

DETAILED ENGINEERING
ESTIMATES
for
COAST STUMPAGE APPRAISAL

COST ESTIMATE METHODOLOGY

&

CONSTRUCTION ESTIMATE FORM

in the

Vancouver Forest Region

February 1, 2001

September 4, 2002 (amendments included)

Table of Contents

Example Calculations List	iii
Figures List	iii
Table 1: Determining Type of Cost Estimate Method	iv
New Road Construction	1
End Haul	1
End Haul to Specified Spoil Location	6
Road Reconstruction	7
Case 1: Existing Roads Widening ≤ 2 metres, CC 1	8
Case 2: Existing Roads Widening ≤ 2 metres, CC 2 – 6	10
Case 3: Existing Roads Widening > 2 metres	12
Case 4a: Full End Haul Estimate	15
Case 4b: Partial End Haul Estimate	16
Surfacing	20
Capping.....	20
Re-Surfacing.....	20
Surfacing	20
Overlanding	31
Trucked in Fills	23
Large Fills	31
Stored Fills	35
Keyed-in Fills (from trucked in materials)	37
Fords	42
Culverts	44
Log Culverts	44
Metal Culverts	45
Log Bridge Structural Repairs	46
Replacement of Bridge Running Planks.....	46
Replacement of Untreated Ties	47
Replacement of Guard Logs or Stringers	48

Table of Contents

(Continued)

Permanent Bridge Structural Repairs	48a
Construction Estimate Form Method	49
Significant Digits Criteria for Calculations	52
Cost Estimate Methodology Forms Section	56
i. End Haul Form	
ii. Road Reconstruction Form	
iii. Log Bridge Structural Repairs	
iv. Culvert Worksheet	
Construction Estimate Forms Section.....	57
i. Construction Estimate Form	
ii. Machine Hour Summary From Time Cards	
iii. Time Card Machinery & Labour	
iv. Time Card Drilling	

Example Calculations List

Example I	End Haul	3
Example II	Case 1	9
Example III	Case 2	11
Example IV	Case 3	13
Example V	Partial End Haul	17
Example VI	Trucked in Fills (material moves directly)	25
Example VII	Trucked in Fills (material moves to storage site)	28
Example VIII	Large Fills	34
Example IX	Stored Fills	36
Example X	Keyed in Fills (no tote road required)	39
Example XI	Keyed in Fills (tote road required)	40
Example XII	Fords	43
Example XIII	Replacement of Bridge Running Planks.....	46
Example XIV	Replacement of Untreated Ties	47
Example XV	Replacement of Guard Logs or Stringers.....	48

Figures List

Figure 1	Case 3 'Road X-Section'	12
Figure 2	Cut Fill Profile	23
Figure 3	Bridge Approach Fills (Road Profile)	31
Figure 4	Bridge Approach Fills with Cribbing (Road Profile)	31
Figure 5	Large Fills for Culverts	32
Figure 6	Large Fills for Road Sections	32
Figure 7	Keyed-in Fills	37
Figure 8	Keyed-in Fills Tote Road.....	37
Figure 9	Profile of a Ford	42

Table 1: Determining Type of Cost Estimate Method

ROADS			
PROJECT TYPE	APPRAISAL TYPE	METHOD	COMMENT
New Road Construction End Haul End Haul to Specified Spoil Location	Initial Appraisal (IA) & Reappraisals (RA)	CEM	
Road Reconstruction Case 1 CC1 Widening ≤ 2 metre (m) Case 2 CC2 - CC6 Widening ≤ 2 m Case 3 Widening > 2 m	IA & RA	CEM	a) Permanent & Semi-Permanently Deactivated Roads b) Abandoned Road c) Missing Section
Case 4a: End Haul Case 4b: Partial End Haul	IA & RA	CEM	Either method can be used
Road Reconstruction: Emergency Work due to water or slope failure and any other road work required concurrent with this project.	IA & RA	CEF	Any occurrence the District Manager must be notified ASAP and be fully documented
Main Access Road	Initial Appraisal	CEF	Coast Appraisal Manual (CAM) Section 4.3.1(1)(a)(ii)
Uphill Side Slopes $> 150\%$	Initial Appraisal	CEF	CAM Section 4.3.1(1)(a)(ii)
Overlanding Trucked in Fills Large Fills Stored Fills	IA & RA	CEM	
Keyed-in Fills (from trucked in material)	IA & RA	CEM	
Two or more Gullies > 10 m deep at centreline in a 300 m section	Initial Appraisal	CEF	CAM Section 4.3.1(1)(a)(ii)
Switchbacks with $> 10,000$ m ³ of excavated volume	Initial Appraisal	CEF	CAM Section 4.3.1(1)(a)(ii)
Regional Manager Approved Projects/Special Designs	IA & RA	CEF	Cost must be submitted and approved prior to construction.

DRAINAGE STRUCTURES			
PROJECT TYPE	APPRAISAL TYPE	METHOD	COMMENT
Log Bridge	IA & RA	CAM	Table 4-3 section 4.3.2.2.1 of CAM
Permanent and New Portable Bridges	IA & RA	CAM	Table 4-5 section 4.3.2.2.2 of CAM and are all found except for barging.
Relocating a Portable Bridge	Initial Appraisal	CEF	
Multi-Span Bridge	Initial Appraisal	CEF	
Pile Driving > 13 metres Depth	Initial Appraisal	CEF	
Fords	IA & RA	CEM	
Log Bridge Repair	IA & RA	CEM	
Culverts	IA & RA	CEM	New roads only for culverts > 900 mm.

CEM - Cost Estimate Methodology CEF - Construction Estimate Form CAM - Coast Appraisal Manual

NEW ROAD CONSTRUCTION

End Haul

A section of road that is being constructed or reconstructed may require some excess material to be removed from the section via end hauling. This excess material is end hauled to another location for two reasons:

1. as spoil material; or
2. as material used for fill, ballasting, surfacing, etc. in another location.

Each of the above reasons use the same basic formulas to develop costs for the road section from which end hauled is occurring. But, when the end hauled material is being used in another section, then the cost estimates are modified for the second section where the end haul material is being used for construction. The explanation of how to determine the estimate for this scenario is on page 23 of this package, the Detailed Engineering Estimates for Coast Stumpage Appraisals.

End haul sections must be a minimum of twenty metres in length to be eligible for end haul cost estimates. To estimate the cost either the Cost Estimate Methodology (CEM) or the Construction Estimate Form (CEF) method are to be used for either end haul or partial end haul. If the CEM method is used then the End Haul Form” is used, see page 56 for the form and page 1 for instructions. If the CEF method is used then it is required that the “**Machine Hour Summary From Time Cards**” and CEF must be submitted, see page 57 for the forms and for instructions see page 50.

Sections that qualify to be cost estimated as end hauled must be designated as end haul in an approved road layout and design plan as per section 60 of the *Forest Practices Code Act of British Columbia* (FPC) and the Forest Road Regulations.

Data Required

The following data must be collected to estimate the costs for end haul:

- starting and ending stations for each end haul section;
- section length for each sideslope category;
- construction category;
- uphill sideslope % (SS);
- rock mass classification;
- spoil areas location or the road stations where the end haul material will be used;
- distance from mid-point of section to the mid-point of the spoil location or where the material will be used;
- volume estimates;
- copy of the approved layout and design that states end haul is required, as per section 8(4) of the Forest Road Regulation, must be submitted for appraisal approval;
- signature of Licensee Representative who prepared the End Haul application; and
- submission on the “End Haul Form”.

If additional loose stabilizing material (surfacing) is required, as per 4.3.2.3 of the Coast Appraisal Manual, determine the cost as per the Surfacing section on page 20. If culverts are required the cost is determined as per the Culvert section on page 44.

NOTE *When doing the calculations for end haul estimates the Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used.*

Calculation Methodology

1. Record the start and end stations for each section that requires end hauling (in the CADS Tabular Roads section record the start and end stations then write in End Haul).
2. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
3. Determine the end haul section's uphill sideslope %.
4. Determine the end haul section's construction category.
5. Determine the end haul section's material type (for mixtures of material type see step 9).
6. Determine the spoil location or road section to which material will be end hauled.
7. Determine the haul distance (d) needed for step 10. This is done by measuring from the mid-point of the end haul section to the mid-point of the spoil site or the road section where the end haul material is being used. To qualify for the trucking formulas the haul distance (d) must be greater than or equal to 0.01 km (10 metres).
8. Determine the total volume (bank cubic meters) of material to be end hauled (normally calculated from the approved geometric design). **No expansion factor to be used.** Cut slopes are ½:1 for 'Other Material' in CC's 1 to 3 and ¼:1 for 'Rock' in CC's 4 to 6, unless otherwise specified in a prescription by a qualified registered professional. This volume **MUST NOT** include volume that will be used in-place for additional stabilizing material/surfacing.

Note: The stabilized finished road surface width is fixed at 5.0 metres except for turnouts, widening for curves, landings, mainlines or where specified by a qualified registered professional in the approved road design.
9. For each construction categories; break the total section end haul volume (determined in step 8) into the Rock Mass Classification (RMC) of "Other Material" and "Rock" volume using the following criteria (which are the midpoints of the Construction Categories):

Construction Category	Other Material	Rock		Construction Category	Other Material	Rock
1	100%	0		4	50%	50%
2	94%	6%		5	25%	75%
3	75%	25%		6	6%	94%

10. Determine Unit Cost(s) using the CAM section 4.3.2.3(1)(b)(ii) formulas for 'Other Material' and 'Soft & Medium Rock'. The trucking distance (d) for this formula was determined in step 7.

Note: The 'Hard Rock' formula in the CAM section 4.3.2.3(1)(b)(ii) can be used instead of the 'Soft and Medium Rock' when the criteria in section 4.3.2(3)(c) of the April 1, 2000 CAM are met.
11. Determine the unadjusted Total Cost by multiplying the volume obtained in step 9 (for each RMC) by the Unit Cost (for each RMC) obtained in step 10.
12. Determine the Total Cost for end hauling by multiplying the ballasting formula cost in step 11 by the maneuverability difficulty factor of 1.3.
13. Once the Total Cost, for the subgrade, has been determined for the section and, **if** required, add the cost of surfacing (see page 20) to obtain the Total Cost estimate for the section
14. The cost of culverts (see page 44) for this section is to be determined separately.

$$\text{TOTAL COST} = (\text{Volume} * \text{Unit Cost}) * \text{Difficulty Factor}$$

(step 12)
(step 9)
(step 10)

Example I (this example uses the April 1, 2000 Coast Appraisal Manual)

SS = 64% CC = 3 Section length = 313 metres (0.313 km)
Subgrade RMC = S (soft/medium rock) Stabilizing/Surfacing RMC = S (soft/medium rock)
Subgrade End Haul Volume = 1,895 m³ Subgrade Haul distance = 452 metres (0.45 km)
Stabilizing/Subgrade Haul distance = 645 metres (0.65 km)
Total % of hard rock is < 60% for the section.

1. Calculate Subgrade Cost for the Road Section

i. Determine Volume (by RMC Type) (step 9)

$OM = \text{End Haul Volume} * \% \text{ (Table in step 9)}$	$Rock = \text{End Haul Volume} * \% \text{ (Table in step 9)}$
$= 1,895 \text{ m}^3 * 0.75$	$= 1,895 \text{ m}^3 * 0.25$
$= 1,421 \text{ m}^3$	$= 474 \text{ m}^3$

ii. Determine Unit Cost (\$/m³) (step 10)

$OM = 7.46 + (0.597 * d)$	$Rock = 10.80 + (0.597 * d)$
$= 7.46 + (0.597 * 0.45)$	$= 10.80 + (0.597 * 0.45)$
$= 7.46 + 0.27$	$= 10.80 + 0.27$
$= 7.73 \text{ \$/m}^3$	$= 11.07 \text{ \$/m}^3$

iii. Determine Unadjusted Total Cost (\$) (step 11)

$Total \text{ Cost } OM = \text{Unit Cost} * \text{Volume}$	$Total \text{ Cost } Rock = \text{Unit Cost} * \text{Volume}$
$= 7.73 \text{ \$/m}^3 * 1,421 \text{ m}^3$	$= 11.07 \text{ \$/m}^3 * 474 \text{ m}^3$
$= \$10,984$	$= \$5,247$

iv. Determine Total Cost (\$) (step 12)

$OM = \text{Total Cost} * \text{Difficulty Factor}$	$Rock = \text{Total Cost} * \text{Difficulty Factor}$
$= \$10,984 * 1.3$	$= \$5,247 * 1.3$
$= \$14,279$	$= \$6,821$

$$\begin{aligned} Total \text{ Cost} &= Total \text{ Cost } OM + Total \text{ Cost } Rock \\ &= \$14,279 + \$6,821 \\ &= \$21,100 \end{aligned}$$

2. Calculate Additional Stabilizing Material/Surfacing Cost for the Road Section

NOTE If additional loose stabilizing material is required as per section 4.3.2.3 of the CAM within the end haul, then determine the cost. In this instance the section requires additional stabilizing material.

i. Determine the Stabilizing/Surfacing Material Depth (D)

Using Table 4-6 Additional Loose Stabilizing Material Depths (metre)
CC of 3 and a Side Slope of 64% the depth of material is **0.3 metre.**

ii. Determine the Volume Formula to Use)

From section 4.3.2.3 of April 1, 2000 CAM
The Stabilizing/Surfacing material type is S therefore the formula is:
$$VR = [1,000 * D] * [6.2 + (1.0 * D)]$$

iii. Determine the Stabilizing/Surfacing Volume for a Kilometre

$$\begin{aligned} VR &= [1,000 * D] * [6.2 + (1.0 * D)] \\ &= [1,000 * 0.3] * [6.2 + (1.0 * 0.3)] \\ &= [300] * [6.2 + 0.3] \\ &= 300 * 6.5 \\ &= 1,950 \text{ m}^3 \end{aligned}$$

iv. Determine the Trucking Stabilizing/Surfacing Unit Cost

Using section 4.3.2.3(1)(b)(ii) of the April 1, 2000 CAM
with an RMC of S the material cost rate is **10.80 \$/m³.**
Distance from source stabilizing material to
centre of the end haul portion of the section is **0.65 km**

$$\begin{aligned} \text{Unit Cost} &= \text{Trucking Material rate} + (\text{Constant} * \text{Distance}) \\ &= 10.80 \text{ \$/m}^3 + (0.597 * 0.65 \text{ km}) \\ &= 10.80 \text{ \$/m}^3 + 0.388 \text{ km} \\ &= 11.19 \text{ \$/m}^3 \end{aligned}$$

v. Determine the Stabilizing/Surfacing Cost for a kilometre

$$\begin{aligned} \text{Kilometre Cost} &= \text{In-Place Unit Cost} * \text{Volume} \\ &= 11.19 \text{ \$/m}^3 * 1,950 \text{ m}^3 \\ &= \$ 21,820 \end{aligned}$$

vi. Determine the Stabilizing/Surfacing Cost for the whole section

$$\begin{aligned} \text{Stabilizing Section Cost} &= \text{Kilometre Cost} * \text{Section Length} \\ &= \$ 21,820 * 0.313 \text{ km} \\ &= \$ 6,830 \end{aligned}$$

3. Calculate the End Haul Sections Total Cost

$$\begin{aligned} \text{End Haul Section Cost} &= \text{Subgrade Cost} + \text{Stabilizing/Surfacing Cost} \\ &= \$ 21,100 + \$ 6,830 \\ &= \$ 27,930 \end{aligned}$$

NOTE: If culverts are required within the end haul section then the cost is determined as per the Culvert Section on page 44.

