two earthen effluent ponds. each having bottom dimensions of 30 ft by 80 ft, will be used to settle-out solids from the hatcher! building and raceway unit effluent. Three sides of the ponds will have standard 3: 1 slopes. while the east berm will feature a 5: 1 slope to facilitate entry by a front-end loader. The ponds will have individually valved 6-inch diameter PVC inlet pipes and concrete outlet structures with slots for level control. The overflow from the ponds will be piped to an open ditch that discharges into the nearby marsh. The effluent ponds could also be used to rear fish.

Biological aspects of the hatchery

Raceway spawning of largemouth bass will be used at the Kalispel Hatchery. Raceway spawning of largemouth bass has been proven successful at Jake Wolf Hatchery and other largemouth bass hatcheries (Tom Hays pers. comm.). These techniques allows the fish culturist to easily observe the brood fish and determine the extent to which successful spawning is taking place. By using artificial spawning nests eggs can be transported to smaller indoor raceways and indoor trough hatching technology can be employed. This reduces the number of broodstock required for meeting the target fingerling production goal.

In early to mid-April. 12 pairs of adults will be taken and crowded into the covered raceway. Broodfish will be kept in this crowded condition for a period of two to three weeks and closely observed while the\- are acclimated to the warmer water temperatures. Prior to this period. the two sloughs and the two effluent ponds (0.11 acre) will be made ready to accept the newly hatched fry. Broodstock requirements were determined based on a need of 150.000 32mm fry and assuming 67% survival.

Once the water temperature in the fingerling rearing ponds approaches 60" F and the brood fish appear ready to spawn. artificial spawning nests will be staggered at eight foot intervals along each side of the raceway. A minimum of 12 to 14 nests are thus accommodated in the 60 ft. raceway.

During each of the spawning periods. nests with eggs are allowed to remain in the raceway for one day and are then transferred to the incubation troughs. Each trough can receive eggs only from spawns that are not more than 1-1/2 days apart. This is done to reduce size disparity and losses due to cannibalism. After two to three days in the troughs. the eggs hatch and fry begin to appear. The fry are held in the troughs for an additional four to five days. until they turn black in color, and are then stocked into the fertilized sloughs at 150.000 per acre. After three weeks the fry that are not released or planted will be brought back to the indoor troughs. or if the numbers exceed 50,000, they will be placed in the raceway. The 32mm fry will be stocked at an initial density of 0.25 lb./ft^3. and trained to receive artificial feed until they achieve a density of up to 1.0 lb./ft^3. At this maximum density. the four indoor troughs (86 ft^3 each) can accommodate up to 45.000 65mm fingerlings (assuming 90% survival). The raceway can accommodate up to 100.000 75mm fingerlings.

Once they are trained on feed (usually 3-4 weeks), the fingerlings are stocked in the sloughs for intensive rearing at a density of 50.000 per acre. Here they will be fed every 15 minutes at first. and every 30 minutes thereafter throughout this intensive rearing phase.

Physical aspects of rearing sloughs

The two sloughs located in the northwest section of the Pend Oreille Wetlands Wildlife Mitigation Project will be converted to largemouth bass nurseries by constructing a small water control structure at the mouth of each slough, and by providing a 4-inch diameter valved water supply pipeline that discharges near the head of each slough. These cost-effective structures will consist of pre-cast reinforced concrete slabs set in place and held by steel or wood piles. This design will include an overflow spillway with stop-log channels for level control and a valved bottom outlet pipe for draining and to facilitate fish harvest and pond maintenance.

The south slough will also be provided with a 2-inch air supply pipeline that can be used to power up to four air lifts, plus four 115 volt GFI outlets (for small dewatering pumps or future automatic feeders) along the eastern edge of the slough. These improvements will enable the intensive rearing and overwintering of fish in this slough. The north slough will be provided with river water and may be used for overwintering and for extensive fry rearing.

Two pumps. each capable of supplying a minimum of 100 gpm at a total dynamic head (TDH) of 78 feet. plus an air blower (80 scfm at 3.5 psi) will be installed in the sound proofed. heated and insulated pumpstation shed. Sufficient room will be provided for the future installation of 2 additional pumps and all electrical controls. A 6-inch diameter supply pipeline will carry water to the two sloughs. The bass can survive for several days without water exchange as long as feeding does not take place.

Biological aspects of rearing sloughs

Prior to largemouth bass spawning, the two sloughs will be filled, fertilized, and otherwise made ready to accept the newly hatched fry. Ten days after hatching. the largemouth bass are stocked into the fertilized sloughs at 150,000 per acre. The sloughs are harvested as soon as the zooplankton. which provide food for fry and fingerlings is eshausted. The grow out period usually lasts only three weeks, at which time approximately 100,000 32mm (1.25 inch) fry can be expected from the north slough, and approximately 50,000 fry from the smaller south slough.

Once they are trained on feed (usually 3-4 weeks), the fingerlings are stocked in the sloughs for intensive rearing at a density of 50.000 per acre. Here they will be fed every 15 minutes at first, and every 30 minutes thereafter throughout this intensive rearing phase (which at this location will probably terminate sometime in October - due to cooler water temperatures and diminished appetite). By the end of this rearing phase, the fingerlings will have grown to between 100mm and 140mm in size, and will have consumed 1.3 tons of feed per acre stocked. A 67% survival rate is expected during this phase. for a maximum production of 50.000 fingerlings for the 2 sloughs.

If the grow out season is shortened because of extreme cold, then the fingerlings could be overwintered in one or both of the sloughs. Overwintering will require the continuous pumping of oxygenated water, even when the sloughs are frozen over. Supplemental aeration. by means of air lifts. will prevent ice from forming near the dam structures and would allow feeding. affording some growth of the yearlings. Overwintering of the fingerlings in the controlled environment of the sloughs should greatly improve their survival. however will not be done.

Bass habitat study

Fluctuations in resenoir levels affect the amount of available cover for fish. The loss of cover is believed to be related to observed declines in standing crops of centrarchid species. such as largemouth bass. which are heavily dependent on stable and sheltered shorelines (Brouha and von Geldern 1979). This lack of cover may result in reduced food availability and higher predation on young-of-year fishes (Brouha and von Geldern 1979). Artificial structures have been used for many years to enhance fish populations.

Durocher et *al.* (1984). reported that recruitment of largemouth bass to 200mm total length intensified with increases in submerged vegetation coverage in Texas resenoirs. Presumably. shelter reduces predation mortality by providing habitat where young fish may not be seen or reached by predators (Miranda and Hubbard 1994). Savino and Stein (1982) concluded that increased cover reduced prey vulnerability.

By increasing cover within the Box Canyon reservoir, it is suspected that there will be an increase in overwinter survival of age 0+ largemouth bass. Currently overwinter survival of 0+ largemouth bass ranges from 0.4 - 3.9 percent (Ashe 1990; Bennett et *al* 1991). Bennett *et al.* (1991) suspected that poor ovenvinter survival of age 0^{+} largemouth is partially due to the lack of cover during the winter months. It is the goal of the bass habitat study to determine habitat structures that will maximize overwintering success of age 0- largemouth bass.

The bass habitat study will consist of two phases. Phase one will utilize the two rearing sloughs associated with the Tribal hatchery. The north slough (experiment) will be divided into two equal parts each part containing two separate types of habitat structures. Both sections will contain orchard trimming structures and Christmas tree structures. The south slough (control) will be divided into two equal parts. The south slough sections will be devoid of overwintering habitat structures.

The study will utilize resident stocks of juvenille bass collected from the Pend Oreille River. If not enough resident fish can be collected. the remaining numbers will be purchased from a hatchery facility in September 1996. The non-resident stock will be a northern strain of largemouth bass. Fish collected will be 0+ age class fish with similar size parameters. and will be stocked in the rearing sloughs during the same month. All collected resident fish will be marked upon capture to identify resident from hatchery stocks. and to further assist in determining stock success under study conditions.

Proportional amounts of fish. by weight (lbs/ft^3) will be added to the sloughs. Both stocks. resident and hatchery. will be mised into each individual section of the sloughs. Approximately 1000 fish will be used for the study. 800 fish will be purchased. and the remaining required amount will be collected from the Pend Oreille River.

Phase two applies the data collected in the first phase of this study. Structures found by the study to lead to the highest percentage of overwintering success, will be utilized and placed in prescribed areas of the Box Canyon Reservoir. Placement of structures within the Box Canyon reservoir will be in sloughs and the main channel within close proximity to the Kalispel Indian Reservation. All sites for habitat placement will be located in zero flow areas of the reservoir. Preferred areas for habitat placement are off the mouths and within sloughs. Potential sites arc Campbell. Calispel, Red Norse. Davis. and Pow - Wow sloughs (Figure 28).

Purchasing outside fish will add a new strain of fish that could potentially benefit the genetics of the present bass strain. If collected data indicates that the purchased fish are more hardy and capable of overwinter survival. then steps can be taken to incorporate their genetics into the hatchery rearing program. Differential survivability between the two stocks will be determined from overwintering survival data.

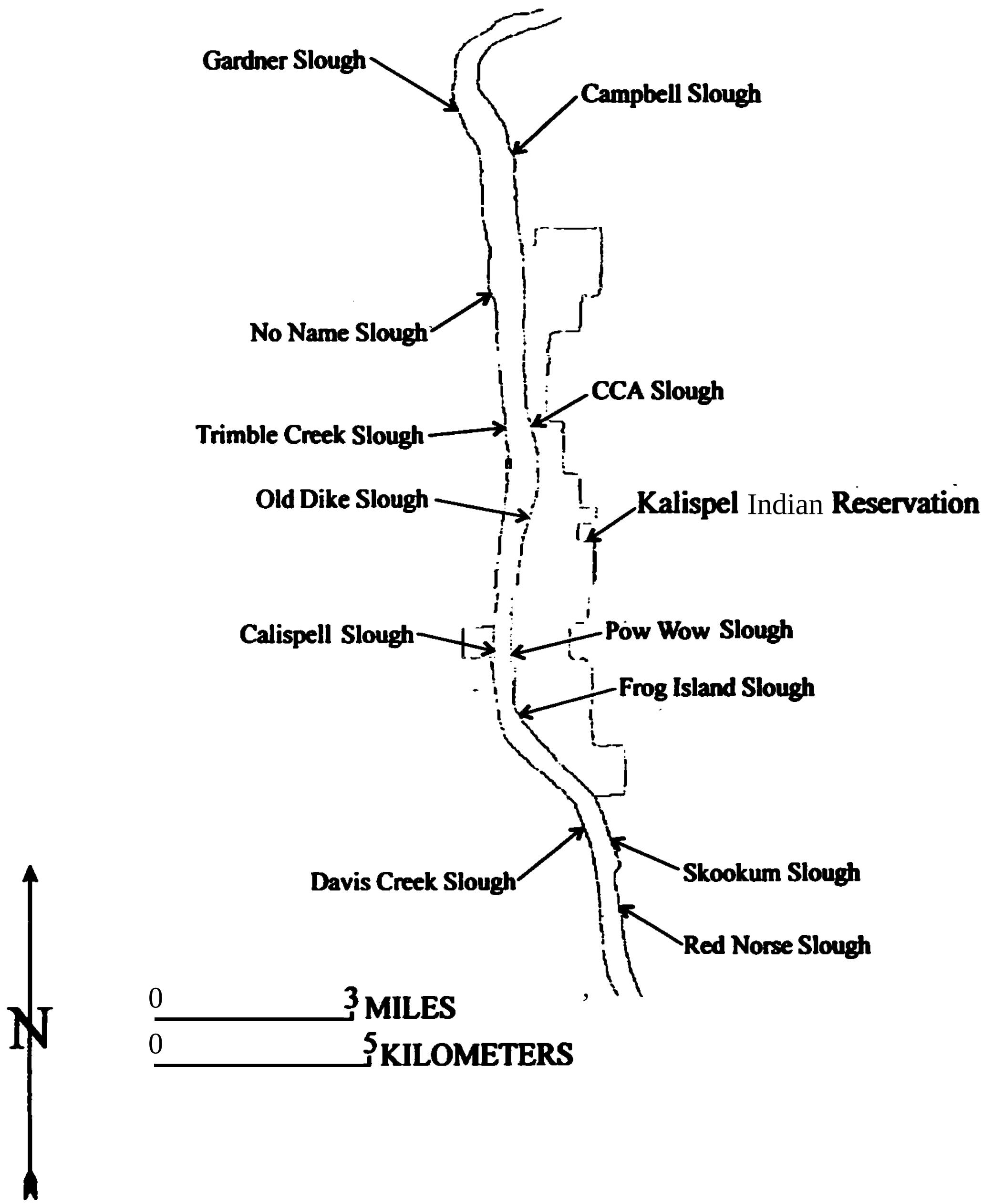


Figure 28. Potential sites for **habitat** placement and largemouth bass release.

Monitoring and Evaluation

Hatchery and rearing sloughs.

Monitoring and evaluation of the hatchery and rearing sloughs will be conducted by electroshocking the following spring. post hatchery release. to determine survivability of 1- age hatchery stocked bass. Before hatchery largemouth bass are released into Box Canyon Reservoir. they will be marked with either fluorescent pigment. fin clips or floy tags. Fluorescent pigment and fin clips can be used on small fish (<120mm). Floy tags can indicate the number of times that tish has been captured. Floy tags will be used on larger fish (> 120 mm). All fish will be released from the hatcher) by October. Potential sites for monitoring include the following sloughs: Calispel. Pow Wow. Frog Island. Red Norse. Davis Creek. Old Dike. CCA. Trimble. So Same. Campbell. Tiger and Gardner (Figure 28). There is a high probability of finding 1+ largemouth bass in sloughs. These sloughs v-ill also be potential release sites for the hatchery. Ten sample transects. 200 meters long will be chosen randomly within the mainstem river. These transects will be clcctroshocked along the shoreline. Monitoring will occur in late spring and all numbers of largemouth bass will be counted. Largemouth bass population will be estimated in the river and sloughs using the Schnabel multiple census as described by Ricker (1975). Numbers of hatchery fish will be counted and compared to that of the total age class. This will determine the contribution of hatchery largemouth bass to the overall population. During following years. age classes will also be monitored to determine hatcher\- contribution. These fish numbers will ultimately be used to see if the hatchery is meeting its biological objective.

Listed below are factors that will be monitored at the hatchery (physical and biological) and rearing sloughs (physical and biological) and are derived from Piper *et al.* (1992).

Physical aspects of the hatchery

<u>Water</u>
(1) Volume in cubic feet for each rearing unit and for the entire hatchery.
(2) Gallons per minute and cubic feet per hour flow into each unit and for the entire hatchery.
(3) Rate of change for each unit and for the total hatchery.
(4) Temperature

Biological aspects of the hatchery

<u>Mortality</u>
(1) Percent survivability from egg to fry
<u>Food and Diet</u>
(1) Cost per pound of feed and cost per pound of fish gained.
(2) Amount of food fed as percentage of fish body weight.

(3) Pounds of food fed per pound of fish produced (conversion).

Fish

(1) Broodstock and number of eggs produced.

(2) Weight and number of fish and eggs on hand at the beginning and end of accounting period.

(3) Gain in weight in pounds.

(4) Date eggs were taken. number per ounce. and source.

(5) First feeding of fry.

Disease

(1) Occurrence, kind. and possible contributing factors.

Physical aspects of rearing sloughs

Water

(1) Volume in acre feet.

(2) Average depth

(3) Inflow required to maintain water level in slough.

(4) Temperature

(5) Fertilization (dates. kind. amount, cost. results).

(6) Algae and zooplankton blooms (dates and secchi visibility in centimeters; kinds of plankton).

Biological aspects of rearing sloughs

Mortality

(1) Percent survivability from fry to fingerling.

Food and Diet

(1) Cost per pound of feed and cost per pound of fish gained.

(2) Amount of food fed as percentage of fish body weight.

(3) Pounds of food fed per pound of fish produced (conversion).

Fish

(1) Gain in weight in pounds.

(2) Average length and weight before release.

Disease

(1) Occurrence. kind. and possible contributing factors.

Bass habitat study

Monitoring and evaluation of the bass habitat study will be conducted during the summer of 1997. The sloughs will be drained and the numbers of live fish in each section will be counted to determine overwintering survival. Comparison will be done to determine which habitat produces the greatest overwintering success. Based on these results. the most effective structure will bc placed in Bos Canyon Reservoir the following fall. Once these structures are in place. they will be electroshocked during the spring months to determine habitat usage. This monitoring will be in conjunction with the bass hatchery monitoring. This monitoring will evaluate if the artificial structures are indeed increasing the overwinter survivability of 0- largemouth bass. This increased survivability will contribute to meeting its biological objectives.

Biological Objectives

Monitoring and evaluation of bass supplementation through hatchery, rearing sloughs and bass habitat study will be evaluated to determine their effectiveness of forwarding bass populations toward meeting the biological objectives adopted by the NWPPC.

Hatchery and rearing sloughs

Biological objective 1

Increase the biomass of harvestable largemouth bass in the Box Canyon Reservoir from a current **6lbs/acre** (44,400 pounds for entire reservoir) to an interim target of **8lbs/acre** (59,200 pounds for entire reservoir) by the year 2003 and a final target of 12lbs/acre (88,800 for entire reservoir) by the year 2008. The interim net gain will be 14,800 pounds of harvestable largemouth bass. The final net gain will be 44,400 pounds of harvestable largemouth bass.

Hatchery

Biological objective 1

Produce 150,000 largemouth bass fry.

Rearing sloughs

Biological objective 1

Produce 100,000, 32mm largemouth bass fry for release into Box Canyon Reservoir on an annual basis.

Biological objective 2

Produce 50,000,14Omm largemouth bass fingerlings for release into Box Canyon Reservoir on an annual basis.

Bass habitat study

Biological objective 1

Increase O+ largemouth bass overwinter survival from current levels of 0.4 -3.9 percent to approximately 15-20 percent. This increase in overwinter survival will contribute to the goal of 12lbs/acre of harvestable bass.

Predicted project outyear budget (x 1000).

OBJECTIVE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bass Hatchery	473	115	0	0	0	0	0	0	0	0
BassINtchayo&M	0	100	104	146	150	154	159	164	168	172
Cutthroat and bull trout investigations	0	85	85	0	0	0	0	0	0	0
Cutthroat and bull trout habitat projects	201	248	250	0	0	0	0	0	0	0
Brook trout removal Cee Cee Ah	2	2	0	0	0	0	0	0	0	0
Bass nursery sloughs	117	0	0	0	0	0	0	0	0-	0
Bass winter cover	2	2	0	0	0	0	0	0	0	0
M&E for objectives listed (LMB,)	0	100	52	38	38	38	0	0	0	0
M&E for objectives listed (CTT, BT)	0	23	20	90	90	90	0	0	0	0
ANNUAL TOTAL	795	675	511	254	278	282	159	164	168	172
10 YR. TOTAL	3,458									

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Appendices

KALISPEL WARM WATER FISH HATCHERY PROJECI'
FINAL DESIGN DEVELOPMENT REPORT

Prepared For

Kalispel Tribe of Indians

Kalispel Natural Resources Department

by

J-U-B Engineers, Inc.

and

JC Aquaculture Consultants

Funded by: U.S. Department of Energy
Bonneville Power Administration

March 1996

Acknowledgments

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Table of Contents

BACKGROUND

The Box Canyon Reach of the Pend OreiIle River was formed in 1955 by the construction of Box Canyon Dam. This created a reservoir which extends 55.8 river miles from Albeni Falls Dam in Idaho, to Box Canyon Dam in Washington The dam forever changed the habitat in this reach from that of a cold water fast-moving river, to a broad-but-shallow reservoir, with velocities ranging from 0.1 feet-per-second (fps) during summer low flows to upwards of 2.0 fps during spring high flows (Falter et al. 1991).

The resultant higher seasonal water temperatures, combined with the much enlarged water surface habitat have enabled the existence of a diversity of fish species (Skillingstad et al. June 1993), the most prominent beii: yellow perch (the most abundant), pumpkinseed, tench, largemouth bass, longnose sucker, mountain whitefish, northern squaw&h, black crappie, brown bullhead and large-scale sucker. The Kalispel Natural Resource Department estimates that in a 30 mile reach of the river, the existing largemouth bass density is approximately 6 pounds per acre. They would like to double this density - to 12 pounds per acre.

The Kalispel Tribe of Indians Warm Water Fish Hatchery to be constructed and operated with funds provided by the Bonneville Power Administration (BPA), is designed to greatly increase the resident largemouth bass (LMB) population in the Box Canyon Reach of the Pend Oreille River through annual plantings of up to 100,000 32mm (1.25 inch) fry, and/or up to 50,000 140mm (5.5 inch) fingerlings.

The warm water fish hatchery wilI be sited on the 436 acre "Flying Goose Ranch" located on the east side of the River, approximately 9 mile north of the Usk bridge on State Highway 20. The land is owned by BPA and will be held in trust by the Kalispel Tribe of Indians. The land is adjacent to the north boundary of the Kalispel Indian Reservation, in Pend Oreille County, Washington.

The project was assigned in the 1993 Northwest Power Planning Council's Phase IV Resident Fish and Wildlife Amendments to the Columbia River Basin Fish and Wildlife Program. The Kalispel Tribe will accomplish the project, and BPA will fund the project. The goal is to plan, design and cost a low-capital bass hatchery. Components of the hatchery project include:

warmwaterhatchery
Bass nursery (north and south sloughs)
Monitoring and evaluation of hatchery
Supplementation and bass rearing facilities

This report documents the warm water fish hatchery physical facility program and presents the Engineer's opinion of probable construction cost. Construction of the hatchery and bass nursery is scheduled for 1996.

SITE INVESTIGATIONS

Site investigations included topographic surveys, geotechnical explorations, and the testing of water quality samples taken in the north and south sloughs - the proposed bass nursery locations. These investigations were limited in scope and are discussed below. The sampled water quality results are summarized on Table 1 at the end of this Section. The complete investigative reports, or data have been appended to this report.

Topographic Surveys

One foot contours were surveyed for the entire area where the hatchery, raceway and other facilities will be placed. The existing road that extends across the wetlands area to the edge of river has also been profiled for design. Both the north and sough slough, that will be utilized in this project, were surveyed for their rough width, length and depth in order that accurate area/volume calculations could be performed for them. A straight line to a water depth of 12 feet out into river was also surveyed for location of the water intake pipeline. The products of this survey have been reduced to 11 x 17 sheets and can be found in Appendix A to this report.

Geotecbnical Engineering Analysis

The results of the geotechnical research, field evaluations, and engineering analyses performed for the site are presented in a report that appears in Appendix B. Conclusions and recommendations with respect to the soil and geologic conditions are included in this report to assist project planning and design. Based on the results of this . evaluation and their experience with similar site conditions, it is the Geotechnical Engineers' opinion that the site is suitable for the proposed development.

Water Quality Investigations

There has been a wealth of water quality and fisheries data collected in the Box Canyon Reach of the Pend Oreille River since it became a reservoir in 1955. J-U-B Engineers, Inc. and JC Aquaculture Consultants reviewed the following recent publications in order to evaluate the water supply source for the hatchery:

1. Trends in Water Quality on the Box Canyon Reservoir of the Pend Oreille River Adjacent to the Kalispel Indian Reservation, by T. Skillingstad and A.T. Scholz. Upper Columbia United Tribes Fisheries Center, Fisheries Technical Report No. 44, October 1993.

2. An assessment of the Pend Oreille River, WA receiving effluent from a Tbermomechanical Newsprint Mill: 199 l/92 Post-Operational

Report (same authors and agency as 1. above). Fisheries Technical Report No. 47, June 1993.

3. Water Quality, Fish and Wildlife Characteristics for Box Canyon Reservoir, Washington - Completion Report 1989-I 990, Section 2: Water Quality, by C.M. Falter, C. Baines and J.W. Calrson. Department of Fish and Wildlife Resources, University of Idaho, July 1991.

4. Box Canyon Reach Bass Migration Study, by Kalispel Natural Resource Department. Final Report, Final Report, 1995.

The above sources agree that the Box Canyon Reach of the Pend Oreille River is a moderately buffered, cool-water (34 F - 75 F), relatively stable water quality reservoir that most often meets EPA criteria for protection of aquatic life. Our study's own sampling of water quality in the two sloughs (at l/4, l/2 and 3/4 depth) that will be used as bass nurseries confirms those findings, and is summarized below as an average for the six samples tested on July 3 1, 1995.

TABLE 1

Flying Goose Ranch Slough Water Quality - July 1995.

Parameter	Average	Range
Temperature (°C)	20.6	18.7-22.3
PH	8.8	8.6-9.1
Dissolved Oxygen (mg/l)	10.0	7.3-12-l
Copper (mg/l)	co.02	co.02
Zinc (mg/l)	co.05	<0.05
Hardness (mg/l)	69.2	65-72
Sulfide (mg/l)	<1	<1

Dissolved oxygen, temperature and **pH** parameters were collected by the Tribe with a water quality meter, and the other parameters were collected by the Tribe and sent to Advance Analytical Services in Spokane, WA for analysis. The individual results of the testing for the six samples can be found in Appendix C.

SPACE PROGRAMMING AND PRELIMINARY PRODUCITON SCHEDULE

Facility requirements and scheduling depend upon the production program. While specific dates are indicated in Table 2 below for the largemouth bass (LMB) program, in reality, exact times of spawning, stocking and harvesting may vary by several'weeks.

Loading densities used in this LMB program are believed to be realistic and are largely based on actual production figures attained in other states. The LMB quantities and sizes presented in the next Section, along with the water temperatures and spawning and stocking rates given in Table 2, below, provide a basis for facility predesign. Actual operating conditions such as water temperature and quality, spawning and stocking dates, and mortality will vary seasonally and from year to year. Production requirements are also expected to change. Because of this need for flexibility, the initial production program has been designed to utilize both intensive and extensive culture practices, taking advantage of both the site area and the available water.

Some broodstock will be kept onsite in the raceway or a designated slough while the rest will be collected each spring from the wild. Minimizing onsite broodstock reduces the need for both adult holding facilities and forage feed, allowing the hatchery to make better use of its resources.

The preliminary production schedule summarized in Table 2 assumes the heating and reuse/biofiltration of spawning and incubation flows (100 gpm minimum from April through May) for the covered raceway and the four indoor troughs.

Table 2

Preliminary Production Schedule

April 7 - 30:	Collect broodstock and place in raceway (2-3 weeks conditioning period at 55-60 F)
May 7 - June 15:	Multiple spawnings and incubation at 60 - 65 F
May 15 - May 30:	Extensive rearing in 2 effluent ponds (passive heating)
May 15 - June 21:	Extensive rearing in 2 sloughs (and partial release/stocking)
June 15 -July 15:	Start on feed in 4 indoor troughs or the raceway
July 15 - September:	Intensive rearing in 1 or 2 sloughs (and partial release/stocking)

LARGEMOUTH BASS PRODUCTION PROGRAM

Eagerly sought by the angler, largemouth bass are one of the most popular freshwater game species. They are stocked and managed as a predator species in many lakes and reservoirs. Their optimum temperature range is **55°F** to **80°F** with spawning temperatures of 60°F to **65°F.** The species temperature tolerance is **33°F** to **95°F.**

Raceway spawning of LMB will be used at the Kalispel Hatchery. The techniques allows the fish culturist to easily observe the brood fish and determine the extent to which **successful** spawning is taking place. By using artificial spawning nests, eggs can be transported to smaller indoor raceways and indoor trough hatching technology are employed. This in turn reduces the number of broodstock required for meeting the target fingerling production goal.

In early - to mid-April, 12 pairs of adults will be taken and crowed into the covered raceway. The concrete raceway unit will be 60 feet long, by 8 feet wide and 4 feet deep. The broodfish will be kept in this crowded condition for a **period** of two to three weeks and closely observed while they are acclimated to the warmer water temperatures. Prior to this period, the two slough (1.5 acre total **surface** area) and the two effluent ponds (0.11 acre) will be filled, fertilized, and otherwise made ready to accept the newly hatched **fry.**

Broodstock requirements were determined based on a need of 150,000 32mm fiy, which is the expected production from the total slough area of 1.5 acres when stocked at the maximum recommended density of 150,000 (swim-up) fry per acre, and assuming 67% survival. It was further assumed that twelve 2.5 pound females, each capable of producing 5,000 (32mm) **fry** per bound of female, would be utilized, along with a male-to-female (M/F) ratio of 1: 1.

Once the water temperature in the fingerling rearing ponds (first the two passively heated effluent ponds, followed by the two sloughs) approaches 60 F and the brood fish appear ready to **spawn,** artificial spawning nests will be staggered at eight foot intervals along each side of the raceway. A **minimum of 12 to 14 nests are thus accommodated in** the 60 **ft.** raceway.

Spawning will commence usually within one to two days (at a tempemture of 60-65 F) and continue until the fish are again crowded in the raceway for a conditioning period of 10 days or more. During this conditioning **period,** the raceway will be cleaned and broodfish will be fed and inspected. Any fish that appears to be spawned-out or damaged will be culled **from** the raceway. The nests are then reintroduced in the raceway and the fish are allowed to spawn a second time. A third spawn is also possible, but usually does not constitute efficient use of raceway space.

During each of the spawning periods (usually 10 days to two weeks) nests with eggs are allowed to remain in the raceway for one day and are then transferred to the incubation troughs. Each trough can receive eggs only from spawns that are not more than 1 -l/2 days apart. This is done to reduce size disparity and losses due to cannibalism. Used nests are replaced with fresh ones to reduce competition within the raceway.

The fiberglass (FRP) incubation troughs will be 24 feet long by 2.5 feet wide, and about 2 feet deep. They can accommodate up to twenty 16-inch x **16-inch** artificial nests (mats) which are held in place vertically by hoods and a wire suspended along the centerline of the trough. The water flow to each unit is 10 gpm. **After** two to three days in the troughs, the eggs hatch and swim-up fiy begin to appear. The fry are held in the troughs for an additional four to five days (7 days total time in troughs), untiI they turn black in color, and are then stocked into the fertilized sloughs at 150,000 per acre. The sloughs are harvested as soon as the zooplankton, which provide food for fry and fingerlings is exhausted. The grow out period usually lasts only three weeks, at which time approximately 100,000 32mm (1.25 inch) fry can be expected from the north slough, and approximately 50,000 fiy from the smaller south slough.

