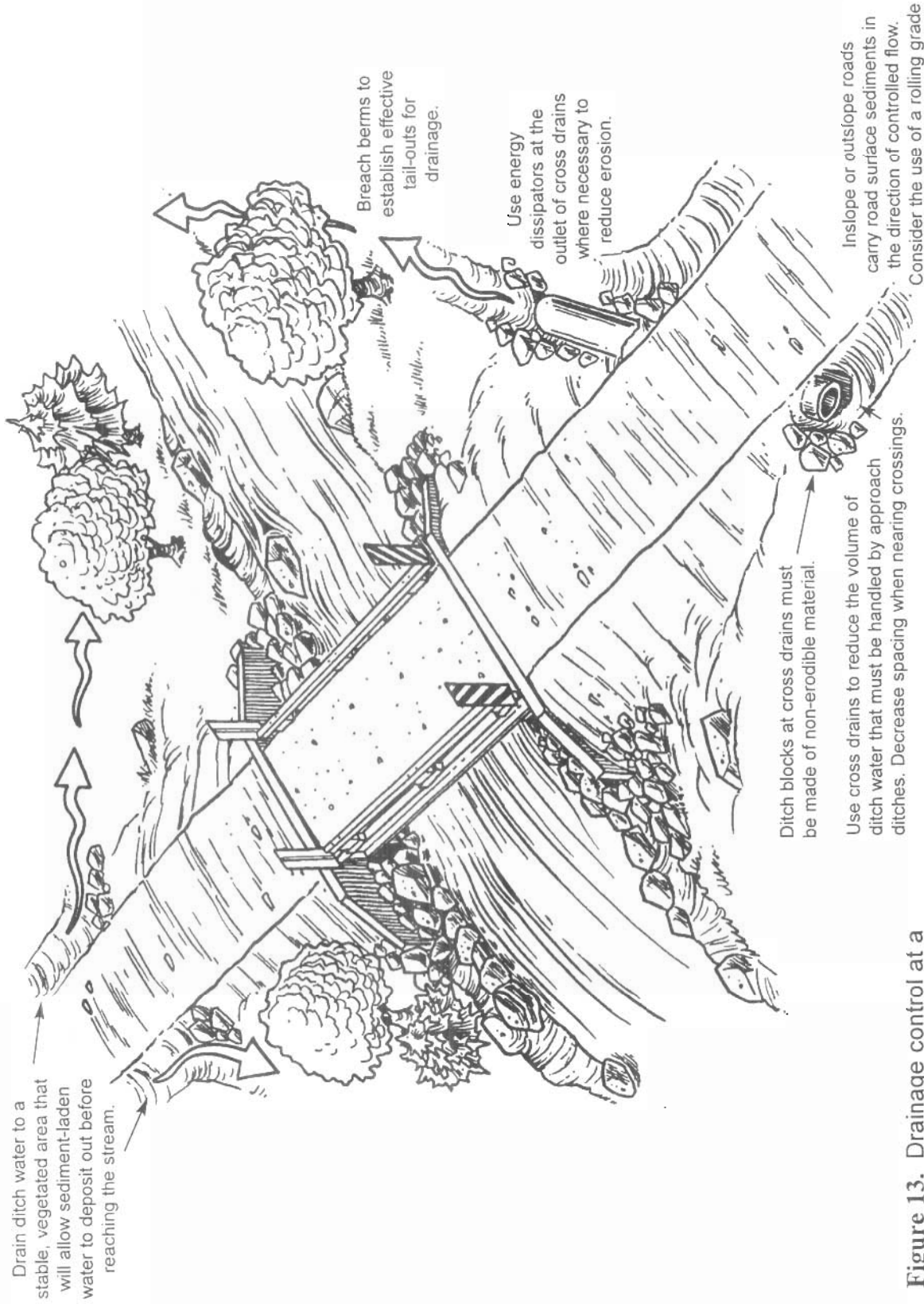


Figure 13. Drainage control at a stream crossing.

ditches dug to carry the water off the road clearing width. It is important to ensure that effective ditch blocks are present. These should be constructed of material sufficient to withstand the erosive forces of the anticipated amount of water carried by the ditch.

Draining ditch water directly into the stream should be avoided. As much ditch water as possible should be drained out of the ditch and into constructed sumps or onto vegetated areas that should allow ditch sediments to deposit out before the water reaches the stream.

4.6.8 Sediment traps and barriers

- Sediment should be controlled at the source. Once entrained in water, it is more difficult to control. Sediment traps and basins, silt fences, straw bale dikes and basins, and geotextiles provide effective means, used singularly or in combination, for controlling sediment during construction. Sediment traps and basins can be either simple, small pits or large, complex engineered structures designed to impound large quantities of sediment. Silt fences and straw bales, in contrast, are designed primarily to intercept and filter small volumes of "sheet flowing," sediment-laden runoff before it reaches the watercourse. Silt fences, however, should never be used as filters within a watercourse, as they have limited capacity to pass water.

- On completion of construction, these temporary control structures should be removed and the sediment stabilized.

4.6.8.1 Sediment traps or basins

- Sediment traps or basins used on forestry roads are excavated pits that capture coarse sediments from ditchlines before they can enter a stream. All sediment traps and basins should be cleaned frequently while they are in place if they are to be effective. At the site of the crossing, ditch water should be directed into the sediment trap or basin.

4.6.8.2 Silt fences

- Silt fences are short-term structures made of wood or steel fence posts and a suitable permeable geotextile. They retain soil on the site and reduce runoff velocity across areas below the fence. Silt fences are effective boundary-control devices and can be used to intercept soil from cutslopes and ditchlines, and to isolate the general work area from the stream. They are intended to prevent sediment entering channelized flows.

- After work is completed, silt fence structures should be removed carefully to prevent the sediment retained from entering the watercourse or being re-mobilized during the next rain event.

4.6.8.3 Straw bales

- Straw bales are best suited where temporary, relatively minor, erosion control is needed while more permanent solutions are being devised. When properly used, straw bales can be effective in intercepting sheet flow runoff at the base of an exposed cutbank, fillslope, or swale, or in acting as a check dam in the ditchline of a road. Proper use means not being stacked, and care should be taken to ensure that noxious weeds and non-native grasses are not spread as a result of using straw bales. Hay bales in particular generally contain the edible portion of grasses and more seeds than straw bales.

4.7 Handling Hazardous Substances

It is important to know and comply with all regulations governing the storage, handling, and application of substances that can be deleterious to fish, including wood preservatives, paints, fuel, lubricants, and fertilizers. See *Guidelines to Protect Fish and Fish Habitat from Treated Wood used in Aquatic Environments in the Pacific Region* for information on the proper use of wood preservatives.

- Uncured concrete or grout can kill fish by altering the pH of the water. Pre-cast concrete and carefully protected grout should be used to eliminate the risk to fish. However, when cast-in-place concrete is required, all work should be done "in the dry" and the site effectively isolated from any water that may enter the stream for a minimum of 48 hours.

- All fuels, lubricants, and other toxic materials should be stored outside the riparian management area of the stream, in a location where the material can be contained. Equipment should be checked for leaks of hydraulic fluids, cooling system liquids, and fuel, and should be clean before fording. All fueling operations should also be done outside of the riparian management area.

- A contingency plan should be developed for the use of all hazardous materials, including spill containment, clean-up, and notification of the appropriate regulatory agencies and water purveyors in the event of a problem. Spill kits, sorbents, and containers for disposal should be retained on site.

5 Maintenance Practices

All stream crossings and sediment control structures require inspection and maintenance.

- The frequency of inspections should be commensurate with the risk of damage to the structure from major storm or runoff events affecting the fisheries resource. Areas prone to serious debris or bedload problems require special consideration and should be accounted for in the choice of structure.

- Ongoing inspection and maintenance of stream crossings and control structures should be conducted on a regular basis to ensure that they:
  - protect fish and fish habitat;
  - maintain safe fish passage; and
  - reduce the risk of releasing sediment or other deleterious substances.

- It is good practice to clearly mark all crossings on fish streams, allowing maintenance staff to readily identify them. Where the operation has a road inventory system, all fish-stream crossings should be marked on the map or electronic database.

- Standard operating procedures relating to road maintenance should be developed and implemented.

- If inspection reveals ongoing maintenance problem, then consideration should be given to the redesign and replacement of the structure to meet fish passage and fish habitat objectives.

5.1 Bridges

- Remedial bridge maintenance activities that do not alter fish habitat, such as painting or sandblasting, may be conducted in accordance with the DFO-Habitat *Guidelines for the Protection of Fish and Fish Habitat During Bridge Maintenance Operations in British Columbia.*

- Large-scale maintenance activities such as dredging or the placement of rip rap or fills below the high water mark usually constitute changes in and about a stream that may result in alteration to fish habitat. Applications describing these works and activities should be submitted to review agencies.