Specified Spoil Location

Phase

When material is end hauled from sections where new road construction is occurring to a spoil site, then the information and directions outlined in the End Haul section on pages 1 to 6 are used to estimate the cost. Full end haul for road reconstruction is on page 15.

During new road construction, if material within a section will be both side cast and end hauled then use information and direction on how to estimate the cost as described in Partial End Haul section on page 16.

Data Required

The same information as is outlined in the Data Required portion of the End Haul section on page 1.

Calculation Methodology

Use the same Calculation Methodology found on page 2.

NOTE *When doing the calculations for end haul estimates the Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used.*

ROAD RECONSTRUCTION

The following road reconstruction Cases provide costing for projects not considered routine maintenance as per Section 4.5.3 of the *Coast Appraisal Manual* - April 1, 2000 (CAM).

Those roads that have been temporarily deactivated do not qualify to use any of the four cases. For culvert replacement (for the following cases) use “Table 4-4: Culvert Cost Estimate” of the CAM. Surfacing costs are to be determined using the method described on page 20.

Note: Those sections requiring reconstruction due to a Forest Practices Code infraction are not to be included in the estimate.

Please Note

- ◆ Roads requiring reconstruction due to initial improper road construction or maintenance practices will not receive a cost estimate.
- ◆ Filling in of water-bars and cross ditches and replacement of culverts up to 900mm and wood culverts up to 3.5 metres long (i.e. temporary deactivation and maintained roads) are considered a function of routine maintenance.
- ◆ If road sections were constructed less than 6.2 metres wide but are deemed safe and passable to vehicles required for logging then an estimate will not be allowed for road widening
- ◆ Sideslope is the uphill sideslope of the original terrain above the cut slope, not the sideslope of the road cut-bank.
- ◆ Subgrade costs, for Cases 1 - 3, from the CAM are to be reduced by \$3,789 to exclude culverts less than or equal to 900 mm. However, for reconstruction, all culverts are added on a site specific basis with the cost determined as per the culvert section on page 44.
- ◆ Additional Stabilizing Material/Surfacing costs for Case 1 – 3 is cost estimated **ONLY** if Additional Stabilizing Material/Surfacing is **actually required** for the section that is having road reconstruction occur.

A map (preferably 1:5,000 or 1:10,000 scale) must be submitted with the cost estimate methodology at the time of initial submission whether it is at the road or cutting permit application, original appraisal or subsequent re-appraisals. This map must show:

- ◇ Roads and road section requiring reconstruction;
- ◇ Road name(s) or number(s) (they must relate to the CEM); and
- ◇ Location and stations of the various proposed works (i.e. sections requiring reconstruction, culverts, new construction).
- ◇ For end haul sections submit plans, profile, X-sections, excavated cut/fill volumes by material type (Other material, soft-medium or hard rock) and the prescription by a qualified registered professional who prescribes end hauling.

NOTE *When doing the calculations for the any of the following cases, the Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used.*

Case 1: Existing Roads Widening ≤ 2 metres, CC1

Phase

The methodology in Case 1 is for those existing road sections requiring one or more of the following:

1. widening up to and including 2 metres (m) in width with a CC of 1 (i.e. no rock);
2. removal from the road prism of:
 - a. vegetation (that can not be re-opened with a grader); or
 - b. slough or slide material (including woody debris);
3. re-ditching and culvert cleaning.

NOTE: Case 1 and 2 is not to be used where filling in of waterbars and cross ditches is a result of temporary deactivation or where grading is the only cost incurred.

If a grader can be used for the above work then Case 1 and 2 do not apply.

Data Required

The following data must be collected to estimate the costs using 'Case 1';

- section length for each sideslope category;
- construction category (CC) - (always CC1 - otherwise Case 2 applies);
- uphill sideslope % (SS) - (see Figure 2 on page 12);
- location & type (rock hardness) of surfacing material;
- location, length, diameter and type of culverts (if they are needed);
- signature of Licensee Representative who prepared the Road Reconstruction application; and
- submission on the "Road Reconstruction Form".

Calculation Methodology

1. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
2. Determine the appropriate value for a section by looking up on "Table 4-2(b): Subgrade Construction Cost Estimate Other RMC's" of the CAM using construction category 1 and the section's uphill sideslope (note that the values in this table are in \$1,000/km).
3. Subtract \$3,789 from the value obtained in step 2 (default culvert allowance).
4. Multiply the resultant from step 3 (above) by a cost factor of 0.20 (20% of the tabular subgrade cost).
5. Multiply the resultant from step 4 (above) by the total length of the section and record as kilometres (one metre equals 0.001 km).
6. Determine the cost of stabilizing/surfacing (see page 20), **if** stabilizing/surfacing is required.
7. Add the cost of the subgrade and the stabilizing/surfacing (if the stabilizing/surfacing cost estimate is applicable) to obtain the Total Cost estimate for the section.
8. The cost of culverts (see page 44) for this section is to be determined separately.

Example II *(this example uses the April 1, 2000 Coast Appraisal Manual)*

$SS = 46\%$ $CC = 1$ Section length = **1,097 metres** (1.097 km) Existing Road Width = **4.8 m**
Stabilizing/Surfacing RMC = **H** (hard rock) Stabilizing/ Surfacing Haul dist. = **in place material**
Total % of hard rock is < 60% for the section.

1. Calculate the Subgrade Cost for the Road Section

$$\begin{aligned} \text{Cost Estimate} &= ((\text{Subgrade Cost} - \text{Culvert Allowance}) * \text{Cost Factor}) * \text{Section Length} \\ &= ((\$31,800 - \$3,789) * 0.2) * 1.097 \text{ km} \\ &= (\$28,011 * 0.20) * 1.097 \text{ km} \\ &= \$5,602 * 1.097 \text{ km} \\ &= \$6,145 \end{aligned}$$

2. Calculate the Additional Stabilizing Material/Surfacing Cost for the Road Section

NOTE *If additional loose stabilizing material is required as per section 4.3.2.3 of the CAM then determine the cost. In this instance the section requires additional stabilizing material.*

i. Determine the Volume of Stabilizing/Surfacing Material

*Because the depth allowed in Case 1 is determined as 20 cm (0.2 m) deep the volume is a constant **1,280 m³**.*

ii. Determine the No Trucking Stabilizing/Surfacing Unit Cost

*Using section 4.3.2.3(1)(b)(ii) of the April 1, 2000 CAM with an RMC of **H** the No Trucking material cost rate is **11.57 \$/m³**.*

iii. Determine the Stabilizing/Surfacing Cost for a kilometre

$$\begin{aligned} \text{Kilometre Cost} &= \text{In-Place Unit Cost} * \text{Volume} \\ &= 11.57 \text{ \$/m}^3 * 1,280 \text{ m}^3 \\ &= \$ 14,810 \end{aligned}$$

iv. Determine the Stabilizing/Surfacing Cost for the section

$$\begin{aligned} \text{Stabilizing Section Cost} &= \text{Kilometre Cost} * \text{Section Length} \\ &= \$ 14,180 * 1.097 \text{ km} \\ &= \$ 15,555 \end{aligned}$$

3. Calculate the cost of Culverts if Required

If culverts are required then they are cost estimated as per Culvert section on page 44.

Case 2: Existing Roads Widening \leq 2 metres, CC 2 - 6

Phase

The methodology in Case 2 is for those existing road section requiring drilling and blasting and one or more of the following:

1. widening up to and including 2 metres (m) width with a construction category of 2 to 6;
2. removal from the road prism of:
 - a. vegetation (can not be re-opened with a grader); or
 - b. slough or slide material (including woody debris);
3. re-ditching and culvert cleaning.

NOTE: If a grader can be used for the above work then Case 1 and 2 do not apply.

If **no** drilling and blasting is required to widen the road then Case 1 must be used.

Data Required

The following data must be collected to estimate the costs using ‘Case 2’:

- section length for each sideslope category;
- construction category;
- uphill sideslope % (SS) - (see Figure 2 on page 12);
- location & type (rock hardness) of surfacing material;
- location, length, diameter and type of culverts (if they are needed);
- signature of Licensee Representative who prepared the Road Reconstruction application; and
- submission on the “Road Reconstruction Form”.

Calculation Methodology

1. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
2. Determine the appropriate value for a section:
 - a. by looking up in “Table 4-2(b): Subgrade Construction Cost Estimate Other RMC’s” of the CAM using the appropriate construction category between 2 to 6 and the sideslope (note that the values in this table are in \$1,000/km); or
 - b. by looking up on “Table 4-2(a): Subgrade Construction Cost Estimate RMC 5 Only” of the CAM using the appropriate construction category between 2 to 6 and the sideslope.
3. Subtract \$3,789 from the value obtained in step 2 (default culvert allowance).
4. Multiply the resultant from step 3 (above) by a cost factor of 0.35 (35% of the tabular subgrade cost).
5. Multiply the resultant from step 4 (above) by the total length of the section and record as kilometres (one metre equals 0.001 km).
6. Determine the cost of stabilizing/surfacing (see page 20), **if** stabilizing/surfacing is required.
7. Add the cost of the subgrade and the stabilizing/surfacing (if the stabilizing/surfacing cost estimate is applicable) to obtain the Total Cost estimate for the section.
8. The cost of culverts (see page 44) for this section is to be determined separately.

Example III (this example uses the April 1, 2000 Coast Appraisal Manual)

$SS = 52\%$ $CC = 3$ Section length = **224 metres** (0.224 km) Existing Road Width = **3.7 m**
Stabilizing/Surfacing RMC = **G** (gravel) Stabilizing/ Surfacing Haul distance = **1.36 km**
Total % of hard rock is < 60% for the section.

1. Calculate the Subgrade Cost for the Road Section

$$\begin{aligned} \text{Cost Estimate} &= ((\text{Subgrade Cost} - \text{Culvert Allowance}) * \text{Cost Factor}) * \text{Section Length} \\ &= ((\$64,600 - \$3,789) * 0.35) * 0.224 \text{ km} \\ &= (\$60,811 * 0.35) * 0.224 \text{ km} \\ &= \$21,284 * 0.224 \text{ km} \\ &= \$4,738 \end{aligned}$$

2. Calculate the Additional Stabilizing Material/Surfacing Cost for the Road Section

NOTE If additional loose stabilizing material is required as per section 4.3.2.3 of the CAM then determine the cost. In this instance the section requires additional stabilizing material.

i. Determine the Volume of Stabilizing/Surfacing Material

Because the depth allowed in Case 2 is determined as 20 cm (0.2 m) deep the volume is a constant **1,300 m³**.

ii. Determine the No Trucking Stabilizing/Surfacing Unit Cost

Using section 4.3.2.3(1)(b)(ii) of the April 1, 2000 CAM
with an RMC of G the No Trucking material cost rate is **5.44 \$/m³**.

iii. Determine the Stabilizing/Surfacing Cost for a kilometre

$$\begin{aligned} \text{Kilometre Cost} &= \text{In-Place Unit Cost} * \text{Volume} \\ &= 5.44 \text{ \$/m}^3 * 1,300 \text{ m}^3 \\ &= \$7,072 \end{aligned}$$

iv. Determine the Stabilizing/Surfacing Cost for the section

$$\begin{aligned} \text{Stabilizing Section Cost} &= \text{Kilometre Cost} * \text{Section Length} \\ &= \$7,072 * 1.097 \text{ km} \\ &= \$7,758 \end{aligned}$$

3. Calculate the cost of Culverts if Required

If culverts are required then they are cost estimated as per Culvert section on page 44.

Case 3: Existing Roads Widening > 2 metres

Phase

The methodology in Case 3 is for those existing old road sections requiring:

1. widening of more than 2 metres (m) width with a construction category of 1 to 6;
2. removal from the road prism of:
 - a. vegetation; or
 - b. slough or slide material (including woody debris);
3. re-ditching and culvert cleaning.