Four troughs, which are re-used once per week, will be required for incubation and fry production for the program described above.

The 100,000 fiy **raised** in the north slough can all be planted or released directly to the Pend Oreille River, or a portion can be combined with those from the south slough, and started on feed back at the hatchery building.

The **fry** that are not released or planted will be brought back to the indoor troughs, or if the numbers exceed 50,000, they will be placed in the raceway. The 32mm **fry** will be stocked at an initial density of 0.25 **lb./ft3,** and trained to receive artificiaI feed (usually Biodiet, supplemented with krill) until they achieve a density of up to 1 .O **lb./ft3.** At this maximum density, the four indoor troughs (86 **ft3** each) can accommodate up to 45,000 65mm fingerlings (assuming 90% survival). The raceway can accommodate up to 100,000 75mm fingerlings.

Once they are trained on feed (usually 3-4 weeks), the fingerlings are stocked in the sloughs for intensive rearing at a density of 50,000 per acre. Hear they will be fed . every 15 minutes at first, and every 30 minutes thereafter throughout this intensive rearing phase (which at this location will probably terminate sometime in October - due to cooler water temperatures and diminished appetite). By the end of this rearing phase, the fingerlings will have grown to between 1OOmm and 14Omm in size, and will have consumed 1.3 tons of feed per acre stocked. A 67% survival rate is expected during this phase, for a maximum production of 50,000 fingerlings for the 2 sloughs.

The heating and reuse of hatchery water should enable the production of 1OOmm to 14Omm fingerlings in one grow-out season during most years. If the grow out season is shortened because of extreme cold or if greater survival/larger fish size is desired then the fingerlings could be overwintered in one or both of the sloughs. Overwintering will required the continuous pumping of oxygenated water - even when the sloughs are frozen-over solidly. Supplemental aeration, by means of air lifts will prevent ice from forming near the dam structures and would allow feeding, and thus some growth of the yearlings when they are stocked the following spring. Overwintering of the fingerlings in the controlled environment of the sloughs should greatly improve their survival.

FACILITY DESCRIPTION

This Section describes the improvements to be constructed at the “Flying Goose Ranch” in order to accommodate the LMB production program presented in the previous Section. The major improvements include: river intake and pump station, water control structures (sloughs), hatchery building, raceway and effluent ponds. All of the above are depicted on schematic level drawings which appear at the end of this Section. The probable costs for the improvements are presented in the last Section - which immediately follows the drawings.

River Intake and Pump Station

The only water supply source for the hatchery complex is the Pend Oreille River. A 500 ft. long, 8-inch diameter pipeline will extend along the river bottom to a minimum elevation of 2,022 feet (“normal” river level is 2,03 1 A.). The pipeline will be weighed down by concrete blocks to prevent movement, and a small stainless steel screen will prevent the entry of larger debris and fish. The intake pipeline is sized for future flow requirements (400 gpm), and will be designed to be easily extended to deeper water, if need be. The pipeline will terminate in a cylindrical “wet sump” located below the pump station floor. Steel grating will cover the open top of the wet sump to facilitate installation, removal and inspection of pump suction/intake lines.

Two pumps, each capable of supplying a minimum of 100 gpm at a total dynamic head (TDH) of 78 feet, plus an air blower (80 scfm at 3.5 psi) will be installed in the sound proofed, heated and insulated pumpstation shed. Sufficient room will be provided for the future installation of 2 additional pumps and all electrical controls. A 6-inch diameter supply pipeline will carry water to the two sloughs, the raceway and the hatchery building. This pipeline is also sized for a future flow of approximately 400 gpm, and will be buried in a shallow trench alongside the access road. This same trench will also carry the 3 phase electrical power supply for the pump station and the sloughs.

An emergency generator will not be installed at the pump station at this time as a cost-reduction measure. During the initial phase of operation, the hatchery building and raceway unit will rely on water reuse and oxygen supplementation/aeration during power outages. The sloughs can survive for several days without water exchange as long as feeding does not take place (extensive rearing of fry during spring months does not require water exchange). As a safeguard, however, a small portable generator could be used to power the air blower and thus provide oxygen to the south slough - the only one equipped for intensive rearing and overwintering during this initial phase.

Water Control Structures

The two slough will be converted to LMB nurseries by constructing a small dam at the mouth of each slough, and by providing a Cinch diameter, valved water supply pipeline that discharges near the head of each slough. The cost-effective dams will consist of steel sheet piling, held in place by steel or wood piles. This design will include an overflow spillway with stoplog channels for level control, and a valved bottom outlet pipe for draining and to facilitate fish harvest and pond maintenance.

The south slough will also be provided with a 2-inch air supply pipeline that can be used to power up to four air lifts, plus four 115 volt GFI outlets (for small dewatering pumps or future automatic feeders) along the eastern edge of the slough. These improvements will enable the intensive rearing and overwintering of fish in this slough. The north slough will be provided with river water and thus it too can be used for overwintering and for extensive fiy rearing. An access road will be installed by the Tribe along the eastern bank of the north slough to facilitate construction of the north dam. During this initial phase, however, neither electrical power nor air will be extended to this slough for cost considerations. Intensive rearing of LMB fry in the north slough will have to wait until the above improvements can be constructed.

The 2 dams will enable a normal pool elevation of 2,034 feet, and result in increased slough water surface areas when compared to "normal" river elevation of 2,03 1 feet. The combined water surface area of the 2 sloughs will be about 1.5 acres - with the larger north slough accounting for a full 1 .O acres.

Hatchery Building

This pre-engineered metal building will consist of two very distinct areas:

1) a "dry" area with ceilings and stud wall partitioning it into offices, restrooms, lunch room and visitor facilities; plus a
2) "wet lab area" with high, exposed ceilings, exposed insulation, floor trenches, a Ioft and a feed preparation room.

The 2,529 ft.2 building will be designed with future expansion in mind, e.g.: a 10 x 10' roll up door and clear access isle to the north end of the building; oversized and stubbed-out water supply and air pipelines (but not water treatment equipment); oversized drains, etc.

The large (1,400 ft2) "wet lab" area will house 4 FRP troughs-each 2.5ft. by 24 ft long; overhead distribution lines for air and water; a floor-mounted and LPG powered boiler with plate heat exchanger and (2) circulation pumps; a 46 inch diameter by 9 ft tall biofilter with backwash motor (for raceway and trough water reuse during power outages and/or early start on spawning and incubation); a wall-mounted 10 lamp ultraviolet (U.V.) disinfection unit; and two loft-mounted water treatment units consisting of a 30 micron rotating drum screen (for screening river water prior to its use at the hatchery and the raceway), and a 12-inch diameter degassing column for re-aerating reuse water and for degassing of any heated water. A 200 ft.2 enclosed area below the Ioft will have a large stainless steel sink, tiled countertops, plastic laminate wall surfaces and a central floor drain. This feed preparation room will contain shelves, a small freezer (not supplied), and numerous GFIC electrical outlets for operating small appliances (misers, blenders, etc.).

Lighting in the wet lab area will consist of 14 fluorescent light fixtures (4 bulbs each) with sealed cleared lens covers. The fixtures will be suspended from the ceiling/roof trusses, and will be wired to control the lighting in four individual areas (4 switches). Space heaters (also suspended from the roof trusses) and three large exhaust fans will provide heating and ventilation for the wet lab spaces.

The office and visitor areas will have electrical baseboard heaters and windows or exhaust fans for ventilation. Handicapped access will be provided to all visitor and office areas.

Raceway Unit

A reinforced concrete raceway, measuring 8 ft wide by 60 fi long and 4 ft deep, will be used for LMB spawning as well as intensive rearing of other species that will be produced at the hatchery. The raceway will be supplied with water both directly from the river (untreated), as well as screened and disinfected hatchery water. A shallow sump on one comer of the raceway will house a submersible pump for reuse of water. Reuse mode will be manually initiated to either save energy when the water is heated during spawning, or as a safety precaution for power outages. The incubation troughs' overflow from the hatchery building can also be diverted to this sump for reuse, thus reducing the size of the hot water boiler. To further reduce energy consumption during cold month, the raceway unit will be full enclosed with an insulated fabric and steel frame enclosure roughly 22 A wide by 70 A long (refer to Raceway Section). Low-pressure air from the hatchery building will be stubbed out along one wall of the raceway to promote fish health during intensive rearing. Space heaters could also be provided (but are not included) to reduce the load on the water boiler during wintertime operations, when LMB broodstock or other fish species are overwintered in the raceway.

Effluent Ponds

Two earthen effluent ponds, each having bottom dimensions of 30 ft by 80 ft, will be used to settle-out solids from the hatchery building and raceway unit effluent. Three sides of the ponds will have standard 3: 1 slopes, while the east berm will feature a 5: 1 slope to facilitate entry by a front-end loader. The ponds will have individually valved 6-inch diameter PVC inlet pipes and concrete outlet structures with slots for level control. The overflow from the ponds will be piped to an open ditch that discharges into the nearby marsh. Each effluent pond will be periodically isolated and allowed to dry. The concentrated waste on the earthen pond bottom will then be removed by a front end loader. This nutrient rich soil will make excellent fertilizer, and after being totally dried, can be spread on crops, pasture and timber land.

The effluent ponds receive water from the hatchery and raceway unit, and thus could be used to overwinter some fish. A solar pond liner (not supplied), as commonly used on swimming pools, could also be used as a passive source of solar heat energy to increase water temperature and improve overwintering survival.

Site Work

Miscellaneous site work includes providing: yard piping to and from the hatchery building and the raceway, and drain/overflow piping to the effluent ponds; filtration and disinfection of river water to be used as potable water-and its transmission to the hatchery building and the residence; a septic system for the hatchery and residence; a monitor and alarm system for the hatchery building and the raceway; electrical power transmission extending to the river pump station and south slough, as well as raceway, water treatment, including the residence to be supplied by the Owner; surfacing of the hatchery building parking and raceway area; and finally an entry gate and fence to control entry to the fish hatchery (existing barbed wire fence is to remain).

PROBABLE COST

The purpose of this cost estimate is to provide current information about project budge requirements. The estimate includes cost items for facility program implementation, except for office furnishings, vehicles, laboratory equipment, computers, and other specialty items. Since there is no diit control over the cost of labor and materials in the context of the competitive bidding process, a guarantee of cost estimate accuracy cannot be given. The cost estimate presented in the Table at the end of this Seciton has been prepared without the benefit of detailed plans and specifications. More detailed cost data will be developed during the project design effort.

Sources

Construciton costs are bhased on unit prices which were determined by J-U-B Engineers and JC Aquaculutre Consultants based on professional experience and recent bid results for similar projects in other locations. Costs were estimated in 1995 dollars and esclated to represent 1996 construciton cost. No allowances were made for extra costs related to overtime work or adverse weather conditions.

Design and Construciton Contigency Allowance

Any construciton project can have certain unpredictable expenses, both minor and major changes in process and design, estimating errors, rapid price changes for some components, labor shortages or strikes affecting both productivity and schedules and overlooked items. To cover the cost of these umpredictable expenses, an allowance for various contingencies must be included I the total project cost at all levels of estimating. The contingency is designed to reduce project risk and should be large enough to cover all likely unforeseen and unpfiedictable events, conditions and occurrences. The contingency will vary accorking to the type of project, complexity of design, length of construction and geographical location. This allowance can be reduced as the desigh progresses from concept through final working documents, but the contigency must remain throughout the life of the project as a reserve for events that experience shows will likely occur.

1) **Design Contigency Allowance: A** design contigency allowance relative to the complexity of the design is to be included in all levels of estimates to compensate for the lack of defmition, omissions, underestimates of both quantities and costs, changes in the design or corrections to erroneous assumptions. Based on past experience, a minimum design contigency applicable for this phase of the project is 10 percent.

2) Construction Contigency Allowance: A construction contigency allowance is used at all levels of estimates to cover unknown site conditions, additional costs caused by longer project schedules, lower than anticipated productivity and cost overrun3 due to a lack of definition in the construction documents. A 5 percent construction contigency is included.

Owner Supplied

The Engineer's Opinion of Probable Cost, which appears on the next page, shows all work to be done by the Contractor under the column entitled "Base Bid". The nit prices for this work include the Contractor's Overhead and Profit mark-up of 20 to 25 percent. For this reason, a portion of the new hatchery work that can be easily provided by the Kalispel Natural Resources Department staff- such as purchasing, installing, and interconnecting water treatment units with PVC

ENGINEER'S OPINION OF PROBABLE COST

Sep. 95

PROJECT:

KALISPEL TRIBE BASS HATCHERY FACILITY

BASED ON PRELIMINARY PROGRAM REPORT

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	BASE BID	OWNER SUPPLIED
1	INTAKE PIPELINE	500	LF	$15	$7,500	
2	STAINLESS STL. SCREEN & BUOY	1	LS	$1,489	$1,489	
3	CONCRETE ANCHORS	110	EA	$23	$2,500	
4	PUMP STATION SHED	100	SF	$25	$2,500	
5	WET SUMP & GRATING	1	LS	$3,500	$3,500	
6	5 HP PUMPS, PIPING & VALVES	2	EA	$6,000	$12,000	
7	5 HP BLOWER & PIPING	1	LS	$3,000		$3,000
8	ELECTRICAL & CONTROLS	1	LS	$3,000	$3,000	
9	DAM W/SPILLWAY & OUTLET VALVE	2	EA	$30,000	$60,000	
10	ACCESS ROADWAY IMPROVEMENTS	1	LS	$10,000		$10,000
11	6" SUPPLY PIPELINE	2,500	LF	$12	$30,000	
12	LOW POINT DRAIN & 4 ISO VALVES	1	EA	$1,500	$1,500	
13	HATCHERY BUILDING (2,550 S.F.)			$37,600	$37,600	
	SLABS, FOOTINGS & ERECTION			$37,600	$37,600	
	STUB WALLS & FINISH	150	LF	$32	$4,800	
	DROP CEILINGS	1100	SF	$3	$3,300	
	BATHROOM FIXTURES	200	FT2	$60	$12,000	
	WINDOW SCREENS	1		$1,000	$100	
	HEATING & VENTILATION	1		$5,000	$5,000	
	ELECTRICAL & LIGHTING NRML	2550	SF	$5	$12,750	
	STAINLESS SINKS/FAUC	1		$2,000	$2,000	
14	HATCHERY BLDG SPECIAL CONSTRUCTION					
	LOFT COLUMNS & FLOORING	200	SF	$22	$4,400	
	FLOOR TRENCH & GRATING	110	SF	$30	$3,300	
	CASE WORK, TILE WORK & WATER	1	LS	$9,000	$9,000	
	10'X10' ROOL UP DOOR IN BLDG					
	CONC. LANDINGS, RAMPS	7	EA	$400	$2,800	
	PIPE HANGERS	100	LF	$25	$2,500	
	LPG TANK (OUTDOORS)	1	LS	$800	$800	
15	LIFE SUPPORT EQUIPMENT:					
	ROTATING DRUM SCREEN (30X24)	1	EA	$12,000		.$12,000
	U.V. DISINFECTION	1	EA	$9,000		$9,000
	BOILER HEAT XCH & RECIRC PUMP	1	LS	$10,000	$10,000	
	46 INCH DIA. BIOFILTER	1	EA	$11,000		$11,000
	OVERHEAD PLUMBING	1	LS	$10,000		$10,000
	2 HP BLOWER & ACCESORIES	1	LS	$3,000		$3,000
	TROUGHS	4	EA	$2,750		$11,000
	12" DEGASSING COLUMN & HEADER	1	EA	$3,000		$3,000
16	RACEWAY: 60'X8'X4'	1	LS	$23,000	$23,000	
17	RE-USE SUMP PUMP & PIPING	1	LS	$4,000	$400	
18	RACEWAY COVER	1	LS	$13,000	$13,000	
19	YARD PIPING	1	LS	$7,000	$7,000	
20	EFFLUENT PONDS	2	EA	$6,500	$13,000	
21	EMERGENCY GENERATOR & PAD	1	LS	$22,000	$22,000	
22	MONITOR & ALARM SYSTEM	1	LS	$20,000		$20,000
23	ELECTRICAL POWER TRANSMISSION	4000	LF	$4	$16,000	
24	POTABLE WATER SYSTEM	1	LS	$5,000	$5,000	
25	SEPTIC TANK SYSTEM	1	LS	$12,000	$12,000	
26	MOBILE HOME	1	LS	$35,000		$35,000
27	PARKING AREA & ROAD SURFACING	1	LS	$2,700	$2,700	
28	ENTRY GATE & FENCE	1	LS	$3,000	$3,000	
	TOTAL BASE BID				$389,039	
	TOTAL OWNER SUPPLIED BID					$127,000
	CONTINGENCY 15%				$58,356	
	ESCLATION 4%				$15,562	
	TOTAL BASE BID				$462,956	
	TOTAL OWNER SUPPLIED					$127,000
	TOTAL ESTIMATED PROJECT COSTS				$589,956	

J-U-B ENGINEERS, INC

W. 422 RIVERSIDE, SUITE 722, SPOKANE, WASHINGTON 99201 (509) 458-3727

APPENDIX A

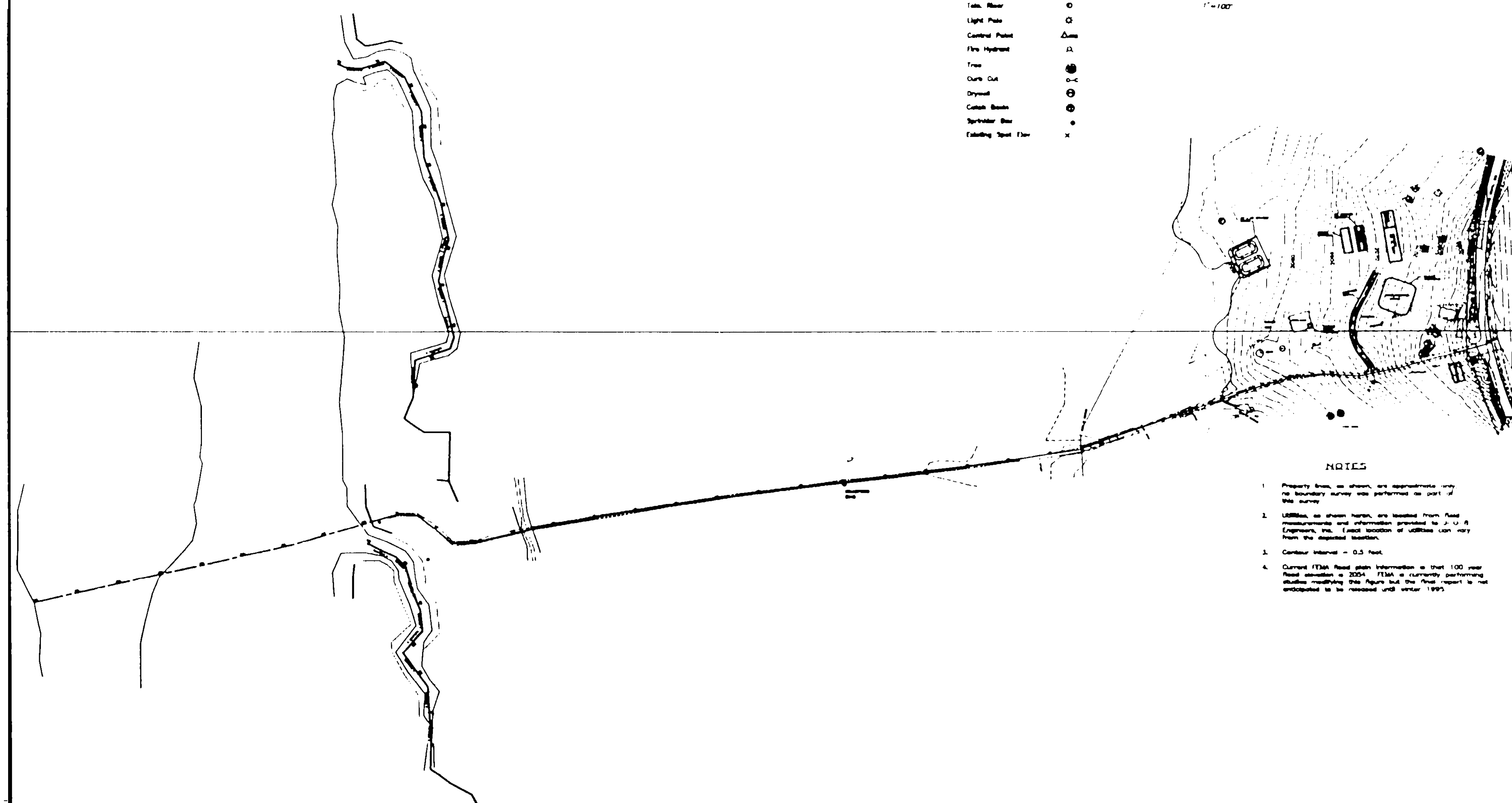
TOPOGRAPHIC SURVEYS

LEGEND

Water Valve	●
Water Manhole	●
Water Meter	
Power Pole	
Guy Anchor	
Tele. Riser	
Light Pole	
Control Point	△
Fire Hydrant	
Tree	
Curb Cut	
Drywell	
Catch Basin	
Sprinkler Box	●
Existing Spot Elev	×

N

1" = 100'



NOTES

1. Property lines, as shown, are approximate only, no boundary survey was performed as part of this survey.
2. Utilities, as shown herein, are located from field measurements and information provided to J-U-B Engineers, Inc. Exact location of utilities can vary from the depicted location.
3. Contour interval = 0.5 feet.
4. Current FEMA flood plain information is that 100 year flood elevation is 2054. FEMA is currently performing studies modifying this figure but the final report is not anticipated to be released until winter 1995.

J-U-B

1250 IRONWOOD DRIVE
Suite 220
COEUR d'ALENE, IDAHO
83814
PHONE: 208-667-1574
FAX: 208-667-2176

KALISPELL INDIAN TRIBE
FISH HATCHERY

USK, WA.

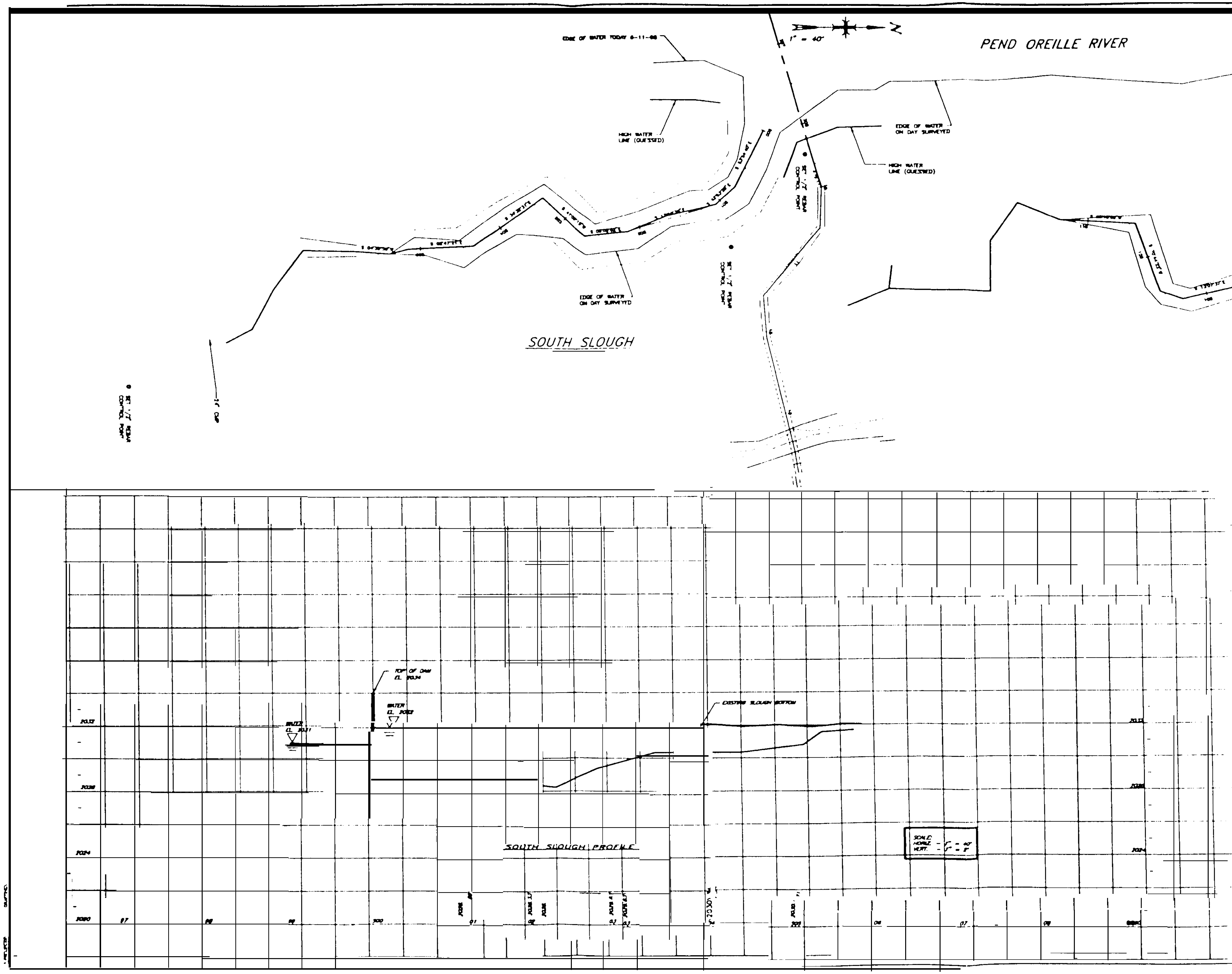
OVERALL SITE PLAN

REUSE OF DRAWINGS

REVISION DATA TABLE

DRAWING DATA

SHEET 6 OF 10



J-U-B
1250 IRONWOOD DRIVE
Suite 220
COEUR d'ALENE, IDAHO
83814
PHONE: 208-667-1571
FAX: 208-667-2178

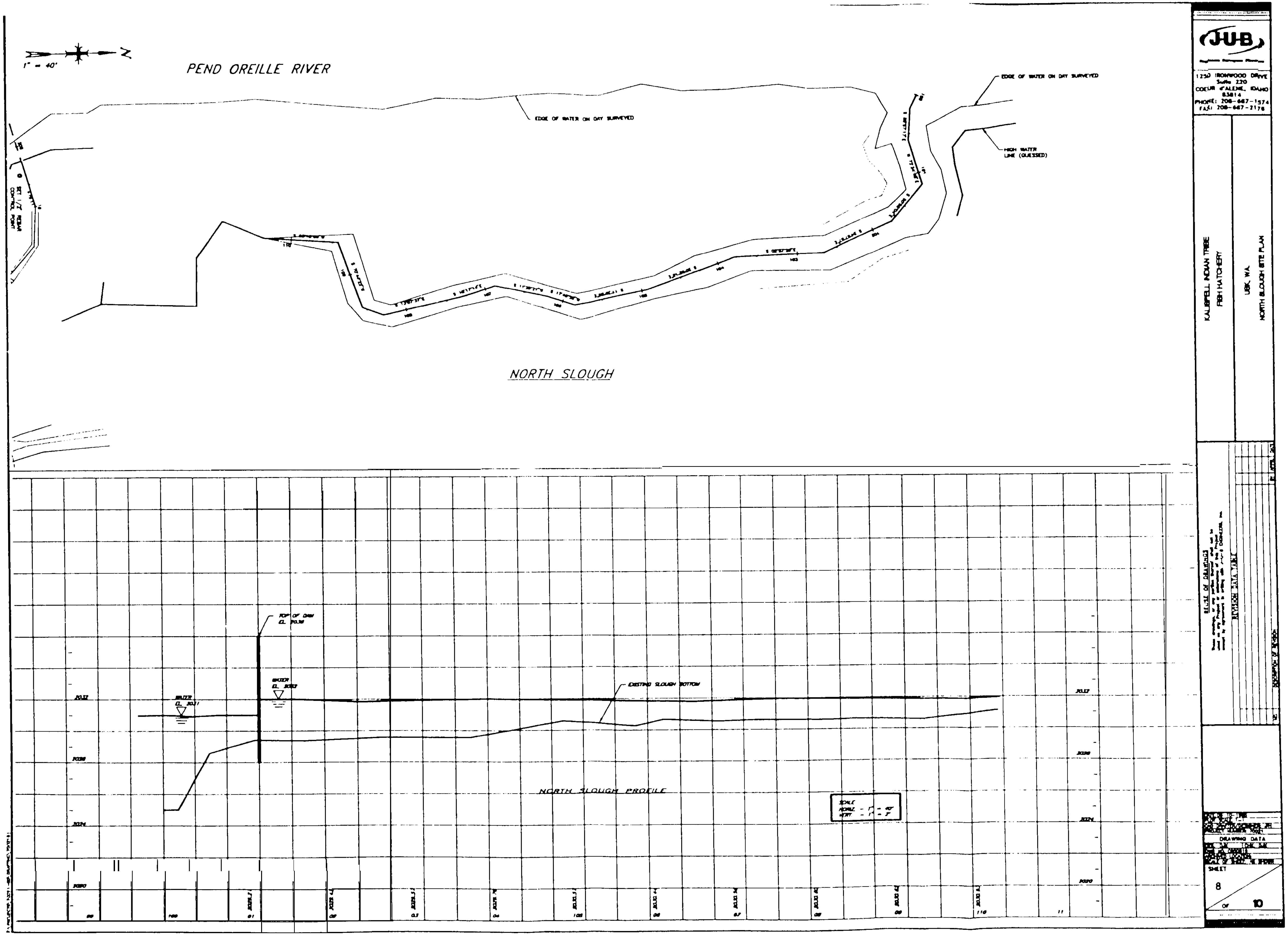
KALISPELL INDIAN TRIBE
FISH HATCHERY

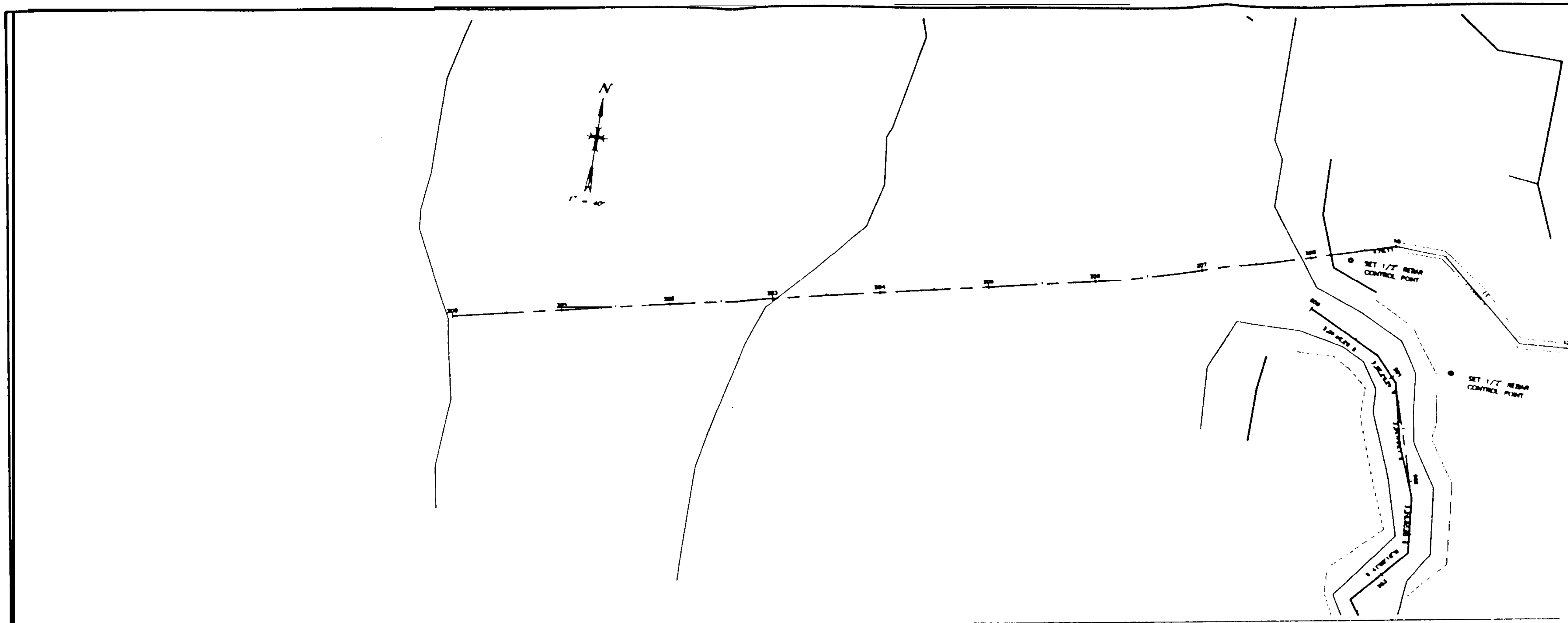
USK, WA.