- Gravel and sediment can get dragged onto the bridge from routine grading. Care should be exercised to prevent this gravel and sediment from entering the stream either directly from the bridge surface or indirectly from material pushed over the edge along the approaches. There are several methods that can be used to address this issue:

perched outlet. This frequently renders the structure impassable to fish. New embedded culvert design and construction techniques should avoid this problem. However, where proponents have responsibilities under the Forest Practices Code for existing culverts built prior to June 15, 1995 that lack fish passage capability, the culverts should be assessed and appropriate actions taken to restore fish passage. This may require reconstruction of the culvert or modification of the site by backwatering or through baffle or weir installation to achieve passage flows.

Where baffles or weirs are proposed, specific biological and engineering input is required. All retrofitted culverts should be inspected to ensure they are functioning. Baffles and weirs are prone to clogging with debris and sediment, and can be ripped out, damaging the culvert or even causing it to fail. They are also known to disrupt the boundary layer, resulting in impaired juvenile fish passage.

Plugging from upstream debris:
Culverts should be cleared of debris as soon as possible. Small accumulations of debris should be removed by hand. Properly designed "trash racks" should be built to accommodate fish passage. These may require frequent maintenance. If debris is a persistent problem, then replacement of the structure to permit natural bedload and debris movement should be considered.

Beaver dams at the inlet:
Beaver dams can prevent fish passage as well as threaten roads. Frequent maintenance is required. Beaver problems can be so persistent in some areas as to be a significant factor in design choice. Bridges are less prone to beaver problems than culverts.

Icing:
In northern areas where ice blocks a culvert and threatens to flood a road, modification of inlet conditions or de-icing (through the use of steam) may be required.

5.3 Sediment Control

Sediment control is an issue when maintaining roads near fish streams. For example, cleaning ditches adjacent to the stream, or grading or cleaning the deck of a crossing structure, can result in the deposit of sediment into a fish stream. During maintenance operations:

- Instruct grader operators not to blade material into streams. Alternatively, consider the use of containment logs to prevent sediment entering the streams.
- Maintain the existing vegetation inside the ditch closest to the stream to allow for filtering of sediment.

As well:

- Ensure that cross-drains and ditch blocks are functioning and road ditches continue to discharge as designed. Inspect all drainage areas to ensure sediment-laden water is being discharged appropriately and not eroding a new channel to the stream.
- Maintain vegetation by hydro-seeding or dry seeding and fertilizing, or by placing sediment and erosion control matting over road cuts and fills where problems are seen to occur. Spot seeding to fill in gaps left during seeding programs is quick, easy, and extremely effective in controlling small problems before they become large.
- Where possible, ensure that ditch outflows near the crossing discharge onto a vegetated area, or into a sump or other sediment control device, and not directly into the stream itself.
- Maintain or re-install permanent erosion control measures installed at the time of construction. Additional structures may be required to adequately control sediment.

6 Deactivation Practices

Environmental impacts associated with the deactivation of stream crossings (including the deactivation of old sites adjacent to a new crossing) can be avoided or mitigated by activities that:

- protect fish and fish habitat;
- provide for fish passage;
- prevent impacts to fish eggs and alevin that are present in the gravel, or on adult and juvenile fish that are migrating or rearing; and
- reduce the risk of releasing sediment and other deleterious substances during work at stream crossings.

- Barring specific access planning objectives to close a road, crossing structures should be retained where continued access is required after deactivation.

- The objectives behind stream crossing deactivation are (1) to restore the original habitat components to pre-crossing conditions, and (2) to close the road to future access. These conditions can be observed in the nearest unmodified section of the stream immediately upstream or downstream of the crossing.

- When planning for deactivation is under way, all crossings where the stream gradient is less than 20% should be considered as fish streams unless specifically identified as being non-fish streams. Thus, a more detailed deactivation plan that takes fish protection into account typically should be prepared. The assumption is that if culverts are removed and the stream channel is re-configured, fish passage should be ensured, as long as the deactivation is carried out correctly.

- Deactivation around fish streams can create special problems. The largest is the control of sediment from deactivation operations. As with construction, deactivation requires a sediment control plan and good implementation. Care should be taken to safely place the fill removed during deactivation; end hauling may be necessary. To prevent sedimentation, all work should be performed "in the dry," habitat features should be restored, and the resulting channel should stabilize before water is re-introduced to the restored channel.

- Many of the guidelines outlined in construction practices (Section 4) also apply to deactivation activity. Particular attention should be paid to those guidelines that relate to sediment control and revegetation.

Appendix 1. Methodology for determining stream channel width

Stream channel width is the horizontal distance between the streambanks on opposite sides of the stream, measured at right angles to the general orientation of the banks. The point on each bank from which width is measured is usually indicated by an observable change in vegetation and sediment texture. This border is sometimes shown by the edges of rooted terrestrial vegetation. Above this border, the soils and terrestrial plants appear undisturbed by recent stream erosion. Below this border, the banks typically show signs of both scouring and sediment deposition.

Recommended approach (see Figure 9)

- Avoid making stream width measurements at unusually wide or narrow points along the stream, or in areas of atypically low gradient such as marshy or swampy areas, beaver ponds, or other impoundments.

- Avoid measuring channel width in disturbed areas. Channel widths can be increased greatly by both natural and human-caused disturbances. These disturbances include those caused by recent exceptional flood events, debris torrents, machine and yarding, and even existing crossing structures. (See the Forest Practices Code *Riparian Management Area Guidebook* for descriptions of disturbed channels.)

- To determine the stream channel width at the crossing site:
  1. Use fibre survey chain at least 50 m long. Include all unvegetated gravel bars in the measurement (these usually show signs of recent scouring or deposition).
  2. Where multiple channels are separated by one or more vegetated islands, assume the width is the sum of all the separate channel widths. Exclude the islands from the measurement.
  3. Calculate the width of the stream reach by averaging at least six separate width measurements taken at equally spaced intervals along a 100-m length of the stream profile (i.e., 50 m upstream and downstream of the crossing site).
  4. Always determine the undisturbed channel boundary. If there is evidence of disturbance, consult with the local resource agencies on the appropriate stream width to use:
     - move either upstream or downstream to points along the stream that do not show signs of disturbance (e.g., where banks are not eroded); or
     - use the boundary of recently recolonized vegetation (e.g., alder, aspen, cottonwood).

Appendix 2. Instream work window for provincial fisheries zones*

Fisheries zones

Species**	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9
Chinook salmon	Jul 15-Sep 15	Jun 15-Jul 31	N/A	Jun 15-Jul 15	Jun 15-Jul 31	Jun 01-Jul 31	N/A	N/A	May 01-Jul 31
Coho salmon	Jun 15-Sep 15	Jul 01- Sep 30	N/A	Jun 15-Sep 30	Jul 01-Aug 31	Jun 15-Aug 15	N/A	N/A	Apr 01-Aug 15
Pink salmon	May 01-Aug 15	Jun 01-Aug 31	N/A	Jun 15-Aug 31	May 15-Aug 15	May 15-Aug 15	N/A	N/A	Mar 15-Jul 31
Chum salmon	May 15-Sep 15	N/A	N/A	N/A	May 15-Aug 31	May 15-Aug 31	N/A	Jul 01-Aug 15	Apr 01-Sep 15
Sockeye salmon	Jun 01-Sep 15	Jun 01-Jul 31	N/A	Jun 15-Jul 15	Jun 15-Jul 15	Jun 15-Jul 31	N/A	N/A	Apr 01-May 31
Kokanee	Jun 15-Jul 31	May 15-Aug 31	Jun 15-Aug 15	Jun 01-Aug 31	Jun 15-Jul 15	Jun 15-Jul 31	Jun 01-Aug 31	N/A	N/A
Steelhead	Aug 01-Nov 15	Jul 15-Oct 30	N/A	Aug 01-Apr 30	Aug 15-Dec 31	Aug 15-Nov 15	N/A	N/A	Aug 15-Nov 15
Rainbow trout	Aug 15-Nov 15	Aug 15-Sep 30	Jul 15-Mar 31	Jul 15-Apr 15	Aug 15-Jan 31	Aug 15-Jan 31	Jul 15-Mar 31	Jul 15-Mar 31	Sep 01-Apr 30
Cutthroat trout	Aug 01-Sep 30	Aug 15-Apr 15	Sep 15-Apr 30	N/A	Aug 15-Dec 31	Aug 15-Dec 31	N/A	N/A	Sep 01-Apr 30
Dolly Varden	Jun 01-Sep 15	N/A	Jun 15-Aug 15	Jul 15-Aug 31	Jun 15-Aug 31	May 15-Aug 31	Jun 01-Aug 31	Jun 01-Aug 31	Jun 15-Aug 31
Whitefish	Jun 01-Sep 15	Jun 01-Sep 15	Apr 01-Oct 31	Jun 01-Sep 15	Jun 01-Sep 15	N/A	Jun 15-Aug 31	Jun 15-Aug 31	Jun 01-Aug 31
Arctic grayling	N/A	N/A	N/A	N/A	N/A	N/A	Jul 15-Mar 31	Jul 15-Mar 31	Jul 15-Mar 31
Walleye	N/A	Jul 30-Apr 01	N/A	N/A	N/A	N/A	Jul 01-Apr 30	Jul 01-Apr 30	N/A
Pike	N/A	N/A	N/A	N/A	N/A	N/A	Jul 01-Apr 30	Jul 01-Apr 30	N/A
Bull trout	N/A	Jul 01-Jul 31	Jun 15-Aug 15	Jun 15-Aug 15	Jun 15-Aug 31	N/A	Jun 15- Aug 15	Jun 15- Aug 15	Jun 15- Aug 31

* Instream work windows are approximations for a particular species over an entire specified area and should be considered time periods of reduced risk only.