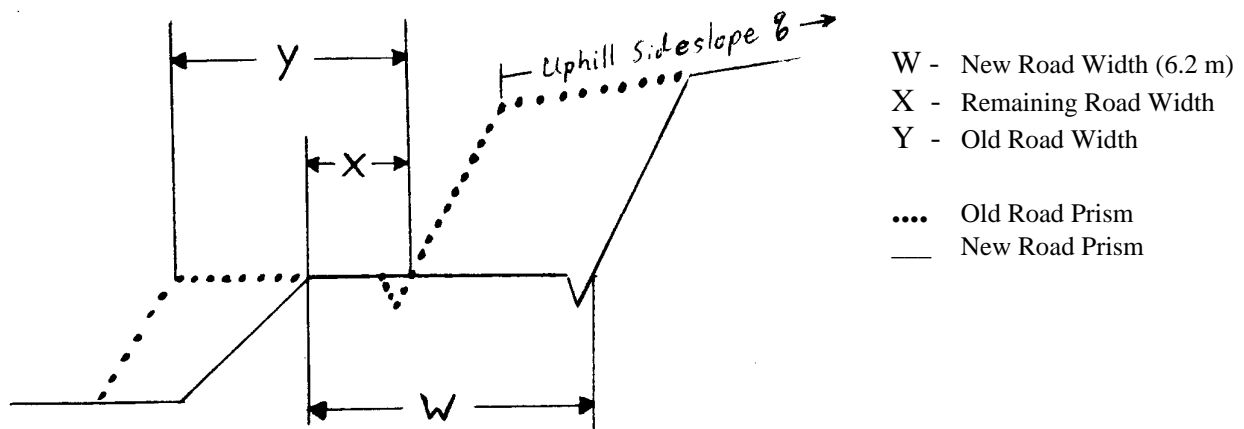
This case is only to be used when moving the road into the cut bank. If a failed road section is relocated requiring new construction, then use the “Tabular Roads” portion of the *Coast Appraisal Data Sheet*.

Data Required

The following data must be collected to estimate the costs for ‘Case 3’:

- section length for each sideslope category;
- construction category;
- uphill sideslope % (SS) - (see Figure 2);
- location, type (rock hardness) of surfacing material;
- X - Width of the existing remaining road section and ditch width (see Figure 1);
- location, length, diameter and type of culverts (if they are needed);
- signature of Licensee Representative who prepared the Road Reconstruction application; and
- submission on the “Road Reconstruction Form”.

Figure 1: Case 3 ‘Road X-Section’



Calculation Methodology

1. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
2. Determine the appropriate value for a section by looking up in “Table 4-2(b): Subgrade Construction Cost Estimate Other RMC’s” or “Table 4-2(a): Subgrade Construction Cost Estimate RMC 5 Only” of the CAM depending on the rock hardness. Use the appropriate construction category between 1 to 6 and the sideslope to determine the value (note that the values in this table are in \$1,000/km).
3. Subtract \$3,789 from the value obtained in step 2 (default culvert allowance).
4. Determine the cost factor using the following formula (see Figure 1):

$$\text{Cost Factor} = \frac{(3w^2 - 4wx) + x^2}{w^2}$$

Where; $w = 6.2$ metres
 $x =$ width of remaining road section and ditch width

5. Multiply the resultant from step 3 by the resultant cost factor obtained in step 4 to get the cost per kilometre.
6. Multiply the resultant from step 5 (above) by the total length of the section and record as kilometres (one metre equals 0.001 km).
7. Determine the cost of stabilizing/surfacing (see page 20), **if** stabilizing/surfacing is required
8. Add the cost of the subgrade and the stabilizing/surfacing (if the stabilizing/surfacing cost estimate is required) to obtain the Total Cost estimate for the section.
9. The cost of culverts (see page 44) for this section is to be determined separately.

Example IV (this example uses the April 1, 2000 Coast Appraisal Manual)

$SS = 49\%$ $CC = 4$ Section length = **560 metres** (0.560 km) Existing Road Width = **3.2 m**
 Stabilizing/Surfacing RMC = **S** (soft/medium rock) Stabilizing/Subgrade Haul distance = **0.72 km**
 Total % of hard rock is < 60% for the section.

1. Calculate the Cost Factor

$$\begin{aligned} \text{Cost Factor} &= \frac{(3w^2 - 4wx) + x^2}{w^2} \\ &= \frac{((3 * (6.2)^2) - (4 * 6.2 * 3.2)) + (3.2)^2}{(6.2)^2} \\ &= \frac{(115.32 - 79.36) + 10.24}{38.44} \\ &= \frac{35.96 + 10.24}{38.44} \\ &= \frac{46.20}{38.44} \\ &= 1.20 \end{aligned}$$

2. Calculate the Subgrade Cost for the Road Section

$$\begin{aligned}\text{Cost Estimate} &= ((\text{Subgrade Cost} - \text{Culvert Cost}) * \text{Cost Factor}) * \text{Section Length} \\ &= ((\$89,200 - \$3,789) * 1.20) * 0.56 \text{ km} \\ &= (\$85,411 * 1.20) * 0.56 \text{ km} \\ &= \$102,493 * 0.56 \text{ km} \\ &= \$57,396\end{aligned}$$

3. Calculate the Additional Stabilizing Material/Surfacing Cost for the Road Section

NOTE If additional loose stabilizing material is required as per section 4.3.2.3 of the CAM then determine the cost. In this instance the section requires additional stabilizing material.

i. Determine the Depth of Stabilizing/Surfacing Material

Using Table 4-6 with a Construction Category of 4 and a Uphill Sideslope 49% the depth is 0.3 m.

ii. Determine the Volume of Stabilizing/Surfacing Material

$$\begin{aligned}\text{Volume of Rock} &= (1,000 * \text{Depth}) * (6.2 + (1.0 * \text{Depth})) \\ &= (1,000 * 0.3) * (6.2 + (1.0 * 0.3)) \\ &= 300 * (6.2 + 0.3) \\ &= 300 * 6.5 \\ &= 1,950 \text{ m}^3\end{aligned}$$

iii. Determine the Trucking Stabilizing/Surfacing Unit Cost

$$\begin{aligned}\text{Unit Cost} &= \text{Soft/Medium Trucking rate} + (\text{Constant} * \text{Distance}) \\ &= 10.80 + (0.597 * 0.72) \\ &= 10.80 + 0.43 \\ &= 11.23 \text{ \$/m}^3\end{aligned}$$

iv. Determine the Stabilizing/Surfacing Cost for a kilometre

$$\begin{aligned}\text{Kilometre Cost} &= \text{In-Place Unit Cost} * \text{Volume} \\ &= 11.23 \text{ \$/m}^3 * 1,950 \text{ m}^3 \\ &= \$ 21,899\end{aligned}$$

v. Determine the Stabilizing/Surfacing Cost for the section

$$\begin{aligned}\text{Stabilizing Section Cost} &= \text{Kilometre Cost} * \text{Section Length} \\ &= \$ 21,899 * 0.56 \text{ km} \\ &= \$ 12,263\end{aligned}$$

Case 4a: End Haul

Phase

Where end hauling is required only movements greater than or equal to 10 metres from the mid-point of the end haul section are eligible for end haul estimates. Either the Cost Estimate Methodology or the Construction Estimate Form method can be used to estimate the costs for either end haul in road reconstruction.

Sections to be end hauled must be a requirement of an approved road layout and design plan as per section 60 of the *Forest Practices Code Act of British Columbia* (FPC) and the Forest Road Regulations.

The methodology for estimating the cost of end hauling during reconstruction of roads follows the same procedure as described in End Haul on page 1.

If required surfacing is cost estimated as per the Stabilizing section on page 20. If culverts are required the cost is determined separately as per the Culvert section on page 44.

NOTE *When doing the calculations for end haul estimates the Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used.*

Case 4b: Partial End Haul Estimate

Phase

There will be situations where only some portion of a section's road prism is required to be end hauled (i.e. the prescription permits 25% of the material to be side casted and the rest to be end hauled). Either the Cost Estimate Methodology or the Construction Estimate Form method can be used to estimate the costs for partial end haul in road reconstruction.

Only movements greater than or equal to 10 metres from the mid-point of the end haul section are eligible for partial end haul estimates.

If this cost estimate methodology is chosen, then the end haul costs are prorated by section length between end haul and tabular road estimations.

NOTE *When doing the calculations for end haul estimates the Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used.*

Data Required

It is the same as for End Haul on page 1.

Calculation Methodology

1. Determine the percentage of the section's road prism that will be end hauled and the percentage of the road section that will be side cast.
2. Determine the length of the section to be end hauled by multiplying the percentage of the section to be end hauled (determined in step 1) by the total length of the section.
3. Determine the cost of the end haul portion using the same calculation methodology as for the Full End Haul Estimate. See page 2 and follow all 14 steps.
4. Determine the length of the section to be side cast by multiplying the percentage of the section to be side cast (determined in step 1) by the total length of the partial end haul section.
5. Determine the cost of the length of the section that is side cast using the "Development-Tabular Roads" portion of the *Coast Appraisal Data Sheets*. Also, on the tabular road sheet note that this section is a partial end haul in the comments column.

Example V (this example uses the April 1, 2000 Coast Appraisal Manual)

A 208 metre section of road has a prescription that permits 25% of the excavated material to be side casted and the remaining volume must be end hauled.

SS = 71% CC = 4 RMC = S (soft/medium rock)
 Section length = 208 metres (0.208 km) End Haul distance = 325 metres (0.33 km)
 End Haul for the Section = 1,120 m³
 Total % of hard rock is < 60% for the section.

1. Determine the Length (in km) to be End Hauled and the Length (in km) to be Side Cast

$$\begin{array}{ll}
 \text{End Hauled} = \text{Length} * \% \text{ to be End Hauled} & \text{Side Cast} = \text{Length} * \% \text{ to be Side Cast} \\
 = 0.208 * 0.75 & = 0.208 * 0.25 \\
 = 0.156 & = 0.052
 \end{array}$$

2. Determine the End Haul Portion the Subgrade Cost

i. Determine the Volume (by RMC) (step 9 on page 2)

$$\begin{array}{ll}
 OM = \text{End Haul Volume} * \% \text{ (Table in step 9)} & \text{Rock} = \text{End Haul Volume} * \% \text{ (Table in step 9)} \\
 = 1,120 \text{ m}^3 * 0.50 & = 1,120 \text{ m}^3 * 0.50 \\
 = 560 \text{ m}^3 & = 560 \text{ m}^3
 \end{array}$$

ii. Determine Unit Cost (\$/m³) (step 10 on page 2)

$$\begin{array}{ll}
 OM = 7.46 + (0.597 * d) & \text{Rock} = 10.80 + (0.597 * d) \\
 = 7.46 + (0.597 * 0.33) & = 10.80 + (0.597 * 0.33) \\
 = 7.46 + 0.20 & = 10.80 + 0.20 \\
 = 7.66 \text{ \$/m}^3 & = 11.00 \text{ \$/m}^3
 \end{array}$$

iii. Determine Unadjusted Total Cost (\$) (step 11 on page 2)

$$\begin{array}{ll}
 OM = \text{Volume} * \text{Unit Cost} & \text{Rock} = \text{Volume} * \text{Unit Cost} \\
 = 560 \text{ m}^3 * 7.66 \text{ \$/m}^3 & = 560 \text{ m}^3 * 11.00 \text{ \$/m}^3 \\
 = \$ 4,290 & = \$ 6,160
 \end{array}$$

iv. Determine Total Cost (\$) (step 12 on page 2)

$$\begin{array}{l} OM = \text{Total Cost} * \text{Difficulty Factor} \\ = \$ 4,290 * 1.3 \\ = \$ 5,577 \end{array} \qquad \begin{array}{l} Rock = \text{Total Cost} * \text{Difficulty Factor} \\ = \$ 6,160 * 1.3 \\ = \$ 8,008 \end{array}$$

$$\begin{array}{l} \text{Subgrade Section Cost} = \text{Total Cost OM} + \text{Total Cost Rock} \\ = \$ 5,577 + \$ 8,008 \\ = \$ 13,585 \end{array}$$

3. Determine For the End Haul Portion the Stabilizing/Surfacing Cost (step 13 on page 2)

NOTE If additional loose stabilizing material is required as per 4.3.2.3 of the CAM, April 1, 2000 within the end haul portion of the partial end haul section, then determine the cost as per the Surfacing Section on page 44. The following example follows the Surfacing Section method

i. Determine the Stabilizing/Surfacing Material Depth (D)

Using Table 4-6 Additional Loose Stabilizing Material Depths (metre)
CC of 4 and a Side Slope of 71% the depth of material is **0.1** metre.

ii. Determine the Volume Formula to Use)

From section 4.3.2.3 of April 1, 2000 CAM
The Stabilizing/Surfacing material type is **G** therefore the formula is:
 $VG = [1,000 * D] [6.2 + (1.5 * D)]$

iii. Determine the Stabilizing/Surfacing Volume for a Kilometre

$$\begin{array}{l} VG = [1,000 * D] * [6.2 + (1.5 * D)] \\ = [1,000 * 0.1] * [6.2 + (1.5 * 0.1)] \\ = [100] * [6.2 + 0.15] \\ = 100 * 6.35 \\ = 635 m^3 \end{array}$$

iv. Determine the Trucking Stabilizing/Surfacing Unit Cost

Using section 4.3.2.3(1)(b)(ii) of the April 1, 2000 CAM
with an RMC of **G** the material cost rate is **7.46 \$/m³**.
Distance from source stabilizing material
to centre of the end haul portion of the section is **0.89 km**

$$\begin{aligned} \text{Unit Cost} &= \text{Material Cost rate} + (\text{Constant} * \text{Distance}) \\ &= 7.46 \text{ \$/m}^3 + (0.597 * 0.89 \text{ km}) \\ &= 7.46 \text{ \$/m}^3 + 0.531 \text{ km} \\ &= 7.99 \text{ \$/m}^3 \end{aligned}$$

v. Determine the Stabilizing/Surfacing Cost for a kilometre

$$\begin{aligned} \text{Kilometre Cost} &= \text{In-Place Unit Cost} * \text{Volume} \\ &= 7.99 \text{ \$/m}^3 * 635 \text{ m}^3 \\ &= \$ 5,074 \end{aligned}$$

vi. Determine the Stabilizing/Surfacing Cost for the whole section

$$\begin{aligned} \text{Stabilizing Section Cost} &= \text{Kilometre Cost} * \text{Section Length} \\ &= \$ 5,074 * 0.156 \text{ km} \\ &= \$ 792 \end{aligned}$$

4. Determine For the End Haul Portion the Total Cost in the Section

$$\begin{aligned} \text{Sum Section Cost} &= \text{Subgrade Section Cost} + \text{Stabilizing Section Cost} \\ &= \$ 13,585 + \$ 792 \\ &= \$ 14,377 \end{aligned}$$

NOTE: If culverts are required within the end haul portion of the partial end haul section then the cost is determined as per the Culvert Section on page 44.

