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VIA E-Mail paul_smith@rams_wcvi.org

January 14, 2003
Regional Aquatic Management Society
Box 413 – 369 Nimpkish Drive
Gold River, BC
V0P 1G0

ATTN: **Mr. Paul Smith**
Nootka/Kyuquot Stewardship Coordinator

Dear Mr. Smith:

RE: **CONUMA RIVER SIDE CHANNEL**
PROPOSED DEVELOPMENT FEASIBILITY STUDY
December 2002 Site Inspection

INTRODUCTION

On December 5th, 2002, Mr. Bruce Walsh and Mr. Don Reid of **nhc** inspected the proposed location for a rearing channel on the right floodplain[1] of Conuma River downstream of the Fisheries and Oceans, Canada (DFO) hatchery (Figures 1 and 2, Photos 1 and 2). Also in attendance were:

- Paul Smith – Nootka/Kyuquot Stewardship Coordinator
- Chris Erickson – Enhancement Technician from hatchery
- Pat Watson – Regional Aquatic Management Society Volunteer

The purpose of the inspection was to:

- Familiarize **nhc** with the site to aid future design,
- Assess the general feasibility of the project,
- Identify potential site specific problems that should be addressed by the design,
- Provide recommendations that will direct further study.

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1 Right and left refer to the respective side when the river is viewed in a downstream direction.

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The site contains numerous and continuous wetted swales, shows signs of fish use in the downstream section, and appears to be an excellent location for a side channel development. However, three main hazards were identified during the site visit that must be addressed by the design of the channel. These are: water and sediment delivered by the unnamed right bank tributary, erosion and sedimentation due to overbank flooding by Conuma River, and depth to the permanent water table in the upper 200m of the channel.

Biological Rationale of Project

The Conuma River is one of the largest rivers draining into Nootka Sound on Vancouver Island's West coast (Figure 1). As such, it is an important producer of anadromous salmonids returning to the sound. To augment the natural production of chum salmon in the river, DFO constructed a fish hatchery on the right floodplain in 1978 (DFO, 2002). While the main purpose of the hatchery was to augment the natural chum population of the river to support a commercial fishery, the hatchery also raised coho, chinook and steelhead salmon to offset any incidental catch in the commercial fishery (DFO, 2002). The success of the hatchery at raising chinook salmon, in particular, has increased the return of this species from a historical level of 1,000 to 3,000 spawning adults to 13,000 to 25,000 spawning adults. This has led to an increase in sport fishing in the area, an important revenue source for the nearby towns of Gold River and Tahsis.

The Conuma River lacks off-channel habitat, which consists of wetted swales, abandoned channels, ponds, and lakes typical of a large river valley. These areas are essential for overwintering anadromous salmonid species such as coho, steelhead and chinook salmon both as a refuge from floods in the main river and rearing areas. As a result, it is thought that this habitat limits the production of all overwintering species and especially coho salmon in the Conuma River watershed. Therefore, any project that increases the amount of available off-channel habitat for rearing will increase the production of these species.

SITE CHARACTERISTICS

The proposed groundwater channel lies on the right floodplain of Conuma River, downstream of Leagh Creek and the Conuma River fish hatchery. The site lies between the Conuma River delta and Leagh Creek's alluvial fan – a distance of about 1.2km (Figure 2). As Conuma River passes the alluvial fan, it is forced up against the left valley wall, creating a partially protected area of floodplain that varies from 400m wide, at the upstream end, to 150m wide, at the downstream end, as Conuma River switches from the left to the right.

The floodplain is dissected by several continuous but only partially wetted swales. The lower 400m of the swales contain isolated pools, short flowing sections, and small pockets of gravel (Photos 3 to 8). The lower 300m of the swales are thought to be tidal and contain brackish water at twelve-foot tides. Above 400m, the main swale branches into two forks: one that leads to the small-unnamed tributary at the mainline and one that continues closer to the centre of the site (Figure 2). The tributary branch runs along the toe of the unnamed tributary's alluvial fan. It contains evidence of occasional larger flows that have scoured the bed, producing a small sediment lobe about 600m upstream of Conuma River. The branch ends in a small pond located beside the forestry road, adjacent to the alluvial fan. The centre swale runs almost continuously from the fork to within 200m of the hatchery. The upper 700m of this depression has occasional isolated ponds, swampy sections and overgrown sections. The swales end about 200m of the hatchery where the ground rises. A test pit excavated in this section of the floodplain in August 2002 failed to detect groundwater within 3m of the ground surface.