** Not a complete list of species of concern. Proponent should consult regional fisheries staff with regard to species not listed here.

Appendix 2a. Map of provincial fisheries zones

Appendix 3. Example of a proponent application plan for a stream crossing project

Fisheries mitigation plan for embedded culvert installation at KM 45 on FSR 22

1. Fisheries Resource Values

An assessment of the fish habitat values involved the following procedures:

- a review of existing fisheries databases
- a detailed habitat inventory and a physical site survey
- fish sampling

(refer to Fish-stream Crossing Guidebook *for methods for identifying fish streams and fish sampling procedures)*

a) Review of existing fisheries databases
The Fisheries Information Summary System (DFO 2001) database identified coho salmon within 250 m downstream of the crossing location in Coho Creek. As there are no barriers and the habitat contains rearing and some spawning opportunity, coho are also likely to use the system. There is a total of 1.5 km of upstream fish habitat before a steep bedrock waterfall of approximately 20 m creates an access barrier to fish.

b) Detailed habitat inventory
Fish habitat was inventoried 100 m upstream and 100 m downstream of the crossing location. Stream profiles are provided in Appendix XX. The average gradient of the channel is 3% over the 200 m stream reach sampled. The average channel width is 1.6 m and the average channel depth is 0.5 m.

A detailed fish habitat assessment (WRP Tech Circ. #8 1996) was also conducted for the stream reach in which the crossing is to be located. The channel type was identified as a Riffle-Pool (RPcw), moderately degraded.

The proposed crossing location contains two pools. Pool #1 is 2 m long and 1.5 m wide with a residual depth of 0.7 m. Pool #2 is 2.5 m long and 2 m wide with a residual pool depth of 1.1 m. A gravel riffle separates the pools. Four pieces of large woody debris control gravel transport downstream. Three pieces of LWD are suspended above the channel and are serving as cover. One undercut bank 3 m long incised 0.5 m exists on the west side of the channel (See photographs in Appendix XX).

c) Fish sampling
Fish sampling was conducted in the stream reach at the proposed crossing site. Baited minnow traps were set for a 24-hour time period. The species identified are shown in Table 1.

Table 1. Summary of fish captured by minnow trapping. Fish sampling was conducted in April 2001.

Species	Number	Fork length (mm)
Chinook salmon	2	82, 76
Rainbow trout	4	60, 55, 45, 55
Largescale sucker	1	95

d) Habitat value at the location of the proposed crossing
Fish habitat in this reach is used for rearing and overwintering and is classified as important according to the *Fish-stream Crossing Guidebook* (2002).

2. Description of Proposed Activities

Installation of an embedded closed-bottom culvert is proposed for this crossing. Design drawings and the methods for installing the structure are provided in Appendix XX.

Instream works includes excavation of the streambed and streambanks for the installation of the culvert. The Designated Environmental Official Timing Windows and Measures Document establishes August 15–September 1 as the preferred instream work window.

3. Impacts to the Fisheries Resources

Streambed: Excavate the streambed to install the culvert.

Streambanks: Streambanks may be permanently altered at the site of the crossing and 5 m upstream and 5 m downstream of the crossing. The undercut bank on the west side may be permanently lost.

Riparian vegetation: Riparian vegetation may be permanently altered at the site of the crossing and 5 m upstream and 5 m downstream of the crossing.

Large woody debris: Four pieces of large woody debris should be lifted out of the channel to accommodate installation of the culvert. This wood is functioning as a cover feature for fish and as a long-term carbon source to the stream.

Sedimentation: Mineral soil may be exposed during grubbing and stripping with the potential to enter the stream. Sediment control plans are included in Section 4 below.

Fish passage: Temporary blockage of fish passage may occur for 3 days during installation.

Stream channel configuration: No changes are predicted to downstream flows or streambanks upstream or downstream of the crossing.

4. Mitigation Proposed

Streambed: A simulated streambed should be placed in the culvert post construction following the methods contained in the *Fish-stream Crossing Guidebook* (2002). Where feasible, larger streambed substrates removed during site preparation should be sorted and re-used to line the culvert.

Streambanks: Streambanks should be stabilized 5 m upstream and 5 m downstream of the crossing using larger boulders and rip rap. Streambanks should be restored to pre-disturbance condition upon removal of the culvert (based on Photograph XX).

Riparian vegetation: Riparian vegetation, mostly shrub and herbaceous vegetation, should be replanted adjacent to the culvert to provide shade and nutrients 5 m upstream and 5 m downstream of the crossing. Riparian vegetation should be restored to pre-disturbance condition upon removal of the culvert (based on Photograph XX).

Large woody debris: The four pieces of large woody debris that were lifted out of the channel to accommodate installation of the culvert should be replaced downstream of the culvert. They should be placed above the high water mark, over the channel, to prevent altering the channel downstream and should function as a cover feature.

Sedimentation: Introduction of sediments and contaminants should be avoided by isolating the worksite using a dam and pump system. Sediment control is described in the sediment control plan attached as Appendix XX.

Fish passage: Permanent fish passage should be restored within 4 days after installation. Fish passage should be achieved for the lifespan of the project and should be restored after removal of the structure.

5. Environmental Monitoring

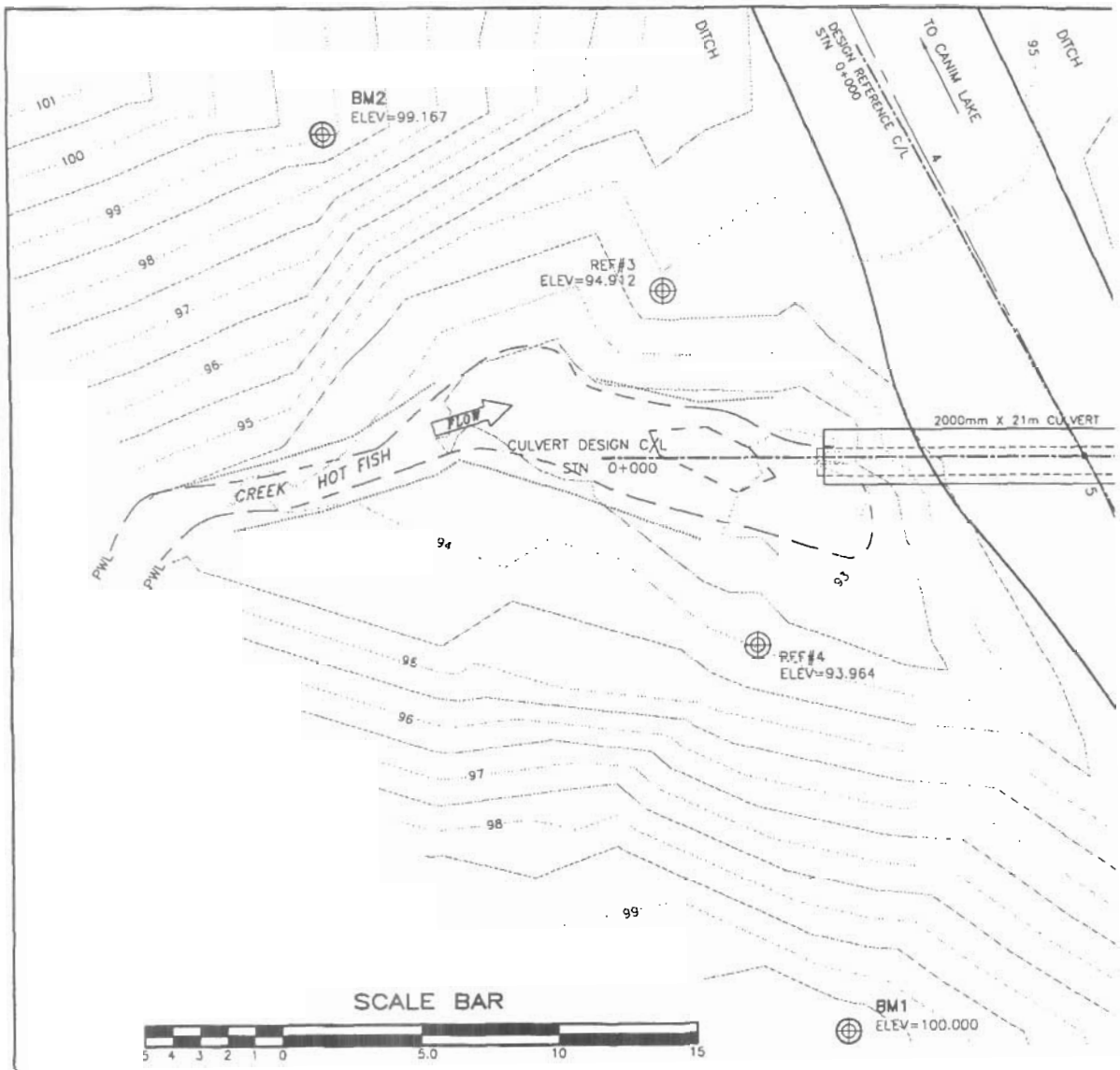
XX contractor should undertake environmental monitoring. This individual should have powers to stop work if any activities lead to sediment entering the stream or if any other activities may harm fish habitat.