5. Determine Cost For Side Cast Portion

Determine the Cost using 'Tabular Roads' portion of the CADS. The section length determined in step 1, $0.208 \times 0.25(25\%) = 0.052 \text{ km}$, is used to determine the section length for the full tabular road cost determination which is on the Tabular Road portion of the CADS. Please remember to make a notation, in comments, on the line entry on the Tabular Road sheet that this is a partial end haul section.

SURFACING

Surfacing, with the exception of capping, is for road sections that require road reconstruction or end haul. The following describes the instances when surfacing will be allowed:

- Capping is as per section 4.3.2.3(2) of the CAM on new road construction when there is insufficient material present to cover large rock protruding from the running surface.
- Re-Surfacing (old Case 5) of an existing road is required because of extensive “wear & tear” of the road surface of a mainline. To qualify for re-surfacing the length of a section must have a minimum loose depth of 0.2 metres over a continuous length 0.5 km or greater, otherwise the cost is considered to be part of routine maintenance.
- Surfacing occurs on roads that are being reconstructed as per Cases 1, 2 & 3 where surfacing may be required.

If surfacing material must be transported from a borrow pit that is located on the road requiring surfacing, the section of road up to 100 metres either side of the borrow pit does not use the trucking of stabilizing material formula. This section of road must use the no-trucking of stabilizing material formula.

NOTE *The Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used.*

Data Required

The following data must be collected to estimate the costs for surfacing:

- section length;
- depth of surfacing (see below)
- volumes (see below);
- ballast type (gravel or rock);
- rock hardness;
- construction category (for Cases 3, 4a & 4b);
- sideslope % (for Cases 3, 4a & 4b);
- identify the source of the gravel/ballast (station of borrow pit(s));
- haul distance;
- signature of Licensee Representative who prepared the Surfacing application; and
- submission on the “Road Reconstruction Form”.

Calculation Methodology

1. Determine if surfacing is actually required.
2. Determine the section length.

3. Determine the depth of loose stabilizing material (D):
 - a. Capping

As per section 4.3.2.3(2) of the CAM. Use the CAM in effect at the date of the appraisal or reappraisal.
 - b. Re-surfacing

Use a 200 millimetre lift of surfacing.
 - c. Case 1 & 2

Use a 200 millimetre lift of surfacing.
 - d. Case 3, 4a & 4b

Using “Table 4-6: Additional Loose Stabilizing Material Depths (metres)” of the CAM.

3. Determine the volume (V) of loose stabilizing material for each section using the formulas in section 4.3.2.3(1)(a) of the CAM.
 - a. Case 1 & 2

The constant volume determined for gravel and rock using the 10 cm depth is:

Gravel	1,300 m ³ per km
Rock	1,280 m ³ per km
 - b. Case 3, 4a, & 4b

Use the depth of loose stabilizing material (D) determined in step 2 (above) enter this value into the appropriate formula depending on whether it is rock or gravel.

4. Determine the haul distance (d) if trucking is required.
 - ◇ Haul distance is measured from the mid-point of the road section receiving the ballast/gravel to the mid-point of the borrow pit.
 - ◇ Haul distance of less than 100 metres is considered local material (no trucking). If the borrow pit is within the road section being resurfaced then the section must be broken down into three separate sections for calculation.
 - i. Section where material is moved less than 100 metres either way along road being re-surfaced from borrow pit.
 - ii. First section of trucking of material which is beyond 100 metres from the borrow pit in one direction.
 - iii. Second section of trucking of material which is beyond 100 metres from the borrow pit in the opposite direction from that described in ii above.

5. Determine the appropriate unit cost (U) to apply to the stabilizing material for each section, when there is:
 - a. No trucking of Stabilizing material, use the values in section 4.3.2.3(2)(a) of the CAM. Use the CAM in effect at the date of the appraisal or reappraisal. The following example is from the April 1, 2000 CAM:

Gravel	U = \$5.33 per m ³
--------	-------------------------------

Soft & Medium Rock U = \$8.66 per m³
Hard Rock U = \$11.43 per m³

- b. Trucking of Stabilizing material, use the formulas in section 4.3.2.3(2)(b) of the CAM. Use the CAM in effect at the date of the appraisal or reappraisal. The following example is from the April 1, 2000 CAM:

Gravel U (\$/m³) = 7.34 + 0.592(d)
Soft & Medium Rock U (\$/m³) = 10.66 + 0.592(d)
Hard Rock U (\$/m³) = 13.43 + 0.592(d)

6. Determine the cost estimate by multiplying the volume determined in step 3 by the unit cost determined in step 5.

$$\text{Cost Estimate} = V * U$$

7. Determine the sections total cost by multiplying the cost estimate determined in step 6 by the section length determined in step 1.

$$\text{Total Cost} = \text{Cost Estimate} * \text{Section Length}$$

OVERLANDING (ROADBED AND EXCESSIVE FILL CONSTRUCTION)

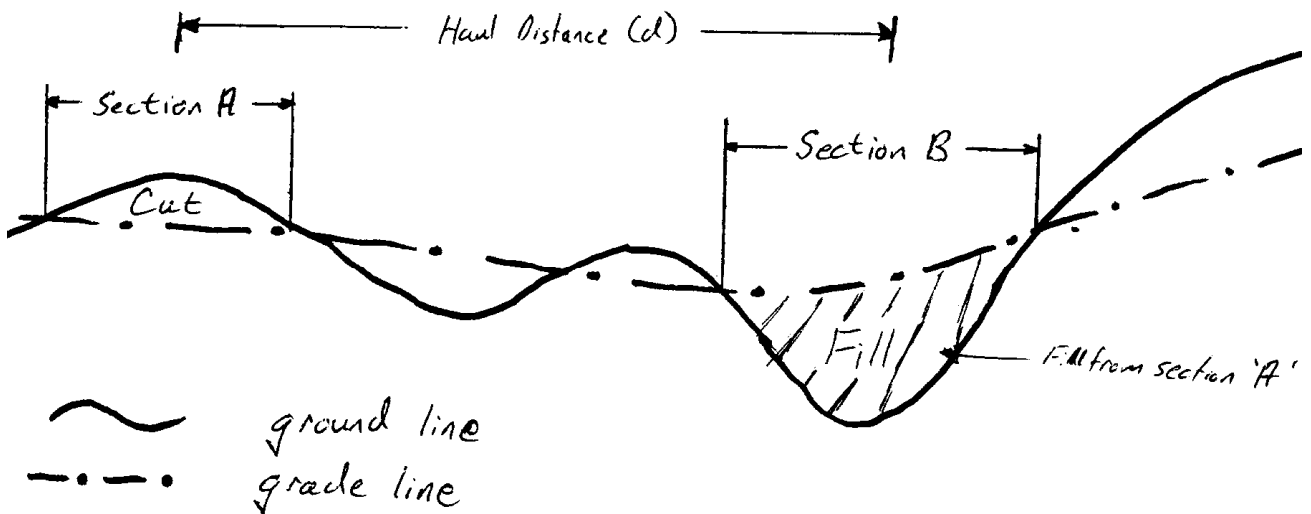
Trucked in Fills

Phase

When road excavation material is end hauled (section A in Figure 1) from one section and used as fill, ballasting, surfacing, etc. material in another location (section B in Figure 1) both sections are considered as engineering sections and are to be cost estimated as follows:

1. The section from which the material is being end hauled (section A in Figure 1) is cost estimated using the End Haul form plus culverts and surfacing where applicable.
2. The section that the material will be used as fill in (section B in Figure 1) is cost estimated using a modified tabular roads method. This modified tabular roads method allows cost estimates for the subgrade portion of the road but no cost estimates are allowed for the additional stabilizing material. The construction category for this section is 1 and the slope must be less than 35%. This section is to be recorded on the Road Reconstruction form. See instructions on page 24.
3. If the material from section A is moved to a storage location, stored and later moved to section B then the Stored Fills cost estimate on page 35 is used and the End Haul form is used to record it.
4. If additional fill material is required to complete the fill section (section B in Figure 1) to the final designed grade, it is cost estimated utilizing either Large Fills or Stored Fills. See the methodologies on page 31 and 35.

Figure 1: Cut Fill Profile



Data Required

The following information needs to be collected:

- starting and ending stations for end haul section (section A);
- starting and ending stations where the end haul material is to be used (section B);
- haul distance;
- section length for each section;
- uphill sideslope % (SS) for each section;
- construction category for each section;
- rock mass classification;
- spoil area location if required;
- storage area location if required;
- pit location for additional material if required for fill section;
- volume estimates;
 - ◊ for the end haul section;
 - ◊ for the road section receiving fill material; or
 - ◊ if necessary for additional fill volume required to complete the fill to the designed graded level;
- copy of the approved layout and design that states end haul is required, as per section 8(4) of the Forest Road Regulation, must be submitted for appraisal approval;
- Licensee Representative signature who prepared the Trucked in Fill application;
- submission on the “End Haul Form” for section A; and
- submission on the “End Haul Form” for section B if stored fills are required and the “Road Reconstruction Form” form for section B if it is coming directly from a road section.

NOTE: Where more than one source of material is being utilized, provide the same information for each source.

Calculation Methodology

For section A in Figure 1:

1. Follow all the steps in the calculation method outlined on page 2 of the CEM except for step 7, which is determining the haul distance. Step 7 is to be replaced with step 2 below.
2. To qualify for the trucking formulas the haul distance (d) must be greater than or equal to 0.01 km. Determine the haul distance (d) by either measuring from the:
 - a. **mid-point of the section** that the end haul material is being hauled from to the **mid-point of the section** where the material is being used; or
 - b. **mid-point of the section** that the end haul material is being hauled from to a **mid-point of the storage site** where the material is being stored.

For section B in Figure 1:

1. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
2. Determine the appropriate value for a section by looking up in “Table 4-2(b): Subgrade Construction Cost Estimate for Other RMC’s” of the CAM using the appropriate construction category between 1 to 6 and the sideslope (the values in this table are in \$1,000/km).
3. Subtract \$3,789 from the value obtained in step 2 (default culvert allowance).
4. Multiply the resultant from step 3 (above) by the total length of the section and record as kilometres (one metre equals 0.001 km).
5. When required the cost of culverts is determined as per the culvert section on page 44.
6. If material for the road prism was stored at a storage site then:
 - a. Follow all the steps in the calculation method outlined on page 2 except for step 7, which is determining the haul distance. Step 7 is to be replaced with step b below.
 - b. To qualify for the trucking formulas the haul distance (d) must be greater than or equal to 0.01 km. Determine the haul distance (d) by measuring from the **mid-point of the storage site** to the **mid-point of the section** (section B) being used to construct the road prism.

NOTE: Please note that in the case of trucked in fills the cost of surfacing is never applied as it is costed against section A.

Example VI (this example uses the April 1, 2000 Coast Appraisal Manual)

In this example the material is moved to the road section where it is being used to construct the road prism.

Section A

SS = 30% *CC = 4* *Section length = 231 metres (0.231 km)*
Subgrade RMC = S (soft/medium rock) *No Stabilizing/Surfacing Required in this Section*
Subgrade End Haul Volume = 1,425 m³ *Subgrade Haul distance = 823 metres (0.82 km)*
Total % of hard rock is < 60% for the section.

Section B

SS = 22% *CC = 2* *Section length = 143 metres (0.143 km)*
Total % of hard rock is < 60% for the section.

Road Section A

(see Figure 1 on page 23)

1. Calculate Subgrade Cost for the Road Section

i. Determine Volume (by RMC Type)

$$\begin{aligned} OM &= \text{End Haul Volume} * \% \text{ (Table in step 9)} & Rock &= \text{End Haul Volume} * \% \text{ (Table in step 9)} \\ &= 1,425 \text{ m}^3 * 0.5 & &= 1,425 \text{ m}^3 * 0.5 \\ &= 712.50 \text{ m}^3 & &= 712.50 \text{ m}^3 \end{aligned}$$

ii. Determine Unit Cost (\$/m³)

$$\begin{aligned} OM &= 7.46 + (0.597 * d) & Rock &= 10.80 + (0.597 * d) \\ &= 7.46 + (0.597 * 0.82) & &= 10.80 + (0.597 * 0.82) \\ &= 7.46 + 0.49 & &= 10.80 + 0.49 \\ &= 7.95 \text{ \$/m}^3 & &= 11.29 \text{ \$/m}^3 \end{aligned}$$

iii. Determine Unadjusted Total Cost (\$)

$$\begin{aligned} \text{Total Cost OM} &= \text{Unit Cost} * \text{Volume} & \text{Total Cost Rock} &= \text{Unit Cost} * \text{Volume} \\ &= 7.95 \text{ \$/m}^3 * 712.50 \text{ m}^3 & &= 11.29 \text{ \$/m}^3 * 712.50 \text{ m}^3 \\ &= \$5,664 & &= \$8,044 \end{aligned}$$

iv. Determine the Adjusted Total Cost (\$) (Manoeuvrability Factor)

$$\begin{aligned} OM &= \text{Total Cost} * \text{Difficulty Factor} & Rock &= \text{Total Cost} * \text{Difficulty Factor} \\ &= \$5,664 * 1.3 & &= \$8,044 * 1.3 \\ &= \$7,363 & &= \$10,457 \end{aligned}$$

v. Determine Total Cost (\$)

$$\begin{aligned} \text{Section Total Cost} &= \text{Total Cost OM} + \text{Total Cost Rock} \\ &= \$7,363 + \$10,457 \\ &= \$17,820 \\ \\ \text{Cost for a Kilometre} &= \$17,820 / 0.231 \\ &= \$77,143 \end{aligned}$$

2. Calculate Additional Stabilizing Material/Surfacing Cost for the Road Section

NOTE If additional loose stabilizing material is required as per section 4.3.2.3 of the CAM within this section, then determine the cost. In this example it is not required.