The right floodplain of Conuma River was harvested in the past and now is covered by a tall second growth coniferous forest. As a result, the site is criss-crossed by overgrown skid roads that were constructed to aid the timber harvest and now provide good access to many parts of the proposed channel alignment (Figure 2). The main access road through the site runs from the hatchery along the south side of the site, parallel to the bank of Conuma River.

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Our first impression of Conuma River (this needs to be confirmed by historic aerial photo investigation) is that the reach near the hatchery is aggrading. This reach, which lies immediately upstream of the delta, would be the depositional area for gravels and cobbles transported from the upper watershed. The river appears wide and has abundant sediment that fills the channel (Photo 9). An inspection of the main river near the proposed site revealed very large bars that crest at or above the top of the stream bank (Photo 10). As a result, there has been significant flow over the bank in the recent past, leading to the erosion of several small side channels through the bank. In the long-term, lateral instability of Conuma River above the delta and near the proposed channel could affect the project.

HYDROLOGY AND HYDRAULICS

Water Sources

Currently the Conuma River fish hatchery receives water from two sources: surface flow from nearby Leagh Creek and six wells located on the Leagh Creek alluvial fan (DFO, 2002). These water sources provide the hatchery with up to 600 L/s of flow during the peak water demand period in the spring, and a minimum flow of about 25 L/s when the hatchery demand is at its lowest, during the summer (Table 1).

Surface water from Leagh Creek is fed by gravity to the hatchery from a low head, concrete weir and screened intake located in a bedrock-controlled portion of Leagh Creek, upstream of the hatchery (Steve Emmonds, 2003). During the summer (June to August), when Leagh Creek is low and the hatchery demand for water is small, there is no water diverted from the creek. This reduces the hatchery's impact on the natural habitat within Leagh Creek at a critical resource time of the year. However, in the spring when hatchery demand for water is high and there is abundant water in Leagh Creek, the surface water diversion from the creek supplies the hatchery with up to 300 L/s. This accounts for about one half of the total hatchery demand.

Up to 300 L/s of ground water is fed to the hatchery from the six wells on the site. This water is pumped from a depth of about 100 feet on the Leagh Creek alluvial fan. The wells are able to provide a constant source of water throughout the year. However, to reduce costs, only one pump is operated through the summer when the demand for water by hatchery operations is low. The single well operating through the summer provides the hatchery with as little as 25 L/s of flow – the minimum flow that will be available to the channel.

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Table 1: Flow to Conuma River Hatchery by Month

Month	Wells (L/s)	Leagh Creek (L/s)	Total Water Use (L/s)
January	140	100	240
February	300	90	390
March	300	210	510
April	300	290	590
May	300	70	370
June	25	0	25
July	25	0	25
August	25	0	25
September	140	130	270
October	140	170	310
November	60	40	100
December	140	130	270
		Minimum	**25**
		Maximum	**590**

Source: Fisheries and Oceans, Canada – Conuma River Hatchery

Three other natural sources of water are available to the channel – seasonal surface water from the small, unnamed right bank tributary, overbank flooding from Conuma River and ground water flow. The small tributary has a watershed area of about 47 ha and likely generates about 12 m^3/s of flow for a 100-year event if a value of 800 m^3/s is adopted for a watershed area of 100 km^2 for the region (Coulson, 1998) and:

$$Q_u = \left(\frac{A_u}{A_k} \right)^n Q_k$$

where Q_u is the unknown discharge, A_u is the watershed area of the study area, A_k is the watershed area of the known or gauged watershed, Q_k is the discharge of the known watershed and n is the exponent of transfer (0.8 for BC).

High water marks of about 800mm in the 1,600mm culvert under the forestry road indicate that a flood of about 1.5 m^3/s has recently flowed through the culvert. This culvert has a total capacity of about 3.5 m^3/s and lies on a 3% gradient. There was very little flow through the culvert on December 5, 2002 suggesting that the tributary dries through much of the year.