SOUTH SLOUGH SITE PLAN

DRAWING DATA

SHEET 7 OF 10


1" = 40'
PEND OREILLE RIVER
EDGE OF WATER ON DAY SURVEYED
EDGE OF WATER ON DAY SURVEYED
HIGH WATER LINE (GUESSED)
SET 1/2" REBAR CONTROL POINT
NORTH SLOUGH
TOP OF DAM EL. 2030.38
WATER EL. 2031
WATER EL. 2032
EXISTING SLOUGH BOTTOM
NORTH SLOUGH PROFILE
SCALE
HORIZ. - 1" = 40'
VERT. - 1" = 2'
2032
2028
2024
2020
J-U-B
1250 IRONWOOD DRIVE
Suite 220
COEUR d'ALENE, IDAHO
83814
PHONE: 208-667-1574
FAX: 208-667-2176
KALISPELL INDIAN TRIBE
FISH HATCHERY
USK, WA.
NORTH SLOUGH SITE PLAN
DRAWING DATA
SHEET
8
OF
10



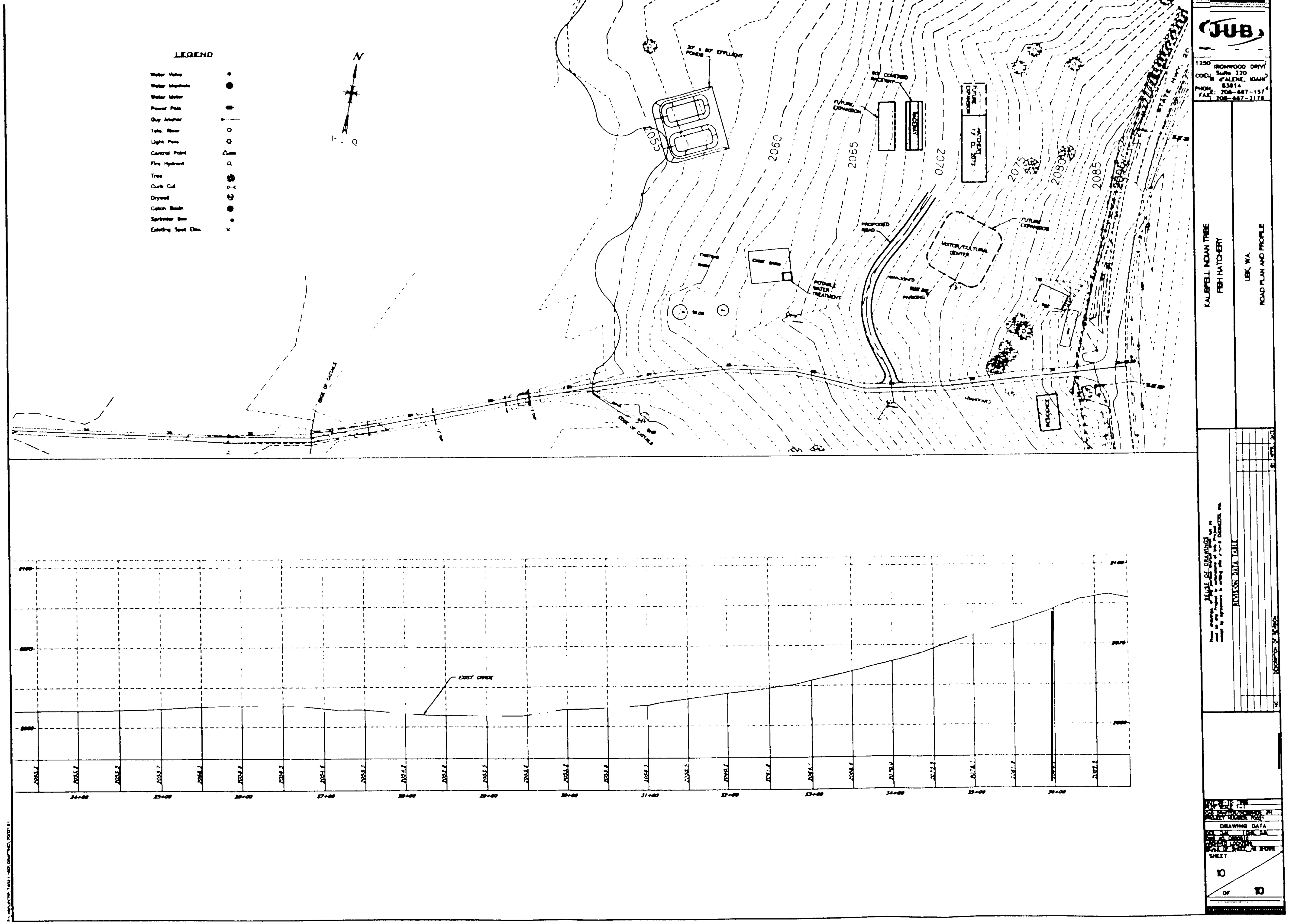
J-U-B

KALISPELL INDIAN TRIBE
FISH HATCHERY

USK, WA.

DRAWING DATA

SHEET 9 OF 10



LEGEND
Water Valve
Water Manhole
Water Meter
Power Pole
Guy Anchor
Tele. Riser
Light Pole
Control Point
Fire Hydrant
Tree
Curb Cut
Drywell
Catch Basin
Sprinkler Box
Existing Spot Elev.
N
30' x 80' EFFLUENT PONDS
FUTURE EXPANSION
PROPOSED ROAD
FUTURE EXPANSION
VISITOR/CULTURAL CENTER
POTABLE WATER TREATMENT
PARKING
RESIDENCE
STATE HWY. 20
EDGE OF CATTAILS
EXIST GRADE
2055
2060
2065
2070
2075
2080
2085
24+00
25+00
26+00
27+00
28+00
29+00
30+00
31+00
32+00
33+00
34+00
35+00
36+00
J-U-B
1250 IRONWOOD DRIVE
Suite 220
COEUR d'ALENE, IDAHO
83814
PHONE: 208-667-1574
FAX: 208-667-2176
KALISPELL INDIAN TRIBE
FISH HATCHERY
USK, WA.
ROAD PLAN AND PROFILE
REVISION DATA TABLE
DRAWING DATA
SHEET
10
of 10

APPENDIX B

SOILS REPORT

REPORT

GEOTECHNICAL ENGINEERING EVALUATION
PROPOSED FISH HATCHERY
LECLERC CREEK ROAD
USK, WASHINGTON

August 25, 1995

August 25, 1995
Project No. S0423-0110

Mr. David J. Kliewer, P.E.
JUB Engineers, Inc.
422 W. Riverside, Ste. 722
Spokane, Washington 99201

RE: REPORT
Geotechnical Engineering Evaluation
Proposed Fish Hatchery
LeClerc Creek Road
Usk, Washington

Dear Mr. Kliewer:

Howard Consultants, Inc. has completed the authorized geotechnical engineering evaluation for the proposed fish hatchery to be constructed on the Leclerc Creek Road, Kalispell Indian Reservation near Usk, Washington. The evaluation was performed in accordance with the authorized scope of our proposal dated July 14, 1995.

The attached report presents the results of our research, field evaluations, and engineering analyses. Conclusions and recommendations with respect to the soil and geologic conditions are included in the report to assist project planning and design. Based on the results of this evaluation and our experience with similar site conditions, it is our opinion that the site is suitable for the proposed development.

The report has been prepared based on limited information about project plans and design. We recommend that we review the final plans and design to verify that our recommendations are consistent with the plans. We recommend that Howard Consultants be retained perform all required and recommended construction observation and monitoring. These services would be performed on a time and expense basis.

We appreciate the opportunity to be of service to you on this project. We are available to answer any questions that you may have regarding this evaluation.

Sincerely,
HOWARD CONSULTANTS, INC.

Chris C. Beck, P.E.
Project Engineer

W. Mark Storey, P.E.
Senior Engineer

WMS:kh

REPORT
Geotechnical Engineering Evaluation
Proposed Fish Hatcheq
Leclerc Creek Road
Usk, Washington

PREPARED FOR:
Mr. David J. Kliewer, P.E.
JUB Engineers, Inc.
422 W. Riverside, Ste. 722
Spokane, Washington 99201

PREPARED BY:
Howard Consultants, Inc.
N. 2128 Pines Road, Suite SN
Spokane, Washington 99206

August 25.1995

TABLE OF CONTENTS

REPORT

Geotechnical Engineering Evaluation
Proposed Fish Hatchery
Leclerc Creek Road
Usk, Washington

INTRODUCTION

Howard Consultants, Inc. has completed the authorized geotechnical engineering evaluation for the proposed fish hatchery to be located adjacent to the Pend Oreille River approximately nine miles north of Usk, Washington. The purpose of the evaluation was to investigate the subsurface soil conditions with respect to the proposed development and to provide geotechnical engineering recommendations to assist project planning, design, and construction. The scope of work for the evaluation was limited to the following:

1. An in-house literature review of pertinent geologic and soil information for the site and surrounding area.

2. A visual field reconnaissance of the geologic and soil conditions for the site to assess the potential for artificial fills or other potentially harmful geotechnical features.

3. A field evaluation by drilling five exploratory borings within the proposed development area. The soils encountered were visually classified using the Unified Soil Classification System (USCS) at the time of exploration and the subsurface profiles were logged.

4. Laboratory tests to assess some of the soil engineering properties and physical characteristics of the subsurface materials sampled.

5. Engineering analyses and preparation of recommendations for foundation design, settlement, lateral earth pressures, earthwork, subgrade preparation, embankment design, earth anchor capacities, and drainage.

6. Preparation of this summary report of our findings.

PROPOSED CONSTRUCTION

It is our understanding that the proposed construction will consist of a hatchery building near the roadway, and two water-retaining structures across the natural sloughs adjacent to the Pend Oreille River. The building will likely have column loads on the order of five kips and perimeter (strip) foundation loads on the order of two to three kips per linear foot. The building is planned to be constructed without a subgrade basement retaining wall. The structure will be supported by the perimeter, strip footings, and by interior column footings. Concrete slab-on-grade floors are anticipated for the building interiors.

Access driveways to the building will be constructed from the east property boundary at the road. Driveway and parking areas will likely be gravel surfaced. Cut and fill grading on the order of two to three feet, will be required to develop the property. Structural fill placement may be required for utility trench backfill, and building pad construction. Final design of the site improvements was not complete at the time of our studies.

EVALUATION PROCEDURES

Five borings were drilled in the proposed building and impoundment areas. The approximate locations of the borings are indicated on Plate 1, Site Schematic. The exploratory locations were established in the field by taping and pacing from existing site features. The field work was performed by a geotechnical engineer from our office on July 28, 1995.

The borings were drilled with a Boretec B-24 trailer mounted drill rig equipped with standard four inch inside diameter flight augers. The soils encountered were visually described and classified in accordance with ASTM D-2487 and D-2488. The subsurface profiles were logged and the depth to groundwater was measured and logged where encountered. In-situ standard penetration (SPT) blow count determinations were conducted in accordance with ASTM D-1586. Selected soil samples were obtained for possible laboratory testing.

PROPERTY CONDITIONS

The proposed fish hatchery facility is to be located approximately nine miles north of Usk, Washington on the east side of the Pend Oreille River. The property is bordered on the north and south by undeveloped land, on the east by Leclerc Creek Road, and on the west by the Pend Oreille River. Access to the development will be from the east, from Leclerc Creek Road. Specifically, the site is centered at the common corners of Sections 17, 18, 19, and 20, Township 34 North, Range 44 East, Willamette Meridian.

At the time of our field evaluation, the ground surface of the property was relatively level at the area of the sloughs, and gently sloping to the west at the area of the proposed building. Maximum relief across the property was on the order of 20 to 25 feet. Vegetation on the site primarily consisted of wild native weeds, brush, and mature trees.

SOIL AND GEOLOGIC CONDITIONS

The USDA Soil Conservation Service (SCS) has mapped the soils on and around the site in "Soil Survey of Pend Oreille County Area, Washington", 1968, as the Cusick silty clay loam, Dalkena fine sandy loam and Sacheen loamy fine sand. The Cusick and Dalkena are mapped as fluvial soils adjacent to the Pend Oreille River, and the Sacheen is mapped as old alluvial fan material next to the road. These soils typically consist of very deep grained sands and silty clays, formed from alluvial reworking of glacial debris deposited on outwash plains. These soils are reportedly low to moderately permeable, are poorly drained, and have rapid runoff. They have a low to moderate shrink/swell potential and a slight erosion hazard. The pH of the soils typically ranges from 6.1 to 7.3. The corrosive potential of the soils is considered moderate for uncoated steel and moderate for concrete.

Bedrock geology at the site was mapped as Quaternary glacial lucustrine deposits overlying Metasedimentary rocks on "Geologic Map of Washington - Northeast Quadrant" by Stoffel and others, 1991. The alluvial soils consist of silt, clay, and minor sand lucustrine and fluvial deposits interbedded. Our exploration and surface observation generally support this mapping.

SUBSURFACE CONDITIONS

Topsoil or fill was encountered at the ground surface in all five borings. The topsoil was 1 to 1.5 foot thick and consisted of brown to dark brown, moist fine sand with roots and organics. The root zone extended up to approximately 18 inches below the ground surface. The fill was up to two feet thick and consisted of sand, gravel, and clayey silt containing minor debris.

Native alluvial soils were encountered below the fill and topsoil in all of the borings. These soils generally consisted of interbedded silt clays, fine silty sands, and clayey sands. The thickness of the individual units ranged from one to eight feet and the relative density ranged from medium dense to dense.

Ground water was encountered in the borings at the time of the field evaluation. The groundwater was observed at depths of 12 to 13 feet in borings B-1 through B-4, and six feet in B-5. It should be noted that the elevation of the water table may vary with changes in precipitation, infiltration, irrigation, and development in the area.

Detailed descriptions of the subsurface conditions encountered in the borings are presented in Appendix A. The Unified Soil Classification System (USCS) shown on Plate 3, should be used to interpret the terms used on the exploratory boring logs and throughout this report. The subsurface conditions encountered varied from boring to boring. There may be additional variance across the site and these conditions may not be apparent until construction. The possible variation of subsurface conditions that may be encountered during construction could affect construction costs, plans, and schedule.

RECOMMENDATIONS

General

It is our opinion that the site is suitable for the proposed fish hatchery development with respect to the soil and geologic conditions encountered. The following recommendations are presented to assist the planning and design of the proposed building and water impoundment structures. Our recommendations are based on our experience with similar soil and geologic conditions and our understanding of the proposed construction.

The recommendations are presented based on our limited understanding of the plans for the project. We recommend that we review the final plans and if necessary revise our recommendations. If we are not authorized to perform the review we cannot be responsible for geotechnical design errors or omissions.

Site Preparation

We recommend that vegetation, fill, and topsoil be excavated from the proposed building, roadway and water impoundment areas prior to initiating site grading. The topsoil should be removed from the site or stockpiled on site and re-used for landscaping. We estimate the thickness of the topsoil to range from 12 to 18 inches across the property. The uncompacted fills encountered in the eastern portion of the property are estimated to range from one to two feet. The fill may be suitable for re-use as backfill and structural fill. Re-use of the fill should be monitored by HCI during construction.

After the topsoil and fill are removed, the upper 8 inches of the exposed native soil subgrade should be, moisture conditioned and compacted to at least 92% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor) prior to construction of roadways or placement of structural fill and backfill.

Excavation

The site soils may be excavated with conventional soil excavation equipment. During the dry months a water truck may be necessary to suppress air-borne dust.

Caving or trench wall failure may hamper excavation of trenches greater than 4 feet deep. The sides of excavations greater than 4 feet deep, including excavation for utility trenches should be sloped at no greater than 1.5:1 (horizontal to vertical) utilizing OSHA regulations and local codes.

Structural Fill

Fill can be classified as backfill, structural fill or non-structural fill. Backfill is defined as soil placed against the outside perimeters of the foundation walls. . Structural fill is defined as fill which underlies, or is within 5 feet of, building and pavement areas. Non-structural fill is fill which is at least 5 feet outside of building and pavement areas. Structural fill should consist of GW, GP, GM, SW, SP, SM, or ML soil as designated by the Unified Soil Classification System, Plate 3.

Structural fill should be placed in eight-inch-thick, loose lifts at near-optimum moisture content and compacted to at least 92% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor). Non-structural fill should be placed in twelve-inch-thick, loose lifts and compacted to at least 85% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor). The on-site sandy and gravelly soils appear to be suitable for use as structural fill and backfill. Areas of clayey soil material exist, and are not suitable sources for structural fill. We recommend that HCI be retained to determine the suitability of specific on-site soils as fill during development of the site. It will be necessary to moisture condition these soils to near optimum moisture content before placement and compaction. We recommend that a large smooth drum vibratory roller be used for compaction.

Spread Footing Foundations

It is our opinion that the site is suitable for the proposed building construction. Structure(s) should be supported by conventional spread footings designed to bear on the native soils or granular structural fill (underlain by native soils). Any fill placed in areas to support foundations must be compacted to a minimum of 92% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor). After the foundation soils are excavated to the planned subgrade, the upper 12 inches of exposed native soil should be moisture conditioned and compacted to remediate the disturbance resulting from excavation activities.

We recommend that foundations for the structure be designed based on a maximum allowable bearing pressure of 1500 pounds per square foot on the native clayey soils. Interior column footings should be embedded at least 16 inches below the top of concrete slabs. The allowable bearing pressure may be increased by up to 30% to account for transient live loads such as wind or seismic. Based on these recommendations, it is our opinion that total and differential settlements will be on the order of 1 1/4 inch and 3/4 inch over a 50 foot span, respectively.

All foundation bearing surfaces should be free of loose soil and debris just prior to placing concrete. Exterior footings should bear at least 36 inches below the exterior ground surface to protect against frost action. The strip footings should be a minimum of 16 inches wide. A coefficient of friction $f_s = 0.25$ should be used for design of foundations supported on the native soil.

When constructing foundations, it is likely that varying geologic conditions will be encountered. Our site exploration delineated several soil types at the proposed bearing level in the area of the proposed building (borings B-1, B-2, and B-3). Grading and excavation operations at the site may expose differing materials within the same foundation excavation. We are of the opinion that transitions from one to another soil type within the same foundation excavation is acceptable provided that the footings are stiffened with extra reinforcing steel to account for "soft" spots.

Lateral Earth Pressures

Below grade walls should be designed to resist lateral earth pressures. We recommend that the lateral earth pressures be calculated using an equivalent fluid pressure (efp) of 70 pounds per cubic foot (pcf) for the at rest case (no wall movement); 50 pcf for the active case (wall movement away from the soil mass); 230 pcf for the passive case (wall movement towards the soil mass). A coefficient of friction between the native soils and concrete of f_s =0.25 should be used for retaining wall designs.

At-rest earth pressures are typically used for foundation retaining walls that support building loads and cannot withstand lateral movement. Gravity or cantilevered retaining walls that do not support building loads and can tolerate lateral displacement can be designed using active earth pressures. Passive earth pressures are typically used in conjunction with the soil coefficient of friction to resist either the active or at-rest earth pressures acting on a retaining structure.

The above equivalent fluid pressures assume that the retaining walls are drained and that there are no hydrostatic forces acting on the walls. We recommend that the walls be drained so that hydrostatic forces do not adversely affect the walls and to reduce the potential for leakage or seepage. We recommend that the exterior wall surfaces be draped with Miradrain (or equivalent). At 4-inch diameter perforated pipe should be utilized to collect the water discharged from the wall drain. A solid 4-inch pipe should then divert these waters to a suitable discharge receptor.

Concrete Slabs-On-Grade

We recommend that the upper 6 inches of subgrade soil underlying concrete slab-on-grade floors be moisture conditioned and compacted to at least 92% of the maximum dry density as determined by ASTM D-1557. The concrete slab-on-grade floors should be underlain by at least 6 inches of 5/8-inch-minus, well-graded, crushed sand and gravel base course with less than 5% passing the #200 sieve. The base course will provide structural support, a leveling course and moisture protection for the slab. The base course should be compacted to at least 95% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor). The slabs should be designed for the anticipated use and loading.

It has been our experience that performance of impermeable floor coverings is significantly affected by moist or wet conditions. Moisture vapor may permeate through typical basement floors. To prevent poor performance of impermeable floor coverings, we recommend that consideration be given to including a moisture and vapor barrier beneath concrete slab-on-grade floors. The barrier should consist of a 2-inch-thick layer of clean coarse sand covered by thick polyethylene sheeting covered with an additional 2-inch-thick layer of clean coarse sand. This barrier should be placed between the base coarse and the concrete slab-on-grade floors.

Road Subgrade Preparation

Subgrade soils for the roadways will likely be native or fill soils consisting of sandy silt and/or silty clay. It is our opinion that the native soils encountered in our borings are acceptable for use as subgrade materials underlying pavements providing the soil meets the specified compaction and site preparation recommendations. The roadway section should be designed to resist frost action and facilitate drainage.

We recommend the base course consist of 5/8 inch-minus, well-graded, crushed sand and gravel, with no more than 5% passing the #200 sieve be included in the roadway design. The base coarse should be compacted to at least 95% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor).

Sheet Piling Water Impoundment

It is our understanding that the hatchery water impoundment structures may be construction may be constructed utilizing driven sheet pile and h-pile system where as the cantilevered portion of the sheet piles will be utilized to retain the water. Sheet piles will be constructed to retain up to six to seven feet of water, above the top of the sediment level. Based on our computations, the sheet piles will be a minimum of seventeen feet long, with seven feet of pile exposed above the sediment level. Free surface water will act both at the toe and behind the impoundment.

Based upon our computations, and observations of the soils within the exploratory borings, PZ-27 Standard US Steel sheet piles may be utilized for construction of the water impoundment. The overflow structure may be constructed utilizing standard "H" piles, constructed in a way that wood slats may be utilized to change the level of water behind the impoundment. The sheet pile wall should extend at least three feet beyond the edge of the impoundment slough on either side. Additionally, the joints between the individual sheet piles should be constructed or provided with suitable leak prevention material as to minimize the potential for leakage of the sheet pile wall system. Based on our assessment of the soils in the area of the proposed impoundments, we are of the opinion that corrosion of the sheet piles will not hamper the effectiveness of the impoundment system for at least 50 years.

Pre-Cast Concrete Water Impoundment Structures

It is our understanding that the proposed hatchery impoundments may be constructed utilizing a pre-cast concrete panel supported on helical earth anchors. The pre-cast panel will be supported against lateral loads via inclined anchors, and will be imbedded into the native soils a sufficient distance to minimize the potential for piping or internal soil erosion.

Based on our computations, and assuming a maximum head differential of seven feet between the interior and exterior of the impoundment structure, we recommend the concrete panel extend a minimum of five and a half feet into firm native material to reduce the potential for future piping or internal soil erosion. This may be accomplished by excavating a trench or ditch perpendicular to the slough, placing the concrete pre-cast panel structure, backfilling the interior side with a bentonite-soil mixture, and backfilling the remainder of the excavation with native material. Helical earth anchors may be installed to resist both lateral and vertical stresses. The anchors must be structurally tied to the panel to provide proper long term support. We recommend the following table for design of helical anchors in the native soils.

Allowable Anchor Capacities
Minimum Extension = 10 feet

Helices Diameter(s) - inches	Tensile Capacity (Kips)	Compressive Capacity (Kips)
6-8	3.9	3.9
8-10	6.5	6.5
10-12	9.8	9.8
8-10-12	12.3	11.7
10-12-14	17.6	15.8

If additional design criterial or information regarding helical anchors is required, we can provide the information.

Embankment Stability

Constructed slopes are commonly susceptible to minor sloughing. To minimize erosion and slope instability, we recommend that constructed slopes be designed for a maximum inclination of 3:1 (horizontal to vertical). Cut slopes and fill slopes constructed for roadways should be designed for a maximum slope of 3:1 (horizontal to vertical). Material placed for fill slopes should be placed in eight-inch-thick, loose lifts and compacted to a minimum of 92% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor). All slopes should be re-vegetated as soon as possible after construction is complete.

Storm Water Drainage and Ground Water

Development of this site will alter the run-off and infiltration characteristics of the site. We recommend that run-off from the proposed site be collected and directed away from the foundations to a suitable discharge receptor. Site grading should allow for positive drainage of surface water away from the proposed structures. Irrigation should be minimized adjacent to the structures.

Ground water was encountered in the borings at the time of the evaluation. Based on our exploration, we anticipate that ground water may be encountered in the excavations at the time of construction. Ground water may exist during the life of the structure. Therefore, recommendations for below grade wall drainage should be followed.

Erosion Control

Erosion control measures such as silt fences, straw bale dikes, and sediment basins may be necessary if construction occurs during heavy periods of precipitation in the winter and spring months. The exposed native soils will be susceptible to gullying and erosion. Minor areas of sloughing may be anticipated on constructed slopes until vegetation is established. We recommend constructed slopes be maintained through removal of sloughed materials and reseeding these areas. All areas that are disturbed during construction should be re-vegetated as soon as practical.

Seismicity

The proposed development site is located within Zone 2B in the 1991 edition of the Uniform Building Code. Zone 2B corresponds to an earthquake of intensity VII on the Modified Mercalli scale or approximately 5.5 on the Richter scale. A soil factor of S_1 S_2 S_3 S_4 as shown in table 16-J in the 1994 Uniform Building Code should be used for seismic design.

Plan Review and Construction Monitoring

We recommend that Howard Consultants, Inc. review the final plans and specifications for the project prior to construction. It has been our experience that having the consultants from the design team review the construction documents prior to bidding minimizes the potential for errors and also reduces costly changes to the contract during construction. Also, we recommend that Howard Consultants, Inc. be retained to provide the following construction monitoring services to verify the soil conditions, report recommendations, and materials specifications requirements are incorporated into the actual construction:

1. Observe earth work operations at the site;

2. Observe the foundation excavations.

The costs for these services are not included in the scope of work for this evaluation. If we are not retained to provide the recommended plan review and construction monitoring services, we cannot be responsible for soil or materials engineering related construction errors or omissions.

