BC hydro
FOR GENERATIONS

Inter-office memo

To:	Siobhan Jackson	August 14, 2009
From:	Sarah Nathan	
CC:	Andrew Watson	
Subject:	Preliminary GHG emissions estimate from construction materials -- Site C Hydro Project	

Introduction

As part of the Stage 2 study to estimate the GHG emissions from the potential Site C project, Jacques Whitford (now Stantec) developed a preliminary inventory of construction activities and related fuel and electricity consumption rates. Emissions embodied in construction materials were not included. The purpose of this memo is to report results from a subsequent calculation of emissions associated with construction materials that were not included in the preliminary study, and to provide low and high emissions ranges for each material based on material allowance and contingencies. Updated low and high emissions ranges for fuel and electricity were also estimated.

Methods

GHG emission ranges were developed by applying the low and high emission factor values found in available literature to the low and high material quantities received by BC Hydro from Klohn Crippen. Base estimates of material quantities were used to develop the low end of the range, and contingencies were used for the high end of the range. Contingencies were 15% for all materials and fuels, except for copper and stainless steel, for which 50% and 25% contingencies were used respectively, as specified by Klohn Crippen. BC Hydro's estimate of emissions from materials has now been reviewed by Stantec, and recommendations have been implemented.

Results

The results of the estimate suggest that construction emissions, including emissions from fuel and electricity consumption as well as those embodied in construction materials, would range from approximately 743,230 tonnes CO_2e to approximately 1,081,149 tonnes CO_2e. Corresponding emissions intensities, for the production of an average of 4,600 GWh for a minimum of 100 years, are 1.62 tonnes CO_2e/GWh to 2.35 tonnes CO_2e/GWh. Please see the tables appended for detailed material quantities and emissions factors.

Table 1: Materials, emission factors, and total emissions

Material	GHG emission factor, low	GHG emission factor, high	Total GHG, tCO2e, low	Total GHG, tCO2e, high	Emissions factor reference
Cement 0.93		1.25	277,446.90	428,849.38	Low: NREL database High: Wilson, A. 1993.
Fly ash	0	0	0.00	0.00	US EPA 2003.
Steel 2.04		3.3	157,355.40	292,727.33	Low: NREL Database High: Pembina Foundation, 2003.
Stainless steel	3.3 6.8		1,584.00	4,080.00	Meier and Kulcinski, 2000.
Copper 7.446		7.446	7,490.68	11,236.01	Low: Meier and Kulcinski, 2000. High: Norgate et al. 2006
Diesel 0.0027		Na	293,971.46	338,067.18	Stage 2 GHG report
Gasoline 0.0024		Na	5,180.08	5,957.09	Stage 2 GHG report
Electricity	0.02	Na	202.0	232.3	Stage 2 GHG report
TOTAL NA		NA	743,230.52	1,081,14 9.28	NA
Emissions Intensity	NA NA		1.62	2.35	NA

Table 2: Low and High quantities for material inputs

Material	Quantity, low	Quantity, high	units
Cement 298,33	0	343,080	tonnes
Fly ash	99,443	114,359	tonnes
Steel (rebar and carbon steel)	77,135	88,704	tonnes
Stainless steel	480	600	tonnes
Copper 1,006		1,509	tonnes
Diesel 107,18	4,680	123,262,383	L
Gasoline 2,187,44	2	2,515,559	L
Electricity	10,100,000	11,615,000	KWh

References:

Meier and Kulcinski, 2000. Life-Cycle energy cost and GHG emissions for gas turbine power. Energy center of Wisconsin.

National Renewable Energy Laboratory database http://www.nrel.gov/lci/database/default.asp.

Norgate, TE, Jahanshahia, S. and Rankina, WJ. 2006. Assessing the environmental impact of metal production processes. Journal of Cleaner Production 15(8-9): 838-848.

Pembina Foundation, 2003. Life Cycle Evaluation of GHG Emissions and Land Change Related to Selected Power Generation Options in Manitoba.

US EPA, 2003. Background Document for Life-Cycle Greenhouse Gas Emission Factors for Fly Ash Used as a Cement Replacement in Concrete. Available at: http://www.epa.gov/climatechange/wycd/waste/downloads/FlyAsh_11_07.pdf#14

Wilson, A. 1993. Cement and Concrete, Environmental Considerations. US Environmental Building News, 2(2). http://www.buildinggreen.com/auth/article.cfm?fileName=020201b.xml.