Conuma River shows signs of recent aggradation and significant overbank flooding. A large November 2002 storm inundated large portions of the right floodplain under 1m to 1.5m depth. This water entered the lower section of the proposed site. Any channel excavated in this area will require a berm to prevent the overbank floods that travel along the roads from entering the channel. Alternatively, a channel could be designed to allow these floods to pass through the channel without significant damage. However, this option would include some risk of sediment carried with the flood flows filling the channel.

The amount of flow generated by groundwater interception will depend on the length of the channel, the head difference between the channel and the surrounding water table, and the properties of the sediments in the site. These parameters are not currently known for the site. Many side channels, although excavated to 1m below the permanent water table depth, do not depend directly on groundwater flow as a source of water. Instead, the flow though these projects is introduced by intakes and diversions like the proposal for the Conuma River channel. However, we expect a significant amount of flow from groundwater at this site if the channel is excavated to a sufficient depth. Reasons for this include:

- The site stratigraphy is composed, primarily, of alluvium, which generally has a high ability to transmit water – hydraulic conductivity.
- The depth to the permanent water table appears small through much of the site. This will allow the excavation to penetrate deep into the water table, increasing the head difference between the channel and the surrounding water table.

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- Groundwater currently discharges through the lower end of the site year-round.
- The site lies between Conuma River to the south, Leagh Creek to the east, and a steep hill slope to the north, three potential groundwater sources.

Channel Dimensions

The current outlet channel of the hatchery provides a good template for the rearing channel construction (Photos 11 and 12). This stable channel has a width of 4 to 5m, lies on a gentle slope of less than 1% between drop structures, and has bed material composed of sands and gravels. The banks are stable, are vegetated by grasses and small shrubs, and are angled at about 2 horizontal to1 vertical (2H:1V). During the inspection, the discharge from the hatchery was about 500L/s, providing a water depth of 0.6 to 0.7m and a mean velocity of 0.2m/s. The frequent redds and adult spawners in the channel suggest that these conditions are suitable for spawning.

POTENTIAL HAZARDS

There exists three main hazards to the development of a rearing channel on the right floodplain of Conuma River: channel drying near the hatchery where the depth to the permanent water table is greater than 3m, overbank flooding by Conuma River, and channel shifting and sediment supply from the small right bank tributary.

Two test pits were excavated along the grade on August 2, 2002 – one about 400m upstream of the right bank tributary and wetland in the middle of the site, and one about 150m downstream of the hatchery (Photo 13). The lower test pit encountered water at a depth of about 0.5m but was dry in December 2002. The upper test pit was excavated about 150m downstream of the hatchery to a depth of 3m. This pit failed to encounter water when dug and was dry in December 2002.

Generally, it is not feasible to excavate a channel below a depth of 3m. The volume of material that must be moved and the size of the opening that must be created to facilitate this large excavation usually create a very costly project. One alternative would be to excavate a shallower channel of about 2m depth between the hatchery outfall and the permanently wetted lower channel. However, this approach is generally not advisable because the channel bed would loose water to the ground. If losses exceed inputs, the upper channel would dry, stranding fish, and flow may not be delivered to the downstream channel. A second alternative would be to use an enclosed pipe from the hatchery outfall to the open channel. This option, while reducing the excavation will shorten the usable channel by about 300m.

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Conuma River overtops its right bank, and appears to regularly flow down the access road and through the lower section of the channel. This presents two problems for a channel – the erosive power of deep, fast flowing water and the input of fine overbank sediments. Flow along sections of the road has eroded all sediment smaller than 25mm. This material has been moved down the road and deposited in the backflooded lower section of the channel, creating sediment lobes that were dry during the December site visit. If a berm is built between the river and the channel to prevent water and sediment from entering the channel, it is likely that sections of the berm near the main access road and at the ends of the overgrown skid roads will require protection, increasing the cost of the project.

The unnamed, right bank tributary is also a potential source of both water and sediment to the channel. Below the mainline culvert, the stream channel is entrenched into the fan surface and laterally stable. However, as the stream enters the BC Hydro right-of-way a sediment lobe fills the channel. This sediment lobe causes the stream to split into several channels, each transporting some gravels and sands down to the swales. This lateral instability and multiple location of sediment delivery should be accommodated in the design of the rearing channel.