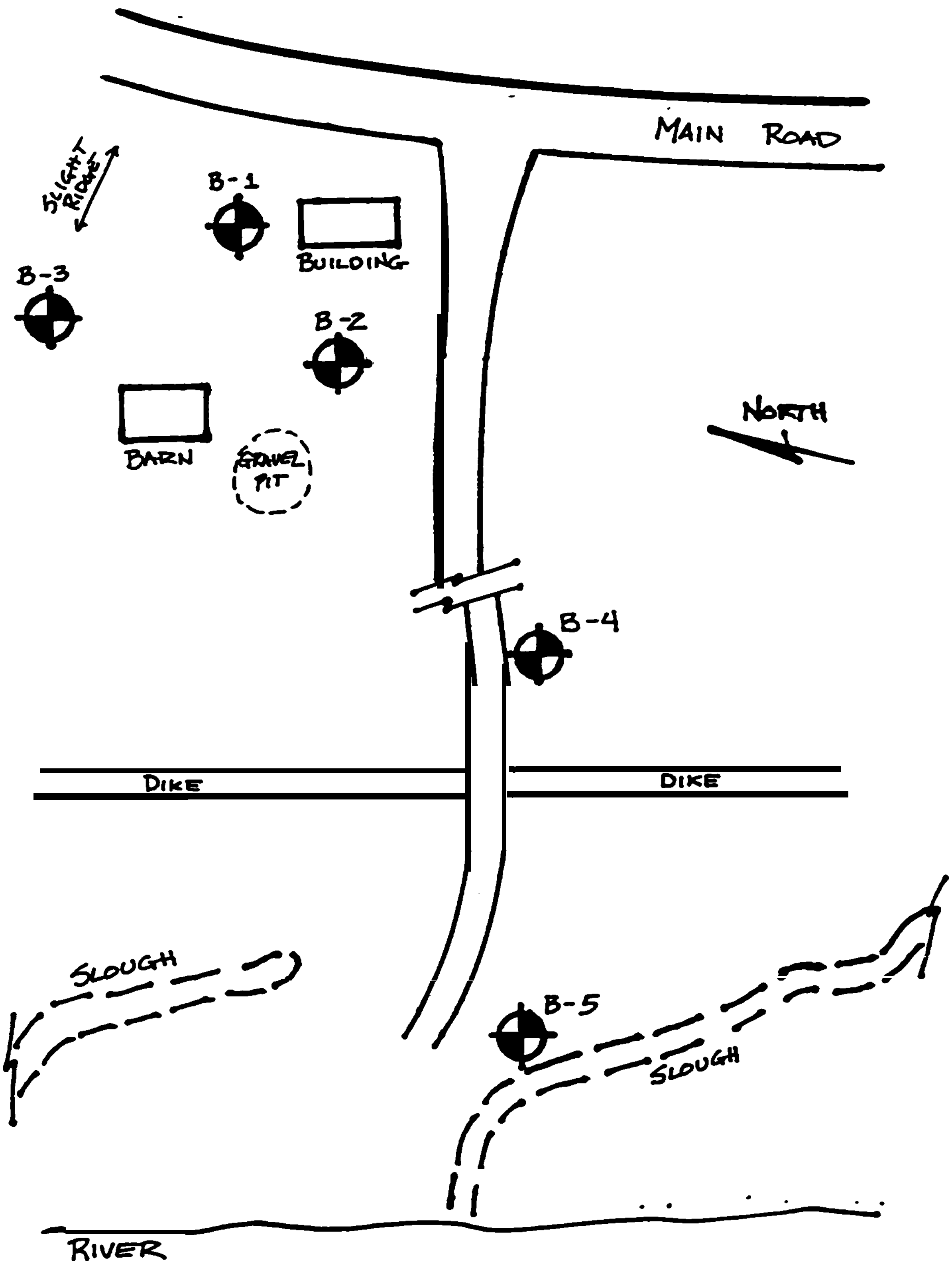
EVALUATION LIMITATIONS

This report has been prepared to assist the planning and design of the proposed fish hatchery located on Leclerc Creek Road, Kalispell Indian Reservation, near Usk, Washington. Our services consist of professional opinions and conclusions made in accordance with generally accepted geotechnical engineering principles and practices. This acknowledgement is in lieu of all warranties either expressed or implied.

The following plates accompany and complete this report:

Plate 1 - Site Schematic
Plate 2 - Unified Soil Classification System
Plate 3 -
Plate 4 - Proctor Test Results
Plate 5 -
Plate 6 -
Plate 7 -
Plate 8 -

Appendix A - Boring Logs



SITE SCHEMATIC

NOT TO SCALE

HCI Howard Consultants, Inc.

PLATE

BY. CHECKED BY .DATE FILE REVS BY DATE

EXPLORATORY BORING DESCRIPTION Description	Depth (Feet)	Sampler Type	SPT (Blows/ft)	Moisture Content (%)	Dry Unit Weight (pcf)	Pocket Penetrometer (tsf)
GRAVEL, SAND, CLAY (Fill) - Dark brown, loose, humid to moist with minor debris.						
	1					
	2					
	3					
Silty CLAY (CL) - Light grey with orange brown mottling, firm, moist.	4		10			
	5					
	6					
	7					
Silty CLAY (CL) - Light gray with orange brown mottling, firm, moist with organic peat stringers. PP = 1.5 tsf.	8		8			1.5
	9					
	10		6			
SAND with Silt and Clay (SP) - Light to medium gray, loose, saturated.	11					
	12					
	13					
	14					
Silty CLAY with fine Sand (CH) - Light to medium grey, soft to very soft, saturated.	15		3			
	16					
	17					
	18					
	19					
Silty Clay to Clayey SAND (CH/SC) - High plasticity clay, sand inner beds, expect interbedded soft clay and loose sand, saturated, grey to brown.	20		4			1
	21					
BORING TERMINATED AT 21.0 FEET.	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					

Project No: S0423-0110	Boring No: B-1
Logged By: CCB	Date Drilled: 07/28/95
Drill Rig: Boretec	Boring Diameter: 7"
Depth to Ground Water: 12'	Surface Elevation: n/a

EXPLORATORY BORING LOG

EXPLORATORY BORING DESCRIPTION Description	Depth (Feet)	Sampler Type	SPT Blows/ft)	Moisture Content (%)	Dry Unit Weight (pcf)	Pocket Penetrometer (tsf)
Grass and Sod to 12" to 18".						
	1					
	2					
	3					
Sand with Gravel (SP/SW) - Light brown grey to tan, fine to coarse, loose to medium dense, humid, subangular.	4		8			
	5					
	6					
	7					
nd with Gravel (SP/SW) - Orange to yellow brown, coarse, medium dense, mist, angular.	8		40			
	9					
	10		17			
	11					
	12					
	13					
REFUSAL AT 13.5 FEET.	14					
	15					
BORING TERMINATED AT 15.0 FEET.	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					

Project No: S0423-0110	goring No: g-2
Logged By: CCB	Date Drilled: 07/28/95
Drill Rig: Boretec	Boring Diameter: 7"
Depth co Ground Water: n/a	Surface Elevation: n/a

EXPLORATORY BORING LOG

APPENDIX C

WATER QUALITY DATA

Advanced Analytical Services

P.O. Box 3928 • E. 1514 Sprague Ave. • Spokane, WA 99202
Phone: 509/535-9791 • Fax 509/535-1537

LABORATORY NUMBER: 11254365

DATE RECIEVED: 7/31/95

DATE COLLECTED:

SYSTEM NAME: SI #1 1:4

SYSTEM ID#: **GROUP:**

COUNTY:

SOURCE TYPE:
SURFACE ☐ WELL ☐
SPRING ☐ PURCHASE ☐

SAMPLE TAKEN:
BEFORE TREATMENT ☐
AFTER TREATMENT ☐

SOURCE NO: **NAME:**

COLLECTED BY:

TELEPHONE:

TREATMENT TYPE:
FLUORIDATION ☐
CHLORINATION ☐
FILTRATION ☐
WATER SOFENER ☐
OTHER ☐

DISTRIBUTION ADDRESS:

NAME:
PRIVATE
KALISPEL TRIBE
P.O. BOX 39
USK, WA 99180

TELEPHONE:

TESTS	*MCL	LESS THAN	RESULTS	UNIT	COMPLIANCE YES	NO	CHEMIST INTIALS
Antimony	0.006			mg/l			
Arsenic	0.05'			mg/l			
Barium	2.0'			mg/l			
Beryllium	0.004			mg/l			
Cadmium	0.005'			mg/l			
Chromium	0.1'			mg/l			
Copper	1.0	<	0.02	mg/l	X		WM
Iron	0.3			mg/l			
Lead	0.05'			mg/l			
Manganese	0.05			mg/l			
Mercury	0.002'			mg/l			
Nickel	0.1			mg/l			
Selenium	0.05'			mg/l			
Silver	0.1'			mg/l			
[illegible]				mg/l			
Thallium	0.002			mg/l			
Zinc	5.0	<	0.05	mg/l	X		WM
Hardness			65	mg/l as			PW
Conductivity	700			[illegible]			
Turbidity	1.0'			NTU			
Color	15.0			COLOR			
Chloride	250			mg/l			
Cyanide	0.2			mg/l			
Fluoride	2.0'			mg/l			
Nitrate	10.0'			mg/l			
Nitrite	1.0			mg/l			
Sulfate	250			mg/l			
TDS	500			mg/l			

LABORATORY COMMENTS:
SULFIDE < 1 mg/L
TOTAL PHOSPHATE 0.057 mg/L
CALCIUM 18 mg/L

REMARKS:

LABORATORY SUPERVISOR: WALTER MUELLER

DATE OF REPORT: 8/14/95

*ND = NOT DETECTED

Advanced Analytica l Services

P.O. Box 3928 • E. 1514 Sprague Ave. • Spokane, WA 99202
Phone: 509/535-9791 • Fax 509/535-1537

LABORATORY NUMBER:	TESTS	*MCL	LESS THAN	RESULTS	UNIT	COMPLIANCE YES	NO	CHEMIST INITIALS
1254366	Antimony	0.006			mg/l			
DATE RECIEVED:	Arsenic	0.05'			mg/l			
/31/95	Barium	2.0'			mg/l			
DATE COLLECTED:	Beryllium	0.004			mg/l			
	Cadmium	0.005'			mg/l			
SYSTEM NAME:	Chromium	0.1'			mg/l			
#1 1/2	Copper	1.0	<	0.02	mg/l	X		WM
	Iron	0.3			mg/l			
	Lead	0.05'			mg/l			
SYSTEM ID# / GROUP	Manganese	0.05			mg/l			
	Mercury	0.002'			mg/l			
COUNTY:	Nickel	0.1			mg/l			
	Selenium	0.05'			mg/l			
SOURCE TYPE:	Silver	0.1'			mg/l			
SURFACE ☐ WELL ☐	Sodium				mg/l			
SPRING ☐ PURCHASE ☐	Thallium	0.002			mg/l			
SAMPLE TAKEN:	Zinc	5.0	<	0.05	mg/l	X		WM
BEFORE TREATMENT ☐	Hardness			71	mg/l as			PW
AFTER TREATMENT ☐	Conductivity	700			umhos			
SOURCE NO: / NAME:	Turbidity	1.0'			NTU			
	Color	15.0			COLOR			
COLLECTED BY:	Chloride	250			mg/l			
	Cyanide	0.2			mg/l			
TELEPHONE:	Fluoride	2.0'			mg/l			
	Nitrate	10.0'			mg/l			
TREATMENT TYPE:	Nitrite	1.0			mg/l			
FLUORIDATION ☐ CHLORINATION ☐	Sulfate	250			mg/l			
FILTRATION ☐ WATER SOFENER ☐ OTHER ☐	TDS	500			mg/l			

LABORATORY COMMENTS:
SULFIDE < 1 mg/L
TOTAL PHOSPHATE 0.084 mg/L
CALCIUM 19 mg/L

DISTRIBUTION ADDRESS:

NAME:
PRIVATE
KALISPEL TRIBE
P.O. BOX 39
USK, WA 99180

TELEPHONE:

REMARKS:

LABORATORY SUPERVISOR: [signature]
WALTER MUELLER

DATE OF REPORT:
8/14/95

*ND = NOT DETECTED

Advanced Analytical Services

P.O. Box 3928 • E. 1514 Sprague Ave. • Spokane, WA 99202
Phone 509/535-9791 • Fax 509/535-1537

LABORATORY NUMBER: 11254367

DATE RECIEVED: 7/31/95

DATE COLLECTED:

SYSTEM NAME: SI#1 3/4

SYSTEM ID#: GROUP:

COUNTY:

SOURCE TYPE: SURFACE ☐ WELL ☐ SPRING ☐ PURCHASE ☐

SAMPLE TAKEN: BEFORE TREATMENT ☐ AFTER TREATMENT ☐

SOURCE NO: NAME:

COLLECTED BY:

TELEPHONE:

TREATMENT TYPE: FLUORIDATION ☐ CHLORINATION ☐ FILTRATION ☐ WATER SOFENER ☐ OTHER ☐

DISTRIBUTION ADDRESS:

NAME:
PRIVATE
KALISPEL TRIBE
P O BOX 39
USK, WA 99180

TELEPHONE:

TESTS	*MCL	LESS THAN	RESULTS	UNIT	COMPLIANCE YES	COMPLIANCE NO	CHEMIST INITIALS
Antimony	0.006			mg/l			
Arsenic	0.05*			mg/l			
Barium	2.0*			mg/l			
Beryllium	0.004			mg/l			
Cadmium	0.005*			mg/l			
Chromium	0.1*			mg/l			
Copper	1.0	<	0.02	mg/l	X		WM
Iron	0.3			mg/l			
Lead	0.05*			mg/l			
Manganese	0.05			mg/l			
Mercury	0.002*			mg/l			
Nickel	0.1			mg/l			
Selenium	0.05*			mg/l			
Silver	0.1*			mg/l			
Sodium				mg/l			
Thallium	0.002			mg/l			
Zinc	5.0	<	0.05	mg/l	X		WM
Hardness			72	mg/l as			PW
Conductivity	700			umhos			
Turbidity	1.0*			NTU			
Color	15.0			COLOR			
Chloride	250			mg/l			
Cyanide	0.2			mg/l			
Fluoride	2.0*			mg/l			
Nitrate	10.0*			mg/l			
Nitrite	1.0			mg/l			
Sulfate	250			mg/l			
TDS	500			mg/l			

LABORATORY COMMENTS:
SULFIDE < 1 mg/L
TOTAL PHOSPHATE 0.12 mg/L
CALCIUM 21 mg/L

REMARKS:

LABORATORY SUPERVISOR: WALTER MUELLER

DATE OF REPORT: 8/14/95

*ND = NOT DETECTED

Advanced Analytical Services

P.O. Box 3928 • E. 1514 Sprague Ave. • Spokane, WA 99202
Phone: 509/535-9791 • Fax 509/535-1537

LABORATORY NUMBER: 11254368

DATE RECIEVED: 7/31/95

DATE COLLECTED:

SYSTEM NAME: SI#2 1/4

SYSTEM ID#: | GROUP:

COUNTY:

SOURCE TYPE:
SURFACE ☐ WELL ☐
SPRING ☐ PURCHASE ☐

SAMPLE TAKEN:
BEFORE TREATMENT ☐
AFTER TREATMENT ☐

SOURCE NO: | NAME:

COLLECTED BY:

TELEPHONE:

TREATMENT TYPE:
FLUORIDATION ☐
CHLORINATION ☐
FILTRATION ☐
WATER SOFENER ☐
OTHER ☐

DISTRIBUTION ADDRESS:

NAME:
PRIVATE
KALISPEL TRIBE
P.O. BOX 39
USK, WA 99180

TELEPHONE:

TESTS	*MCL	LESS THAN	RESULTS	UNIT	COMPLIANCE YES	COMPLIANCE NO	CHEMIST INITIALS
Antimony	0.006			mg/l			
Arsenic	0.05			mg/l			
Barium	2.0			mg/l			
Beryllium	0.004			mg/l			
Cadmium	0.005			mg/l			
Chromium	0.1			mg/l			
Copper	1.0	<	0.02	mg/l	X		WM
Iron	0.3			mg/l			
Lead	0.05			mg/l			
Manganese	0.05			mg/l			
Mercury	0.002			mg/l			
Nickel	0.1			mg/l			
Selenium	0.05			mg/l			
Silver	0.1			mg/l			
Sodium				mg/l			
Thallium	0.002			mg/l			
Zinc	5.0	<	0.05	mg/l	X		WM
Hardness			69	mg/l as			PW
Conductivity	700			umho/			
Turbidity	1.0			NTU			
Color	15.0			COLOR			
Chloride	250			mg/l			
Cyanide	0.2			mg/l			
Fluoride	2.0			mg/l			
Nitrate	10.0			mg/l			
Nitrite	1.0			mg/l			
Sulfate	250			mg/l			
TDS	500			mg/l			

LABORATORY COMMENTS:
SULFIDE < 3 mg/L
TOTAL PHOSPHATE 0.21 mg/L
CALCIUM 20 mg/L

REMARKS:

LABORATORY SUPERVISOR: [signature]
WALTER MUELLER

DATE OF REPORT: 8/14/95

*ND = NOT DETECTED

Advanced Analytical Services

P.O. Box 3928 • E. 1514 Sprague Ave. • Spokane, WA 99202
Phone: 509/535-9791 • Fax 509/535-1537

TESTS	*MCL	LESS THAN	RESULTS	UNIT	COMPLIANCE YES	COMPLIANCE NO	CHEMIST INTIALS
Antimony	0.006			mg/l			
Arsenic	0.05'			mg/l			
Barium	2.0'			mg/l			
Beryllium	0.004			mg/l			
Cadmium	0.005'			mg/l			
Chromium	0.1'			mg/l			
Copper	1.0	<	0.02	mg/l	X		WM
Iron	0.3			mg/l			
Lead	0.05'			mg/l			
Manganese	0.05			mg/l			
Mercury	0.002'			mg/l			
Nickel	0.1			mg/l			
Selenium	0.05'			mg/l			
Silver	0.1'			mg/l			
Sodium				mg/l			
Thallium	0.002			mg/l			
Zinc	5.0	<	0.05	mg/l	X		WM
Hardness			71	mg/l as			PW
Conductivity	700			umhos/			
Turbidity	1.0'			NTU			
Color	15.0			COLOR			
Chloride	250			mg/l			
Cyanide	0.2			mg/l			
Fluoride	2.0'			mg/l			
Nitrate	10.0'			mg/l			
Nitrite	1.0			mg/l			
Sulfate	250			mg/l			
TDS	500			mg/l			

LABORATORY NUMBER: 11254369

DATE RECIEVED:

DATE COLLECTED: 7/31/95

SYSTEM NAME: SW2 3/4

SYSTEM ID#: **GROUP:**

COUNTY:

SOURCE TYPE:
SURFACE ☐ WELL ☐
SPRING ☐ PURCHASE ☐

SAMPLE TAKEN:
BEFORE TREATMENT ☐
AFTER TREATMENT ☐

SOURCE NO: **NAME:**

COLLECTED BY:

TELEPHONE:

TREATMENT TYPE:
FLUORIDATION ☐
CHLORINATION ☐
FILTRATION ☐
WATER SOFENER ☐
OTHER ☐

DISTRIBUTION ADDRESS:

NAME:
PRIVATE
KALISPEL TRIBE
P.O. BOX 39
USK, WA 99180

TELEPHONE:

LABORATORY COMMENTS:
SULFIDE < 1 mg/L
TOTAL PHOSPHATE 0.033 mg/L
CALCIUM 18 mg/ L

REMARKS:

LABORATORY SUPERVISOR: [signature]
WALTER MUELLER

DATE OF REPORT: 8/14/95

*ND = NOT DETECTED

Advanced Analytical Services

P.O. Box 3928 • E. 1514 Sprague Ave. • Spokane, WA 99202
Phone: 509/535-9791 • Fax 509/535-1537

ABORATORY NUMBER: 1254370

IATE RECIEVED: /31/95

IATE COLLECTED:

SYSTEM NAME: #2 1/2

SYSTEM ID#: GROUP:

COUNTY:

SOURCE TYPE: SURFACE ☐ WELL ☐ SPRING ☐ PURCHASE ☐

SAMPLE TAKEN: BEFORE TREATMENT ☐ AFTER TREATMENT ☐

SOURCE NO: NAME:

COLLECTED BY:

TELEPHONE:

TREATMENT TYPE: FLUORIDATION ☐ CHLORINATION ☐ FILTRATION ☐ WATER SOFENER ☐ OTHER ☐

DISTRIBUTION ADDRESS:

NAME:
PRIVATE
KALISPEL TRIBE
P.O. BOX 39
USK, WA 99180

TELEPHONE:

TESTS	*MCL	LESS THAN	RESULTS	UNIT	COMPLIANCE YES	NO	CHEMIST INITIALS
Antimony	0.006			mg/l			
Arsenic	0.05'			mg/l			
Barium	2.0'			mg/l			
Beryllium	0.004			mg/l			
Cadmium	0.005'			mg/l			
Chromium	0.1'			mg/l			
Copper	1.0	<	0.02	mg/l	X		WM
Iron	0.3			mg/l			
Lead	0.05'			mg/l			
Manganese	0.05			mg/l			
Mercury	0.002'			mg/l			
Nickel	0.1			mg/l			
Selenium	0.05'			mg/l			
Silver	0.1'			mg/l			
Sodium				mg/l			
Thallium	0.002			mg/l			
Zinc	5.0	<	0.05	mg/l	X		WM
Hardness			68	mg/l			PW
Conductivity	700			umhos			
Turbidity	1.0'			NTU			
Color	15.0			COLOR			
Chloride	250			mg/l			
Cyanide	0.2			mg/l			
Fluoride	2.0'			mg/l			
Nitrate	10.0'			mg/l			
Nitrite	1.0			mg/l			
Sulfate	250			mg/l			
TDS	500			mg/l			

LABORATORY COMMENTS:
SULFIDE < 1 mg/L
TOTAL PHOSPHATE 0.22 mg/L
CALCIUM 20 mg/L

REMARKS:

LABORATORY SUPERVISOR: [signature] WALTER MUELLER

DATE OF REPORT: 8/14/95

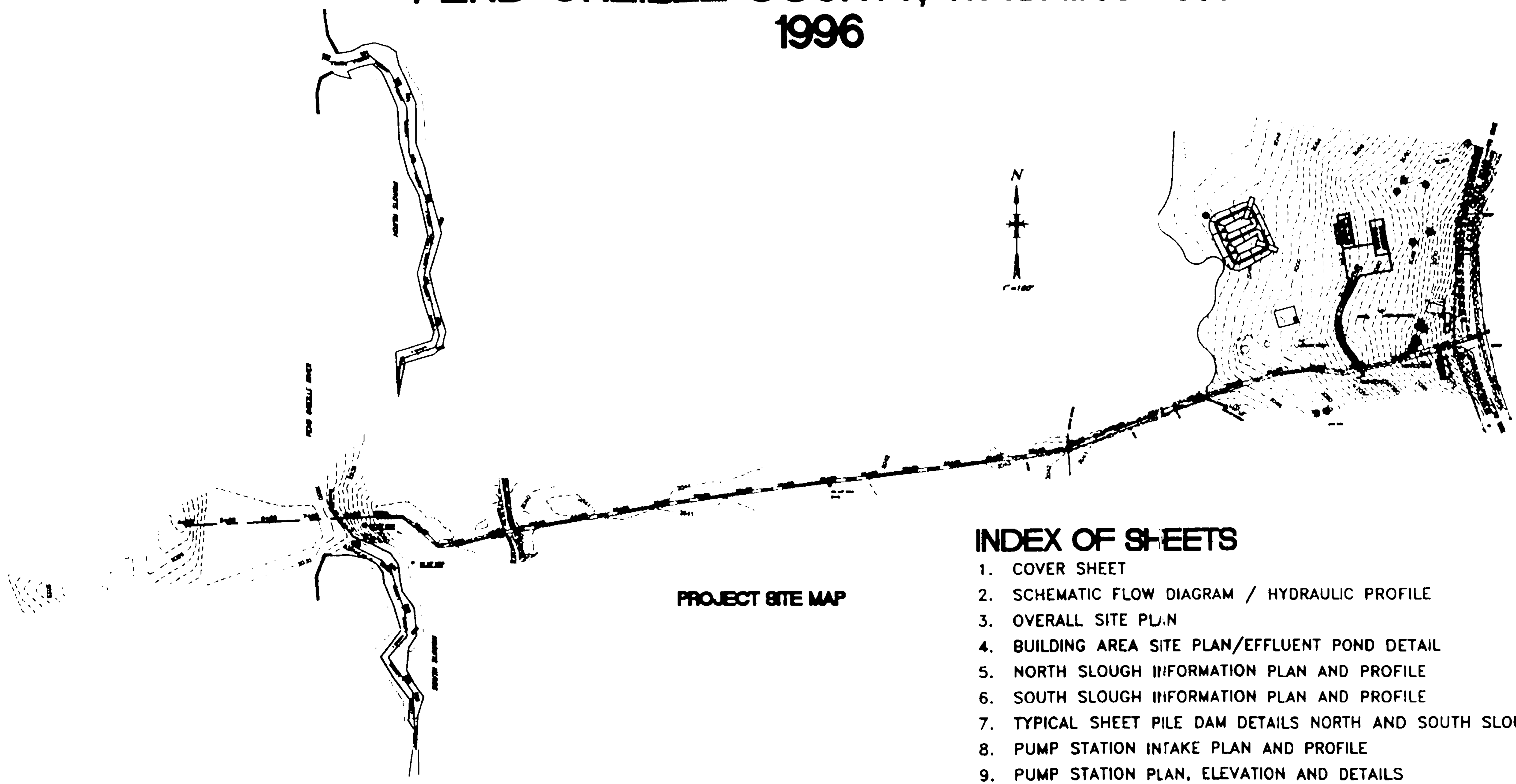
*ND = NOT DETECTED

Slough 1		31-Jul-95	
	DO (mg/L)	Temp (C)	pH
1/4	12.1	21	9.05
1/2	9.6	19.3	8.89
3/4	7.33	18.7	8.93
Slough 2			
1/4	11.84	22.3	8.58
1/2	11.36	21.8	8.65
3/4	7.81	20.4	8.61

APPENDIX D

ENGINEERING DESIGN FOR LARGEMOUTH BASS HATCHERY, REARING SLOUGHS, AND EFFLUENT PONDS

KALISPEL INDIAN TRIBE
FISH HATCHERY PROJECT
PEND OREILLE COUNTY, WASHINGTON
1996



PROJECT SITE MAP

INDEX OF SHEETS

1. COVER SHEET
2. SCHEMATIC FLOW DIAGRAM / HYDRAULIC PROFILE
3. OVERALL SITE PLAN
4. BUILDING AREA SITE PLAN/EFFLUENT POND DETAIL
5. NORTH SLOUGH INFORMATION PLAN AND PROFILE
6. SOUTH SLOUGH INFORMATION PLAN AND PROFILE
7. TYPICAL SHEET PILE DAM DETAILS NORTH AND SOUTH SLOUGH
8. PUMP STATION INTAKE PLAN AND PROFILE
9. PUMP STATION PLAN, ELEVATION AND DETAILS
10. SURFACE WATER PIPELINE PLAN & PROFILE STA. 100+00 TO 113+5(
11. SURFACE WATER PIPELINE PLAN & PROFILE STA. 113+50 TO 125+7!
12. EXISTING ACCESS ROAD PROFILE INFORMATION ONLY
13. RACEWAY ENCLOSURE STRUCTURE DETAILS AND SECTIONS
14. HATCHERY BUILDING FOUNDATION AND DETAILS
15. HATCHERY BUILDING FLOOR PLAN AND ELEVATIONS/ PLUMBING PLAN!
16. LIFE SUPPORT PLAN /SECTION AND DETAILS
17. GENERAL DETAILS

E1 THRU E4 ELECTRICAL SECTIONS AND DETAILS

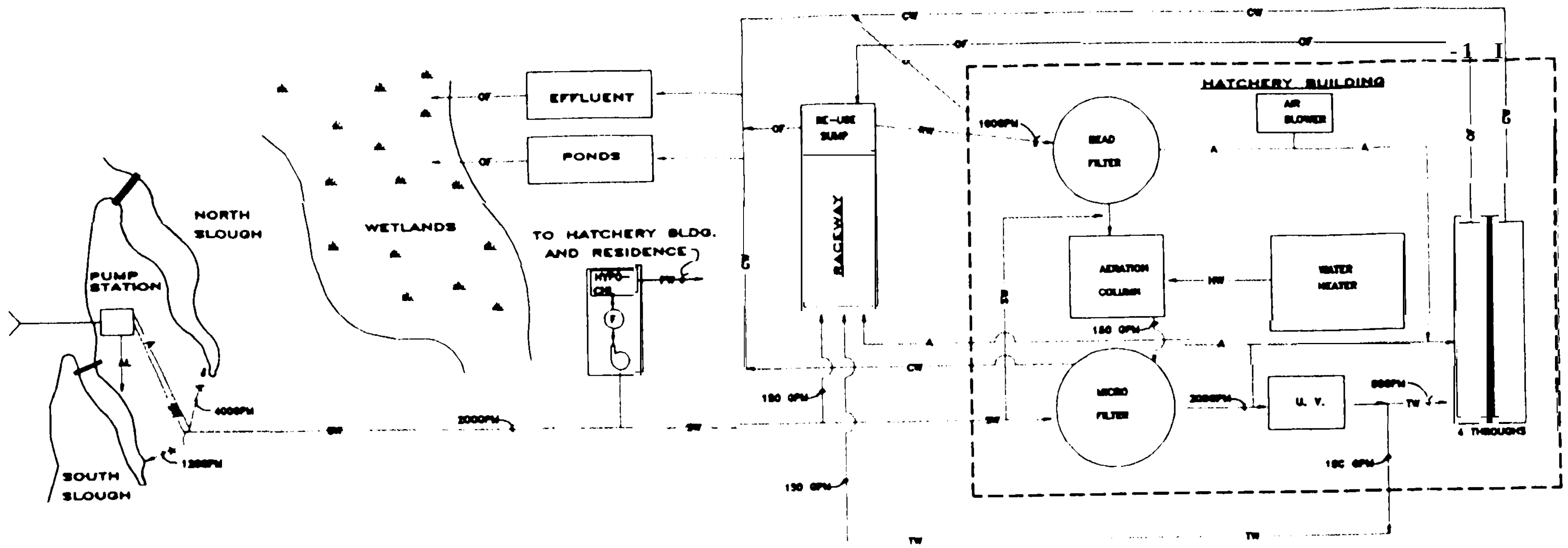
ENGINEER

J-U-B ENGINEERS, INC.