Road Section B

(see Figure 1 on page 23)

1. Calculate the Subgrade Cost for Road Section

i. Determine Which RMC Table to Use (Table 4-2 – Subgrade Construction Cost Estimate)

This depends upon the amount of hard rock in the road section, in this example the road section has hard rock that is less than 60% of the total. This means that Table 4-2 (b) – Other RMC's is used.

ii. Determine the Tabular Cost per Kilometre

The Construction Category is 2 and the Uphill Side Slope is 22% the tabular cost is then determined using a CC 1 and slope of 22% is **28.9** which must be multiplied by 1,000. Therefore the tabular cost for a kilometre is **\$28,900**.

iii. Determine the Adjusted Tabular Cost per Kilometre

$$\begin{aligned} \text{Adjusted Cost per km} &= \text{Tabular Cost per km} - \text{Cost of Culverts in Tabular Roads} \\ &= \$28,900 - \$3,789 \\ &= \$25,111 \end{aligned}$$

iv. Determine the Actual Cost for the Road Section

$$\begin{aligned} \text{Total Cost} &= \text{Adjusted Cost per km} * \text{Section Length} \\ &= \$25,111 * 0.143 \\ &= \$3,591 \end{aligned}$$

Example VII (this example uses the April 1, 2000 Coast Appraisal Manual)

In this example the material is moved to a storage site and then is moved to the road section where it is being used to construct the road prism.

Section A

$SS = 48\%$ $CC = 3$ *Section length = 163 metres (0.163 km)*
Subgrade RMC = H (hard rock) *No Stabilizing/Surfacing Required in this Section*
Subgrade End Haul Volume = 985 m³ *Subgrade Haul distance = 1,280 metres (1.28 km)*
Total % of hard rock is < 60% for the section.

Section B

$SS = 42\%$ $CC = 3$ *Section length = 115 metres (0.143 km)*
Subgrade RMC = G (default setting) *No Stabilizing/Surfacing Required in this Section*
Subgrade Volume = 1,800 m³ *Subgrade Haul distance = 2,510 metres (2.51 km)*
Total % of hard rock is < 60% for the section.

Road Section A

(see Figure 1 on page 23)

1. Calculate Subgrade Cost for the Road Section

i. Determine Volume (by RMC Type)

$OM = \text{End Haul Volume} * \% \text{ (Table in step 9)}$	$Rock = \text{End Haul Volume} * \% \text{ (Table in step 9)}$
$= 985 \text{ m}^3 * 0.75$	$= 985 \text{ m}^3 * 0.25$
$= 738.75 \text{ m}^3$	$= 246.25 \text{ m}^3$

ii. Determine Unit Cost (\$/m³)

$OM = 7.46 + (0.597 * d)$	$Rock = 13.59 + (0.597 * d)$
$= 7.46 + (0.597 * 1.28)$	$= 13.59 + (0.597 * 1.28)$
$= 7.46 + 0.76$	$= 13.59 + 0.76$
$= 8.22 \text{ \$/m}^3$	$= 14.35 \text{ \$/m}^3$

iii. Determine Unadjusted Total Cost (\$)

$$\begin{aligned} \text{Total Cost OM} &= \text{Unit Cost} * \text{Volume} \\ &= 8.22 \text{ \$/m}^3 * 738.75 \text{ m}^3 \\ &= \$6,073 \end{aligned}$$

$$\begin{aligned} \text{Total Cost Rock} &= \text{Unit Cost} * \text{Volume} \\ &= 14.35 \text{ \$/m}^3 * 246.25 \text{ m}^3 \\ &= \$3,534 \end{aligned}$$

iv. Determine the Adjusted Total Cost (\$) (Manoeuvrability Factor)

$$\begin{aligned} \text{OM} &= \text{Total Cost} * \text{Difficulty Factor} \\ &= \$6,073 * 1.3 \\ &= \$7,895 \end{aligned}$$

$$\begin{aligned} \text{Rock} &= \text{Total Cost} * \text{Difficulty Factor} \\ &= \$3,534 * 1.3 \\ &= \$4,594 \end{aligned}$$

v. Determine Total Cost (\$)

$$\begin{aligned} \text{Section Total Cost} &= \text{Total Cost OM} + \text{Total Cost Rock} \\ &= \$7,895 + \$4,594 \\ &= \$12,489 \end{aligned}$$

$$\begin{aligned} \text{Cost for a Kilometre} &= \$12,489 / 0.163 \\ &= \$76,611 \end{aligned}$$

2. Calculate Additional Stabilizing Material/Surfacing Cost for the Road Section

NOTE If additional loose stabilizing material is required as per section 4.3.2.3 of the CAM within this section, then determine the cost. In this example it is not required.

Road Section B

(see Figure 1 on page 23)

1. Calculate the Subgrade Cost for the Road Section (part 1)

i. Determine Which RMC Table to Use (Table 4-2 – Subgrade Construction Cost Estimate)

*This depends upon the amount of hard rock in the road section, in this example the road section has hard rock that is less than 60% of the total. This means that **Table 4-2 (b) – Other RMC's** is used.*

ii. Determine the Tabular Cost per Kilometre

The Construction Category is 3 and the Uphill Side Slope is 42% the tabular cost is then determined using a CC 1 and slope of 35% is **30.9** which must be multiplied by 1,000. Therefore the tabular cost for a kilometre is **\$30,900**.

iii. Determine the Adjusted Tabular Cost per Kilometre

$$\begin{aligned} \text{Adjusted Cost per km} &= \text{Tabular Cost per km} - \text{Cost of Culverts in Tabular Roads} \\ &= \$30,900 - \$3,789 \\ &= \$27,111 \end{aligned}$$

iv. Determine the Actual Cost for the Road Section

$$\begin{aligned} \text{Total Cost} &= \text{Adjusted Cost per km} * \text{Section Length} \\ &= \$27,111 * 0.115 \\ &= \$3,118 \end{aligned}$$

2. Calculate the Subgrade Cost for the Road Section (part 2)

i. Determine Volume of Material for Road Section Construction

The volume to be used is the amount of volume that is to be hauled from the storage site to the road section. In this case the prescribed amount is **1,800 m³**.

ii. Determine Unit Cost (\$/m³)

$$\begin{aligned} \text{Unit Cost} &= \text{Gravel No Trucking rate} + (\text{Constant} * \text{Distance}) \\ &= 5.44 + (0.597 * d) \\ &= 5.44 + (0.597 * 2.51) \\ &= 5.44 + 1.50 \\ &= 6.94 \text{ \$/m}^3 \end{aligned}$$

iii. Determine Total Cost

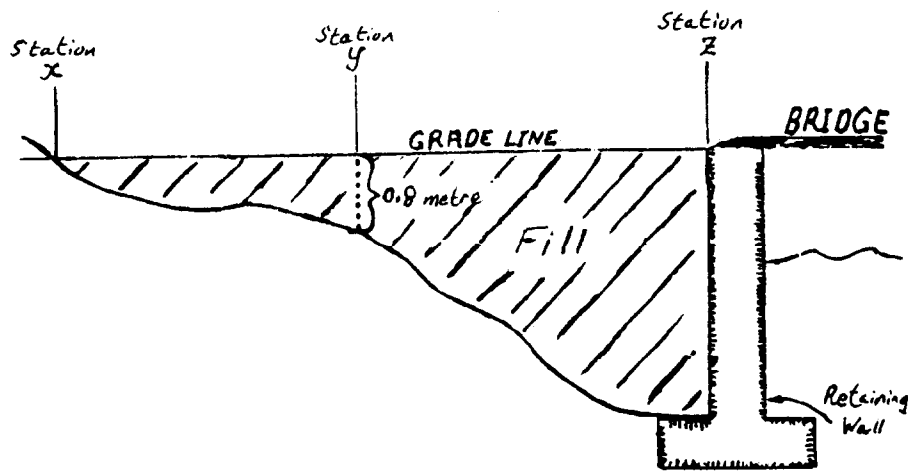
$$\begin{aligned} \text{Total Cost for Road Section} &= \text{Unit Cost} * \text{Volume Material} \\ &= 6.94 \text{ \$/m}^3 * 1,800 \text{ m}^3 \\ &= \$12,492 \end{aligned}$$

$$\begin{aligned} \text{Cost for a Kilometre} &= \$12,492 / 0.115 \\ &= \$108,626 \end{aligned}$$

Large Fills

During construction of bridge approaches (see Figure 3 & Figure 4), installation of culverts (see Figure 5) or road sections (see figure 6) there may be instances where fills exceed 80 cm (0.8 metres) in depth. The 0.8 metres depth is the maximum allowed in “Table 4-6: Additional Loose Stabilizing Material Depths (metres)” of the CAM. Therefore, instead of using construction category and side slope to generate the depth of fill, use the calculation method outlined on page 32 when the fills for bridge approaches and culverts exceed 0.8 metres in depth. This approach is only to be used where the materials being used is fill obtained from borrow pits. If the material being used as fill is obtained from a storage area, use the Stored Fills approach on page 35.

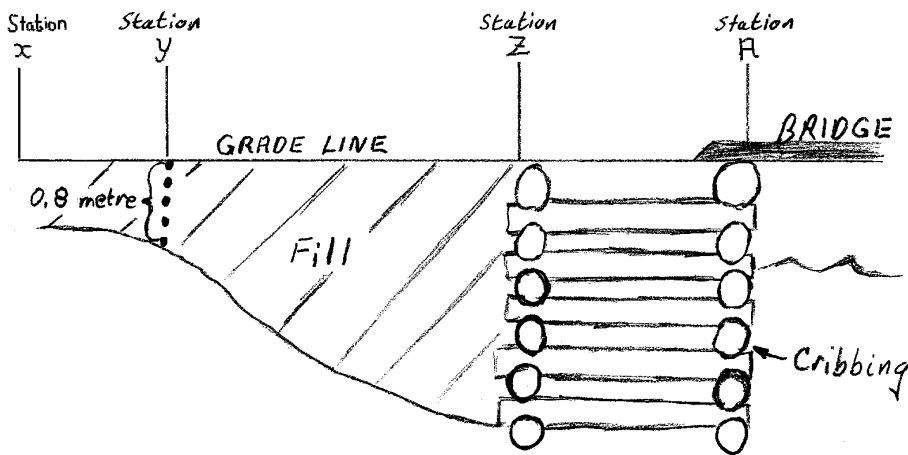
Figure 3: Bridge Approach Fills (Road Profile)



In the case demonstrated in Figure 3 & 4 the fill from station X to station Y is based on Table 4-6 of the CAM.

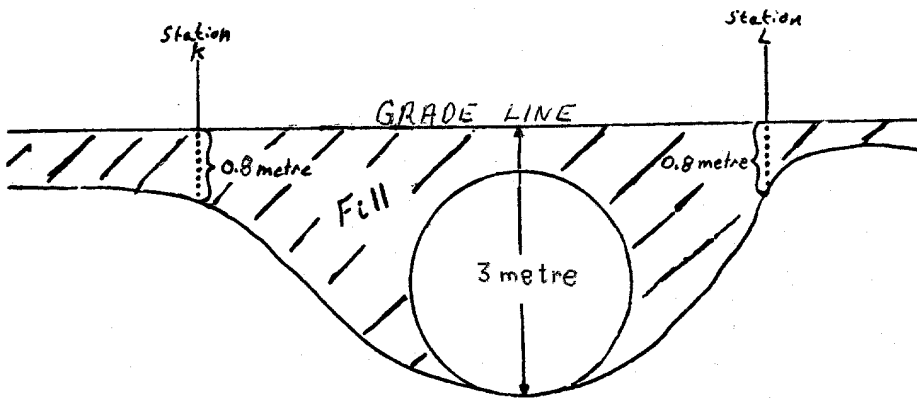
In Figure 3 & 4 from station Y to station Z, regardless of the bridge abutment type, the actual volume of fill is estimated via bridge plan or a geometric design and the cost estimate is calculated using the procedure outlined on page 32.

Figure 4: Bridge Approach Fills with Cribbing (Road Profile)



In the case demonstrated in Figure 4 the volume of fill within the cribbing (station Z to station A) is not to be included in this cost estimate method. The reason for this is it is already part of the bridge cost estimate.