The environmental monitor should photographically record with dates and times the three phases of the project:

- streambed preparation
- culvert installation and substrate placement
- resumption of channel flow within the culvert

This record should be available upon request from agencies monitoring the works.

Appendix 4. Example construction drawings for an embedded round culvert



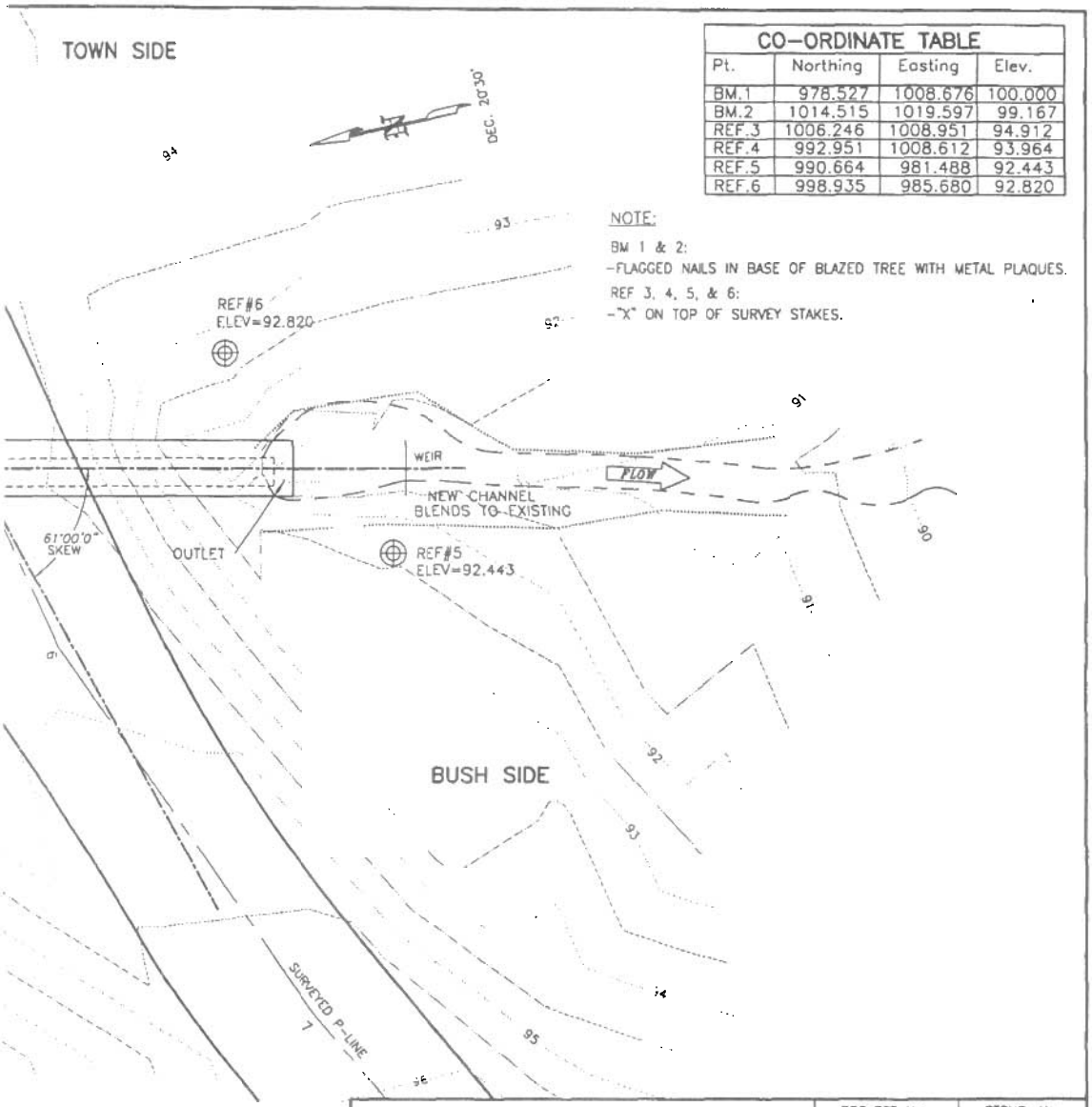
P

LEGEND

- PROPOSED CULVERT
- P-LINE FLAGGED IN FIELD
- CULVERT CENTRELINE ALIGNMENT
- EXISTING DITCHLINE
- PWL (AUG 14/2001)
- 100 CONTOUR
- DESIGN CENTRELINE ALIGNMENT
- TOP OF BANK

NOTES

1. Stream Class: S3
2. Design Flood: 1.3 m3/s
3. Average Stream Gradient: 6%
4. Average Stream Width: 1.8metres
5. Streambed/banks: Gravel, sand and cobbles
6. Expected Design Life: 40 years
7. Design Vehicle: MOF L75
8. Scour Protection Details see dwg.
9. Downstream Weir Details see dwg.



CO-ORDINATE TABLE			
Pt.	Northing	Easting	Elev.
BM.1	978.527	1008.676	100.000
BM.2	1014.515	1019.597	99.167
REF.3	1006.246	1008.951	94.912
REF.4	992.951	1008.612	93.964
REF.5	990.664	981.488	92.443
REF.6	998.935	985.680	92.820

NOTE:

BM 1 & 2:
-FLAGGED NAILS IN BASE OF BLAZED TREE WITH METAL PLAQUES.

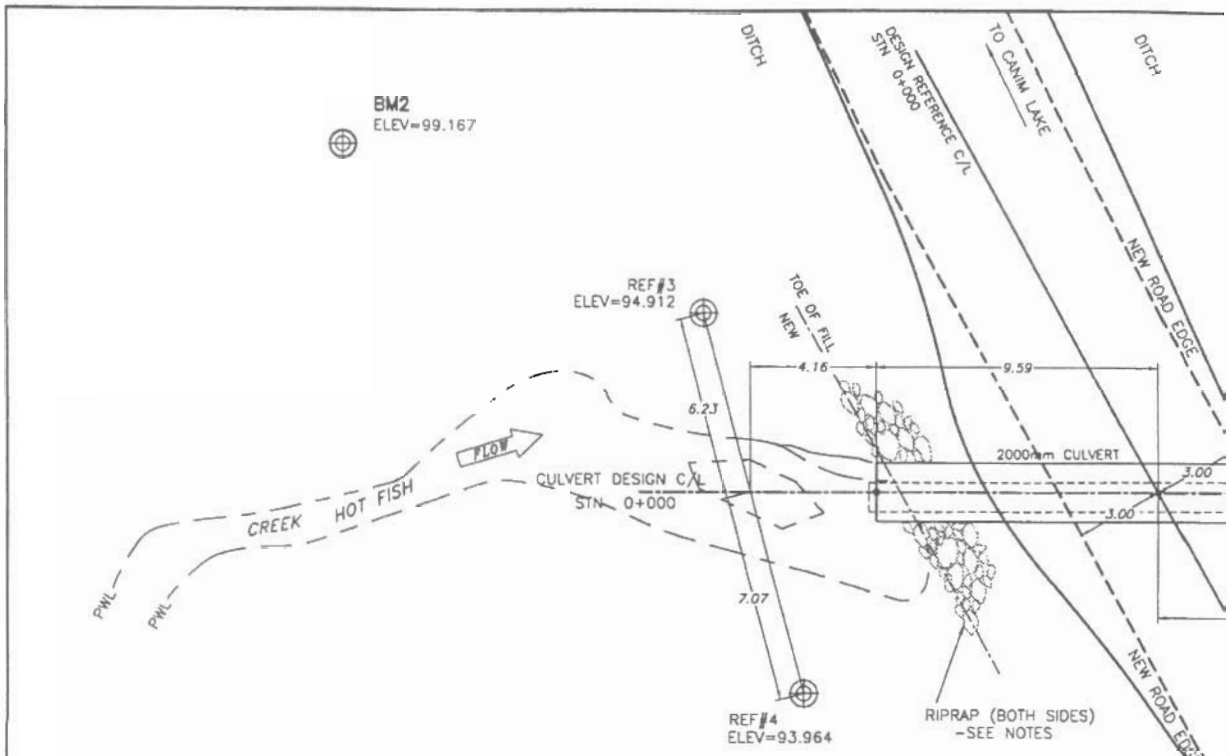
REF 3, 4, 5, & 6:
-"X" ON TOP OF SURVEY STAKES.