West 422 Riverside, Suite 722 • Spokane Washington 99201
Telephone (509) 458-3727
Fax (509) 458-3762

OWNER

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, WASHINGTON



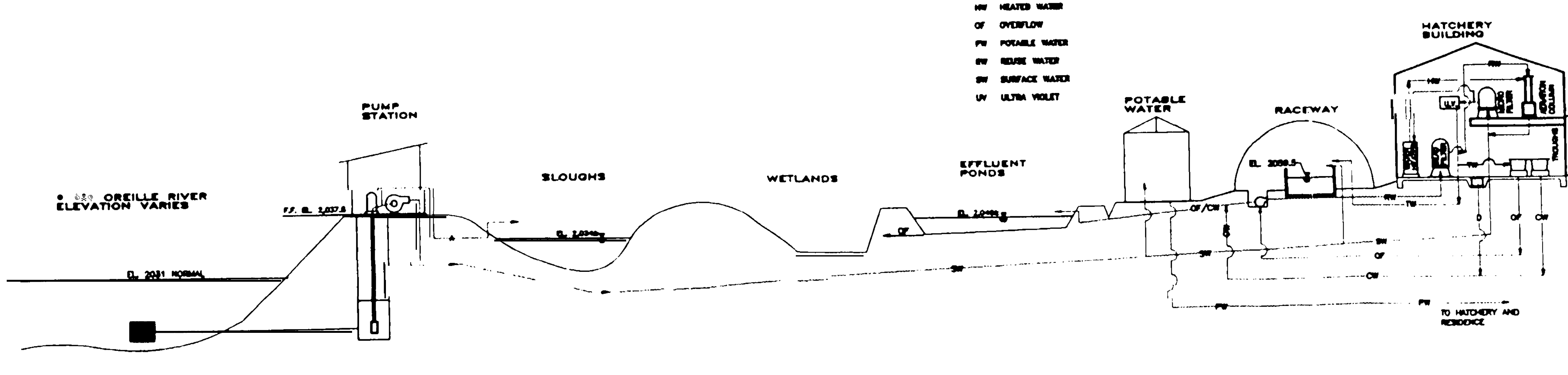
SCHEMATIC FLOW DIAGRAM
NOT TO SCALE

NOTE:
MAXIMUM FLOWS ONLY ARE SHOWN
THESE FLOWS ARE NOT ADDITIVE.

THIS DRAWING FOR INFORMATIONAL PURPOSE ONLY

LEGEND

A	AUXILLARY WATER
AL	AIR
CW	CLEANING WASTE
D	DRAIN
F	FILTER
HW	HEATED WATER
OF	OVERFLOW
PW	POTABLE WATER
RW	REUSE WATER
SW	SURFACE WATER
UV	ULTRA VIOLET



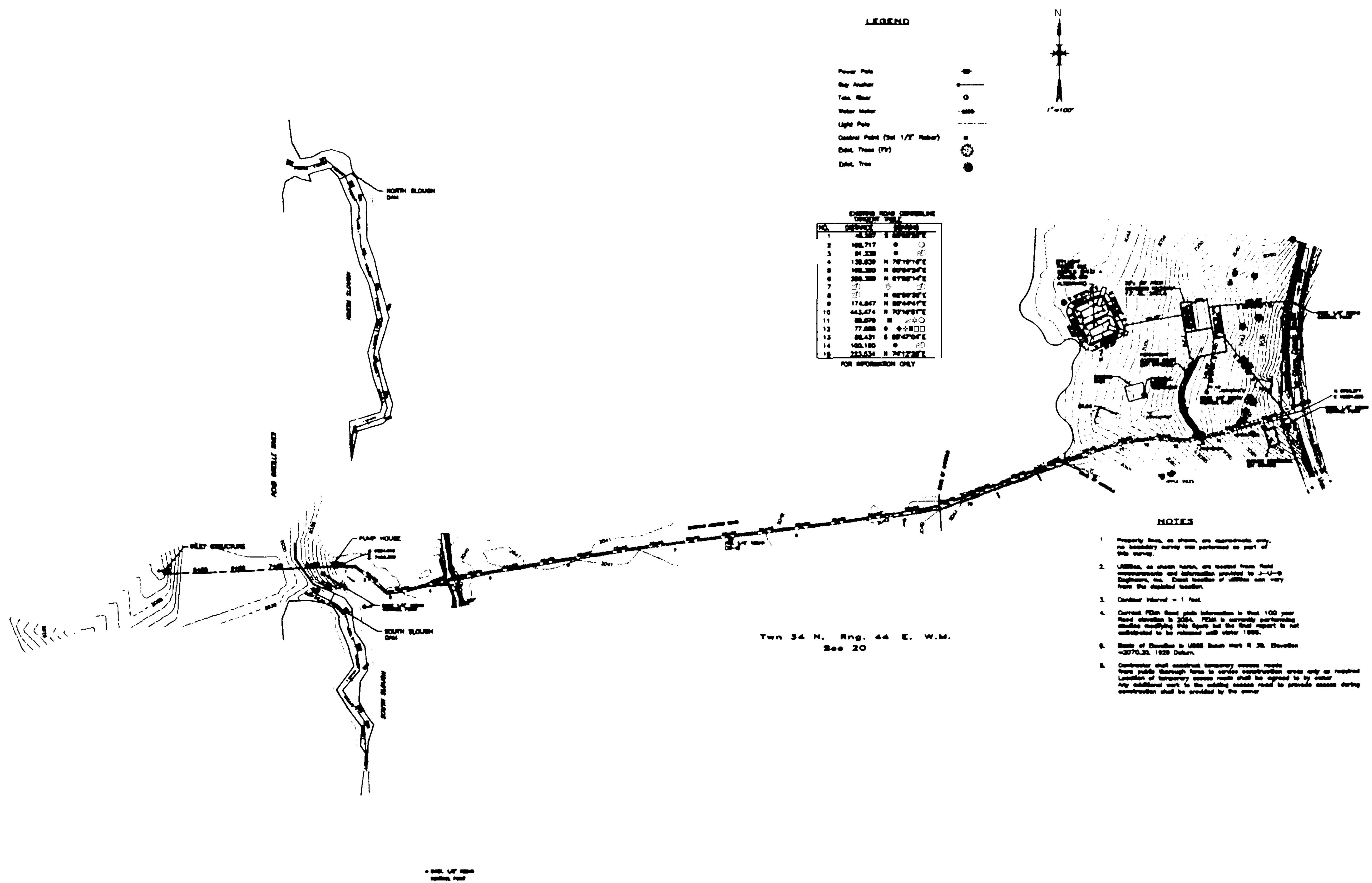
HYDRAULIC PROFILE
NOT TO SCALE

J-U-B ENGINEERS, Inc.

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK, WASHINGTON

FISH HATCHERY PROJECT
SCHEMATIC FLOW DIAGRAM
HYDRAULIC PROFILE

SHEET 2 of 17



EXISTING ROAD CENTERLINE TANGENT TABLE

NO.	DISTANCE	BEARING
1	[illegible]	S [illegible] E
2	168.717	[illegible]
3	[illegible]	[illegible]
4	138.[illegible]	N 70°[illegible]"E
5	[illegible]	N [illegible]"E
6	[illegible]	N [illegible]"E
7	[illegible]	[illegible]
8	[illegible]	N [illegible]"E
9	174.847	N [illegible]"E
10	443.474	N 70°[illegible]"E
11	[illegible]	[illegible]
12	77.[illegible]	[illegible]
13	[illegible].431	S [illegible]"E
14	100.180	[illegible]
15	223.634	N 74°[illegible]"E

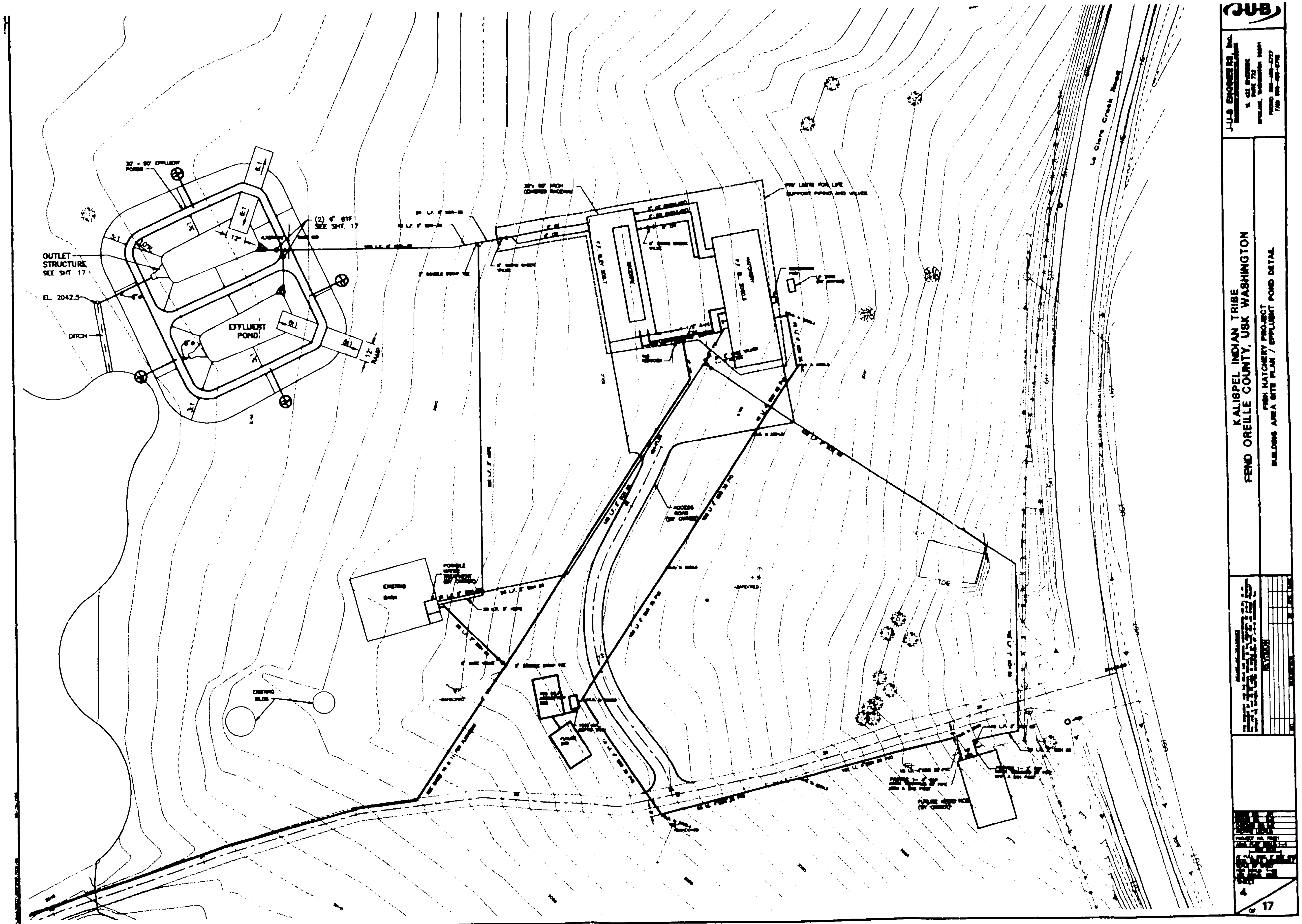
J-U-B

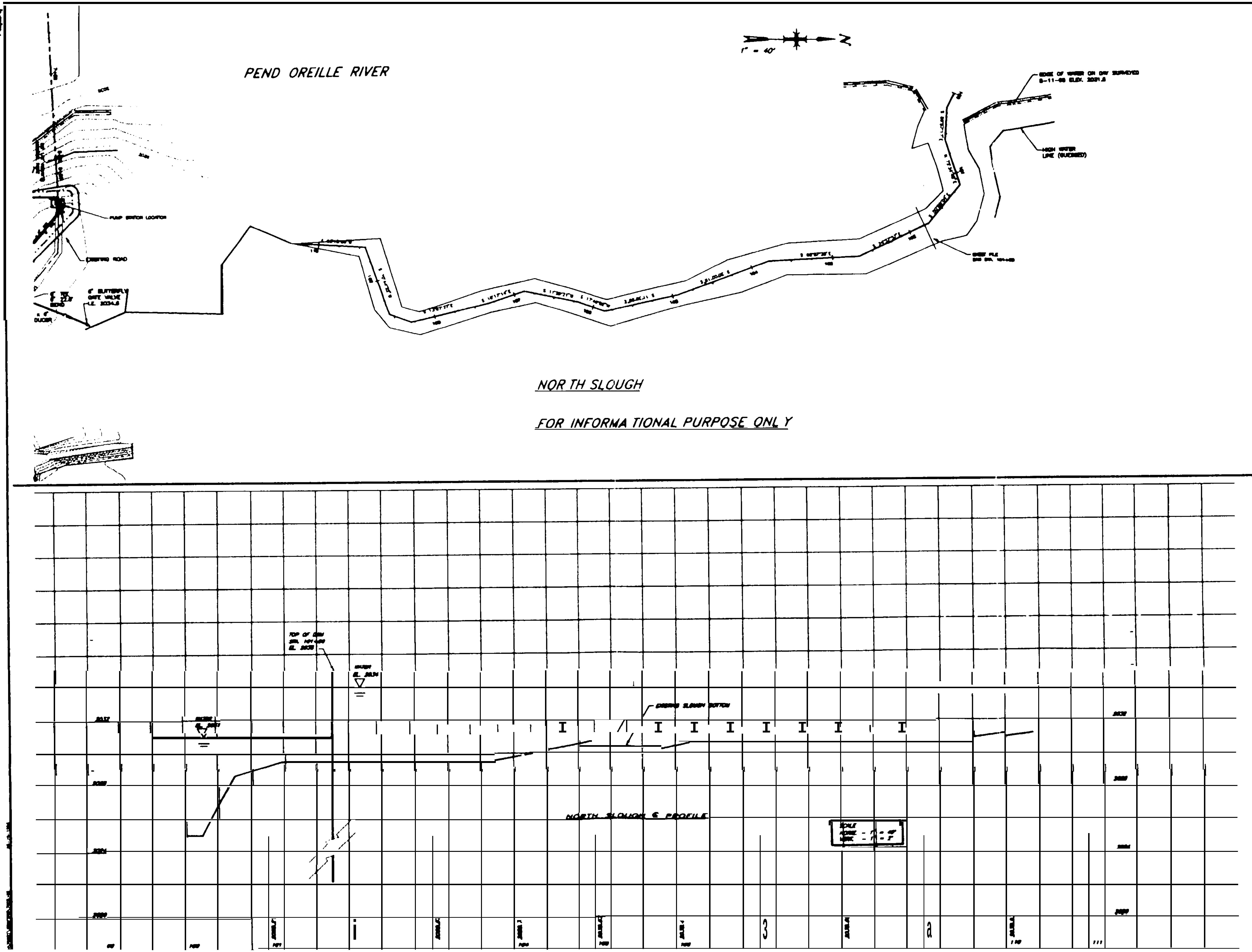
J-U-B ENGINEERS, Inc.

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
OVERALL SITE PLAN

3 / 17


30' x 80' EFFLUENT PONDS
OUTLET STRUCTURE
SEE SHT. 17
EL. 2042.5
DITCH
EFFLUENT POND
(2) 6" BTF
SEE SHT. 17
30'x 80' ARCH COVERED RACEWAY
PAY LIMITS FOR LIFE SUPPORT PIPING AND VALVES
ACCESS ROAD (BY OWNER)
EXISTING BARN
EXISTING SILOS
FUTURE WEED ROW (BY OWNER)
TOE
Le Clerc Creek Road
J-U-B
J-U-B ENGINEERS, Inc.
KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON
FISH HATCHERY PROJECT
BUILDING AREA SITE PLAN / EFFLUENT POND DETAIL
4
of 17



KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
NORTH SLOUGH INFORMATION PLAN AND PROFILE

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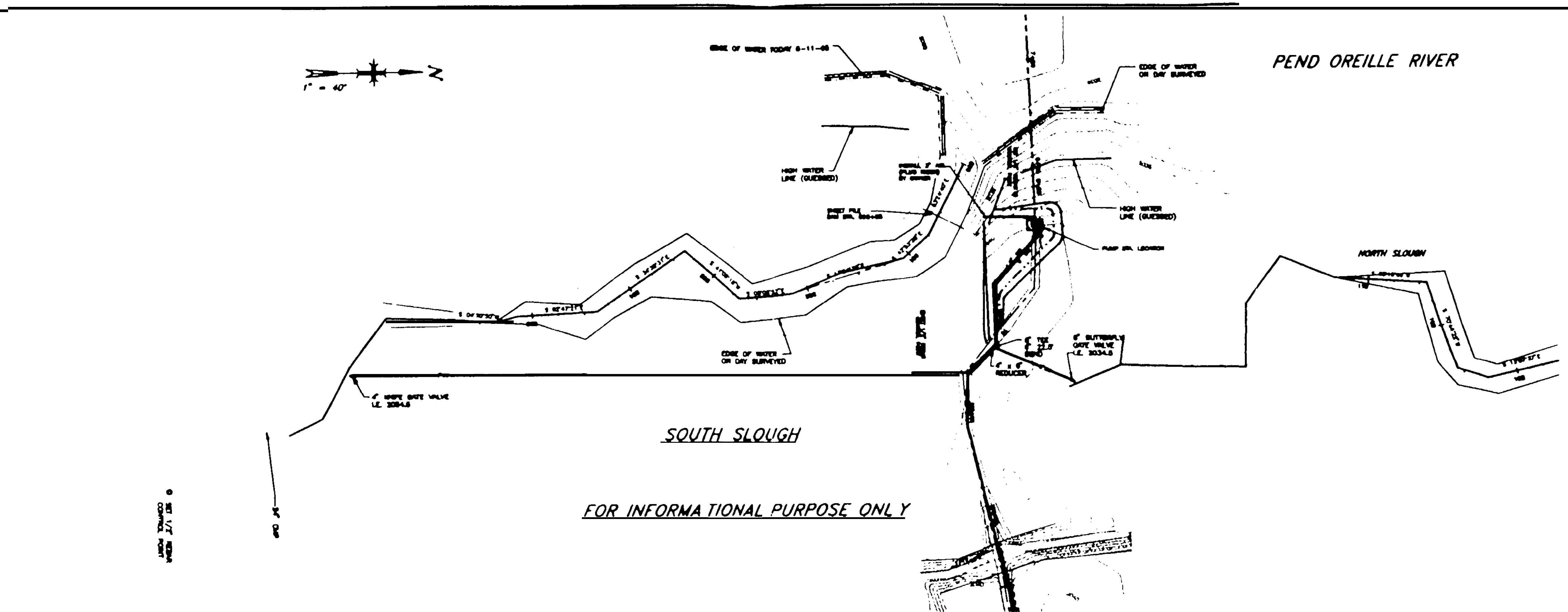

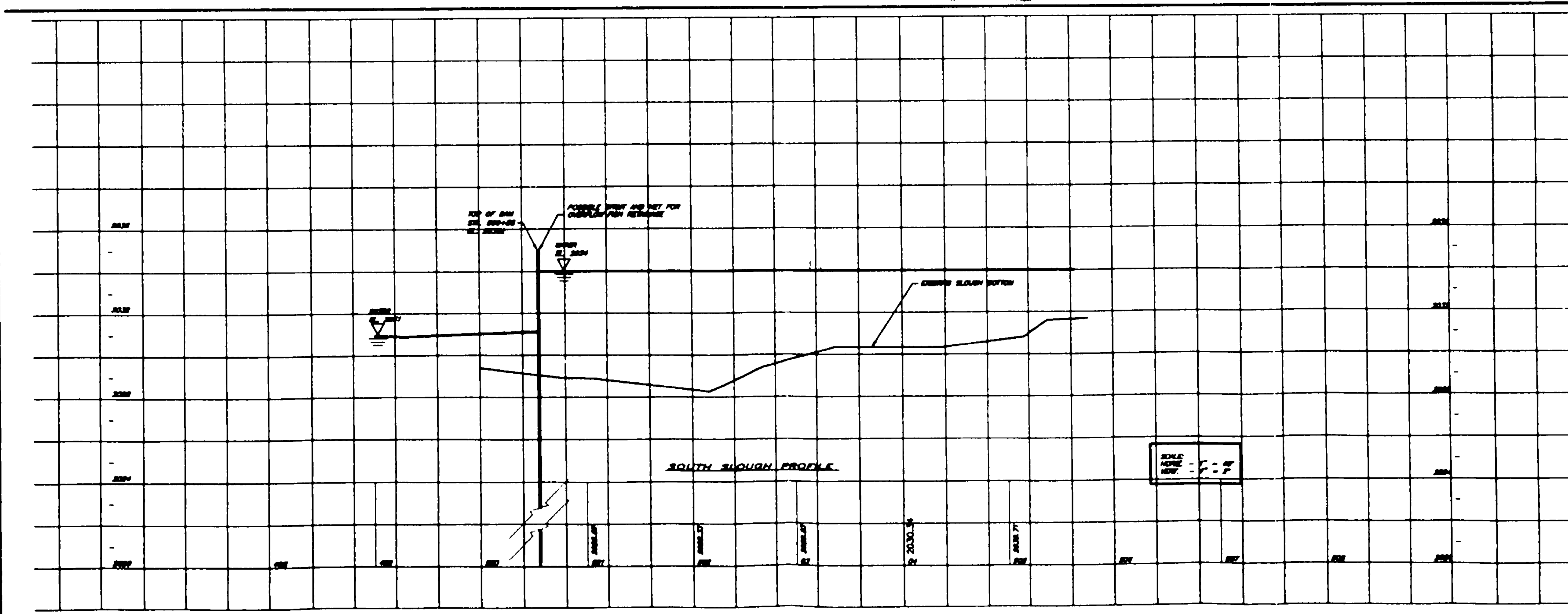

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT

SOUTH SLOUGH INFORMATION PLAN AND PROFILE

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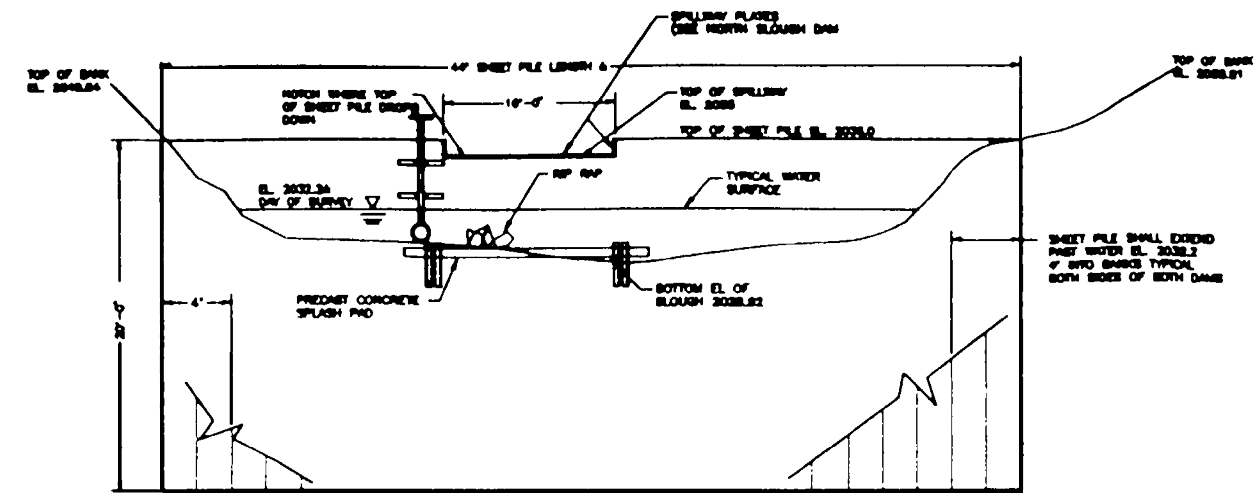
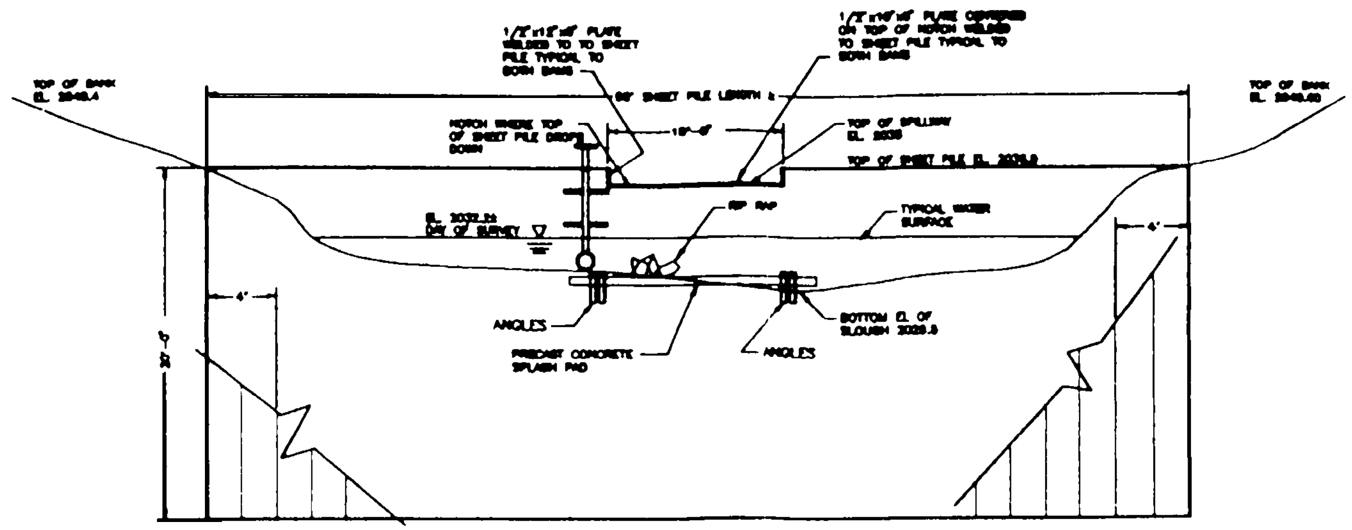
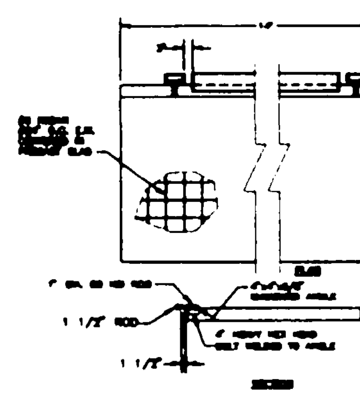


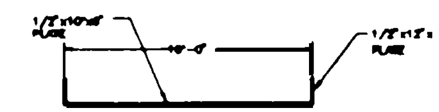
SOUTH SLOUGH SHEET PILE DAM ELEVATION LOOKING UPSTREAM
NOT TO SCALE



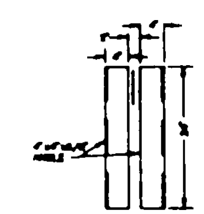
NORTH SLOUGH SHEET PILE DAM ELEVATION LOOKING UPSTREAM
NOT TO SCALE



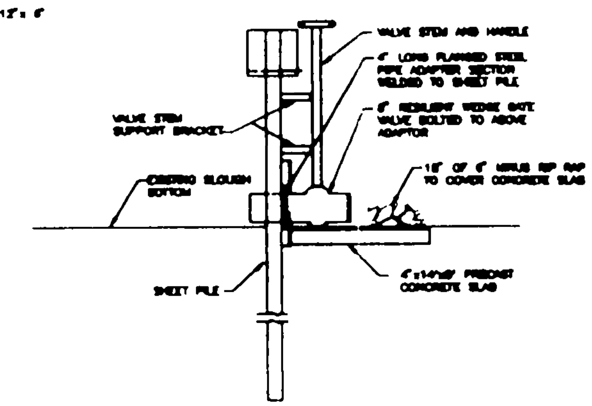
PRECAST CONCRETE SPILLWAY SPLASH PAD
NOT TO SCALE



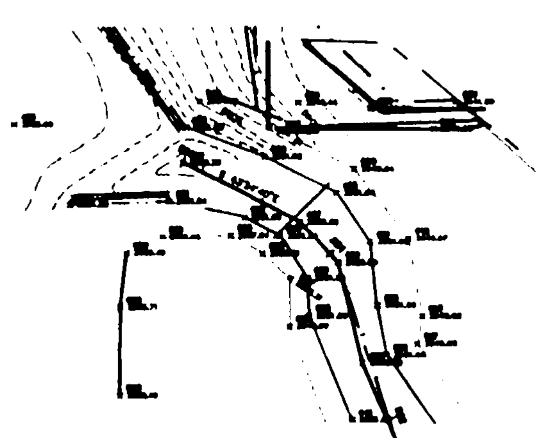
SPILLWAY TOP PLATES DETAIL
NOT TO SCALE



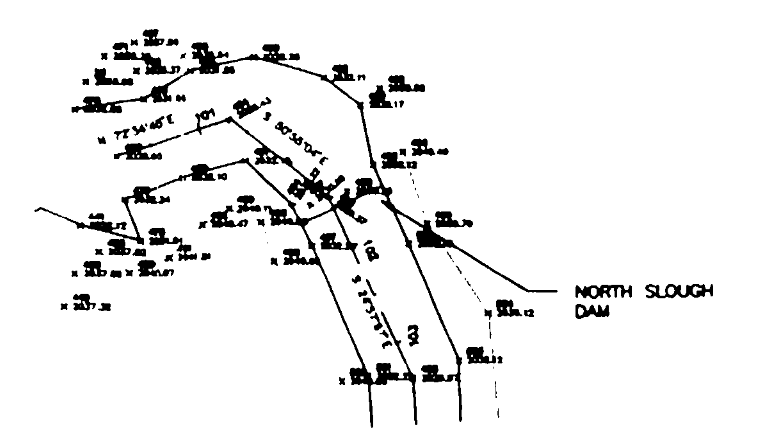
ANGLE SPILLWAY PAD CONNECTORS
NOT TO SCALE



TYPICAL DAM X-SECTION
NOT TO SCALE



SOUTH SLOUGH SITE TOPOGRAPHIC ELEVATIONS



NORTH SLOUGH SITE TOPOGRAPHIC ELEVATIONS

J-U-B ENGINEERS, Inc.