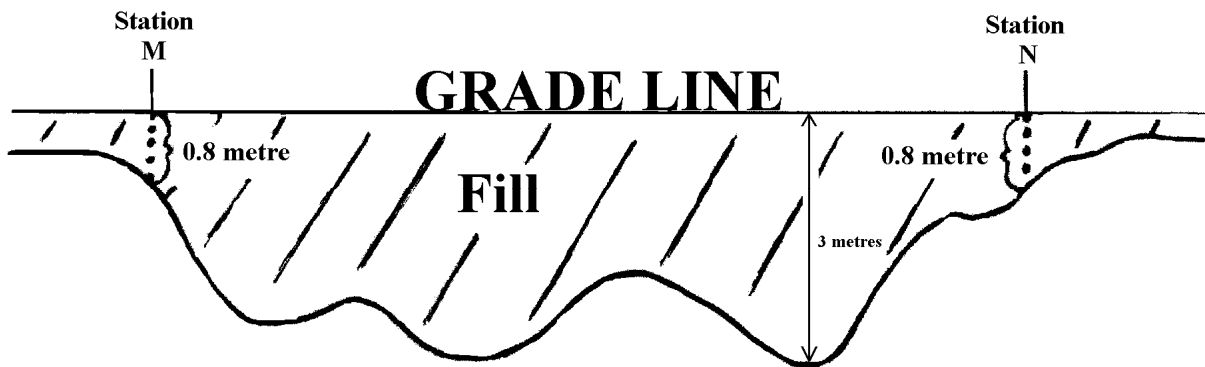
Figure 5: Large Fills for Culverts



NOTE: To qualify for large fills around culverts there must be a minimum of 3 metres from the 'Grade Line' at centre line to the bottom of the culvert, see Figure 5.

In the case demonstrated in Figure 5 only the fill volume between station K and station L can be cost estimated as large fills.

Figure 6: Large Fills for Road Sections (Overlanding)



NOTE: To qualify for large fills on a road section, the length of the section must be a minimum of 20 metres. Within this section there must be at least one point in the section which must be 3 metres in depth, or greater, from the 'Grade Line' at centre line to the bottom of the terrain topography, see Figure 6.

Data Required

The following data must be collected to estimate the costs for large fills:

- X-section profile of fills;
- volumes calculated from X-section (excluding the volume that the culvert occupies);
- ballast type (gravel or rock);
- rock hardness;
- construction category (normally not required);
- sideslope % (normally not required);
- identify the location of the fill material;
- Licensee Representative signature who prepared the Large Fill application; and
- haul distance (from fill location to the project site).

Calculation Methodology

1. Record the start and end stations for section requiring large fill or for the bridge approach.
 - a. For bridge approaches, the start of the section is located where the fill exceeds 0.8 of a metre (see Figure 3 on page 31) and the end section is at the bridge abutment.
 - b. For large fills on culverts, the start and end of the section is located where the fill exceeds 0.8 of a metre (see Figure 4 on page 31).
2. Determine the section length.
3. Determine if a particular culvert qualifies for large fills; it does if the bottom of the culvert is at least three (3) metres below the grade line of the road. Bridge approaches automatically qualify as soon as the fill depth exceeds 80 cm in depth.
4. Determine the volume of fill/ballast required. This is done from the bridge plan or geometric design from an approved (by the **district engineering staff**) layout and design.
5. The unit cost is determined by using the trucking formulas in section 4.3.2.3 of the CAM.
6. Determine the Total Cost by multiplying the volume required in the large fill (determined in step 4) by the unit cost (determined in step 5).
7. Culvert, when required, have their costs developed as per the Culvert section on page 44.

NOTE *The Coast Appraisal Manual in effect at the date of the appraisal or re-appraisal must be used for the above calculations.*

Example VIII (this example uses the April 1, 2000 Coast Appraisal Manual)

<i>RMC = G (gravel)</i>	<i>Section length = 15 metres (0.015 km)</i>
<i>Haul distance = 690 metres (0.69 km)</i>	<i>End Haul for the Section = 435 m³</i>
<i>Total % of hard rock is < 60% for the section.</i>	

1. Calculate the Trucked in Fill Cost for the Road Section

i. Determine the Trucking Unit Cost

$$\begin{aligned}
 \text{Unit Cost} &= \text{Material Cost rate} + (\text{Constant} * \text{Distance}) \\
 &= 7.46 \$/\text{m}^3 + (0.597 * 0.69 \text{ km}) \\
 &= 7.46 \$/\text{m}^3 + 0.410 \\
 &= \$7.87 \$/\text{m}^3
 \end{aligned}$$

ii. Determine the Volume of the Material for the Section

The volume is determined by a qualified registered professional in a bridge plan or geometric design and approved by the district engineering staff. For this example the volume is 435 m³.

iii. Determine the Cost of the Section

$$\begin{aligned} \text{Cost of Section} &= \text{Unit Cost} * \text{Volume} \\ &= 7.87 \$/\text{m}^3 * 435 \text{ m}^3 \\ &= \$3,423 \end{aligned}$$

iv. Determine the Cost for a Kilometre

$$\begin{aligned} \text{Cost of Kilometre} &= \text{Cost of Section} / \text{Section Length} \\ &= \$3,423 / 0.015 \text{ km} \\ &= \$ 228,200 \end{aligned}$$

2. If Required Calculate the Cost of Culverts

If culverts are required then they are cost estimated as per Culvert section on page 44.

Stored Fills

Material from one section of a road construction is end hauled to a storage location and then subsequently used in another road section, bridge approach, installation of a culvert, etc.. When this occurs the material is gravel as there is no cost of developing a borrow pit.

To calculate these types of fill the ‘No trucking of stabilizing material’ unit cost estimate for gravel will be added to the “Trucking of stabilizing material” unit cost estimate for gravel. That is, “No Trucking Unit Cost” will replace the constant value in “Trucking of stabilizing material” equation.

Data Required

The following data must be collected to estimate the costs for stored fills:

- X-section profile of fills;
- volumes calculated from X-section (excluding the volume that the culvert occupies);
- ballast type is always gravel;
- construction category (normally not required);
- sideslope % (normally not required);
- identify the midpoint of the storage location of the fill;
- Licensee Representative who prepared the Stored Fill application; and
- haul distance (from the storage location of the fill to the project site mid-point).

Calculation Methodology

1. Record the start and end stations for section using stored fill.
2. Determine the section length.
3. Determine the volume of fill/ballast required. This is done from an approved (by the **district engineering staff**) layout and design.
4. The unit cost is determined by using a modified trucking formulas in section 4.3.2.3 of the CAM. Use the No Trucking cost of gravel and the trucking distance ratio. The following example of this new formula uses the CAM April 1, 2000 values:
i.e. $\$5.44 + 0.597(d)$
5. Determine the Total Cost by multiplying the volume of fill required (determined in step 3) by the unit cost (determined in step 4).

Example IX *(this example uses the April 1, 2000 Coast Appraisal Manual)*

$SS = 66\%$ $CC = 4$ $RMC = S$ (soft/medium rock)
Section length = 72 metres (0.072 km) Haul distance = 344 metres (0.34 km)
Volume of Fill for the Section = 1,012 m³
Total % of hard rock is < 60% for the section.

1. Calculate the Stored Fill Cost for the Road Section

i. Determine the Unit Cost

Because the fill material being used has been developed at another location and transported to the storage location the no-trucking gravel cost of \$5.44 (from CAM) shall be used in the trucking formula (from CAM).

$$\begin{aligned} \text{Unit Cost} &= \text{No-Trucking Cost} + (\text{Constant} * \text{Distance}) \\ &= \$/\text{m}^3 5.44 + (0.597 * 0.34 \text{ km}) \\ &= \$/\text{m}^3 5.44 + 0.20 \\ &= \$5.64 \end{aligned}$$

ii. Determine the Volume of the Material for the Section

The volume is determined by a qualified registered professional and approved by the district engineering staff. For this example the volume is 1,012 m³.

iii. Determine the Cost of the Section

$$\begin{aligned} \text{Cost of Section} &= \text{Unit Cost} * \text{Volume} \\ &= 5.64 \$/\text{m}^3 * 1,012 \text{ m}^3 \\ &= \$5,708 \end{aligned}$$

iv. Determine the Cost for a kilometre

$$\begin{aligned} \text{Cost of Kilometre} &= \text{Cost of Section} / \text{Section Length} \\ &= \$5,708 / 0.072 \text{ km} \\ &= \$ 79,278 \end{aligned}$$

2. If Required Calculate the Cost of Culverts

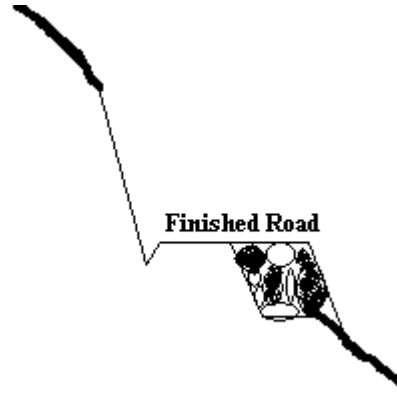
If culverts are required then they are cost estimated as per Culvert section on page 44.

KEYED-IN FILLS (from trucked in material)

Figure 8: Keyed-in Fill Tote Road



Figure 7: Keyed-in Fill



- 'Keyed in Fills' is where a cut (key) into the natural ground line on the fill side is made and large rocky material is placed to act as a key to hold the material that will be part of the road prism (see Figure 7).
- The material used as the key is sharp angular rock - generally shot rock. To qualify to use this estimate the material must be trucked in from at least 100 metres. Use of local material does not qualify.
- This type of design is normally part of a professional prescription for potentially unstable terrain.
- A tote road may be required. (see Figure 8). Example XI on page 41 demonstrates this calculation. Example X on page 40 demonstrates calculation if a tote road is not required.

Data Required

The following data must be collected to estimate the costs for large fills and a geometric design:

- copy of the approved layout and design and the professional prescription;
- volume of key material determined from an approved geometric design;
- section that requires key material;
- identify the type, rock hardness and source of the key material;
- Licensee Representative who prepared the Keyed-in Fill application; and
- haul distance (from mid-point of section where key rock is being used to the mid point of where the key material is being obtained) from source of key material.

Calculation Methodology

1. Record the start and end stations for each section that requires keyed in fill.
2. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
3. Determine the distance (d) that the keyed material must be hauled. This is done by measuring from the mid-point of the section that keyed in fill is required to the mid-point of the source (pit or end haul section) from which the material is being hauled.
4. Determine the volume of key material required. This is done via an approved geometric design and a prescription prepared by a qualified registered professional.
5. The unit cost is determined by using the trucking formulas in section 4.3.2.3(1)(b)(ii) of the CAM.
6. Determine the total cost by multiplying step 5 by step 4 to determine the cost of the key material.
7. Use the tabular road costs for the rest of the construction of this section.

NOTE: If tote roads are necessary then the cost estimate will be done as per Table 4.2(b) CAM.

Example X *(this example uses the April 1, 2000 Coast Appraisal Manual)*

In this example the section of road is built without a tote road.

SS = 77% CC = 4 RMC = S (soft/medium rock)
Section length = 163 metres (0.163 km) Haul distance = 850 metres (0.85 km)
Volume of Fill for the Section = 880 m³ Total % of hard rock is < 60% for the section.

1. Calculate the Keyed in Fill Cost for the Road Section

i. Determine the Unit Cost

$$\begin{aligned}\text{Unit Cost} &= \text{Trucking Cost} + (\text{Constant} * \text{Distance}) \\ &= 10.80 \$/\text{m}^3 + (0.597 * 0.85 \text{ km}) \\ &= 10.80 \$/\text{m}^3 + 0.51 \\ &= 11.31 \$/\text{m}^3\end{aligned}$$

ii. Determine the Volume of the Material for the Section

The volume is determined by a qualified registered professional and approved by the district engineering staff. For this example the volume is 880 m³.

iii. Determine the Cost of the Section

$$\begin{aligned}\text{Cost of Section} &= \text{Unit Cost} * \text{Volume} \\ &= 11.31 \$/\text{m}^3 * 880 \text{ m}^3 \\ &= \$9,953\end{aligned}$$

iv. Determine the Cost for a kilometre

$$\begin{aligned}\text{Cost of Kilometre} &= \text{Cost of Section} / \text{Section Length} \\ &= \$9,953 / 0.163 \text{ km} \\ &= \$ 61,060\end{aligned}$$

2. Calculate the Tabular Road Cost for the Road Section

Once the keyed in fill material has been calculated the road section also receives the tabular road cost for construction of the actual road surface and remaining sub-grade. Enter all required data on the tabular road section of the CADS.

3. Calculate the cost of Culverts if Required

If culverts are required then they are cost estimated as per Culvert section on page 44.

Example XI *(this example uses the April 1, 2000 Coast Appraisal Manual)*

In this example the section of road is built with a tote road.

$SS = 81\%$ $CC = 4$ $RMC = S$ (soft/medium rock)
Section length = **56 metres** (0.056 km) Haul distance = **1,070 metres** (1.07 km)
Volume of Fill for the Section = **365 m³** Total % of hard rock is < 60% for the section.