LAN
1:200

SCALE: AS NOTED (Metric)	PROJECT No.	STRUC. No.
SITE PLAN		

REV.	DESCRIPTION	BY	APPD	DATE	
					Survey:
					Design:
					Drawing:
0	FOR CONSTRUCTION				DWG No.
					SHEET 1 OF 5

Appendix 4. (continued)



LEGEND

- PROPOSED CULVERT
- EDGE OF NEW ROAD
- CULVERT CENTRELINE ALIGNMENT
- PWL (AUG 14/2001)
- 100 CONTOUR
- DESIGN CENTRELINE ALIGNMENT
- DESIGN TOE OF FILL
- EXISTING EDGE OF ROAD

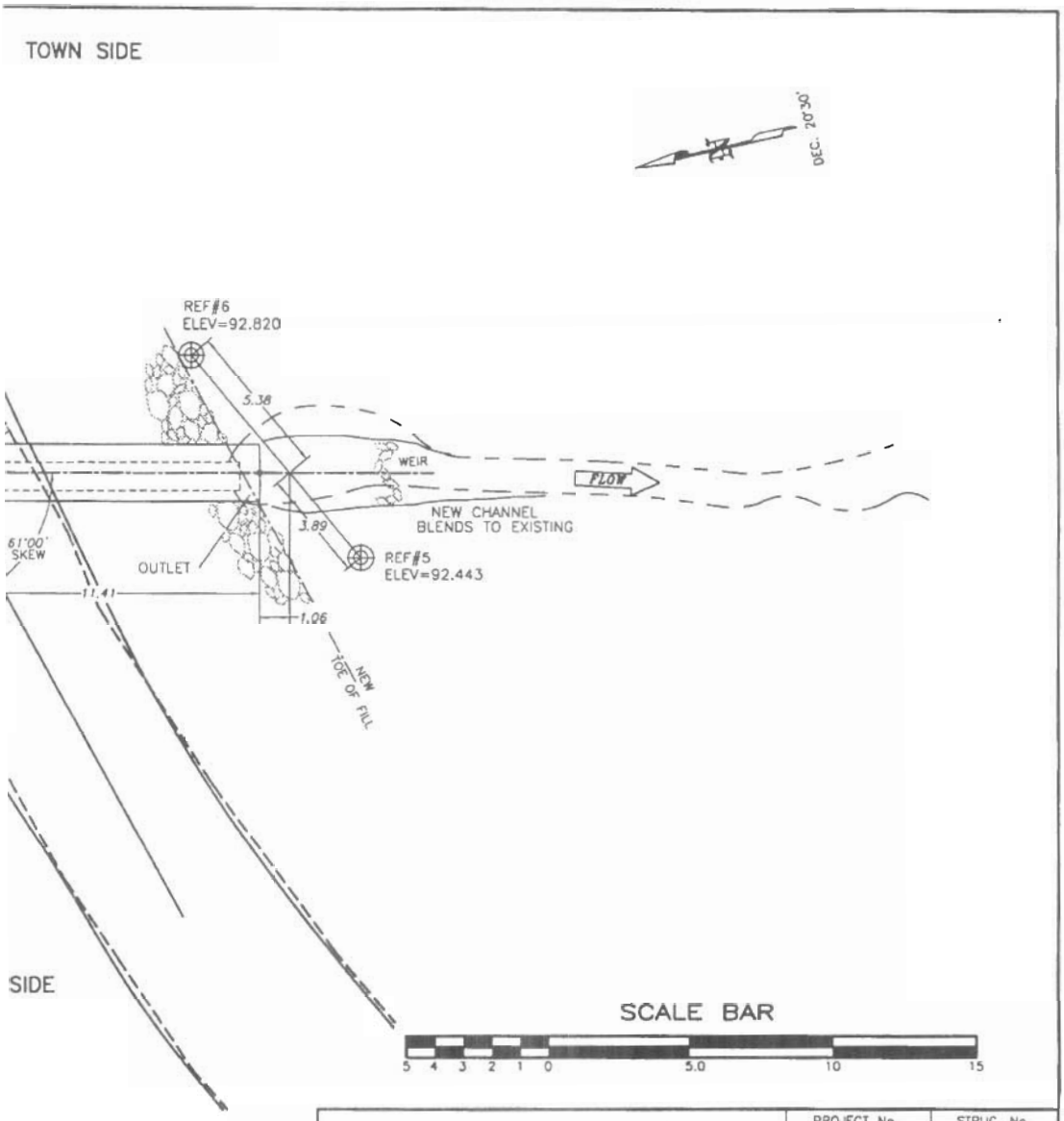
BUSH

BM1
ELEV=100.000

Installation Measures

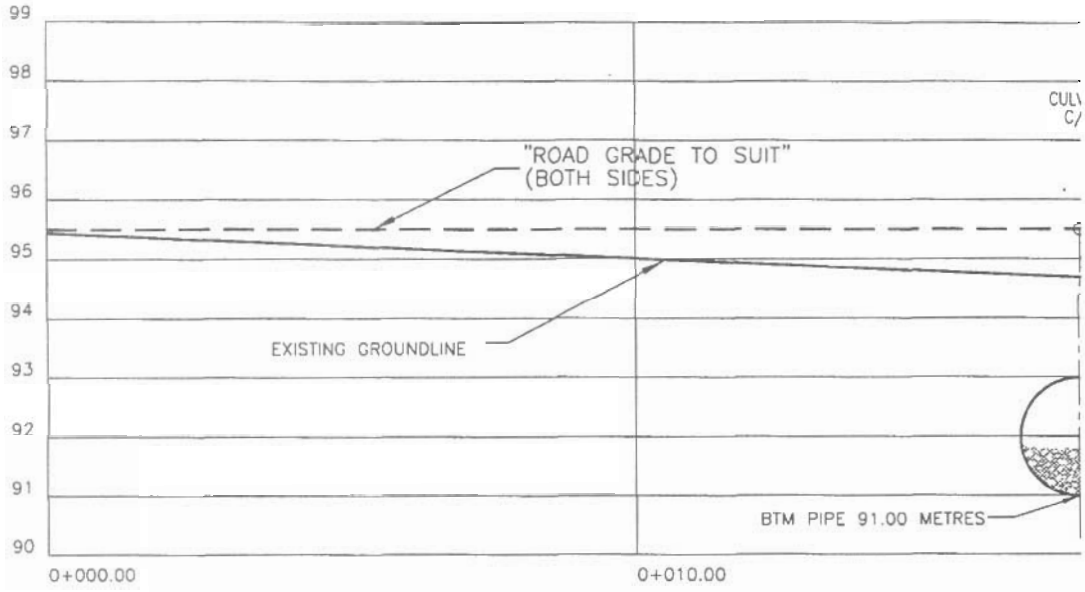
1. All required materials and equipment shall be assembled in advance such that the installation can proceed without delay.
2. The installation site shall be isolated from running water such that the culvert bedding and installation can occur in the dry. The site shall use methods that have been approved with consultation of MWLAP representatives.
3. The culvert shall be installed using appropriate mechanical vibratory compaction and following good installation practices in conformance with manufacturers specifications for bedding and backfill. Fill to be well compacted with vibrating drum rollers, plates or jumping jacks. Compaction to be such that culvert does not deflect more than 100mm out of shape.
4. Select backfill shall be used. Material within 300 mm of the culvert shall be 75 mm minus material. Backfill shall be compacted in maximum 300mm lifts for the full height of the culvert.
5. Seed disturbed soils with suitable erosion control mix following construction.