Another design consideration, although not necessarily a hazard, is the penetration of salt-water into the downstream end of the swales. Currently, twelve-foot plus tides penetrate the lower 300m of the swales, producing brackish conditions in these permanently wetted swales. If further salt-water intrusion into the channel is undesirable, the excavation may be limited at the point of maximum tide penetration. This would result in a high section or hump in the profile that will limit the salt-water intrusion. However, depending on conditions such as streambed losses, depth to groundwater, and total flow in the upper channel, this high section of the profile may dry during low flow periods of the year. This would create a seasonally isolated upper channel. If salt-water intrusion into the channel is not a concern, no hump would be required.

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CONCEPTUAL DESIGN AND BUDGET

A preliminary cost estimate for the rearing channel planned for the right bank floodplain of Conuma River is about $284,000 (Table 2) based on the following assumptions:

- A channel with a bottom width of 4m (Figure 2),
- 2H:1V side slopes,
- An average depth of excavation of 2m,
- A total channel length of 1000m from 300m below the hatchery to the upstream extent of salt water penetration near the existing access road,
- A total excavated volume of 21,000 m^3 allowing for 30% expansion of the volume following excavation,

- The excavated material would be spoiled nearby on a berm to reduce truck turn-around time,
- A 300m long culvert that would be used to convey water from the hatchery outfall to the upstream end of the open channel.

Table 2: Schedule and Cost Estimates:

Item	Unit	Quantity	Rate	Total	
Excavated Volume					
Channel length	m	1000			
Unit excavation	m^2	21			<--assumes 30% soil expansion
Total volume	m^3	21000			
Excavating/Hauling					
Turnaround time	hr	0.3			
Truck volume	m3	10			
Number of trucks		3			
Unit volume	m^3/hr	90			
Excavating/hauling	hr	233.3			
Excavating/hauling	days	23.3			<--assumes 10hr work days
Complexing					
Additional Excavator	days	7			
Assume	hr	70			
Construction Costs					
Mob/Demob	l.s.			$ 2,000	
Excavator	hrs	303.3	$ 175	$ 53,083	<--Blue book rate - CAT 330 BL
Trucks	hrs	700.0	$ 125	$ 87,500	<--Articulated truck (Volvo A25)
Swampers	days	53.7	$ 250	$ 13,417	
Environmental Monitor	days	30.3	$ 400	$ 12,133	
Construction Super	days	30.3	$ 500	$ 15,167	
Professional Review	days	5.0	$ 1,600	$ 8,000	
Meals/accommodation	days	65.7	$ 100	$ 6,567	
Professional Travel	l.s.			$ 1,000	
Service Vehicle	days	30.3	$ 50	$ 1,517	
Enviro Vehicle	days	30.3	$ 85	$ 2,578	
Miscellaneous Equip.	days	30.3	$ 25	$ 758	
Complex (logs/rootwads)	l.s.			$ 15,000	
Riprap (for berm)	l.s.			$ 15,000	
Conveyance pipe	m	300.0	$ 10	$ 3,000	
			SUBTOTAL	**$ 236,720**	
			Engineering (10%)	**$ 23,672**	
			10% Contingency	**$ 23,672**	
			TOTAL	**$ 284,064**	

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RECCOMENDATIONS AND SPECIAL CONSIDERATIONS

1). We recommend that the entire site be surveyed prior to any further work. Ideally these surveys would include:

- The channel alignment and profile,
- A profile of the main river,
- A groundwater profile completed at the driest time of the year,
- Cross sections that traverse the whole floodplain from river thalweg in the south to the hill slope in the north,
- All existing roads and skid trails that will be used for access,
- Tide elevations and the time of reference or the whole survey tied to a geodetic survey control marker,
- Local high water marks both along the main river and through the proposed alignment,
- The elevation of the hatchery outlet,
- The extent of the unnamed tributary alluvial fan and location of the current channels,
- The location and elevation of the water surface of the small pond located at the base of the unnamed tributary alluvial fan.