1. Calculate the Keyed in Fill Cost for the Road Section

i. Determine the Unit Cost

$$\begin{aligned} \text{Unit Cost} &= \text{Trucking Cost} + (\text{Constant} * \text{Distance}) \\ &= 10.80 \$/\text{m}^3 + (0.597 * 1.07 \text{ km}) \\ &= 10.80 \$/\text{m}^3 + 0.64 \\ &= 11.44 \$/\text{m}^3 \end{aligned}$$

ii. Determine the Volume of the Material for the Section

*The volume is determined by a qualified registered professional and approved by the district engineering staff. For this example the volume is **365 m³**.*

iii. Determine the Cost of the Section

$$\begin{aligned} \text{Cost of Section} &= \text{Unit Cost} * \text{Volume} \\ &= 11.44 \$/\text{m}^3 * 365 \text{ m}^3 \\ &= \$4,146 \end{aligned}$$

iv. Determine the Cost for a kilometre

$$\begin{aligned} \text{Cost of Kilometre} &= \text{Cost of Section} / \text{Section Length} \\ &= \$4,176 / 0.056 \text{ km} \\ &= \$ 74,571 \end{aligned}$$

2. Calculate the Tote Road Cost

i. Determine Which RMC Table to Use (Table 4-2 – Subgrade Construction Cost Estimate)

*This depends upon the amount of hard rock in the road section, in this example the road section has hard rock that is less than 60% of the total. This means that **Table 4-2 (b) – Other RMC's** is used.*

ii. Determine the Tabular Cost per Kilometre

The Construction Category is 4 and the Uphill Side Slope is 81% but the cost estimate is then determined using a CC 1 and slope of 22% is **28.9** which must be multiplied by 1,000. Therefore the cost estimate for a kilometre is **\$99,000**.

iii. Determine the Adjusted Tabular Cost per Kilometre

$$\begin{aligned} \text{Adjusted Cost per km} &= \text{Tabular Cost per km} - \text{Cost of Culverts in Tabular Roads} \\ &= \$99,000 - \$3,789 \\ &= \$95,211 \end{aligned}$$

iv. Determine the Actual Cost for the Road Section

$$\begin{aligned} \text{Total Cost} &= \text{Adjusted Cost per km} * \text{Section Length} \\ &= \$95,211 * 0.056 \\ &= \$5,332 \end{aligned}$$

3. Calculate the Tabular Road Cost for the Road Section

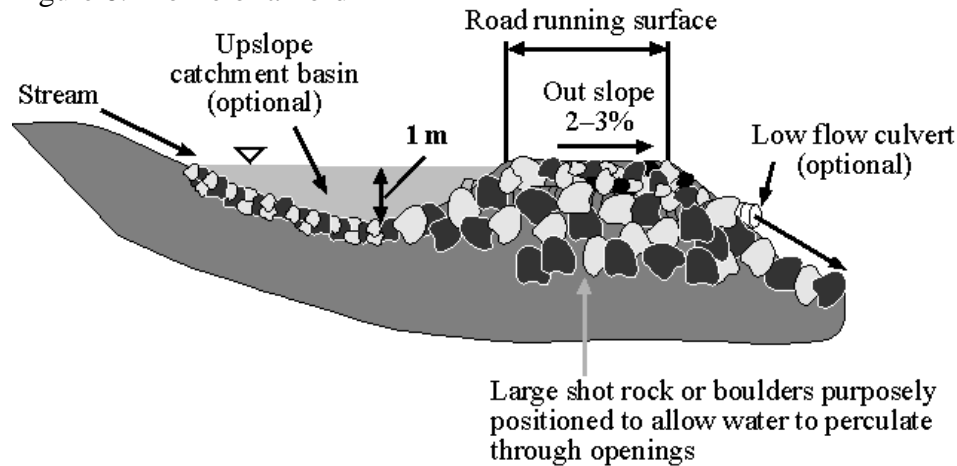
Once the keyed in fill material has been costed, the road section also receives the tabular road cost for construction of the actual road surface and remaining sub-grade. Enter all required data on the tabular road portion of the CADS.

4. Calculate the cost of Culverts if Required

If culverts are required then they are cost estimated as per Culvert section on page 44.

FORDS

Figure 6: Profile of a Ford



Fords are constructed to allow water to pass under a road surface. To achieve this it may be necessary to haul in large material to construct the ford.

Data Required

The following data must be collected to estimate the costs for large fills:

- volume of rock material required to be hauled in as determined from a professional prescription or geometric design;
- section length that requires material;
- identify the source of the material;
- type of key material;
- rock hardness of material;
- haul distance (from mid-point of the location where material is being obtained for the ford to the mid-point of the ford);
- Licensee Representative who prepared the Ford Application; and
- culverts length and diameter (if a culvert(s) are used in construction of the ford).

Calculation Methodology

1. Record the start and end stations for the ford (this is on either end of the ford itself). In the Tabular Road section of the Coast Appraisal Data Sheet make a note for this section in the comments.
2. Determine the section length in accordance with section 4.3.2.1(3)(b) of the CAM.
3. Determine the haul distance (d) that the material, to construct the ford, must be hauled from. This is done by measuring from the mid-point of the ford to the mid-point of the source where the material is being obtained from. To qualify to use the trucking formulas, the minimum haul distance is 100 metres.
4. Determine the volume of shot rock or boulders required. This is done via a qualified registered professional's prescription and must be approved by the **district engineering staff**.
5. The unit cost is determined by using the trucking formulas in section 4.3.2.3(1)(b)(ii) of the CAM other wise use the in place unit costs in section 4.3.2.3(1)(b)(i) of the CAM.
6. Determine the total cost by multiplying step 5 by step 4 to determine the cost of the material required to construct the ford.
7. Use the tabular road costs for the rest of the construction of this section.
8. Determine the cost of any culverts separately (see page 44).

Example XII (this example uses the April 1, 2000 Coast Appraisal Manual)

$SS = 47\%$ $CC = 2$ $RMC = H$ (hard rock)
Section length = **60 metres** (0.060 km) Haul distance = **2,500 metres** (2.50 km)
Volume of Fill for the Section = **525 m³** Total % of hard rock is < 60% for the section.

1. Calculate the Keyed in Fill Cost for the Road Section

i. Determine the Unit Cost

$$\begin{aligned}\text{Unit Cost} &= \text{Trucking Cost} + (\text{Constant} * \text{Distance}) \\ &= 13.59 \$/\text{m}^3 + (0.597 * 2.50 \text{ km}) \\ &= 13.59 \$/\text{m}^3 + 1.49 \\ &= 15.08 \$/\text{m}^3\end{aligned}$$

ii. Determine the Volume of the Material for the Section

The volume is determined by a qualified registered professional and approved by the district engineering staff. For this example the volume is **525 m³**.

iii. Determine the Cost of the Section

$$\begin{aligned}\text{Cost of Section} &= \text{Unit Cost} * \text{Volume} \\ &= 15.08 \$/\text{m}^3 * 525 \text{ m}^3 \\ &= \$7,917\end{aligned}$$

iv. Determine the Cost for a kilometre

$$\begin{aligned}\text{Cost of Kilometre} &= \text{Cost of Section} / \text{Section Length} \\ &= \$7,917 / 0.060 \text{ km} \\ &= \$ 131,950\end{aligned}$$

2. Calculate the Tabular Road Cost for the Road Section

Once the keyed in fill material has been calculated the road section also receives the tabular road cost for construction of the actual road surface and remaining sub-grade. Enter all required data on the tabular road portion of the CADS.

3. Calculate the cost of Culverts if Required

If culverts are required then they are cost estimated as per Culvert section on page 44.

CULVERTS

The “Cost Estimate Methodology - Culvert Worksheet” must be filled out when applying for culverts:

1. greater than 1,000 millimetres (mm) in size under section 4.3.2.2.3 of the CAM; and
2. culverts are under 1,000 mm in size because of road reconstruction & replacement and end haul under section 4.3.1(2) of the CAM;

The location of each culvert must be recorded on the “Cost Estimate Methodology - Culvert Worksheet” as accurately as possible. Do not amalgamate culverts by class on this worksheet.

The total of all culverts for **each appraisal year** must be totalled by diameter class and then recorded on the tabular culvert portion of the *Coast Appraisal Data Sheet*. Appraisal year means the first year that the cost (or culvert) was placed in an appraisal or reappraisal.

Log Culverts

Data Required

- show location of culvert(s) on map;
- station number where each individual culvert is located on “Culvert Worksheet”;
- Licensee Representative signature who prepared Culvert application
- span; and
- crib height.

Calculation Methodology

1. Determine the span of the log culvert. This is measured from centre to centre of the sill logs to the nearest ten centimetres (0.10 m).
2. The average crib height, which is the distance from the bottom of the bottom sill log to the point where the stringer rests on the top sill log as measured along the centre line of the bridge and measured to the nearest ten centimetres (0.1 m).
3. If the span is greater than or equal to 3.5 metres than use Table 4-3 of the April 1, 2000 CAM. Otherwise the cost estimate of the log culvert is \$1,000.
4. Record all information for each wooden culvert on the Culvert Worksheet provided in the Cost Estimate Methodology forms section on page 55.
5. Sum up all of the wooden culverts by appraisal year and status, then record the sum as one entry on Tabular Culvert portion of the *Coast Appraisal Data Sheet*.

NOTE: If the span is greater than or equal to 3.5 metres use
“Table 4-3: Log Bridge Cost Estimate” from the CAM.

Metal Culverts

Data Required

- show location of culvert(s) on map;
- station number where each individual culvert is located on “Culvert Worksheet”;
- Licensee Representative signature who prepared Culvert application
- diameter; and
- length.

Calculation Methodology

1. If the culvert has a diameter greater than or equal to 2000 mm submit a Construction Estimate Form (see section 4.3.3 of the CAM). Also DO NOT record culverts greater than 2000 mm in the culvert section of the *Coast Appraisal Data Sheet*, these must be recorded in the Bridges portion of the *Coast Appraisal Data Sheet*.
2. For culverts less than 2,000 mm in diameter use Table 4-4: Culvert Cost Estimate, of the April 1, 2000 CAM. The CAM in place at the time of submission of the appraisal or reappraisal must be used to determine costs of culverts.
3. Record all information for each wooden culvert on the Culvert Worksheet provided in the Cost Estimate Methodology forms section on page 55.
4. Sum up each diameter category of metal culvert and record the sum as one entry for each diameter category by appraisal year in the Tabular Culvert portion of the *Coast Appraisal Data Sheet*.

LOG BRIDGE STRUCTURAL REPAIRS

Replacement of Bridge Running Planks

Data Required

To qualify to obtain the cost for replacing the running planks on a log bridge, greater than fifty percent of the deck running surface must be replaced. The following data must be collected to estimate the cost for replacement of running planks on a log bridge:

- location;
- station;
- bridge name or unique identifier;
- span;
- surface area of bridge that is to be replaced; and
- total surface area of the bridge.

Calculation Methodology

1. Determine the surface area of the log bridge that needs to be replaced.
2. Determine the total surface area for the log bridge.
3. Determine the bridge span as measured from the centre of the sill logs to the nearest 0.1 metre.
4. Using the span of the bridge look up the single sill log cost from “Table 4-3: Log Bridge Cost Estimate” in the CAM.
5. Multiply the cost determined in step 4 (above) by 15% (0.15).
6. Divide the surface area of the log bridge that needs to be replaced by total surface area for that log bridge.
7. Multiply the resultant obtained in step 5 by the resultant in step 6.

Example XIII (this example uses the April 1, 2000 Coast Appraisal Manual)

Bridge Width = 3.2 metres
Area to be Replaced = 18.73 m³

Bridge Span = 13.3 metres
Total Area of the Bridge = 42.56 m³

$$\begin{aligned} \text{Cost Estimate} &= (\text{Bridge Cost} * 0.15) * (\text{Area to be Replaced} / \text{Total Area of the Bridge}) \\ &= (\$19,500 * 0.15) * (18.73 \text{ m}^3 / 42.56 \text{ m}^3) \\ &= (2,925 * 0.44) \\ &= \$1,287 \end{aligned}$$

Replacement of Untreated Ties

Data Required

The following data must be collected to estimate the cost for replacement of untreated ties:

- location;
- station;
- bridge name or unique identifier;
- bridge span;
- number of ties to be replaced; and
- total number of ties on the bridge.

Calculation Methodology

1. Determine the number of ties, on the log bridge, that need replacing.
2. Determine the total number of ties in the log bridge.
3. Determine the bridge span as measured from the centre of the sill logs to the nearest 10 centimetres (0.1 m).
4. Using the span of the bridge look up the single sill log cost from “Table 4-3: Log Bridge Cost Estimate” in the CAM.
5. Multiply the cost determined in step 4 (above) by 10% (0.10).
6. Divide the number of ties that need replacing, in the log bridge, by the total number of ties in the log bridge.
7. Multiply the resultant obtained in step 5 by the resultant obtained in step 6.

Example XIV (this example uses the April 1, 2000 Coast Appraisal Manual)

Bridge Span = 15.2 metres

Number of Ties to be Replaced = 5

Total Number of Ties in the Bridge = 45

$$\begin{aligned} \text{Cost Estimate} &= (\text{Bridge Cost} * 0.10) * (\# \text{ of Ties to be Replaced} / \text{Total \# of Ties in Bridge}) \\ &= (\$23,200 * 0.10) * (5 / 45) \\ &= 2,320 * 0.11 \\ &= \$255 \end{aligned}$$

Replacement of Guard Logs or Stringers

Data Required

The following data must be collected to estimate the cost for replacement of untreated ties:

- location;
- station;
- bridge name or unique identifier;
- bridge span; and
- number of guard logs or stringers to be replaced.

Calculation Methodology

1. Determine the number of guard logs or stringers that need to be replaced on a log bridge.
2. Determine the bridge span as measured from the centre of the sill logs to the nearest 10 centimetres (0.1 m).
3. Using the span of the bridge look up the single sill log cost from “Table 4-3: Log Bridge Cost Estimate” in the *Coast Appraisal Manual*.
4. Multiply the cost determined in step 4 (above) by 7% (0.07).
5. Multiply the resultant obtained in step 4 by the number of ties in the bridge to be replaced determined in step 1.

Example XV (this example uses the April 1, 2000 Coast Appraisal Manual)

Bridge Span = 18 metres

Number of Guard Logs to be Replaced = 1

$$\begin{aligned} \text{Cost Estimate} &= ((\text{Bridge Cost} * 0.07) * \text{Number of Guard Logs to be Replaced}) \\ &= ((\$28,800 * 0.07) * 1) \\ &= 2,016 * 1 \\ &= \$2,016 \end{aligned}$$

Bridge Span = 13 metres

Number of Stringer Logs to be Replaced = 3

$$\begin{aligned} \text{Cost Estimate} &= ((\text{Bridge Cost} * 0.07) * \text{Number of Guard Logs to be Replaced}) \\ &= ((\$19,500 * 0.07) * 3) \\ &= 1,365 * 3 \\ &= \$4,095 \end{aligned}$$

NOTE: Structural repairs for permanent bridges require individual estimates. Use a Construction Estimate Form (CEF). Cost for repair of rip rap is considered maintenance as the original bridge cost estimate accounted for the appropriate amount and type of rip rap to design.