PLAN
1:200



SCALE: 1:200 (Metric)					PROJECT No. / STRUC. No.
GENERAL ARRANGEMENT					
					Survey:
					Design:
					Drawing:
0	FOR CONSTRUCTION				DWG No.
REV.	DESCRIPTION	BY	APPD	DATE	SHEET 2 OF 5

Appendix 4. (continued)



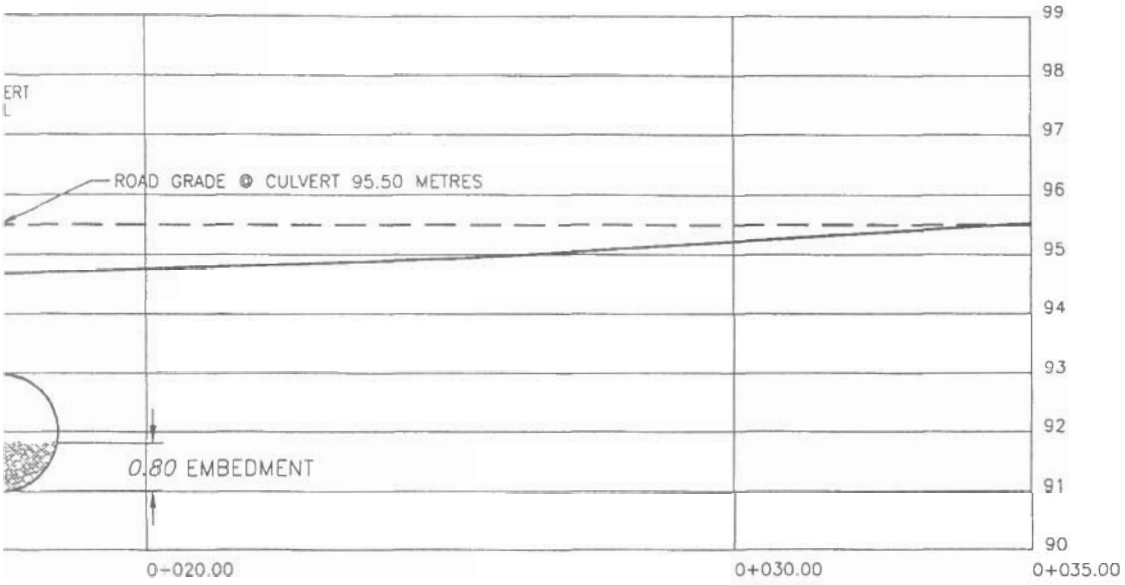
PROPOSED ROAD CE

(61°00' SKEW TO CU
SCALE HOR 1:100

NOTES

Specific notes regarding substrate to be utilized in the culvert should be noted in the design. The specifications for the material should note size, type and gradation. For steeper streams, the streambed material specifications should note specifications for supplemental larger material (i.e. D90) which would be incorporated to assist in retaining substrate in the embedded culvert.

1. An objective is for the backfill in the culvert to simulate the natural streambed.
2. If suitable materials for backfilling the culvert are not available on site, suitable materials shall be imported.
3. The backfill in the culvert to installed to the design streambed level using clean gravel, cobbles of similar size and distribution as in the natural streambed.
4. Substrate material to be imported into culvert to a nominal depth of 800mm (40% of culvert diameter) using suitable methods.
5. All voids in the substrate shall be filled in with clean sandy gravels.
6. Substrate material to be free of organics (roots, logs, twigs, etc.).
7. If practicable, excavated streambed material shall be set aside to be utilized for placement in the culvert. Particular attention should be paid to salvaging the natural streambed surface material to be used for the upper layer in the culvert.



NTRELINE PROFILE

_VERT C/L)
/ERT 1:100

SCALE BAR

5 4 3 2 1 0 5.0

SCALE: AS NOTED (Metric)	PROJECT No.	STRUC. No.
PROPOSED ROAD CROSS SECTIONS PROFILE		

REV.	DESCRIPTION	BY	APPD	DATE	
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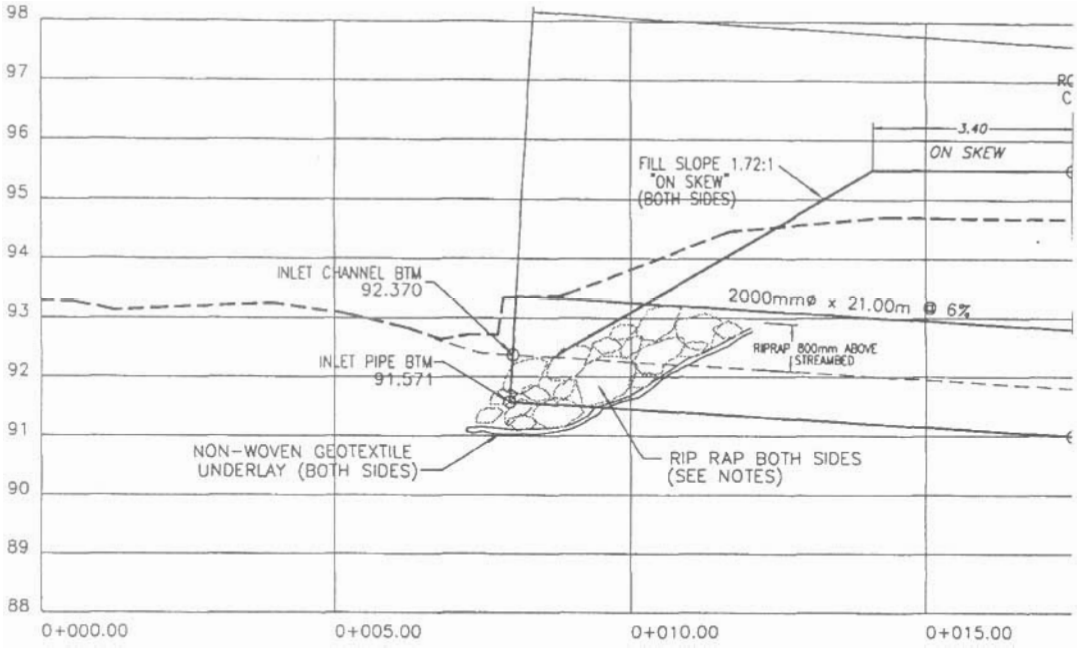
					Design:
					Drawing:
0	FOR CONSTRUCTION				DWG No.
					SHEET 3 OF 5

Appendix 4. (continued)



CULVERT

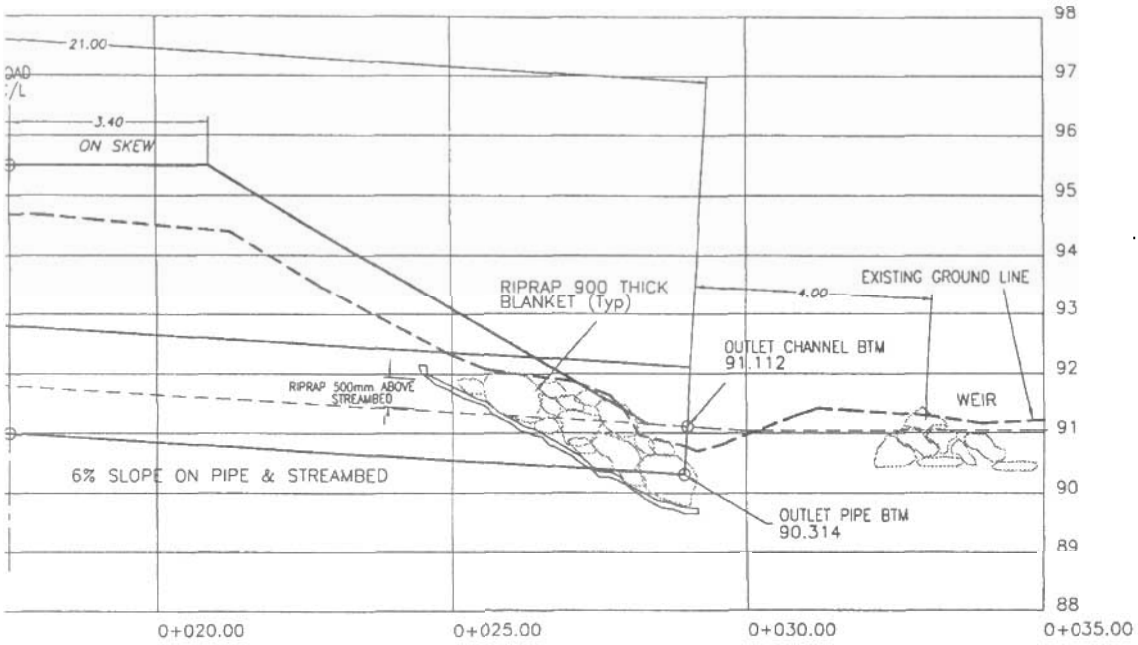
(61°00' SKEW
SCALE HOR 1:1(

RIPRAP SPECIFICATIONS

CLASS OF RIPRAP (Kg)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADUATION: PERCENTAGE LARGER THAN GIVEN ROCK DIAMETER (mm) RIPRPAP		
		85%	50%	15%
200	900	260	620	840

NOTES

1. Riprap shall be placed to the extent, depths and thickness noted on the drawings.
2. Riprap to be underlain with non-woven geotextile underlay.
3. Riprap to be clean (free of fines), solid, angular, blocky stones; well graded to fill gaps between larger stones, and placed carefully to obtain well graded blanket of interlocking stones.
4. Minimum riprap layer thickness is 900mm.