2). We recommend that the depth to the permanent water table be established in the upper section of the channel. The two upstream test pits were dry during the December field trip. Ideally, this depth should be included on the final survey drawings. The depth to groundwater near the hatchery appears to one of the largest hurdles facing the project and the final design must account for a very deep and costly excavation, streambed losses, or an alternate way of getting the hatchery outflow to the lower channel (e.g. a pipe).

3). We recommend that the channel be designed to pass 600 L/s but remain fully functional at a base flow of 25 L/s. Channel sections below the unnamed right bank tributary should be designed to convey more than 600 L/s.

4). We recommend that the small alluvial fan and unstable channel of the unnamed tributary be incorporated into the long-term design of the channel. The design should incorporate both the water and sediment delivered by this stream and address or account for the channel stability on the fan.

5). While no debris flow evidence was found below the unnamed tributary and bedrock can be seen to dominate the tributary’s watershed, we recommend that the upper watershed be examined by historic aerial photograph and by foot for the possibilities of landslides and debris flows.

6). We recommend that overbank flow from Conuma River be prevented from entering the channel by the construction of a continuous berm located between the river and the channel. The berm would likely terminate where the existing channel crosses the main access road.

7). We recommend that the effect of tidal influence in the downstream section of the channel be incorporated into the design. Controlling salt-water intrusion may limit the depth of excavation through much of the channel.

8). We recommend exploring options to prevent future chum salmon spawning on the main access road. It may be possible to incorporate sections of the road right-of-way within a drivable berm, thus raising the road surface above flood levels in the main river.

9). All of the water spilled from the hatchery could be diverted into the rearing channel. Fish should be prevented from entering the current overflow channel because we suspect that it will dry during base flow conditions without the hatchery input.

10). A preliminary cost estimate for this project is $284,000 (Table 2). However, this estimate should be reviewed after the site survey is complete and a firmer estimate of the volume of sediment to be excavated is known.

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We trust that the above report aids your planning process for this exciting project.

Yours truly,
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Don Reid, R.P.Bio.
Geomorphologist

Bruce Walsh, P.Eng.
Review Principal

LITERATURE CITED

Coulson, C.H. and W. Obedkoff. March 1998. British Columbia Streamflow Inventory. Province of British Columbia, Ministry of Environment, Lands and Parks. Water Inventory Section, Resources Inventory Branch.

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Emmonds, Steve. January, 2003. Manager – Conuma River Fish Hatchery. Personal Communication.