PERMANENT BRIDGE STRUCTURAL REPAIRS

Replacement of Bridge Running Surface

Data Required

To qualify for an appraisal cost estimate for replacement of the wooden running surface on a permanent bridge, greater than fifty percent of the deck running surface must be replaced. Two types of materials are recognized:

- 1) Wooden planks, or
- 2) Pre-cast concrete slabs.

The following data must be collected to estimate the cost for replacement of the running surface on a permanent bridge:

- location;
- station;
- bridge name or unique identifier;
- span length;
- surface area (m²) of bridge decking that is to be replaced; and
- total surface area (m²) of the bridge.

Calculation Methodology

1. Wooden Planks
 - (a) Determine the surface area of the permanent bridge that needs to be replaced.
 - (b) Determine the total surface area of the permanent bridge.
 - (c) Divide the surface area of the permanent bridge that needs to be replaced (step 1(a)) by total surface area for that permanent bridge (step 1(b)).
 - (d) Determine the bridge span as measured from the centre of the sill logs to the nearest 0.1 metre.
 - (e) Using the span of the bridge look up the zero abutment height cost from “Table 4-5: Permanent/Portable Bridge Cost Estimate” in the CAM.
 - (f) Multiply the cost determined in step e by eight percent (8% or 0.08).
 - (g) Multiply the resultant obtained in step 1(c) by the resultant in step 1(f).
2. Pre-Cast Concrete
 - (a) Determine the surface area of the permanent bridge that needs to be replaced.
 - (b) Multiply the surface area determined in step 2(a) by \$425 per square metre.

CONSTRUCTION ESTIMATE FORM METHOD

Phase

The Cost Estimate Methodology (CEM) is the primary method of determining engineered estimates for end haul, partial end haul and bridge approaches. However, there may be times when CEM is not appropriate, in these instances the alternative method for applying for engineered costs is the Construction Estimate Form (CEF) method. Other instances when a CEF may be used are found on “Table 1: Determining Type of Cost Estimate Method” on page iii of this package.

When using the CEF method of estimating engineered costs the following must be done

- time cards having the specified information must be submitted (pg. 56) upon request.
- Machine Hour Summary From Time Cards must be submitted (pg. 56).
- project summary, the CEF, of the time cards and invoices on the specified form (pg. 56).
- proof of payment (i.e. invoices, copies of contract document, etc.) upon request.
- costs based on publicly tendered projects may also be accepted. All tender information, the bids received, and a copy of the signed contract must be submitted upon request.

Failure to submit the above will result in a cost estimate based on the formulas in the CAM or CEM (either Tabular road or detailed engineering as determined by the appraisal officer).

If information is lacking in the submission of a CEF one of the following will occur:

- a. if it is prior to the appraisal or re-appraisal date and if the missing information can be supplied prior to the appraisal or re-appraisal date based on the CAM, then request the missing information;
- b. if not supplied by the specified time, use the Ministry of Forests estimates (the CEM).

Dispute Resolution

Should a disagreement about an engineered cost occur the dispute resolution mechanism may be used.

If all of the required information submitted is correct but the cost is higher than the average efficient operator would incur then the normal review and framework of resolution established in the CAM will be used. However the licensee, at their cost, may elect to have the project reviewed, by one of the following:

- a. member of the Coast Appraisal Advisory Committee Joint Roads Sub-Committee (or a members representative);
- b. independent contractor; or
- c. accept the Ministry of Forests estimate.

Time Card Requirements

For projects where the engineered cost estimate for appraisal will be submitted using the CEF the following information **must** be provided on the time card:

- i. Licensee, Contractor Name & Division
- ii. Project location
- iii. Road name
- iv. Stations Worked
- v. Date: year/month/date (ccyy/mm/dd)
- vi. Machine type and identification
(or year, make, model, serial number and capacity)
- vii. Machine attachments (if applicable)
- viii. Machine starting and stopping time
- ix. Operating hours
- x. Stand by Time
- xi. Name of the operator
- xii. Daily signature of the operator verifying hours claimed
- xiii. Daily signature of the supervisor verifying the hours claimed

The above should be considered as the minimum information recorded on a time card. The above time card information is required on all work on or after January 1, 2001. Failure to have this information available upon request will result in this engineering cost method being unacceptable. Any work performed prior to January 1, 2001 will not require all of the above information.

The timecards **must** also identify the number of hours for each work phases described below and record the stations where the work occurred.

- i. For excavators record the operating hours and stand-by time, in hours, spent on end hauling.
- ii. For drill rigs record:
 - a. Lineal metres of holes drilled (upon request)
 - b. Rock hardness (appraisal definition; soft, medium and hard)
 - c. Amount and type of blasting agents used (provide copies of invoices)
 - d. Complete the blasting log, WCB requirement (upon request).
- iii. For dump trucks:
 - a. Load size (m³)
 - b. Number of loads hauled
 - c. Distance to spoil sites or the stations dumped on the subgrade (record either on time card or on the project summary sheet)
- iv. For spread cat:
 - a. Location on the subgrade where spreading occurred
 - b. Spreading at the spoil site
- v. For other equipment identify the location and activity the machine was used for end hauling:

Operating Time

Operating time is the time the machine is running and includes time when the machine is waiting (i.e. an empty dump truck waits while another truck is loaded, spread cat is waiting for another load of end haul material to spread, etc.). These hours are paid at the all found rate as per the 'Appendix I: Equipment and Labour Rates' in the CAM.

Stand-by Time

All equipment must record stand-by time which is defined to be the time when the machine is shut down, remains at the project site and is still required for the project. The operator may or may not be on the project site. Stand-by time is paid at 0.5 times the hourly rate of the equipment (without the operator) regardless if the operator is on site to a maximum of 8 hours per day. Down time due to mechanical breakdown is not chargeable.

If the operator is running more than one piece of equipment the shut down equipment is charged at the stand-by rate.

In the case of a drill rig when the crew is loading and blasting the rig is considered to be on stand-by time while the crew is considered to be on operating time. If the compressor is being used to blow blasting agents into the boreholes, the all found rental rate is applicable. If sticks or gels are loaded into the holes, then the stand-by rate is paid for the drill and the crew is on operating time. The crew is also considered to be on operating time when travelling to pick up powder, all to a maximum of 8 hours per day.

NOTE: *Once a piece of equipment is no longer required for the construction project then that time piece of equipment must be discharged and no longer charged to the project.*

Data Required

1. CAM section 4.3.3 requires submission of project details to district manager prior to commencement. Lead-time as per section 2.2 of the CAM.
2. What project detail is required under section 4.3.3 of the CAM, see list under section 4.3.3.1 of the CAM – further outlined above.
3. Engineered Estimates – need survey reference station & points marked in the field and shown on engineered drawings. Reference points to be left in place for “As-Built” control and Ministry of Forest field checks.
4. Original estimates must follow the CEM were applicable.
5. CEM cost prevails unless Time Card methodology is adhered to and summarized as per the Machine Hours Summary From Time Cards and CEF form attached.

NOTE: *Inputs in the CEF can only be revised once and this can occur only after construction is completed. This ability is to allow for unforeseeable major changes from the original estimate at appraisal, it is not for as built revisions.*

NOTE: *Tabular drainage (bridges and culverts) structures are all found costs, with the only allowable add-on cost estimate being ‘barging’ for permanent bridges.*

Barging Cost

As per section 4.3.2.2.2 of the CAM, barging of permanent bridge is an acceptable CEF cost estimate to Table 4-5: Permanent/Portable Bridge Cost Estimates.

Engineering Cost

The cost for design and engineering is only allowed as a separate cost for permanent bridges that exceed 30 metres in length or that have multiple spans. No additions or deletions to the bridge cost estimates (other than barging) are permitted where the bridge is less than 30 metres in length. Those less than 30 metres in length have all found costs in the Tabular Bridge cost estimate

Certification Cost

Projects listed on page iv in Table 1: Determining Type of Cost Estimate Method that qualify for detailed engineering estimates (either CEM or CEF) and that require certification by the *Forest Practices Code of British Columbia Act*, may be cost estimated using a CEF. Certification costs are not an acceptable CEF cost estimate if they are for company staff or contractors on long term (one year or more) or renewable shorter length contracts.

Contract Supervision Cost

The cost for supervision is permissible only in conjunction with certification requirements and only for contracted supervision. The contract supervision staff must not be on long term contract (one year or more) or renewable shorter length contracts.

NOTE: *Lump sum entry of information for a project on a CEF is permissible if the project invoice clearly states what is being cost estimated and the invoice must be attached to the CEF.*

**SIGNIFICANT DIGIT REQUIREMENTS
FOR CALCULATING THE
COST ESTIMATE METHODOLOGY**

Significant Digits

To improve appraisal submissions consistency and efficiency the following directions on calculating Cost Estimate Methodology must be followed. The use of different levels of significant digits can result in large variation depending upon the sensitivity of the input variable or resultant.

A significant digit is the number of spaces to the right of the decimal that is allowed to be carried during calculation and as the result of a calculation.

Example:

312	No significant digits or zero significant digits
312.2	One significant digit
312.16	Two significant digits
312.158	Three significant digits

'Road Reconstruction Form'

General

	Measurement Type	Significant Digits	Example
Section Length	kilometres	3	0.451 km
Uphill Sideslope	percent	0	37%
Construction Category		0	2
Total Cost for a Kilometre (Subgrade & Surfacing)	\$	0	\$1,545
Cost for the Section	\$/section	0	\$4,545
Total Cost	\$	0	\$5,250

Subgrade

	Measurement Type	Significant Digits	Example
Remaining Road Width (Cases 1 - 3)	metres	1	2.7 m
Cost Factor Calculations & Resultants		2	0.67
Unit Cost Calculations		2	3.62
Unit Cost Resultants	\$/ m ³	2	7.61 \$/m ³

Surfacing

	Measurement Type	Significant Digits	Example
Surfacing Depth (Additional Loose Stabilizing Material Depth)	metres	1	0.5 m
Haul Distance	kilometres	2	1.15 km
Unit Cost (Truck Distance X Constant) Calculations		3	0.685
Unit Cost (CAM rates) Calculations	\$/m ³	2	5.45 \$/m ³
Unit Cost Resultant	\$	0	\$2,360

'End Haul Form,'

General

	Measurement Type	Significant Digits	Example
Section Length	kilometres	2	0.451 km
Total Cost for a Kilometre (Subgrade & Surfacing)	\$	0	\$1,545
Cost for the Section	\$/section	0	\$4,545
Total Cost	\$	0	\$5,250

Subgrade

	Measurement Type	Significant Digits	Example
Uphill Sideslope	percent	0	37%
Construction Category		0	2
Haul Distance	kilometres	2	1.15 m
Total End Haul Volume (determined via geotechnical design)	cubic metres	0	450 m ³
Total End Haul Volume Calculations & Resultants	cubic metres	0	450 m ³
Cost Calculations & Resultants	\$/ m ³	0	\$471

Surfacing

	Measurement Type	Significant Digits	Example
Haul Distance	kilometres	2	1.15 m
Unit Cost (Truck Distance X Constant) Calculations		3	0.685
Unit Cost (CAM rates) Calculations	\$/m ³	2	5.45 \$/m ³
Unit Cost Resultant	\$	0	\$2,360

Culverts

	Measurement Type	Significant Digits	Example
Diameter	metres	1	1.2 m
Length	metres	0	14 m
Length Calculation	metres	0	14 m
Cost Calculation & Resultant	\$	0	\$2,360

COST ESTIMATE METHODOLOGY

FORMS

Construction Estimate Methodology paper forms originally in this document in 2001

- **End Haul Form** is now the End Haul (ECAS39) screen in the ECommerce Appraisal System. Input appraisal data elements into this screen for submission and do not provide as an attachment in ECAS.
- **Road Reconstruction Form** is now the Road Reconstruction (ECAS38) screen ECommerce Appraisal System. Input appraisal data elements into this screen for submission and do not provide as an attachment in ECAS.
- **Culvert Worksheet** is an EXCEL spreadsheet that can be found on the Coast Revenue Section Website. Input appraisal data elements into this form and attach in ECAS only as an EXCEL form (i.e. NOT a PDF).
- **Permanent Bridge Structural Repairs Form** is a WORD document that can be found on the Coast Revenue Section Website . Input appraisal data elements into this form and attach in ECAS either as a WORD or a PDF document.
- **Log Bridge Structural Repairs Form** is a WORD document that can be found on the Coast Revenue Section Website as. Input appraisal data elements into this form and attach in ECAS either as a WORD or a PDF document.

It is suggested you remove this page
from your paper copy as

CONSTRUCTION ESTIMATE FORMS

Construction Estimate Form paper version originally in this document in 2001

- **Construction Estimate Form** is a WORD document that can be found on the Coast Revenue Section Website. Input appraisal data elements into this form and attach in ECAS either as a WORD or a PDF document.

- **Time Cards – Machinery & Labour** is a WORD document that can be found on the Coast Revenue Section Website. Input appraisal data elements into this form and attach in ECAS either as a WORD or a PDF document. Use where required.

- **Time Cards – Drilling** is a WORD document that can be found on the Coast Revenue Section Website. Input appraisal data elements into this form and attach in ECAS either as a WORD or a PDF document. Use where required.

- **Machine Hour Summary from Time Cards** is a EXCEL spreadsheet that can be found on the Coast Revenue Section Website. Input appraisal data elements into this form and attach in ECAS either as an EXCEL spreadsheet or a PDF document

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