PROFILE

TO ROAD C/L)
00 VERT 1:100

SCALE BAR

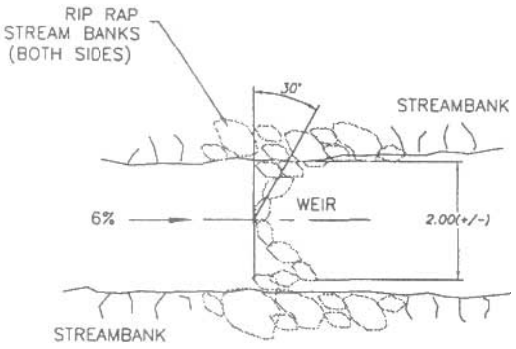
5 4 3 2 1 0 5.0

SCALE: AS NOTED (Metric)	PROJECT No.	STRUC. No.

CULVERT CENTRELINE PROFILE

REV.	DESCRIPTION	BY	APPD	DATE	
					Survey:
					Design:
					Drawing:
0	FOR CONSTRUCTION				DWG No.
					SHEET 4 OF 5

Appendix 4. (concluded)

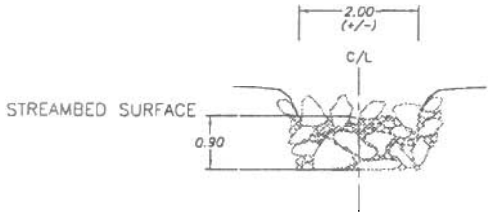


WEIR PLAN

SCALE 1:100

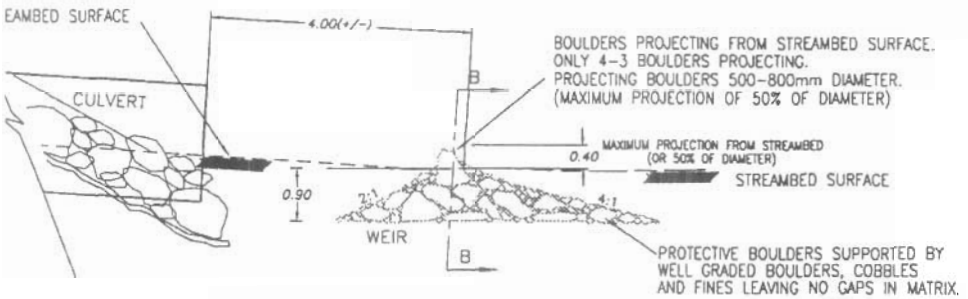
Note:

This drawing is an example of a weir that is an inherent part of the design. Where other measures are to be incorporated (such as trash racks or stream channel bank riprap), the design should provide drawings and specifications for materials and installation.



WEIR SECTION B–B

SCALE HOR 1:100 VERT 1:100



WEIR PROFILE

SCALE HOR 1:100 VERT 1:100

SCALE BAR

5 4 3 2 1 0 5.0

SCALE: AS NOTED (Metric)				PROJECT No.	STRUC. No.
WEIR DETAILS					
				Survey:	
				Design:	
				Drawing:	
0	FOR CONSTRUCTION			DWG No.	
REV.	DESCRIPTION	BY	APPD	DATE	SHEET 5 OF 5

Glossary

Alevin The *Collegiate Dictionary* defines "alevin" as young fish with the external yolk sac still attached.

Fish The federal *Fisheries Act* defines "fish" as all fish, shellfish, crustaceans and marine animals, and the eggs, spawn, spat and juveniles of fish, shellfish, crustaceans and marine animals.

Fish habitat The federal *Fisheries Act* defines "fish habitat" as the spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.

Fish stream The *Fish-stream Identification Guidebook* defines "fish stream" as a stream that

a. is frequented by any of the following species:
   (i) anadromous salmonids;
   (ii) rainbow trout, cutthroat trout, brown trout, bull trout, Dolly Varden char, lake trout, brook trout, kokanee, largemouth bass, smallmouth bass, mountain whitefish, lake whitefish, arctic grayline, turbot, white sturgeon, black crappie, yellow perch, walleye or northern pike;
   (iii) identified threatened or endangered fish classified under Section 71 (of the Operational Planning Regulation);
   (iv) regionally important fish classified under Section 71, or
b. has a slope gradient, determined in accordance with the Ministry of Forests publication *Fish-stream Identification Guidebook*, as amended from time to time, of less than 20%.
   (i) Unless the stream has been identified in a fish inventory carried out in accordance with the Ministry of Forests publication *Fish-stream Identification Guidebook*, as amended from time to time, as not containing any of the species of fish specified in paragraph (a), or
   (ii) Unless
      (A) The stream is located upstream of a known barrier to fish passage identified on a fish and fish habitat inventory map,
      (B) All reaches upstream of the barrier are simultaneously dry at any time of the year, and
      (C) No perennial fish habitats exist upstream of the barrier.

Reach The *Fish-stream Identification Guidebook* defines a "reach" as a watercourse that has a continuous channel bed that meets one of the following requirements:

a. the channel bed is at least 100 m in length, measured from any of the following locations to the next of any of the following locations:
   (i) the location where the watercourse begins or ceases to have a continuous channel bed;
   (ii) the location where
      (A) a significant change in morphology occurs; for example, at the junction of a major tributary, and
      (B) the mean width of the channel bed, as measured over a represen-

tative 100 m length of channel bed, upstream and downstream of the morphological change, is sufficient to change the riparian class of the watercourse, if the watercourse were a stream;

(iii) the location where

(A) a significant change in morphology occurs; for example, at the junction of a major tributary, and

(B) the mean gradient of the channel bed, as measured over a representative 100 m length of channel bed upstream and downstream of the morphological change, changes from less than 20% to 20% or more, or vice versa;

b. the channel bed is at least 100 m in length, made up of one or more segments, the boundaries of which are any of the locations referred to in paragraph (a).

c. the channel bed is less than 100 m in length, if the continuous channel bed

(i) is known to contain fish,

(ii) flows directly into a fish stream or a lake that is known to contain fish, or

(iii) flows directly into a domestic water intake.

Stream

The Forest Practices Code defines a "stream" as a reach flowing on a perennial or seasonal basis, and having a continuous channel bed. It doesn't matter whether the bed or banks of the reach are locally obscured by overhanging or bridging vegetation or soil mats, as long as the channel bed:

1) is scoured by water, or
2) contains observable deposits of mineral alluvium.

The primary feature for determining whether a watercourse is a stream under the Code is the presence of a continuous channel bed. If a continuous channel bed exists, then either one of two other key features should be present demonstrating fluvial processes. Flowing water should have:

1) scoured the channel bed, or
2) deposited any amount of mineral alluvium within the channel.

Water flow in the channel may be perennial, ephemeral (seasonal), or intermittent (spatially discontinuous).

Stream channel width

The *Fish-stream Identification Guidebook* defines "stream channel width" as the horizontal distance between the streambanks on opposite sides of the stream, measured at right angles to the general orientation of the banks. The point on each bank from which width is measured is usually indicated by an observable change in vegetation and sediment texture. This border is sometimes shown by the edges of rooted terrestrial vegetation. Above this border, the soils and terrestrial plants appear undisturbed by recent stream erosion. Below this border, the banks typically show signs of both scouring and sediment deposition.

References and Recommended Additional Reading

Information and guidelines from many sources were incorporated in the development of this guidebook. See the following references for more information on assessment procedures, hydraulic design, and best management practices.

Site Assessment Techniques/Stream Hydrology

Hicks, D.M. and P.D. Mason. 1991. Roughness characteristics of New Zealand rivers.NIWA-Environmental Data. Box 8602, Christchurch, N.Z.

Jarrett, R.D. 1984. Hydraulics of high gradient streams. Jour. Hyd. Engin. 110(11):1519–1539.

Newbury, R.W. and M.N. Gaboury. 1993. Stream analysis and fish habitat design: a field manual. Newbury Hydraulics Ltd., Gibsons, B.C.

Erosion and Sediment Control

Goldman, S.J., K. Jackson, and T.A. Bursztynsky. 1986. Erosion and sediment control handbook. McGraw-Hill, Inc. New York, N.Y.

Fish Passage Guidance and Design Criteria

American Iron and Steel Institute. 1994. Handbook of steel drainage and highway construction products. 5th ed. American Iron and Steel Institute. Washington, D.C.

Bates, K. 1992. Fishway design guidelines for Pacific salmon. Washington Dep. Fish and Wildl., Olympia, Wash.