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FIGURES

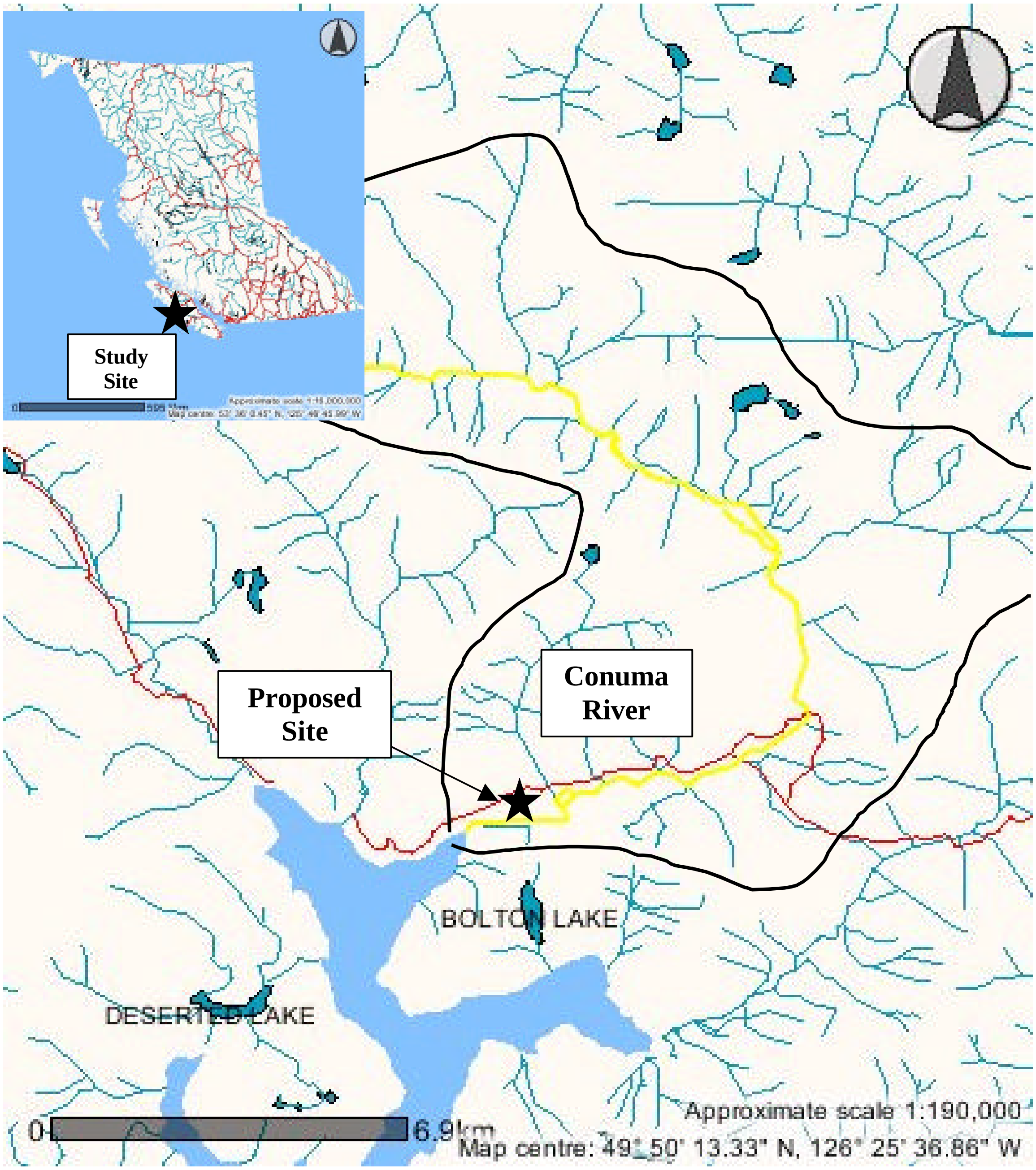
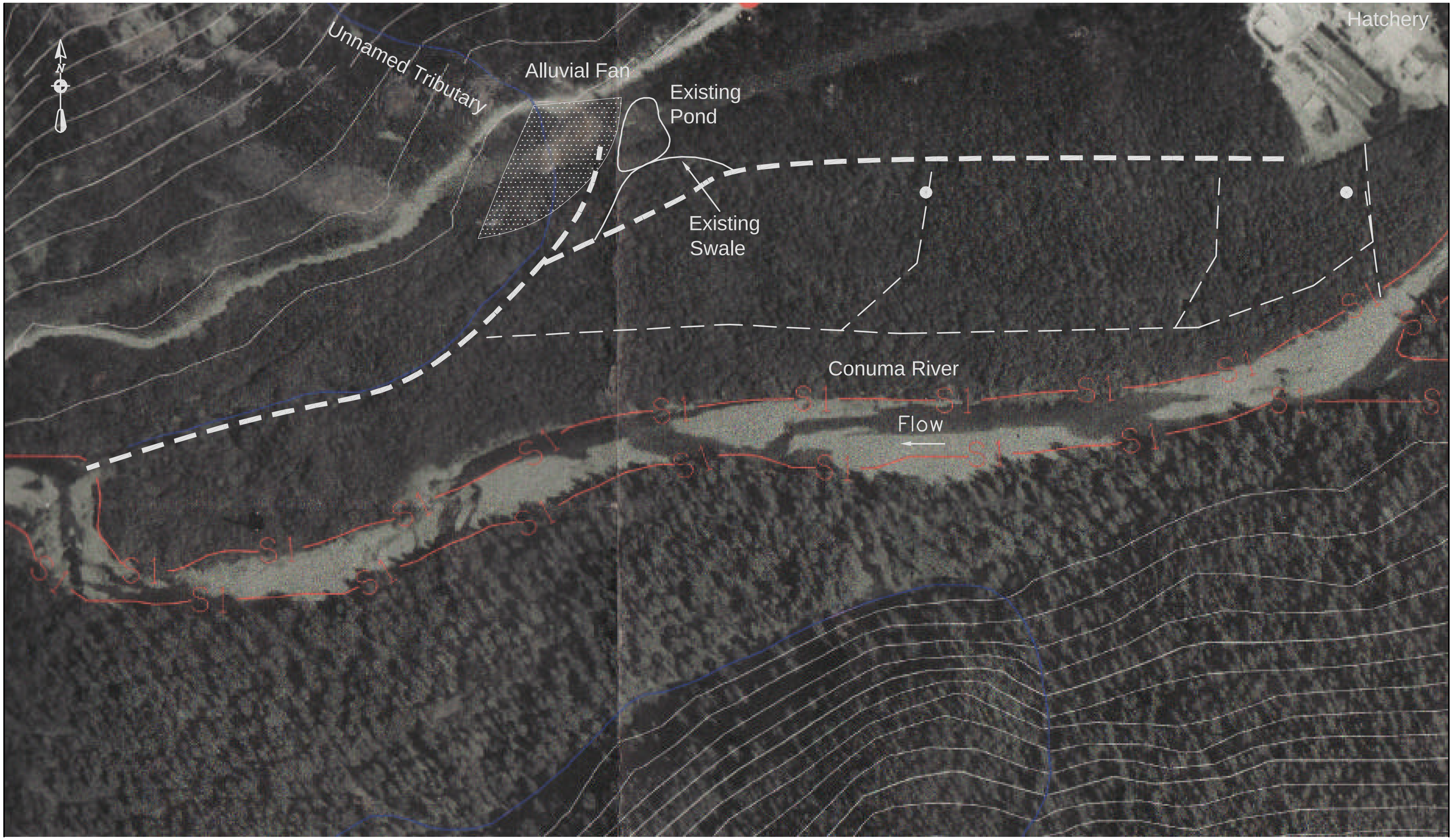
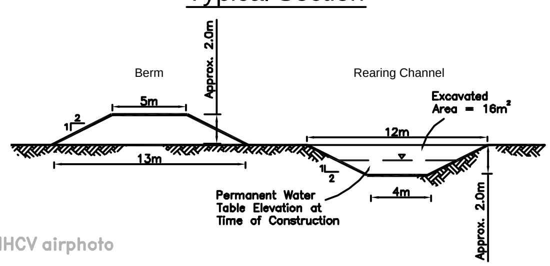