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK, WASHINGTON

FISH HATCHERY PROJECT
DAM DETAILS

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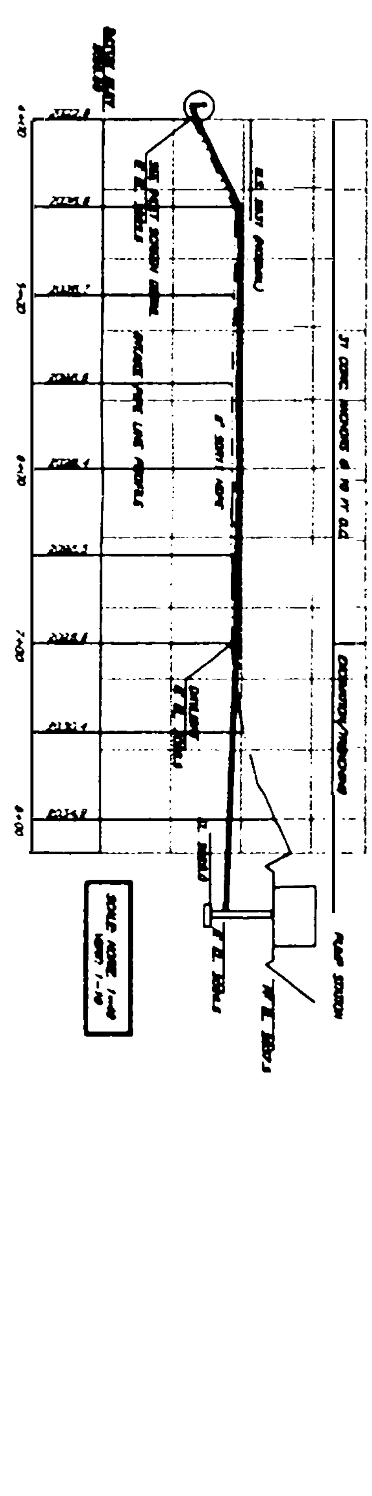
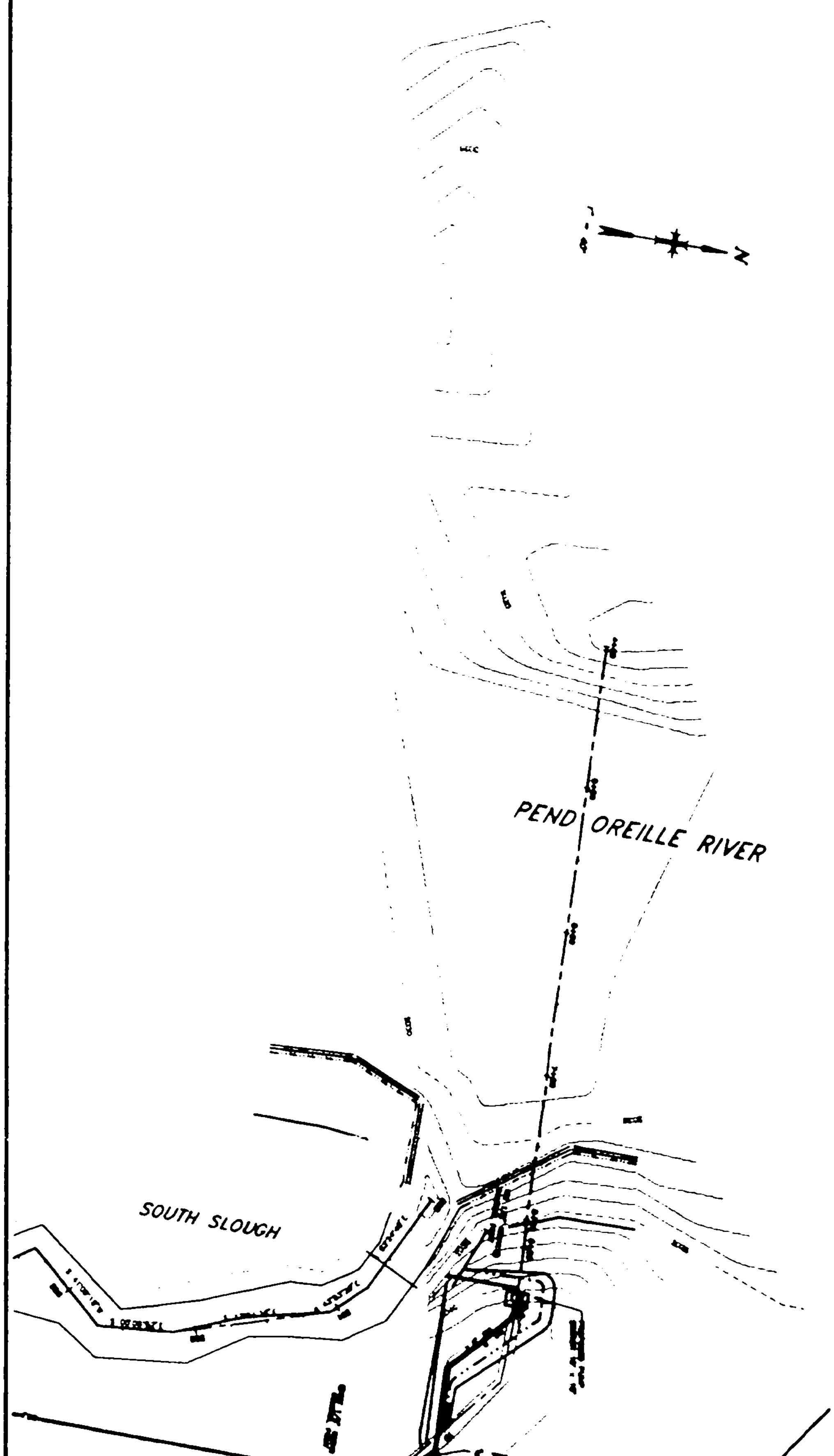




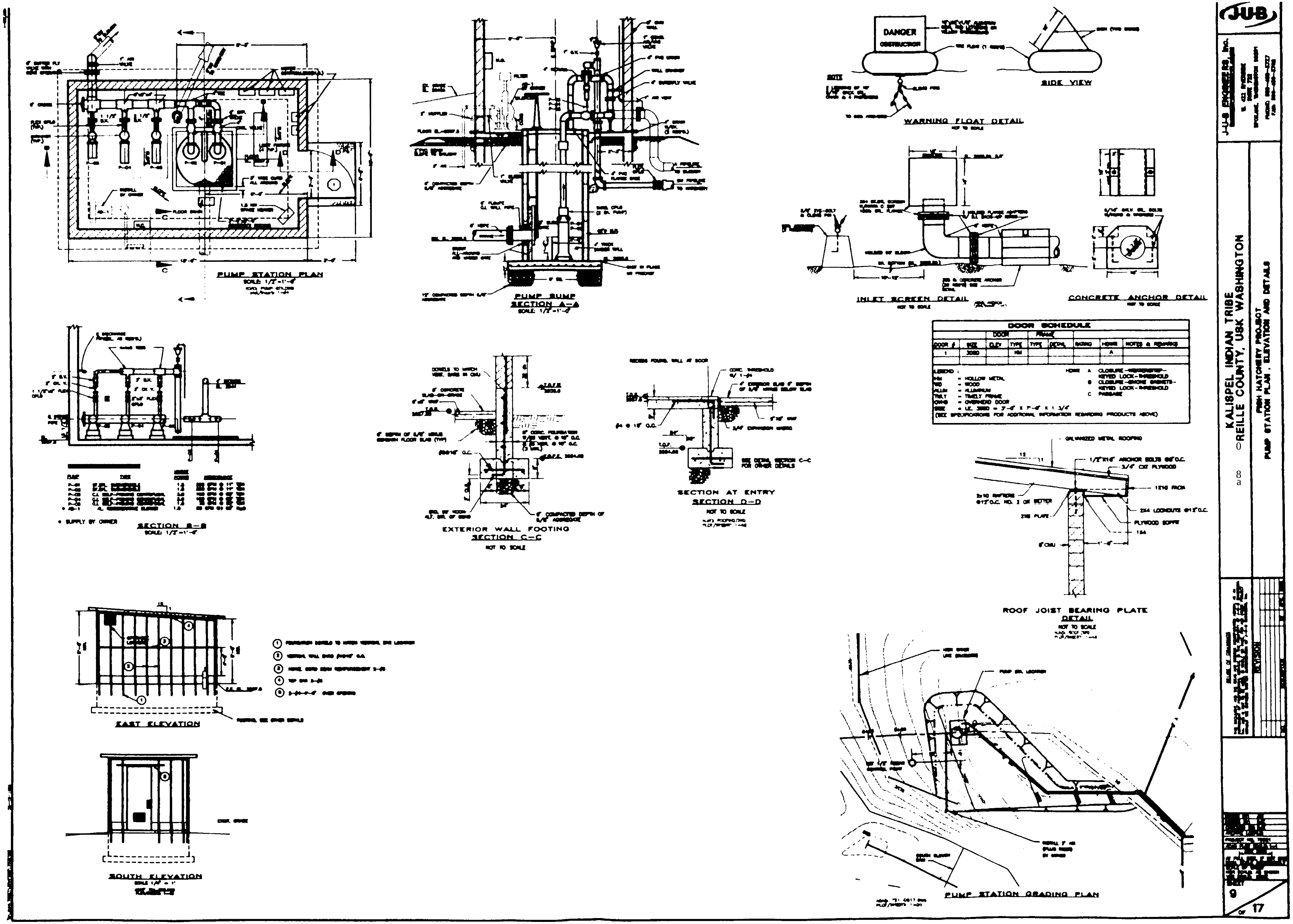
KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
PUMP STATION INTAKE PLAN AND PROFILE

REVISION

J-U-B ENGINEERS, Inc.

SHEET 8 of 17

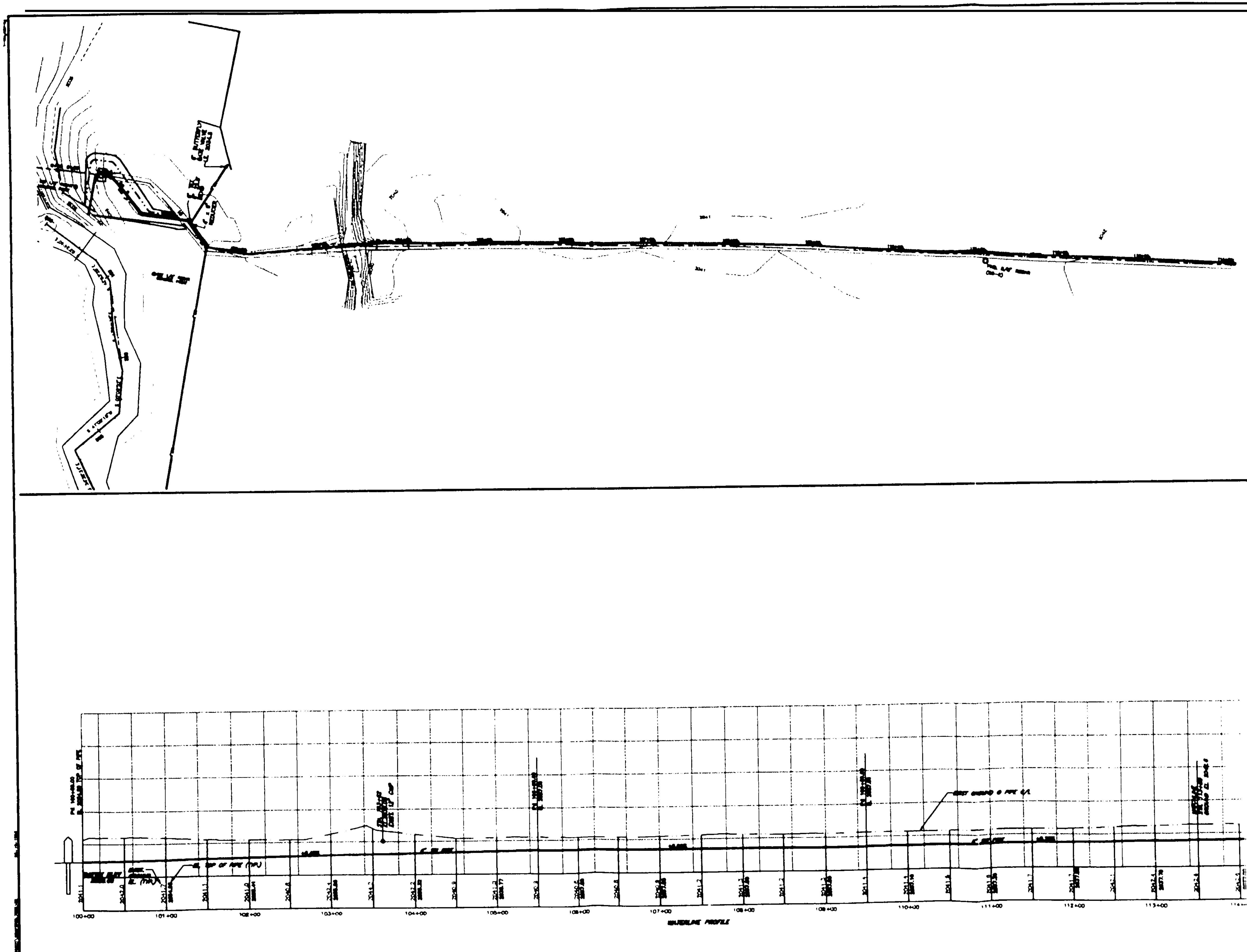


DOOR SCHEDULE

DOOR #	SIZE	DOOR QTY	DOOR TYPE	FRAME TYPE	FRAME DETAIL	RATING	HDWR	NOTES & REMARKS
1	3080		HM				A	

LEGEND:
HM = HOLLOW METAL
WD = WOOD
ALUM = ALUMINUM
TMLY = TIMELY FRAME
OHD = OVERHEAD DOOR
SIZE = I.E. 3080 = 3'-0" X 7'-0" X 1 3/4"
(SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION REGARDING PRODUCTS ABOVE)

HDWR
A CLOSURE - [illegible] - KEYED LOCK - THRESHOLD
B CLOSURE - SMOKE GASKETS - KEYED LOCK - THRESHOLD
C PASSAGE



J-U-B ENGINEERS, INC.

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

SURFACE WATER PIPELINE PLAN AND PROFILE
STA. 100+00 TO STA. 114+00

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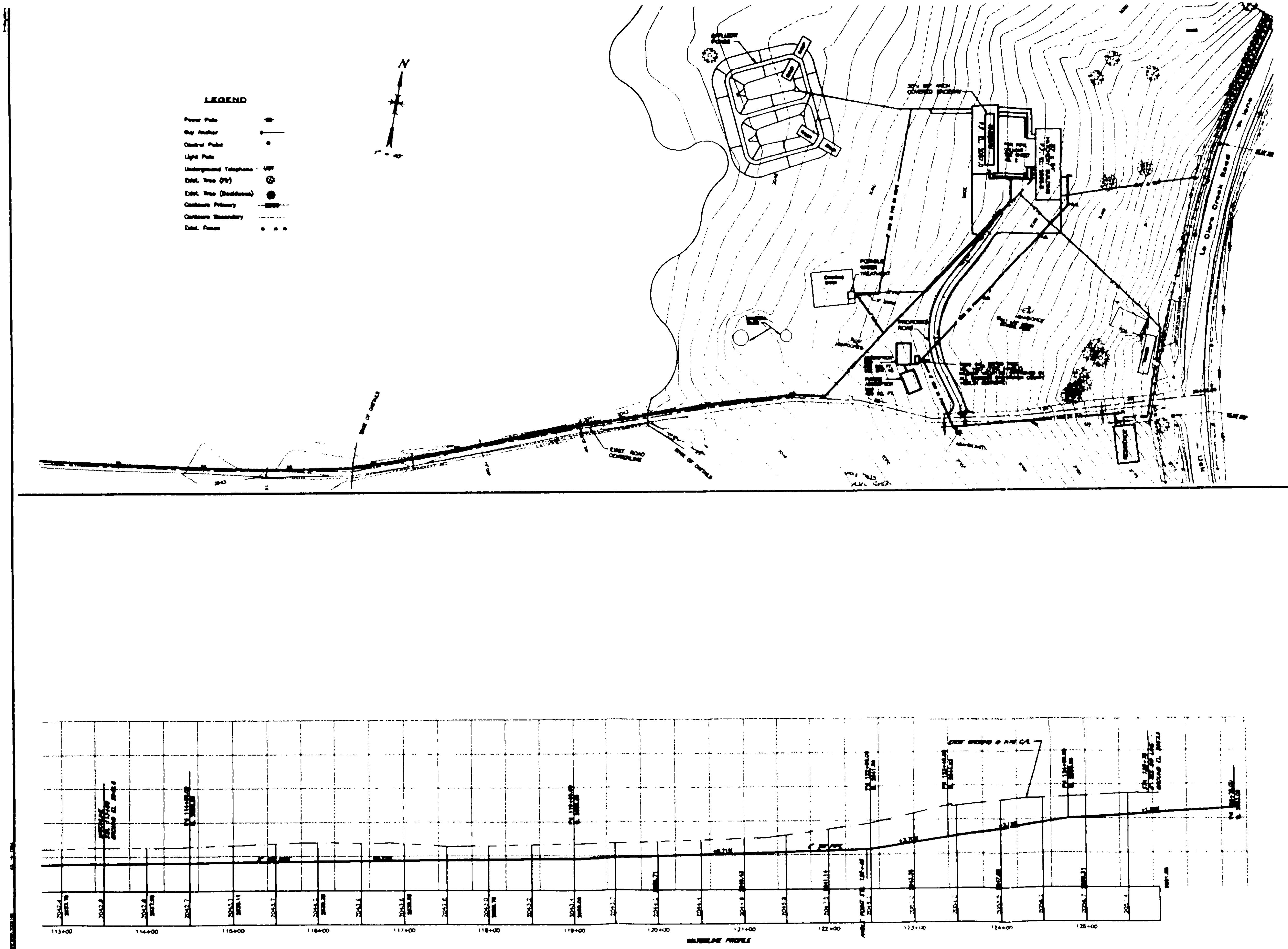

J-U-B

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KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
SURFACE WATER PIPELINE PLAN AND PROFILE
STA. 113+00 TO STA. 125+75

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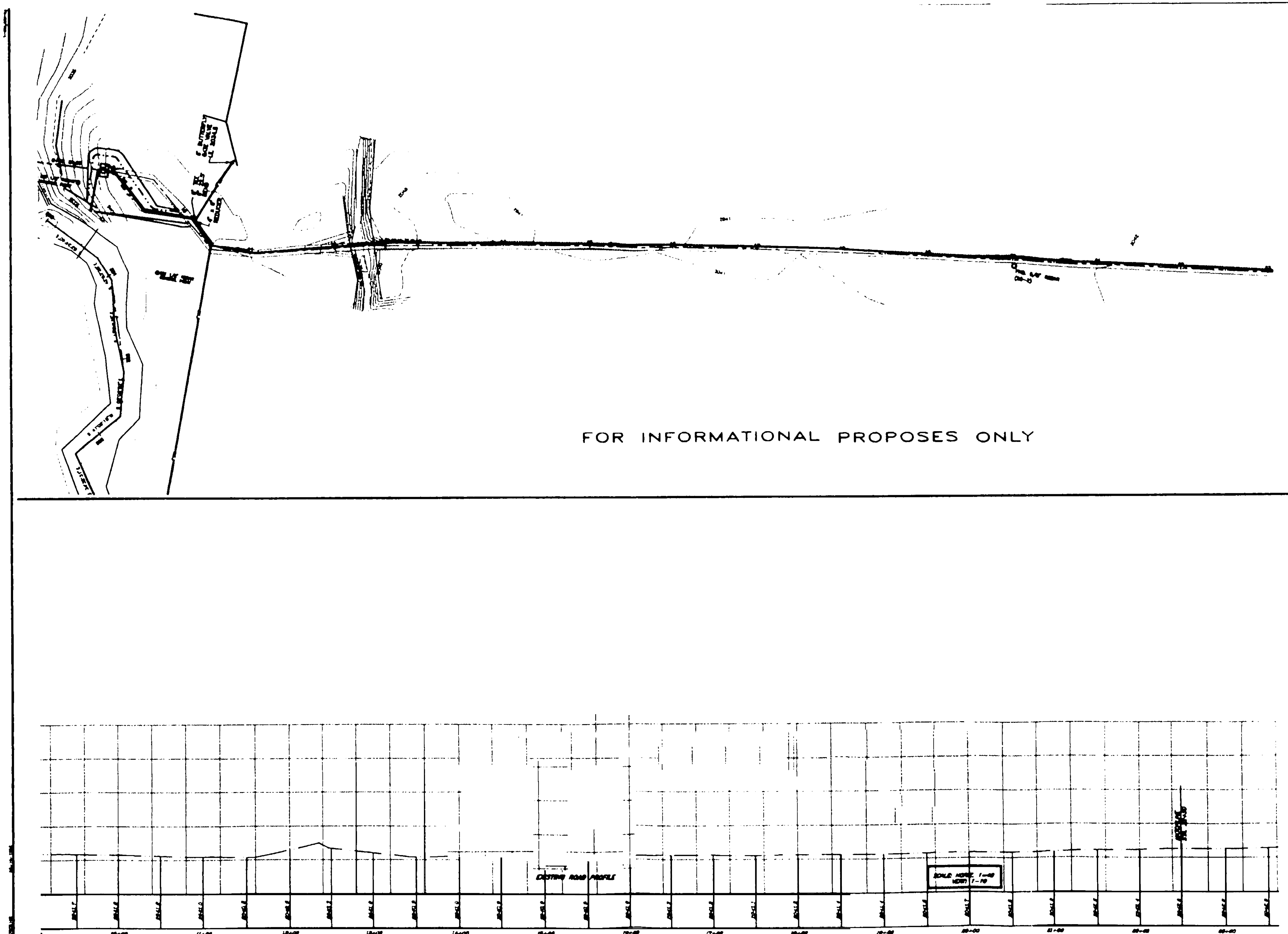

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KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
EXISTING ACCESS ROAD PLAN AND PROFILE
STA. 9+00 TO STA. 22+50

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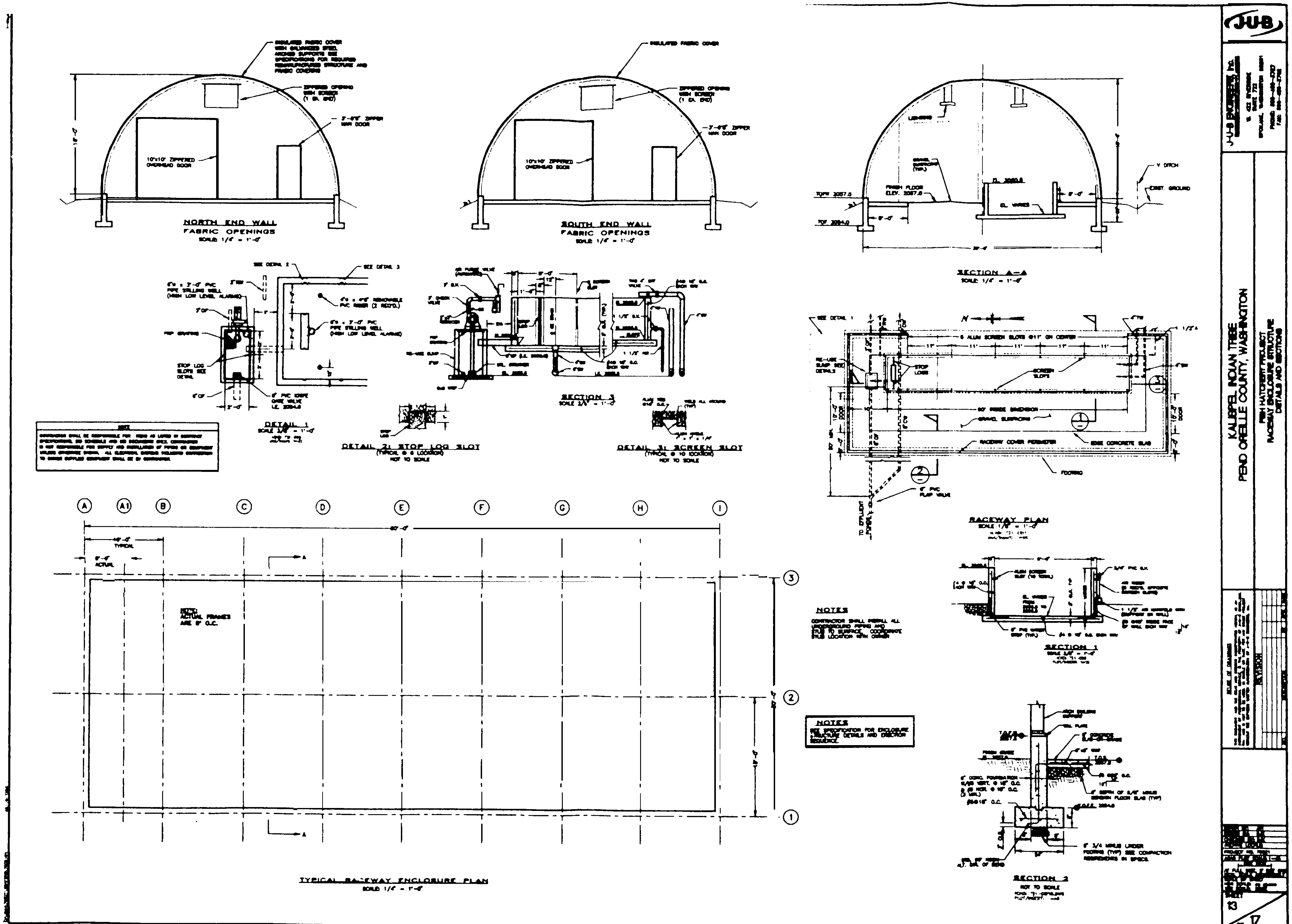
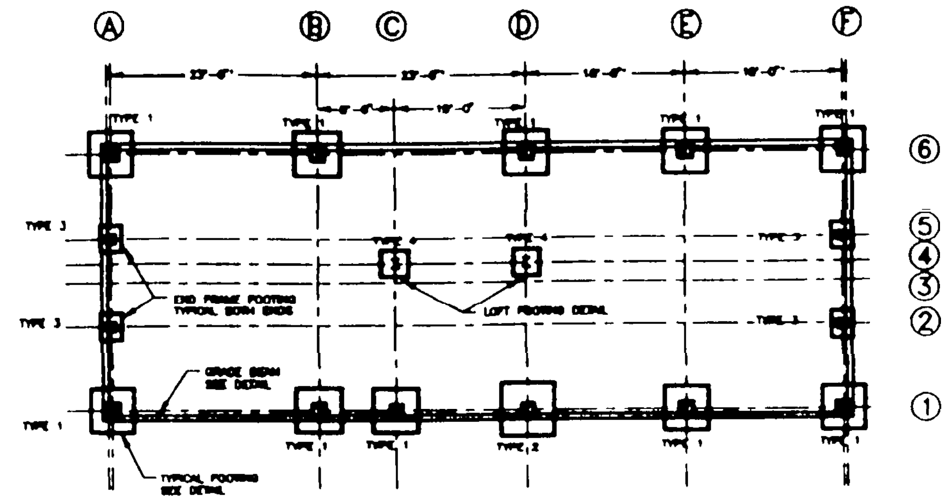
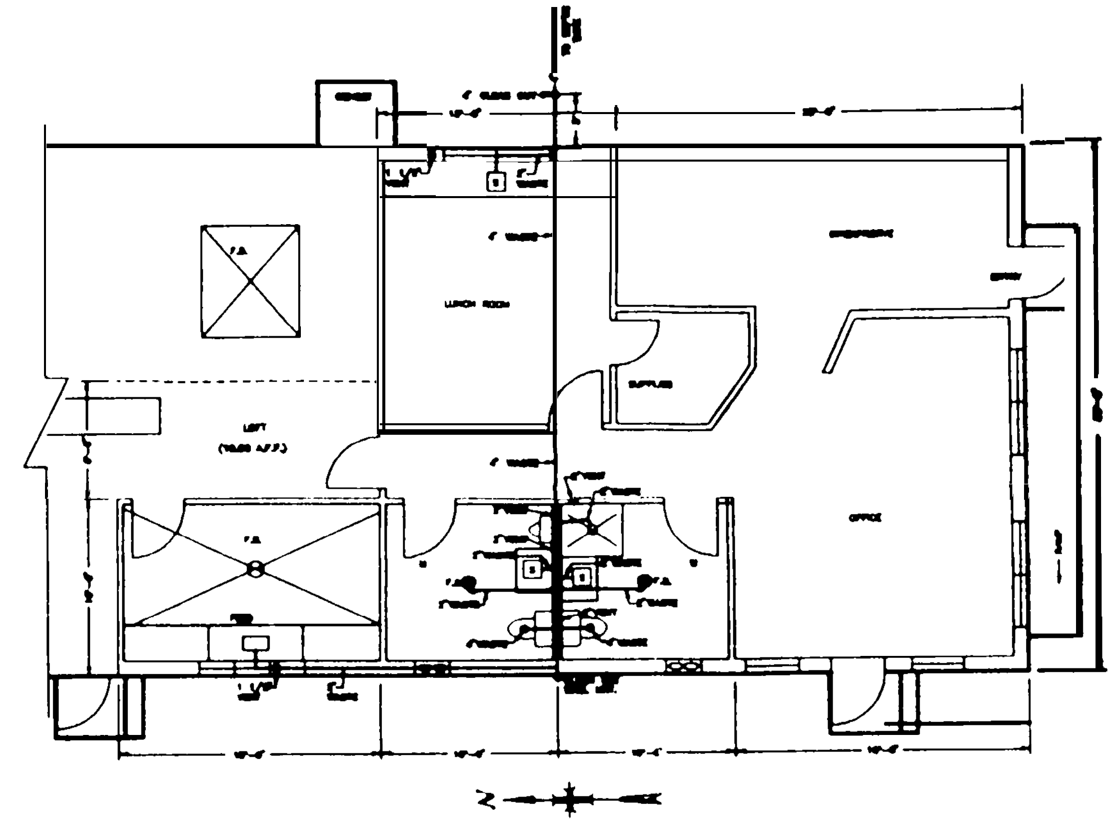
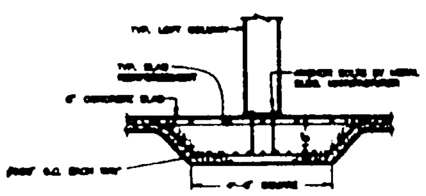