Dane, B.G. 1978. Culvert guidelines: recommendations for the design and installation of culverts in British Columbia to avoid conflict with anadromous fish. Can. Dep. Fish. and Oceans. Fish. Serv. Tech. Rep. No. 811. Vancouver, B.C.

Oregon Department of Fish and Wildlife. 1995. Interim fish passage guidance at road crossings. Memorandum to field dated June 16, 1995, provided by E.G. Roberson, Hydrologist, Oreg. Dep. For. ODF, 2600 State Street, Salem, Oreg.

Stream Simulation for Culvert Installations

Katopodis, C. 1993. Fish passage at culvert highway crossings. Presentation notes, "Highways and the Environment." Can. Dep. Fish. and Oceans. Freshwater Institute, Winnipeg, Man.

McKinnon, G.A. and F.N. Hnyka. 1993. Fish passage assessment of culverts constructed to simulate stream conditions on Laird River tributaries. Can. Dep. Fish. and Oceans. Tech. Rep. No. 1255. Freshwater Institute, Winnipeg, Man.

Robison, E.G. and M. Pyles. 2001. Forest road stream crossing design guide. For. Eng. Dep., Oreg. State Univ., Corvallis, Oreg.

Culvert Studies

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers. North Pacific Division, Portland, Oreg.

Fitch, G.M. 1997. Designing highway culverts that do not impede the movements of resident fish species. Road Eng. J. Nov. 1, 1997.

Road Location and Layout

Furniss, M.J., S.A. Flanagan, J. Ory, K. Moore, and T.S. Ledwith. 1999. Watershed-scale road stream crossing risk assessment. USDA For. Serv. Six Rivers National Forest, McKinleyville, Calif. Website: http://watershed.org/WMChome/new/sum_96/risk.html.

Holmes, D.C. 1989. Manual for roads and transportation. Vol. II, revised ed. B.C. Inst. Technol., Burnaby, B.C.

Bioengineering

Polster, D.F. 1997. Bioengineering for water management and slope stability. *In* Road construction strategies under the Forest Practices Code. Paper delivered at an Insight Conference, June 18–19, 1997, Toronto, Ont.

Road Construction, Maintenance, Deactivation

Hynson J. et al. 1982. Handbook for protection of fish and wildlife from construction of farm and forest roads. Eastern Energy and Land Use Team, USDI Fish and Wildl. Serv., Kearneysville, W. Va.

Ketcheson, G.L. and W.F. Megahan. 1996. Sediment production and downslope sediment transport from forest roads in granitic watersheds. USDA For. Serv. Res. Pap. Intermountain Res. Sta., Ogden, Utah.

Levinski, C.L. 1982. Best management practices for road activities. Vol. I & II. Mimeo, Idaho Dep. of Heath and Welfare, Boise, Idaho.

Rothwell, R.L. 1974. Erosion control on forest roads. *In* Environmental considerations of road construction. A short course presented at the Forest Technology School in Hinton, Alta.

———.1978. Watershed management guidelines for logging and road construction. Can. For. Serv. Western For. Res. Cent., Edmonton, Alta.

Fish Habitat Protection/Identification

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Clarke, C. (editor) 1997. Mechanical Shock Sensitivity in Salmonid Eggs. Fisheries and Oceans Canada, Pacific Biological Station. Aquaculture Update No. 78. Nanaimo, B.C.

Forest Practices Board. 1998. Forest planning and practices in coastal areas with streams. Tech. Rep., Victoria, B.C.

Guidelines to protect fish and fish habitat from treated wood used in aquatic environments in the Pacific Region. Can. Tech. Rep. Fish. Aquat. Sci. 2314.

Wilford, D. 1998. A strategy for forest management and restoration on alluvial fans in the Prince Rupert Forest Region. B.C. Min. For., Smithers, B.C.

Wright, D.G. and G.E. Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107.

Referenced Forest Practices Code Guidebooks

1995. Forest road engineering guidebook. Forest Practices Code. Victoria, B.C.

1995. Riparian management area guidebook. Forest Practices Code. Victoria, B.C.

1998. Fish-stream identification guidebook. 2nd ed. Forest Practices Code. Victoria, B.C.

Fish Species Migratory Timing

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Resear. Board of Canada, Ottawa, Ont. Bull. 180.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fish. Resear. Board of Canada, Ottawa, Ont.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Resear. Board of Canada, Ottawa, Ont. Bull. 184.

FSC
ARCHITECTS
& ENGINEERS

APPENDIX 5 - A Project Description Form provided by DFO.

Fisheries and Oceans Canada

Lower Fraser Area

Project Review Information Requirements for Works Affecting Fish Habitat

The information Proponents provide on this form is the minimum necessary for Fisheries and Oceans Canada to evaluate compliance with the Federal Fisheries Act.

1. **Proponent:** _____
   Address: _____
   City: _____
   Postal code: _____ Contact: _____
   Telephone: _____ Fax: _____
   E-mail: _____

2. **Project title:** _____

3. **Location of works:**
   Regional district/ land use authority: _____
   City/ municipality: _____
   Street address of pertinent property: _____
   Complete legal description of all lands affected by changes: _____
   _____
   Watercourse name: _____
   Location on watercourse: _____
   What watercourse/ waterbody does it flow into? _____

4. **Agent(s) name:** _____
   Address: _____
   City: _____
   Postal code: _____ Contact: _____
   Telephone: _____ Fax: _____
   E-mail: _____

5. **Environmental Monitor:** _____
   Address: _____
   City: _____
   Postal code: _____ Contact: _____
   Telephone: _____ Fax: _____
   E-mail: _____

Canada

6. **Proposed timing:**
   Start (day/month/year): _____
   Finish (day/month/year): _____

7. **Notification to Ministry of Water Land and Air Protection (MWLAP)**
   Has MWLAP been notified of the proposed works? ☐ Yes ☐ No
   ☐ Other Ministry (specify) _____

8. **Tenure to land:** ☐ Registered owner ☐ Lessee
   ☐ Other (specify) _____

9. **Restrictive covenant on property?** ☐ Yes ☐ No

The following information should be prepared by qualified professionals and must be attached for review of the project:

10. **Written justification for the proposed works, including:**
    - Confirmation that no alternatives to the proposed work exist.
    - Confirmation that the works are permitted under local by-laws, zoning, etc.

11. **Description of proposed activities, including:**
    - Detailed description of proposed works including how works are to be carried out and what machinery will be used.
    - Clearly marked and detailed drawings of the proposed works (to scale).
    - Detailed description of all materials to be used. Note the placement of materials and/or structures in and around watercourses must be consistent with DFO and MWLAP regulations, standards, policies and guidelines

12. **Description of existing fish and fish habitat, including:**
    - Fish presence and distribution
    - Fish habitat assessment (instream and riparian)
    - Hydrological information

13. **Fish habitat impact assessment, including:**
    - Potential impacts to fish and fish habitat
    - Identification of the nature, magnitude, duration (permanent and temporary) and location of impacts

14. **Mitigation proposed, including:**
    - A description of all actions, including contingency plan(s), that will be taken to avoid, reduce or eliminate the impacts outlined above.
    - Sediment, runoff and erosion control plans, which emphasize minimizing disturbances and source control.
    - Vegetation disturbance replacement/ remediation plan.

15. **Habitat compensation plans** (if the project is likely to cause the harmful alteration, disruption or destruction (HADD) of fish habitat)
    - Fish habitat compensation plan must be consistent with "The Department of Fisheries and Oceans Policy for the Management of Fish Habitat", 1986.
    - Written approval from all affected landowners.
    - Area based habitat balance
    - Itemized cost of compensation (construction, planting and monitoring (during construction and post construction))

16. **Maps**
    - Small scale overview location map (approx. 1:20,000)
    - Detailed large scale map(s) of the site (1:500 or larger) indicating:
        - Location of proposed works in relation to all watercourses within the property.
        - Location of any designated parks, environmentally sensitive areas, wildlife refuges, restrictive covenants, etc.
        - Location of major streets.
        - Delineation of vegetation removal.

17. **Photographs**
    - Detailed photographs of the site, taken from a variety of perspectives, appropriately marked to clearly display:
        - The proposed works area including any vegetation to be disturbed.
        - The proposed area of compensation for habitat losses associated with the proposed works.

It is understood that the completion of this form does not constitute approval or authorization under the Federal Fisheries Act.

Signed: _____ **Date:** _____
(Proponent/ Agent)

Note:
- **All maps and/or drawings must be submitted folded.**
- **Please complete each section. All incomplete submissions will be returned unprocessed.**
- **Policy and guideline documents are available on line at:** *http://www-heb.pac.dfo-mpo.gc.ca/publications/publications_e.htm*

Project Review Information Requirements should be submitted to:

Fisheries and Oceans Canada
Habitat and Enhancement Branch
100 Annacis Parkway, Unit 3
Delta, BC, V3M 6A2

For further information, call 604-666-6479

Canada