Figure 1: Study Site



Typical Section



NHCV airphoto

Scale 1:6,000 Approx.

Legend:
- Proposed Channel Alignment (Approx.)
- Access Roads (Approx.)
- Test Pits

CONUMA RIVER CHANNEL

Location of Proposed
Side Channel Development
(Aerial Photograph)

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Figure 2

PHOTOGRAPHS

Photo 1: Looking upstream into Conuma River watershed. Conuma River hatchery is visible in lower centre (photo from DFO website).

Photo 2: Looking down at the Conuma River hatchery (photo from DFO website).

Photo 3: The lower swales where they cross the main access road.

Photo 4: Looking upstream into the main swale at about 300m upstream of Conuma River. Note the sediment lobe due to overbank flow from Conuma River.


Photo 5: Isolated pools and short flowing sections of the lower swales.


Photo 6: Larger gravel section in the lower swales.


Photo 7: Overgrown and ponded sections of the swales.


Photo 8: The upstream extent of flowing water at about 500m on December 5.

Photo 9: Looking upstream at Conuma River just below the hatchery. The proposed channel site lies behind the alders to the left of the photo.

Photo 10: Looking toward the right bank of Conuma River adjacent to the proposed site. Note the height of the gravel bar and the small channels leading into the trees.


Photo 11: The hatchery outfall.


Photo 12: The stable hatchery outlet channel.

Photo 13: Dry 3m deep test hole near the hatchery. Note the 1m deep overbank sediments over top of gravels and sands.

Photo 14: Gravel transport down the laterally unstable channels on the unnamed tributary alluvial fan. This source of sediment will have to be incorporated into the channel design.


Photo 15: Looking up at the bedrock dominated watershed of the unnamed tributary.