NORTH END WALL
FABRIC OPENINGS
SCALE 1/4" = 1'-0"
10'x10' ZIPPERED OVERHEAD DOOR
SOUTH END WALL
FABRIC OPENINGS
SCALE 1/4" = 1'-0"
10'x10' ZIPPERED OVERHEAD DOOR
INSULATED FABRIC COVER
SECTION A-A
SCALE 1/4" = 1'-0"
V DITCH
EXIST. GROUND
DETAIL 1
DETAIL 2: STOP LOG SLOT
NOT TO SCALE
SECTION 3
DETAIL 3: SCREEN SLOT
NOT TO SCALE
RACEWAY PLAN
SCALE 1/8" = 1'-0"
60' INSIDE DIMENSION
RACEWAY COVER PERIMETER
EDGE CONCRETE SLAB
FOOTING
A
A1
B
C
D
E
F
G
H
I
1
2
3
60'-0"
ACTUAL FRAMES ARE 8' O.C.
TYPICAL RACEWAY ENCLOSURE PLAN
SCALE 1/4" = 1'-0"
NOTES
CONTRACTOR SHALL INSTALL ALL UNDERGROUND PIPING AND STUB TO SURFACE. COORDINATE STUB LOCATION WITH OWNER
NOTES
SEE SPECIFICATION FOR ENCLOSURE STRUCTURE DETAILS AND ERECTION SEQUENCE.
SECTION 1
SECTION 2
NOT TO SCALE
J-U-B
KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, WASHINGTON
FISH HATCHERY PROJECT
RACEWAY ENCLOSURE STRUCTURE
DETAILS AND SECTIONS
13
OF 17



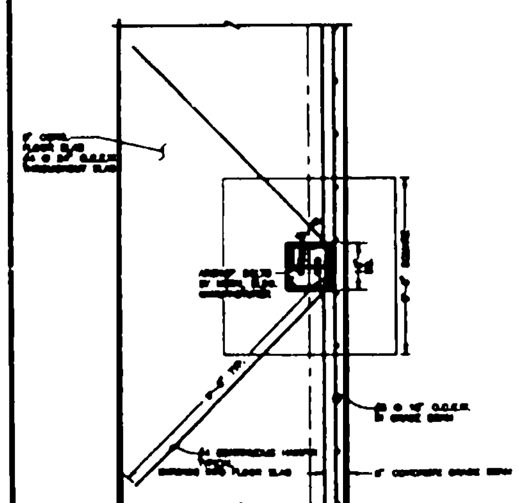
FOUNDATION PLAN



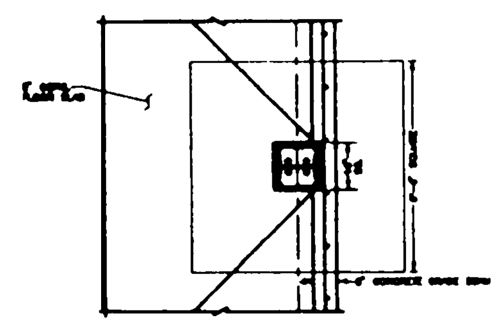
WASTE PLUMBING PLAN



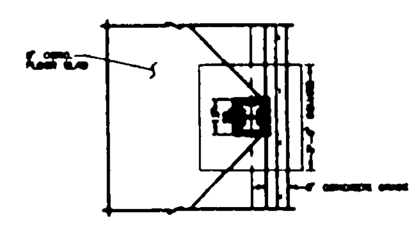
LOFT COLUMN FOOTING
TYPE 4
SCALE 1/2"=1'-0"



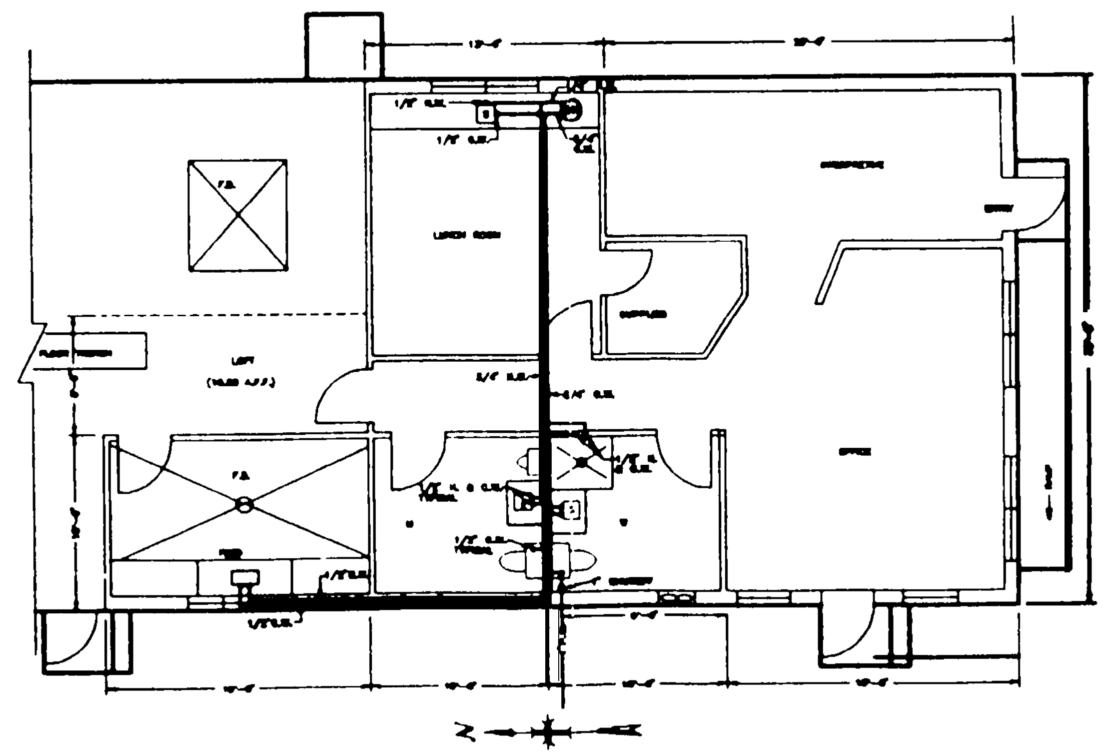
FOOTING PLAN TYPE 1



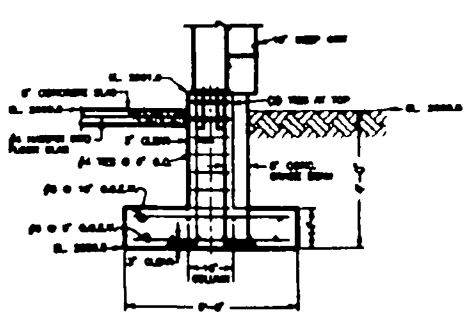
FOOTING PLAN TYPE 2



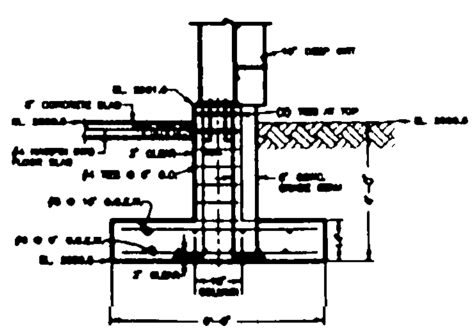
FOOTING PLAN TYPE 3



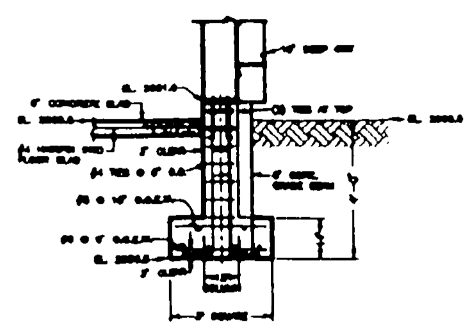
POTABLE WATER PLUMBING PLAN



TYPE 1 (9 EACH)
SCALE 1/2"=1'-0"



SPECIAL RF COLUMN LINE D-1
TYPE 2
SCALE 1/2"=1'-0"



END FRAME FOOTING
TYPE 3
SCALE 1/2"=1'-0"

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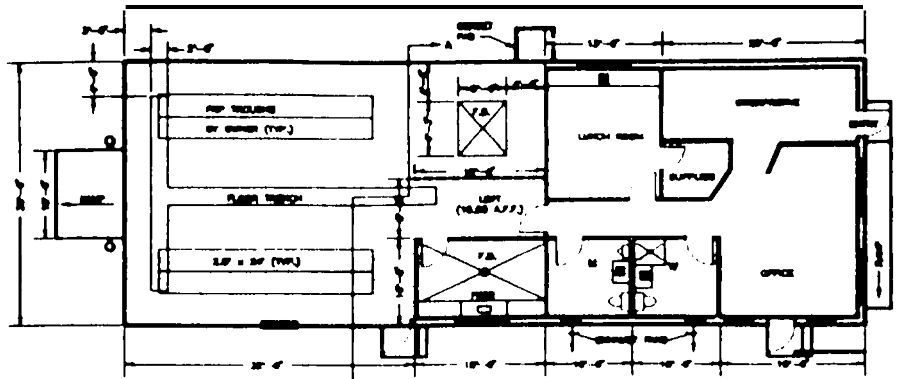
KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, WASHINGTON

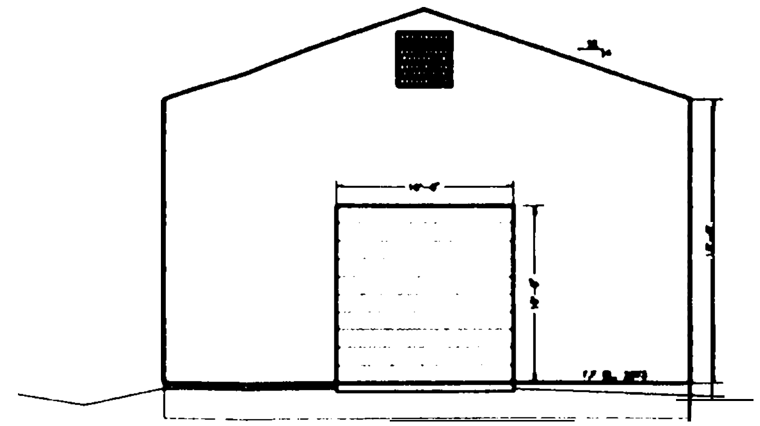
FISH HATCHERY

HATCHERY BUILDING FOUNDATION DETAILS AND PLUMBING

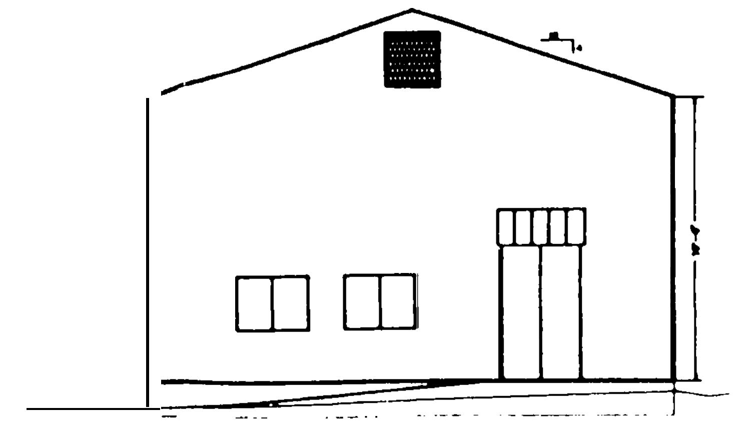
SHEET 14 OF 17



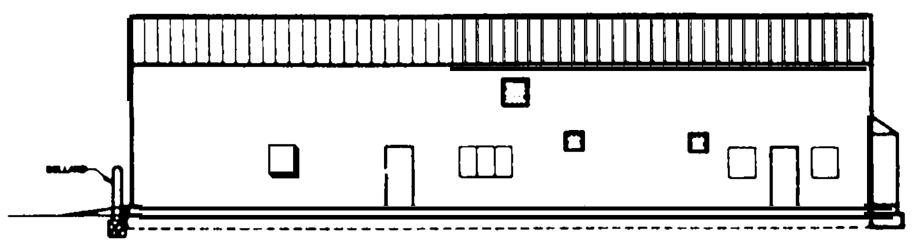
FLOOR PLAN



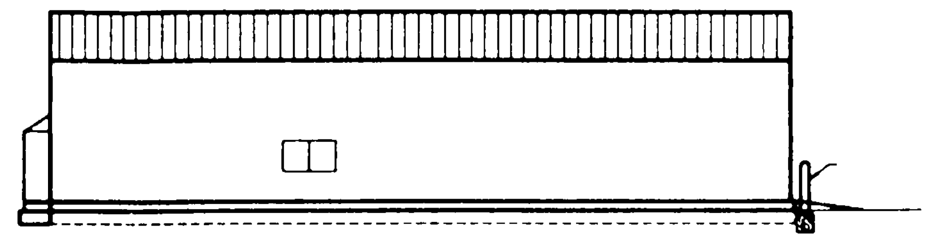
NORTH ELEVATION



SOUTH ELEVATION

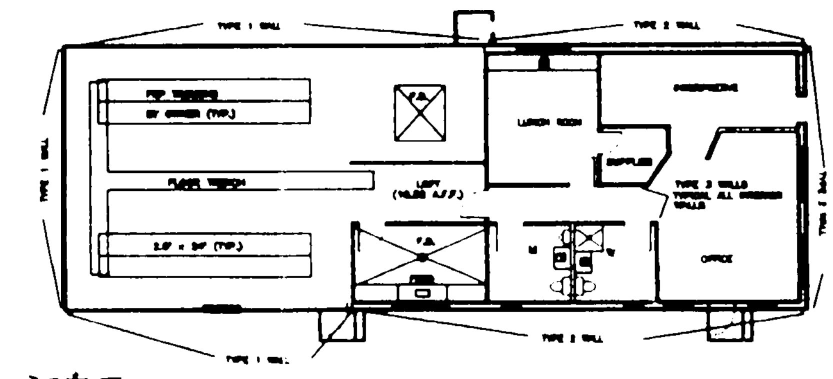


WEST ELEVATION

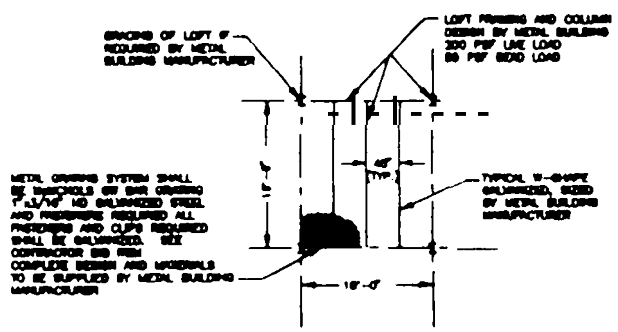


EAST ELEVATON

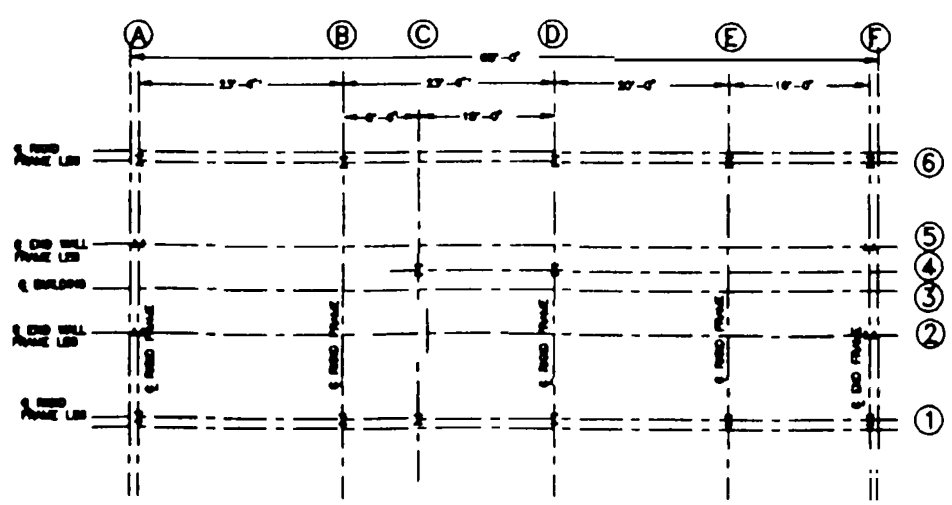
DOOR SCHEDULE



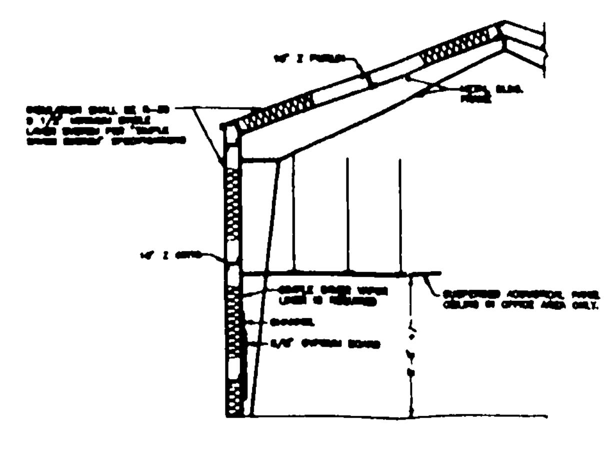
FLOOR PLAN



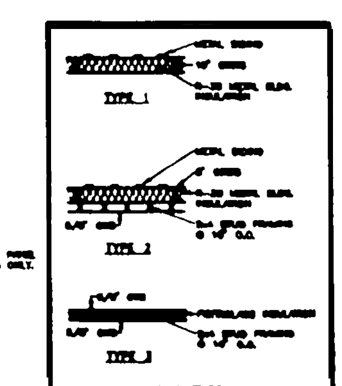
LOFT FRAMING PLAN



RIGID FRAME PLAN



HATCHERY BUILDING INSULATION DETAIL



WALL TYPES

J-U-B ENGINEERS, Inc.

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, WASHINGTON

FISH HATCHERY

HATCHERY BUILDING FLOOR PLAN AND ELEVATIONS

REVISION

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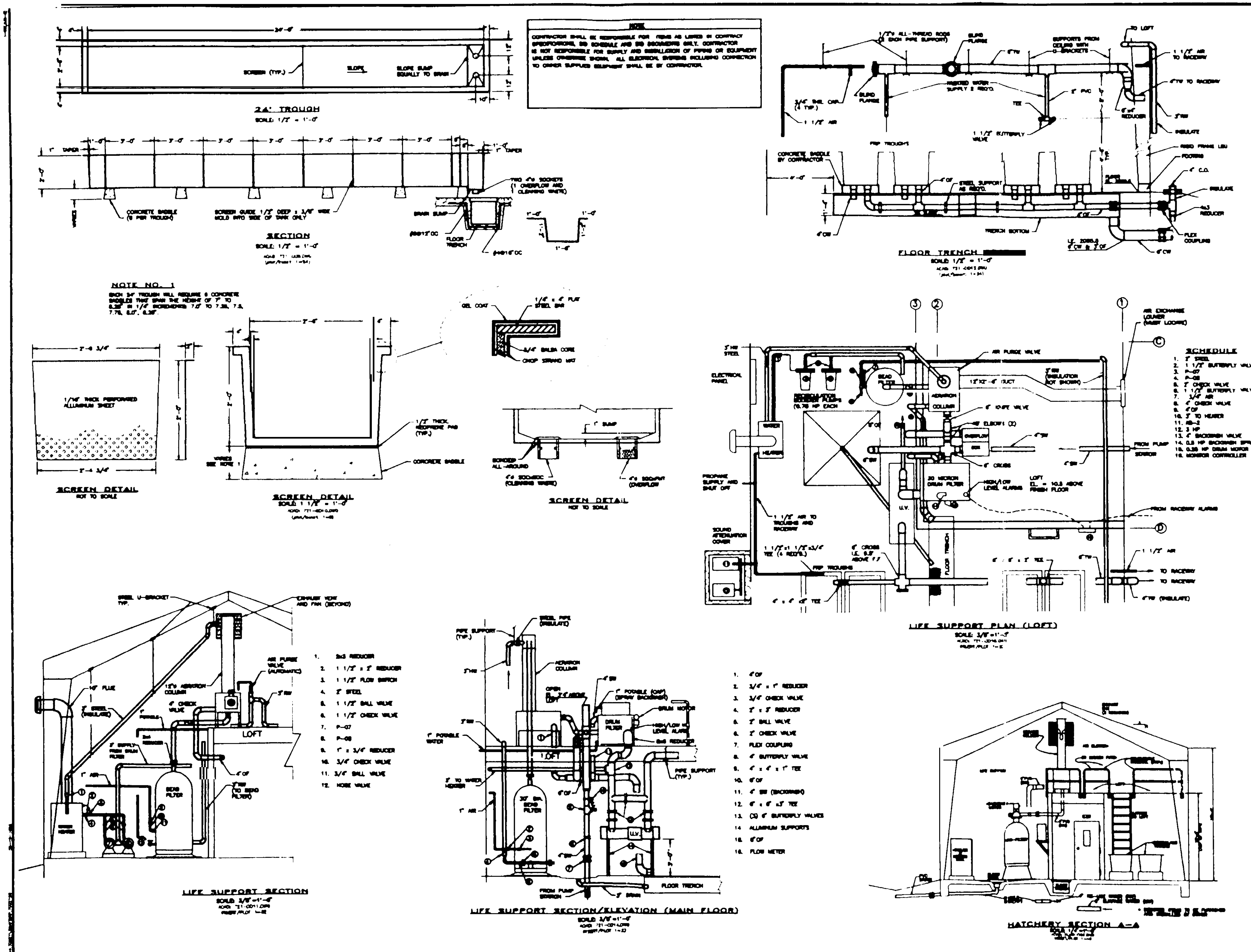

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KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
LIFE SUPPORT PLAN /SECTION AND DETAILS

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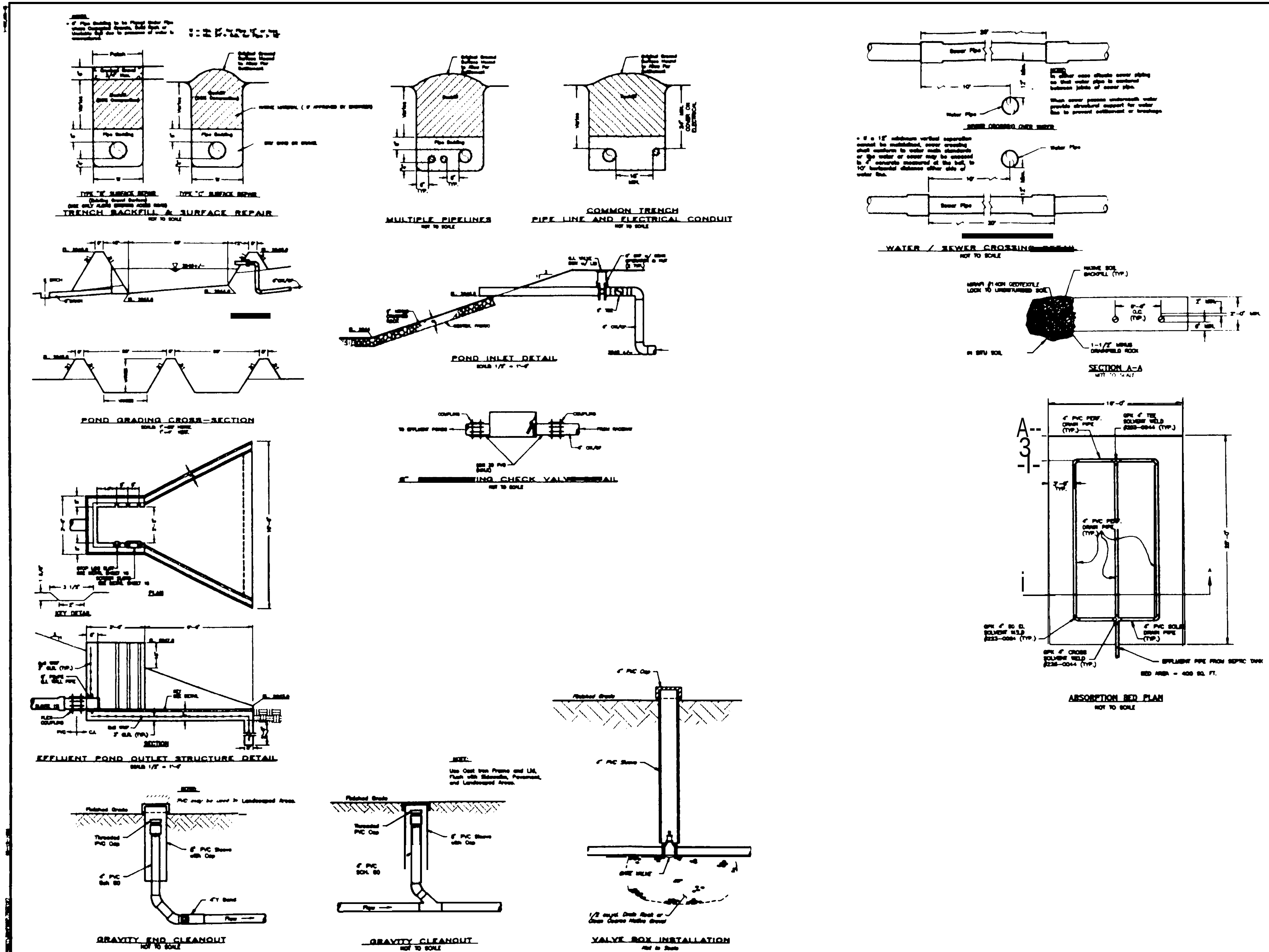

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KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

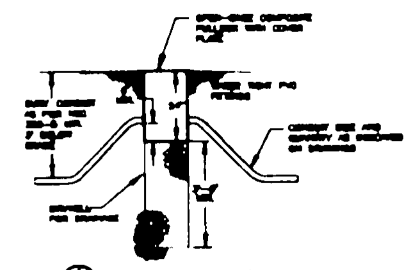
FISH HATCHERY PROJECT
CIVIL /PIPING AND TRENCH DETAILS

17 OF 17

J-U-B ENGINEERS, Inc.

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

FISH HATCHERY PROJECT
OVERALL SITE ELECTRICAL PLAN



PULL-BOX DETAIL
NOT TO SCALE

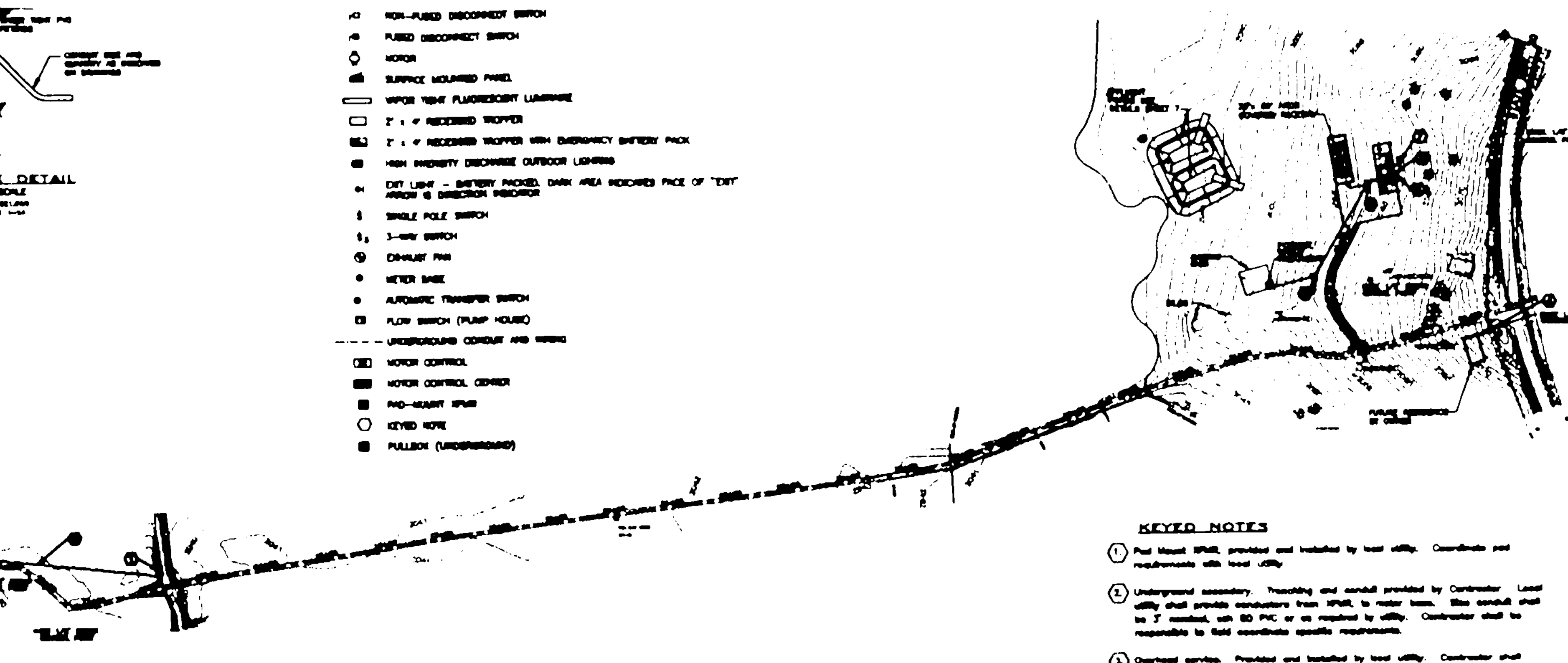
ELECTRICAL LEGEND

- DUPLEX RECEPTACLE
- RECEPTACLE
- QUAD RECEPTACLE
- MOUNTING HEIGHT TO CENTER A.F.F. (18" A.F.F. UNLESS OTHERWISE NOTED)
- GFCI GROUND FAULT CIRCUIT INTERRUPTING
- WP WEATHER PROOF
- I.G. ISOLATED GROUND
- TELEPHONE JACK
- NON-FUSED DISCONNECT SWITCH
- FUSED DISCONNECT SWITCH
- MOTOR
- SURFACE MOUNTED PANEL
- VAPOR TIGHT FLUORESCENT LUMINAIRE
- 2' x 4' RECESSED TROFFER
- 2' x 4' RECESSED TROFFER WITH EMERGENCY BATTERY PACK
- HIGH INTENSITY DISCHARGE OUTDOOR LIGHTING
- EXIT LIGHT - BATTERY PACKED. DARK AREA INDICATES FACE OF "EXIT" ARROW IS DIRECTION INDICATOR
- SINGLE POLE SWITCH
- 3-WAY SWITCH
- EXHAUST FAN
- METER BASE
- AUTOMATIC TRANSFER SWITCH
- FLOW SWITCH (PUMP HOUSE)
- UNDERGROUND CONDUIT AND WIRING
- MOTOR CONTROL
- MOTOR CONTROL CENTER
- PAD-MOUNT XFMR
- KEYED NOTE
- PULLBOX (UNDERGROUND)

LEGEND

- Power Pole
- Guy Anchor
- Tele. Riser
- Water Meter
- Light Pole
- Control Point (Set 1/2" Rebar)
- Exist. Trees (PV)
- Exist. Tree

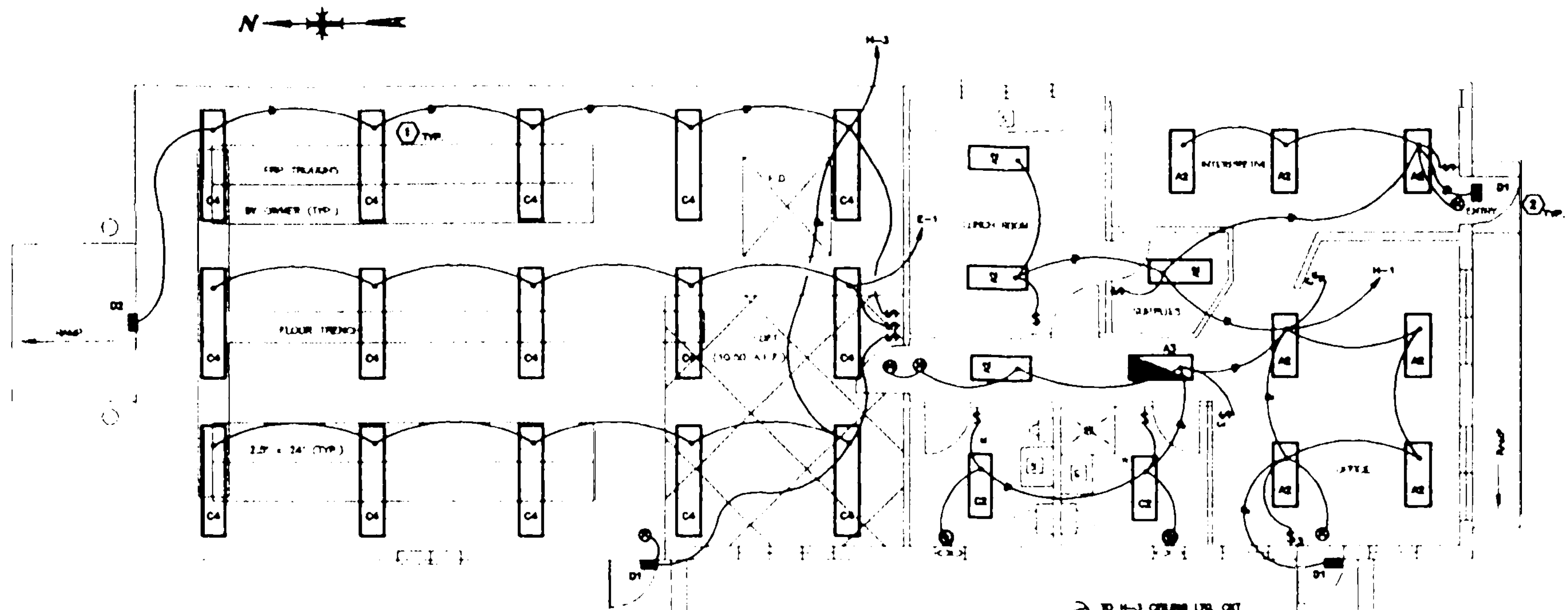
N
1" = 100'



KEYED NOTES

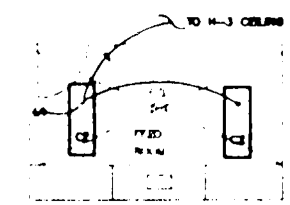
1. Pad Mount XFMR, provided and installed by local utility. Coordinate pad requirements with local utility.
2. Underground secondary. Trenching and conduit provided by Contractor. Local utility shall provide conductors from XFMR to meter base. Size conduit shall be 3" nominal, sch 80 PVC or as required by utility. Contractor shall be responsible to field coordinate specific requirements.
3. Overhead service. Provided and installed by local utility. Contractor shall coordinate service entrance requirements with utility.
4. Contractor shall include costs for material and labor associated with reconnection of overhead service to residence. Contractor shall coordinate requirements with local utility.
5. Underground subfeeds to outbuildings. Size conduit and conductors in accordance One-line Diagram, sheet E4, and NEC. PVC shall be sch 80. Minimum 3' depth.
6. Provide stub-out conduit for future expansion. Conduit shall be 3" PVC sch 80, capped, and buried in accordance with NEC.
7. Contractor shall be responsible to field coordinate specific emergency generator pad requirements and location. Coordinate with LPG storage tank supplier.
8. Provide pull box as shown in detail E1-1. Minimum size box 18" x 18" x 24" with gasketed cover. Logo on plate shall read "Electrical". Cover shall require special tool for access. Quazite or equal.

SHEET E1 OF 4



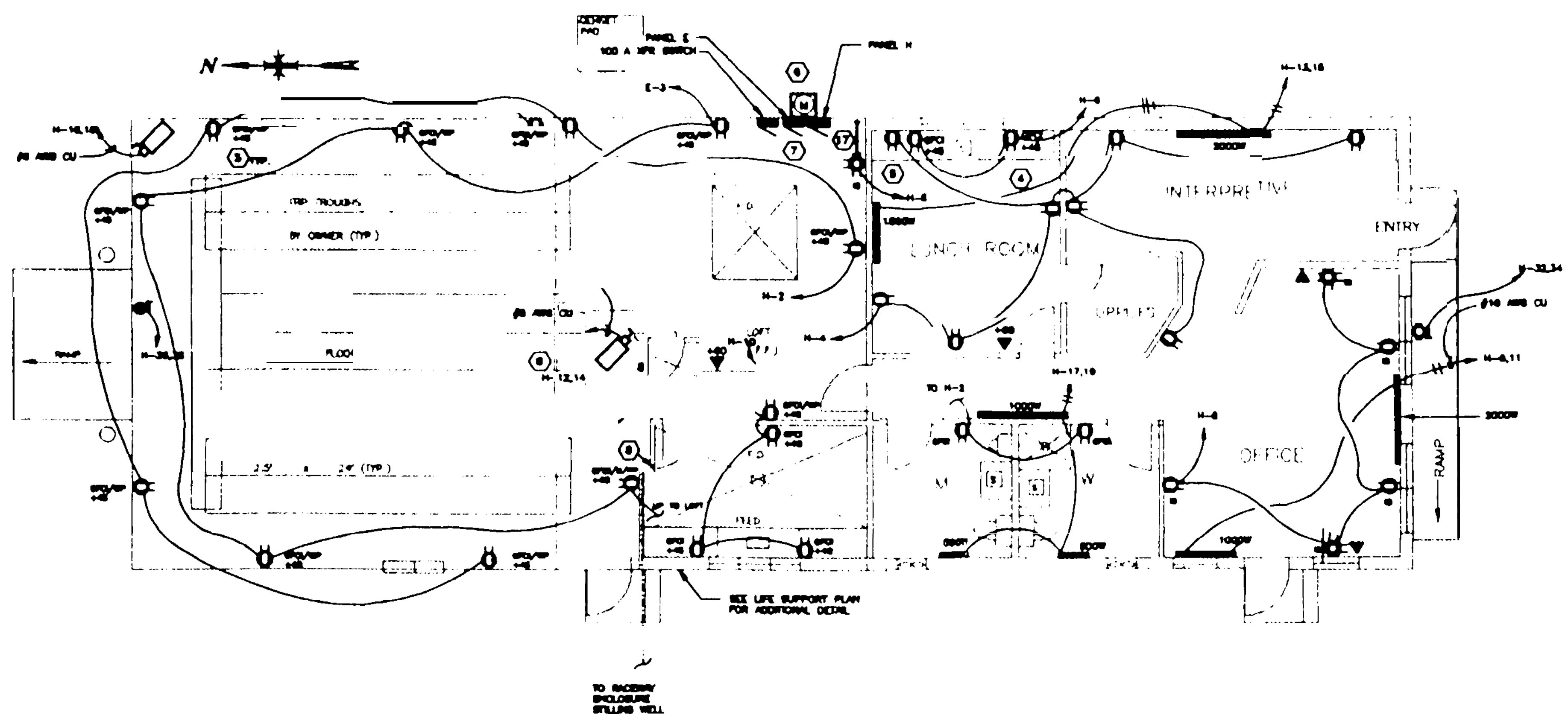
HATCHERY LIGHTING PLAN

SCALE: 1/4"=1'-0"



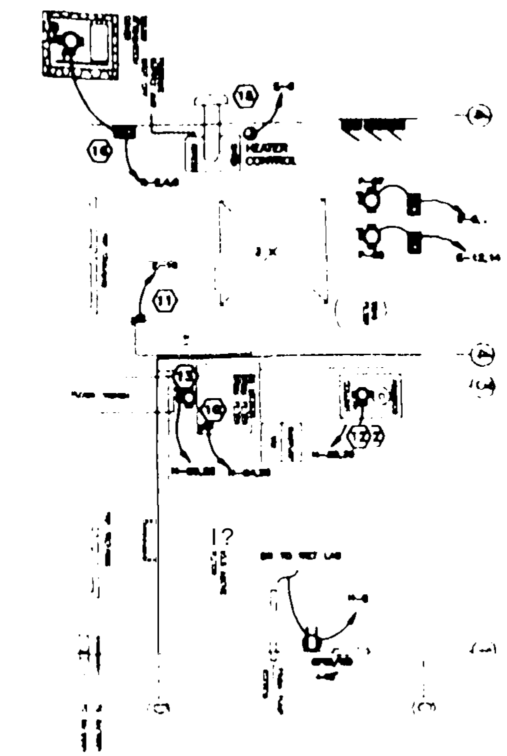
FEED ROOM LIGHTING LAYOUT

SCALE: 1/4"=1'-0"



HATCHERY POWER PLAN

SCALE: 1/4"=1'-0"



LIFE SUPPORT AREA POWER LAYOUT

SCALE: 1/4"=1'-0"

1. Suspend out lab lighting fixtures by pendants/chains from ceiling trusses. Coordinate exact location, mounting height, and switching with Life Support equipment installer and Owner. Recommended mtg height 10' AFF.

2. High intensity discharge security lighting. Mount 12" above top of 7' door. Mount in accordance with manufacturer's specification.

3. Verify exact mounting height and location of GFCI receptacles with Owner and Life Support equipment installer.

4. Kitchen GFCI receptacles. Verify exact mounting height and location with Cabinet layout.

5. Undercounter appliance receptacle. Coordinate exact mounting height and location Cabinet layout.

6. Provide and install 400A outdoor meter socket, [illegible] or equal. Surface mount [illegible] Feed overhead from [illegible] on ONE-LINE DIAGRAM, Sheet E14. Contractor responsible for coordinating overhead service equipment requirements with local utility. Electrical to make connections at line side of meter and from load side of meter to Panel H.

7. Electrical Panels. Coordinate exact location of electrical equipment with mechanical and Life Support equipment installer. Mount in accordance with NEC and manufacturer's requirements.

8. Stub-up 1" PVC for high/low level alarm from stilling wells to raceway enclosure. Field coordinate conduit installation as required.

9. Unit heaters to be provided by mechanical. Provide and install disconnect switch. Coordinate exact size, location, and mounting requirements with mechanical. All connections by electrical.

10. Backwash spray by others. Provide and install 20A 3P disconnect switch, NEMA 3R. Coordinate exact location with Life Support equipment installer. All connections by electrical.

11. UV Disinfection unit. Provide and install 20A 1P disconnect switch, NEMA 3R. Coordinate exact location with Life Support equipment installer. All connections by electrical.

12. Exhaust on roof above aeration columns. Provide and install 20A 3P disconnect switch, NEMA 3R. Coordinate exact location with life support equipment installer. All connections by electrical.

13. Micron Drum filter motor by others. Provide and install 20A 3P disconnect switch, NEMA 3R. Coordinate exact location with Life Support equipment installer. All connections by electrical.

14. Air Blower compressor motor by mechanical. Provide and install 20A 3P disconnect NEMA 3R. Coordinate exact location with mechanical. All connections by electrical.

15. Water Heater by mechanical. Provide and install aluminum J-Box with gasketed cover plate for heater control. Route conduit and circuits as indicated to emergency panel.

16. Pumps by mechanical. Electrical to provide and install motor controller per schedule. Field coordinate exact location and rating with mechanical. All connections by electrical.

17. Telephone backboard. Electrical to provide and install telephone backboard in accordance with specification. Coordinate exact location and requirements with local utility.

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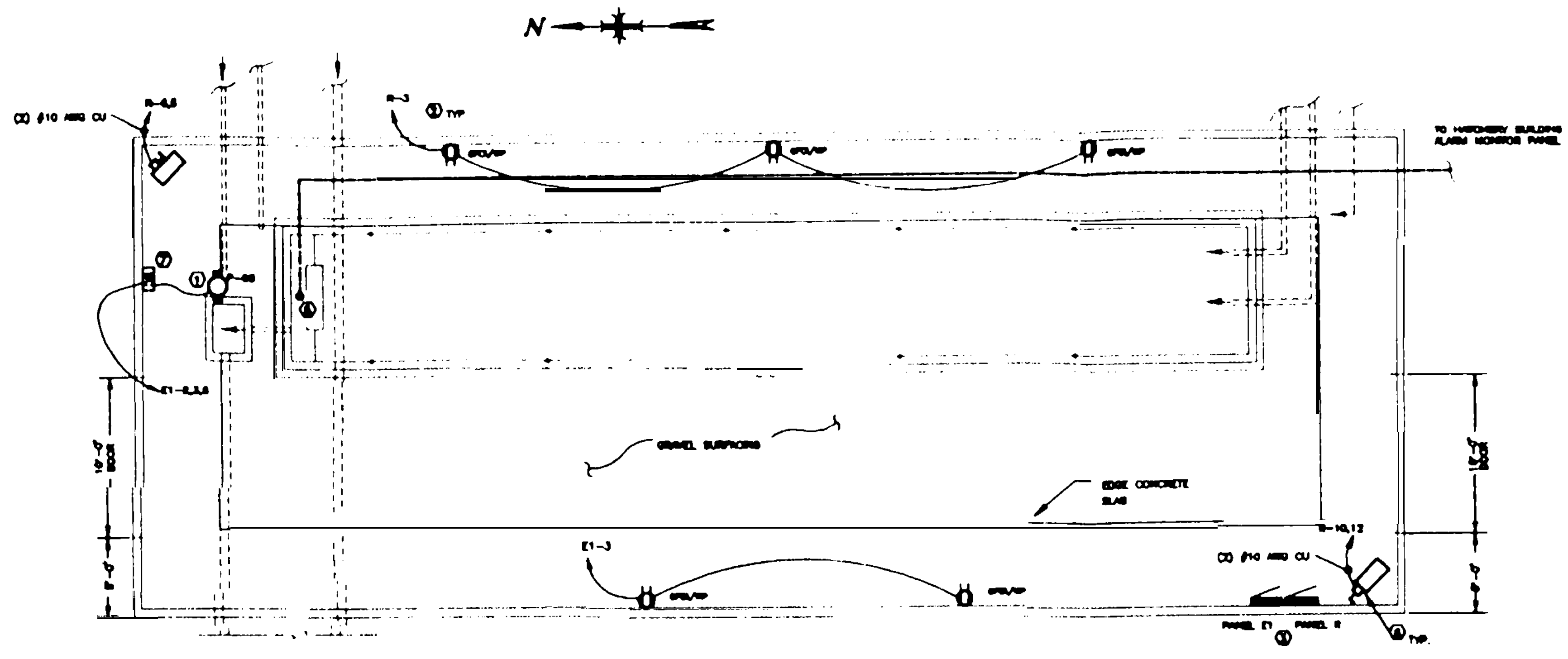
SPOKANE, WASHINGTON

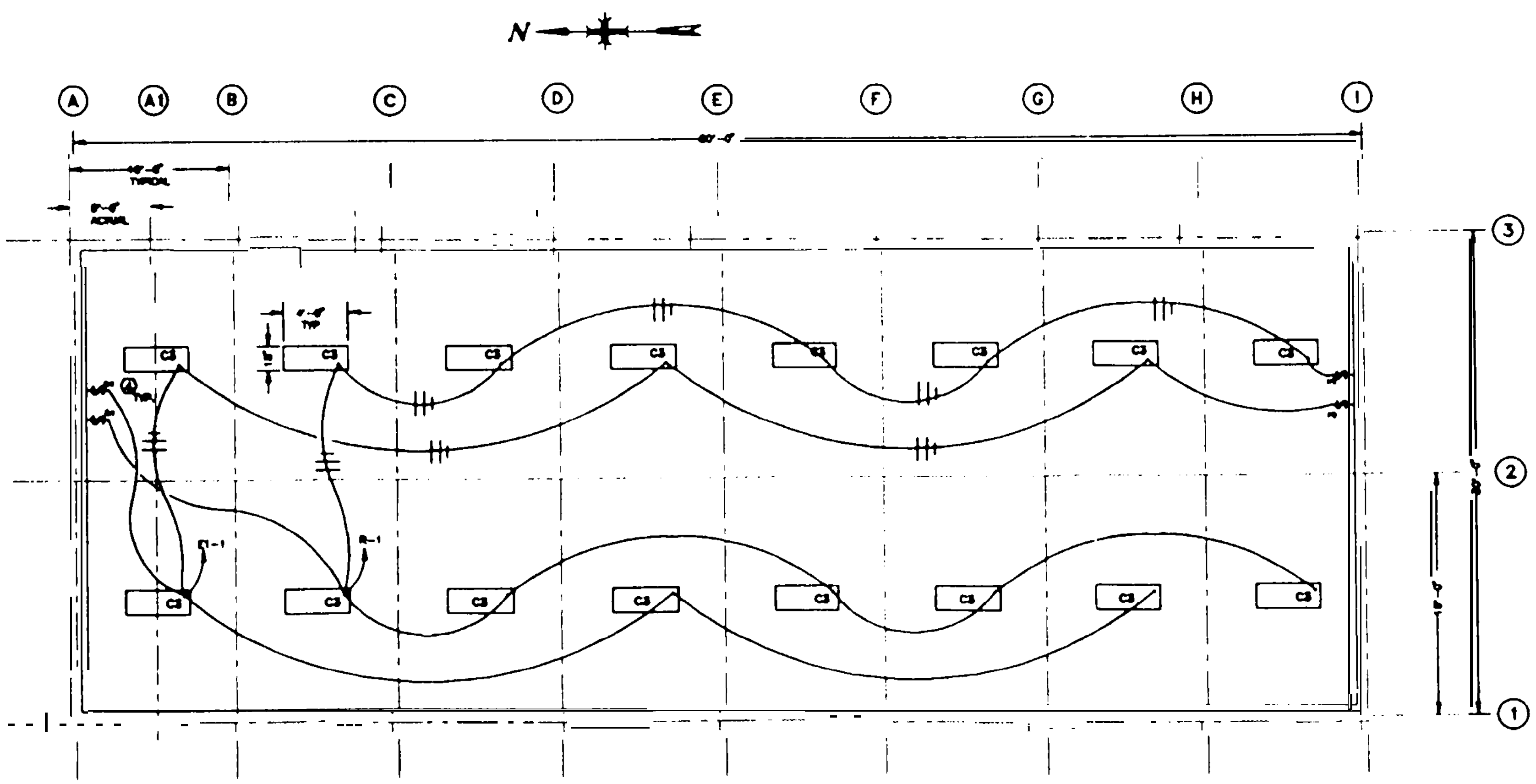
KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, WASHINGTON

FISH HATCHERY
HATCHERY LIGHTING AND POWER LAYOUT
LIFE SUPPORT POWER LAYOUT

E2



RACEWAY WIRING PLAN
SCALE 1/4" = 1'-0"



RACEWAY LIGHTING PLAN
SCALE 1/4" = 1'-0"

KEYED NOTES

1. Coordinate exact meter location with mechanical.

2. Provide and install 20A GFCI receptacle. Mount in cast aluminum single gang box with 3/4" hub. Weather proof cover plate shall be aluminum with rubber gasket and hinged cover. Securely fasten box and conduit to support rails in accordance with NEC and manufacturer's instructions. Coordinate exact mounting requirements with raceway building manufacturer.

3. Panels R and E1 shall installed in accordance with NEC. Coordinate exact location and mounting requirements with raceway manufacturer and owner.

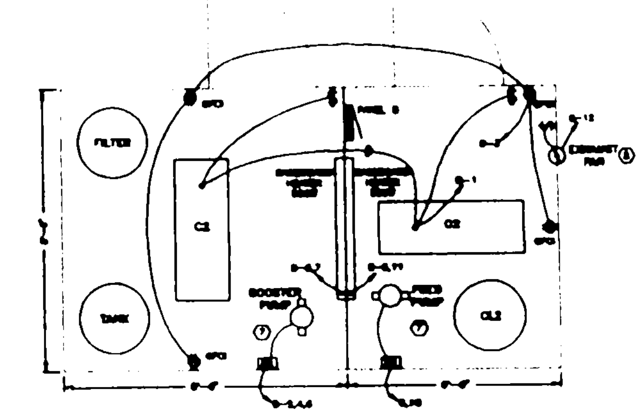
4. Provide and install 20A 1P 3-way switch. Mount in cast aluminum single gang box with 3/4" hub. Cover Plate shall be aluminum with rubber gasket.

5. Stub-up 1" PVC for High/Low Level Alarms for stilling wells. Route PVC underground to Hatchery Buildings to monitor controller. Coordinate exact location of conduit stub-ups with Life Support Equipment Installer. Utilize trenching provided for AC Power Subfeed to raceway enclosure. Coordinate specific wiring requirements with Life Support Equipment Installer.

6. Unit heaters provided by mechanical. Electrical to provide and install disconnect switch. Coordinate size, location, and mounting requirements with mechanical. All connections by Electrical.

7. Pumps by mechanical. Electrical to provide and install motor controllers per schedule. Field coordinate exact location, and rating with mechanical. All connections by electrical.

8. Exhaust fan by others. Provide and install minimum 20A 1P disconnect switch. Field coordinate exact location and mounting requirements with mechanical. All connections by electrical.

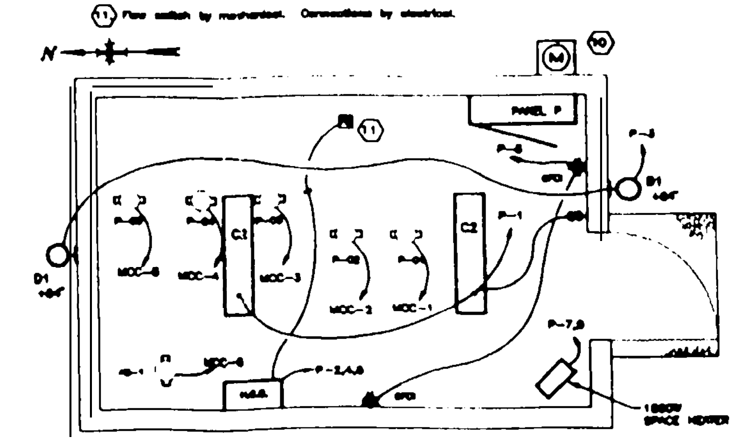


POTABLE WATER ELECTRICAL LAYOUT
SCALE 1/2" = 1'-0"

KEYED NOTES

10. Provide and install 200A outdoor meter socket, [illegible] series, or equal. Mount to exterior of building in accordance with NEC and manufacturer's recommendations. Feed underground as indicated on One-line Diagram, sheet E1. Utility will make connections at secondary side of XFMR and line side of [illegible]. Contractor responsible for connections on load side of meter to Panel P.

11. Flow switch by mechanical. Connections by electrical.



PUMP STATION LIGHTING/POWER
SCALE 1/2" = 1'-0"

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KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, WASHINGTON

RACEWAY POTABLE WATER, PUMPHOUSE ELECTRICAL

E3
of 4

KALISPEL INDIAN TRIBE
PEND OREILLE COUNTY, USK WASHINGTON

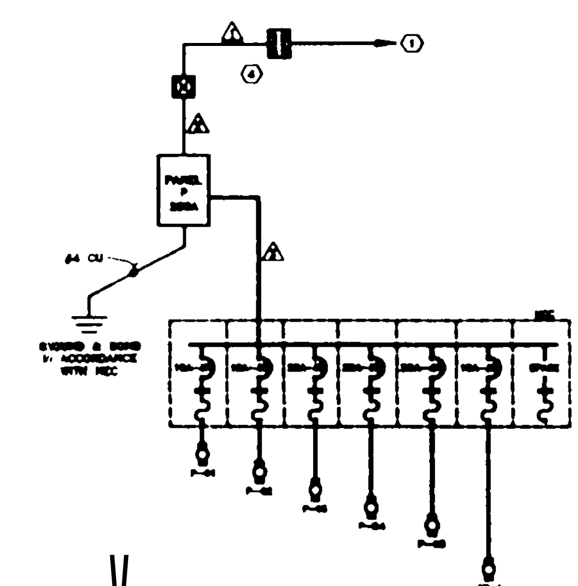
FISH HATCHERY PROJECT

PANEL SCHEDULES, LOAD CALCULATIONS, AND ONE-LINE-DIAGRAM

J-U-B ENGINEERS, Inc.

PUMP HOUSE LOAD SUMMARY

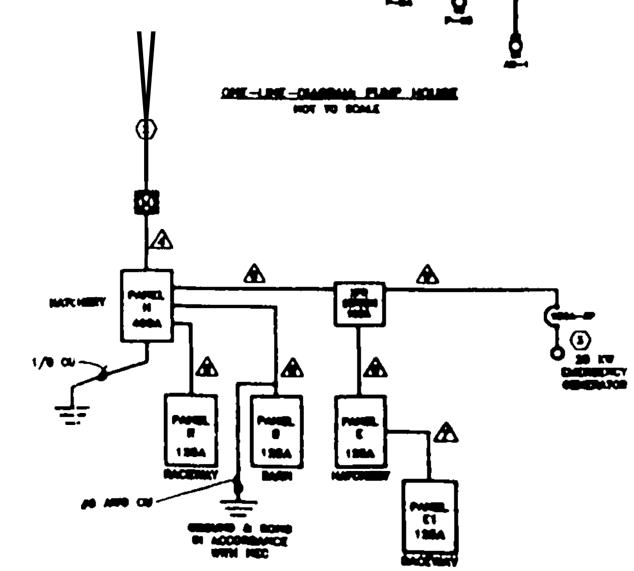
HATCHERY BUILDING LOAD SUMMARY



KEY NOTES

1. UNDERGROUND SERVICE TO PEND OREILLE COUNTY PUD XFMR AT POLE.
2. OVERHEAD SERVICE DROP IN ACCORDANCE WITH UTILITY AND NEC REQUIREMENTS.
3. PROVIDE SOLIDLY INTERCONNECTED NEUTRAL THROUGH XFR SWITCH TO PANEL H NEUTRAL PER NEC 250-[illegible](4).
4. PAD MOUNT 3Ø XFMR BY UTILITY.

- 1 3" PVC, CONDUCTOR BY UTILITY
- 2 (4) 3/0 CU, 2"C
- 3 (4) #1 AWG CU, #6 CU GND, 1 1/2" C
- 4 2 SETS (4) 3/0 CU, 2" C
- 5 (4) #1 AWG CU, #6 CU GND, 2" PVC
- 6 (4) #1 AWG CU, 1 1/2" C
- 7 (4) #6 AWG CU, #8 CU GND, 2" PVC
- 8 (4) #1 AWG CU, 2" PVC
- 9 (4) #1 AWG CU, 2" PVC



E4